Technology Adoption by Emergent Users: A User-Usage Model

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by

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Dedicated to **Mother Padmavati**, the guardian Goddess of Powai.

नमामि पूर्वि मातृके

नमामि देवि कालिके ।

ज्वालामुखि मातेश्वरि

वीणाधरे शुभकारिणि ।।

वन्दे भावितात्मना:

कुलदेवतो नमाम्यहम् ।

नमामि हरहरे प्रभो

अद्वितीयम् असीमितम् ।।

Approval Sheet

This thesis entitled **Technology Adoption by Emergent Users: A User-Usage Model** by Devanuj Kanta Balkrishan (Roll no. 09413003) is approved for the degree of **Doctor of Philosophy**.

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Abstract

We propose a User-Usage model to describe and predict (Technology) Adoption of Information and Communication Technology (ICT) by the users who have been significantly disadvantaged in terms of the capabilities to access, learn and use ICT artefacts and, at the same time, could benefit from them in terms of improvement in quality of life. We have termed this class of users as the 'Emergent Users' (EU) to signify the hope absent in the terms such as 'poor', 'low-literate' et cetera.

We define Technology Adoption as initiation, learning and sustenance of usage. It is well appreciated that ICT could benefit the EUs in many ways, such as improving the access to and the efficiency of education, healthcare and governance; and helping in the livelihood activities. However, an ICT intervention may not reach its potential if Technology Adoption is inadequate. That implies, if we aim to design ICT artefacts that are meaningful for the EUs, we need to study Technology Adoption by them.

The User-Usage model is a two-dimensional categorical matrix. Depending on the user-related factors such as Age, Gender, Prevalence et cetera (the input variables), the 'placement' of a user in the User-Usage model (the output variables) could be decided. The vertical dimension of the model represents the User Types—the archetypical categories of the users based on their usage patterns. There are six User Types. Basic Users do only the tasks that require one or two presses of hardware buttons. Navigators can navigate the menu hierarchies. Text-Inputters can type text. Savers can follow, design and manage the directory structures to save files. Account-Holders can use account based applications to manage online identities and communicate with other accounts. Transactors can buy things online. The User Types are arranged in the increasing order of the ability to deal with complexity (for example, Savers deal with more complex tasks than Basic Users).

The horizontal dimension of the model comprises of the Stages of Usage—the typical interaction behaviours. The Stages of Usage are acquired as part of a user's journey in acquiring the skills for using an artefact. The journeys are interspersed with the barriers that a user may face. These are four in number—the barrier of non-exposure to ICT, the barrier of task-complexity avoidance, the barrier of low frequency of usage and the barrier of inability to form adequate mental models. A Stage of Usage lies between two adjacent barriers. The five Stages of Usage resulting from the barriers are Unexposed, Novice (cannot deal with task complexity), Rote-Learner (memorise task as a recipe or routine), Fluent (same as Rote Learners but have done tasks a large number of times, so exhibit better command) and Competent (have adequate mental models, so can put their knowledge to new situations which the others can not.) The Stages of Usage are also arranged in the increasing order of the difficulty of the barriers.

The placement on the User-Usage model would inform about Technology Adoption potential of a user both quantitatively and qualitatively. As both the dimensions are ordinal, two users could be compared. At the same time, every User Type and Stage of Usage would also inform how would a user interact with the ICT artefacts of various kinds.

The rules of the placement of the user on the User-Usage model were arrived through a quantitative study involving 85 rural and semi-urban users across India. Many user-related factors that were identified through the literature and the contextual user studies (that were done as part of the research) were operationalised. The relationships between the factors and the User Types and the Stages of Usage were determined statistically.

Age, Education level, Gender, Proactiveness (motivation to use ICT for its own sake) and Time (total time since the first use of ICT) have been found to be the significant factors in determining both User Types and Stages of Usage. The fact that these are readily available for a population in the form of the census data helps to make a prediction about the number of people belonging to the different User Types and Stage of Usage. We have demonstrated that by using the data from the 2011 census.

We have also used the User-Usage model as an analytical lens to understand the widespread Adoption of WhatsApp among the EUs in India. We have found that WhatsApp has challenged the User-Usage model by helping the Navigators among the EUs accomplish complex tasks of managing an ‘Account’. These tasks include establishing social online identities, managing off-line communication, sharing and forwarding content, and creating and joining groups. At the same time, we have also realised that WhatsApp acts like an exception to the rule because it is only through design-innovation that the barriers posed by the complex tasks needed to operate accounts could be circumvented by the EUs. Through this exercise we were able to identify the design principles which could facilitate the EUs overcome the barriers of Technology Adoption.

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Chapter 1

Introduction

1.1 Introduction

This is a discussion about artefacts. It is woven around three important aspects—who are the users of the artefacts, how they are used and how their design fits the users' needs and contexts. Doing so is required because user, usage and design are essential and inseparable aspects of an artefact. A definition may help see how–

> An *artefact* is an object that has been *design*ed so that it could be *use*d by a *user*[1].

Expressed in detail, this work is about Information and Communication Technology(ICT) artefacts. They are commonly called 'digital technologies'[2]. Also, it is about the people—whom we wish to address as the 'Emergent Users' (EU)—who have been traditionally disadvantaged by the 'digital divide' (the gap that bars many people from benefiting from the ICTs). Further, it is about how the Emergent Users use and interact with ICT artefacts. Finally, and most importantly, it is about how to help design meaningful ICT products for the EUs.

The term 'emergent' signifies the people who, until the start of the 21st century, were not considered to be the users of ICTs, and therefore their needs and contexts were long

[1] Dysfunctional artefacts do exist but as novelties

[2] Today mobile phones are the dominant forms of ICTs used by people.

neglected (Section 2.1). Often low-literate and having less income, this group is now 'emerging', as an important user segment[3], owing to the factors such as increased availability and affordability of ICT artefacts. The reason for the 'emergence', a profound one, lies in the promise that ICTs hold for human development. Interestingly and paradoxically, the factors responsible for the non-usage of ICTs could be alleviated by ICTs themselves, if they are designed meaningfully in response to the users' needs, capabilities and contexts. In such a scenario, where a long-neglected group of users is emerging to claim its dues, generating knowledge for the design of ICT artefacts is important.

As the scope, we would discuss only one type of ICT artefacts—the mobile phone. We have also restricted our definition of an Emergent User to be the one who lives in a rural or a semi-urban part of India, is between 25 to 55 years of age, and has acquired less than or equal to 12 years of education. A detailed description of the scope is provided in Section 2.2.

1.2 Design of ICTs for the Emergent Users

ICTs can potentially benefit the EUs (see Section 2.3). It requires that the designs are appropriate with respect to their needs, capabilities and contexts. However, designing *meaningful* ICTs for the EUs (ICT4EU) has been found to be difficult. This is evident in high failure rates of Information and Communication Technologies for Development (ICTD)[4] projects. The extent of failure could be judged from a survey by Dodson et al. [2012], where they have analysed 40 papers published in Information Technologies & International Development (ITID) between 2003 and 2010. They have found that 70% of them have reported some kind of failure, that is, instances where 'the outcome of...an ICTD initiative has failed to meet some or all of its objectives.' The same is also reflected in a World Bank report (Group [2011]) about its own ICTD initiatives where it is stated that:

[3] A detailed discussion of the emergent users, their ICT usage and the related issues is provided in section 2.1

[4] ICTD and ICT4EU are equivalent as we will discuss in chapter 2. However, for the sake of convention, we will use the former

> The high failure rate of ICT projects in both private and public sector projects and across developed and developing countries suggest that these projects are inherently risky and challenging.

The above mentioned World Bank report also lists the reasons of failure. It suggests that organizational and political pressure, improper understanding of target users and failure to address real problems & needs are major contributors. Heeks [2002] describes the underlying mechanisms of such failures. He points out that the contexts in which designers are situated differs from those of the users, and therefore, understanding of the actual users' reality remains inadequate and leads to a 'design-actuality' gap. The same insight resonates with Dodson et al. [2012] when they inform that:

> The majority of research articles we sampled displayed a top-down, push approach to development, some of which overlooked local context.

Another insight is provided by Tongia and Subrahmanian [2006]. According to them, failures result because of the complexity of the underlying space defined by four 'C's– Computers, Connectivity, Content and (Human) Capacity. The last one, capacity, is more difficult to deal with and requires that different stakeholders work together. Exacerbated by information asymmetries and ill-understood social contexts, design of ICTD becomes a 'wicked problem'. In such scenarios, the top-down approaches might fail. As a remedy, they suggest that 'design' based approaches, which give primacy to issues like (identification of) the stakeholders and their needs, alignment of the incentives of the various stakeholders and their participation in design & measurement of success and sustainability should be used.

In view of the above, it is worthwhile to generate knowledge for the use of ICT Design practitioners[5] which could help them design ICT artefacts that respond well to the needs, capabilities and contexts of the EUs. Developing a model to describe and predict ICT usage is a good choice. Accordingly, this work aims to *develop a model that may describe and predict ICT usage by the EUs and subsequently help in designing meaningful ICT artefacts for them.*

[5] Frayling [1993] terms the approach as 'Research for Design'.

1.3 Modelling/Theorising ICT Usage by the Emergent Users

Why develop a model? Would not prevalent praxial methods, such as user studies, suffice for making meaningful ICT artefacts for the EUs? How does modelling substitute or complement these methods?

Development of models for ICT usage by the EUs is a worthy endeavour. ICT4EU systems are complex in nature as they consist of many components and interrelationships. They could not be comprehended fully *in-situ*. It is where the models have a role. Though the models cannot take place of methods like user studies, they can complement them in the manner described in the next few paragraphs.

Models being digested, abstracted, compact and general representations of complex systems (see Birta and Arbez [2013]; Jørgensen and Bendoricchio [2001]) are suited for designing ICTD. As simplification-tools, models do not carry a *complete* picture of a reality. Often acting as lenses (in accordance to questions sought), they highlight some aspects of the reality while suppressing some other. Additionally, they are operationalisable in some sense, that is, they are able to answer 'what-if' type of questions. Models capture the dynamics of an underlying system in a way which makes them amenable to project or anticipate the system's behaviour in controlled conditions. In short, simplified representation of a problem-space, description and prediction of a system's behaviour are the ways in which models could help the design of ICT systems.

Models (and underlying theories) can aid ICTD design at various points. During exploratory phases, by highlighting relevant issues they can help in forming broad directions of inquiry. During analysis, they can provide various perspectives for looking at the collected data. Later, they can help design activity by allowing adjustment of various parameters in order to see how they affect the shape of the potential system.

We need to also emphasise the fact that models are abridged representations of theories. Building a new model invariably accompanies building up or summarising theories. Theories are important not only as a vehicle of knowledge expansion but also as aides to praxis. Like any good theory, as suggested by Halverson [2002], we would like ours to have the following powers:

- *Rhetorical* power. Theories map many correlated and relevant concepts and bind them together as meta-concepts that could be expounded out when needed. The precision of the meanings and the tightness of the semantic architecture of the underlying concepts ensure that these meta-concepts could be communicated in an abstract but unambiguous manner. To quote the author:

  > Theory should help us talk about the world by naming important aspects of the conceptual structure and how it maps to the real world. This is both how we describe things to ourselves and how we communicate about it to others. Further, it should help us persuade others that our view is correct.

  Any complex practice like Designing ICT4EU requires comprehension and communication of complex phenomena. This is where the binding ability of theories helps. For example, the word EU binds a complex set of issues from a particular perspective (as explained and correlated in section 2.1 in chapter 2). Henceforth, the term 'EU' will act as a vehicle for these issues whenever it is used in textual or verbal communication. In case the term fails to convey its own meaning adequately, a reference to the source (such as this work) could be easily made in order to expound it. That means, people could use this term without the need to explain the underlying issues or the risk of being ambiguous.

- *Descriptive* power. Because of the rigour that goes into theory building, theories can explain and define many phenomena and their relationships in a comprehensive manner. It is not easy to make sense of a reality in a single go, nor is it needed. Theories help in revealing the underlying order by highlighting, from a particular perspective and in an easily comprehensible manner, *only* the relevant issues and their causal relationships. For example, a theory informing the design of ICT4EU from a purely cognitive perspective would be concerned with the issues of cognition and the underlying reasons. While doing so, it will place the concepts and their relationship into a simple 'framework'. In this way, it will give a limited but a comprehensible picture of the reality.

- *Inferential* power. Theories are developed by studying 'networks of causalities'–the complex interconnected network of causes and effects of real phenomena. Therefore, if they are provided with hypothetical causes, they can predict the potential effects.

- *Application* power. Theories are helpful when they could be used to solve or analyse a situation. Transformation of theories into models may bring out their application power.

1.4 Human-Computer Interaction

Human-Computer Interaction (HCI), as a domain of study and practice, concerns with the interaction between an ICT artefact and a human user. A prime concern of HCI is enhancing the interaction between users, who would belong to a large range, and ICT, which is complex, varied and changes rapidly (Jacko [2012]). The practitioners of HCI strive to enhance the interaction using many principles (Kim [2015]), such as reducing the cognitive load, understanding a user's task and the goals to be fulfilled by the tasks, building adequate conceptual models (the way a user would conceptualise an artefact), aiding the learnability.

We are concerned with many of these principles as they directly affect usage, thus affecting Technology Adoption. In other words, this work approaches the issue of Technology Adoption from an HCI perspective. However, many of these principles have evolved in the domain of the non-emergent users of ICT and therefore need adaptation or reformulation according to the emergent contexts. This is the concern of a specific domain called Human Computer Interaction for Development (HCI4D), which has been dealt with in detail in Section 2.4.4, (after we have discussed development).

1.5 Usage

As has been initiated in the introduction, this work revolves around the binary aspect of the EUs and the ICTs. In simpler terms, the two are 'User' and 'Artefact'. As discussed in section 1.1, the relation between the two is defined by another term–'Usage'[6]. Therefore, the relevant statement to start with is:

The EUs use ICTs

In order to convert this statement into an enquiry, we need to add interrogative qualifiers. This results in the question:

How and why the EUs use ICTs?

This is the central question for this work. It encompasses User, Artefact and Usage. (*cf.*) Section 1.1)

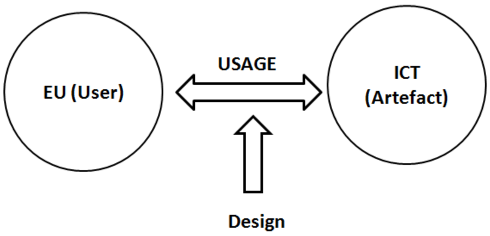

Figure 1.1: The relationship between EU and ICT is defined by Usage, which is shaped by Design.

As design practitioners, we are concerned with the *usage* of an artefact. It is pertinent to point out that 'usage' is not a standalone concept. Its meaning is enmeshed within a larger scheme of things. On examining it at a basic level it signifies a human action (Section 4.2.1). However, actions do not occur in isolation. They are directed towards achieving some goals which themselves reside in the larger human context where an individual plays her economic, social and political roles.

The word 'usage' can be understood in two ways—by focussing on the short-term context, and on the long-term. In the short-term case, it will be like, *"He used a screwdriver to open a case which he found difficult otherwise."*. Here we do not know if the person often used a screwdriver, or had picked it up for that instance only. We also do not know if he would use it again. This statement might have resulted from just an observation of an operation which might have been isolated from the other instances of using a screwdriver. The long-term case is exemplified as, *"He uses a screwdriver for many myriad things that he comes across daily in his work"*. In this case, we are talking about a habit or a pattern

[6]'Ownership' is another connotation, but the term 'Usage' is used to imply ownership too.

that has been performed over a large span of time.

From the above discussion, it is evident that 'use' could be divided into sporadic and sustained modes. The former could be further divided into one-time and infrequent usage. There are situations where sporadic usage can help an Emergent User meet her objectives. For example, a housewife might visit an ATM infrequently due to the fact that her husband normally looks after the financial aspects of the household. Or, for example, one may need to use a coin-operated automatic ticket vending machine (ATVM) on a railway station in extreme emergencies. However, the condition of sustenance is important. It is because if an artefact has to serve any useful purpose, dexterity and expertise are needed, which are achieved only after *sustained* usage. Sporadic usage may give way to long-term usage, but only if a user builds up the engagement. The habits would not be built up in a day, they will happen only if a person continuously engages in a given behaviour over, let us say, months.

For the purpose of this research, studying long time usage will demonstrate the efficacy of usage. A user who is able to use an artefact to its fullest capacity would be able to a lot in terms of meeting his life-goals (for example, those related to livelihood) in comparison to another who is not. It should be noted that users will differ on this capability. Some users would be putting their expertise to various situations in a creative manner, while others would be struggling to accomplish basic tasks. There are likely to be many gradations amongst the two extremes and studying long time usage would inform about the range of expertise.

Nevertheless, studying first time usage is equally important for examining patterns over the long term. This is because, first time usage encompasses many aspects related to capabilities and constraints, and intentions and motivation of an Emergent User. As the first time-behaviour is a critical juncture, it signifies some sort of a struggle–called a 'duel' by Tarde (which we shall see in detail in section 3.2) that happens between the choices available at that point of time. A user might deliberate whether to go to the bank physically to withdraw money, or to start using an ATM card after she realises that the crowd of the customers has not waned away even after the 20th of the month. Another user might try to overcome his inability to type, read, or assign mnemonics on a mobile phone by finding some way to remember contacts (like remembering the visual profiles of the text). Apart from long deliberations and struggle, there could also be moments of recognition as well as answers to the quests related to some long felt needs. There could be a businessman who might have recognised how an ATM card could save his time. Or, an illiterate person who would have tried to find from friends if there was a way to save contacts using 'pictures'. These underlying reasons, whether deliberations, recognition or quests, which end up in a user actually deciding to *initiate* using an artefact are termed as 'triggers' (discussed in section 4.2.1 and 6.1) by us. To understand the concept of a trigger is to ask–"What had happened when you first picked up...?", or "Why did you start...?" Triggers are, typically, products of situations where many factors line up together to compel a user towards initiating the usage of an ICT artefact. For example, the recognition of an ATM as a time-saving device would have come after a few instances of loss due to time wastage. The need for taking pictures would have come after the birth of a child.

1.6 Technology Adoption and the Emergent Users

With these two things—initiation and sustenance—in focus, we introduce the terms Technology Adoption and Technology Acceptance. The first word comes from "Technology Acceptance Model", a highly influential work from Davis et al. [1992a]. In this work, acceptance is not defined explicitly. Nevertheless, it is encapsulated in the objective which is to predict the motivation of the users to use a proposed information system. The second term is from "Technology Adoption Lifecycle" proposed by Moore [2002]. Here too, the word 'adoption' is not detailed out but forms the core theme as is shown by the questions like–"the [electric] cars...are quieter and better for the environment...When are you going to buy one?" (p7)–and its many answers, like, "When I have seen electric cars prove themselves..." Both the authors use the terms Acceptance and Adoption interchangeably, and we too shall treat them at par. However, we will prefer the term "Technology Adoption".

There are a few authors, who have defined Adoption/Acceptance explicitly. For example, in Dillon and Morris [1996], it is "the demonstrable willingness...employ information technology for the tasks it is designed to support." In the work of Beal and Bohlen [1957], adoption is characterised by "...continued use of the idea..., and...satisfaction with..."

In view of the above, we would define Technology Adoption as the following:

> *Technology Adoption is a collection of behavioural states resulting from a user's positive intention to start using a technology for accomplishing a task that fulfils some of his objectives; the motivation to put an effort in learning it; once learnt, sustaining its use over a sufficiently large span of time; and finally achieving mastery with respect to usage.*

We would like to emphasise that our definition of Technology Adoption considers usage—goal-oriented behaviour of a user directed towards an artefact—to be central. However, it focusses on three specific aspects of usage–initiation, learning and sustenance.

Having defined Technology Adoption, we need to ask—*Why studying Technology Adoption is important in EU contexts?* The answer lies in the fact that the discourse of ICT4EU embeds in itself the discourse of (human) development. Consider the definition of the EUs. As we have stated earlier, the EUs are the ones who have faced barriers in using ICTs. These barriers have stemmed from their low buying capacities which have hampered their access to devices, low exposure to formal knowledge affecting their ability to use them and low political power which has rendered them insignificant users of technology. Then, we should also look at the promises which ICTs hold for the EUs. ICTs can help the EUs in terms of livelihood, education, civic participation and a plethora of aspects that can help them expand their choices. Some ways it could happen in is through the facilitation of banking, education, travel, & healthcare, and ease of access to the governments and the institutions. It is pertinent to note here that ICTs reduce costs of service delivery very much like the industrial revolution had reduced the costs of production and lowered the barriers against access to tools and consumable objects. As discussed in detail in section 2.4.2, access to services and their fast and efficient delivery is a critical component in development. It is where ICTs have an important role. In simpler words, discussing ICT4EU is actually a discussion on the issues pertaining to poverty, education, civic participation, livelihood et cetera, which are nothing but the issues of development. It should be clearer by looking at a classical perspective on development. For example, UNDP [2017] states that the three objectives of development are greater well-being, more freedom to live a life one values and an expanded set of choices. Therefore, ICT4EUs is essentially synonymous with ICT for Development, though we would treat the EUs as a locus of analysis (which we rationalise in section 2.1 in chapter 2). Now, if the ICTs have to be effective in the agenda of development, then they not only need to be well engineered but also be effectively used. Whether it is an application for finding market prices or a platform to sell crafts, the most effective case would be when the ultimate beneficiary uses an ICT artefact with proficiency and on her own. Any short-term, interrupted or delegated usage will fall short of an ICT artefact's actual potential, and its effective contribution towards human development. A young housewife would benefit better regarding her children's health if she could find information on her own and not by requesting someone else in the family. Or, a farmer would benefit more if he could gather weather information on the go and not by being dependent on another person. This shows us how Technology Adoption is an important issue to discuss if we are aiming at designing meaningful ICT4EU. A detailed discussion on this could be found in section 2.4 in chapter 2.

We also need to ask, '*What are the challenges involved in the study of Technology Adoption by the Emergent Users?'*. Firstly, as we shall see in section 2.1 in chapter 2, characterising an EUs is a challenge. A large number of users could qualify as EU depending upon the different ways they had been barred from ICT usage. Therefore, any study on technology adoption by the EUs has to first define its population. Subsequently, one needs to examine the constructs that gave rise to the barriers, or helped them cross the barriers. One should also study the effect of these constructs on behaviours related to usage, learning and access to technology. Identification of these affecting constructs and the resulting behaviours can only be done in the users' contexts and through first-hand data collection. Much of the existing work on Technology Adoption is situated in the contexts of the non-Emergent Users of ICTs and might not be adequate for the EUs. Once the affecting constructs and the resulting behaviours are identified, their various connections need to be identified and understood. Subsequent to that, a synthetic understanding could be built in the form of a model (It has been attempted. Our model is briefly explained in the next section and in detail in Chapter 6).

Doing all of the above would need lenses which could be loaned from the existing knowledge of Human-Computer Interaction (HCI) and other fields. The existing literature on Technology Adoption would also help in the synthesis. It will also be required to study the users in their contexts. Our next three chapters are aimed at collecting the lenses. Chapter 3 surveys the Technology Adoption literature to understand how others have analysed and synthesised the problems, albeit in different contexts and from different viewpoints. Chapter 4 aims at understanding theoretical concepts that might help in understanding the connections between the affecting constructs and the user behaviour. Some of these concepts are covered in the subsequent chapter, that is Chapter 5, where they are embedded contextually in an analysis of the field studies which were done to identify the affecting constructs and the behaviours themselves.

1.7 The Motivation for the Research

From our practice of design and construction of ICT artefacts, we have realised that some users are better at handling higher levels of complexity encountered while using ICTs as compared to the others. We have arrived at the following conclusions:

- User populations are not homogeneous.
- Different users have different levels of capability to handle ICT.
- A user's ability to achieve a goal depends upon her/his capability to handle ICT artefacts.
- The capability to handle an ICT artefact depends on its design.
- The capability to handle a particular design (of ICT artefacts) by a user probably depends upon the user's characteristics.
- The usage behaviour with respect to a given ICT artefact will depend on the user's capabilities and therefore on her/his characteristics.
- The usage behaviour may evolve over time. However, that too is dependent on the user's capabilities and the given design.

- Design can help the user achieve her/his goals provided it is in done in accordance to her/his capabilities.

ICTs help the EUs (Section 2.4.2). The benefits of ICT need to reach the EUs more effectively. Design is a critical component in this endeavour (Section 1.2). However, designing for the EUs is a difficult affair owing to the reasons discussed in Section 1.6. How do we design meaningful ICT artefacts for the EUs? In fact, what defines 'meaningfulness'? We have discussed in Section 1.6 that for an artefact to be effective in its purpose, it needs to be 'adopted' well. This implies, in order to design better, we have to understand the usage. Usage, being the relationship between the user and the artefact, is embedded in its context. For the EU contexts, the issues pertaining to ICT usage may be very different as compared to the non-Emergent Users' context, for which a large repertoire of knowledge exists. Therefore, our aim is to investigate in what manner the EUs, from a given context, use ICT artefacts. This involves, an examination of the constructs that may affect, the triggers for, and the barriers against Technology Adoption. With that understanding we have envisaged to come up with a tool (a methodology, model or framework) that could help in analysing ICT usage by the EUs in a given context and inform the design response.

The observations mentioned above have provided us with a starting point. When we look them from the perspectives of the contexts of EUs, they become more pronounced. The contexts of the EUs are not understood to the extent of the non-Emergent Users. The context themselves are various, owing to the social and cultural heterogeneity of the EUs. In that case, it becomes difficult to seek in what manner users from a particular EU population would differ from another. Further, the (in)capabilities of the EUs may be different from the non-Emergent Users, who have been the focus of ICT design. This would require a fresh assessment, or at least a re-assessment, of the user-capabilities within every EU context.

1.8 The Objectives of the Research

We aim to investigate ICT Adoption by EUs in their context. As there could be many contexts, we would choose one. An immediate context is that of the users in rural and semi-urban India. A *contextual investigation* would entail visiting the users in their place of living and working in order to 'imbibe' the knowledge pertaining to Technology Adoption. It will help us understand how Technology Adoption by the EUs differs from that by the non-EUs.

The knowledge gathered through contextual investigation and other sources would inform us about the reasons for adoption and non-adoption of ICT and the manner in which adoption happens. It will help us identify the *constructs* that affect Technology Adoption by the EUs. It will also help identify the *triggers* for the initiation of usage, and the *barriers* that hinder Technology Adoption.

We also aim to describe and operationalise various levels and types of Technology Adoption. Instead of stating whether or not a technology has been adapted successfully, we would like to inform *to what extent* it has been and provide *the description for the usage behaviour* pertaining to each of the level/type. The descriptions would constitute a model. Each of the descriptions would inform about the usage behaviour of a user belonging to a particular level/type.

We aim to identify the constructs that affect Technology Adoption by the EUs. We also aim to examine the role of the identified constructs in deciding a user's probability of belonging to a level/type and describing/predicting her/his usage behaviour. Both the constructs and the levels/types will be operationalised. We also aim to examine the significance of the various constructs.

We also aim to apply the model to analyse a given design that has been successfully adopted by the EUs. We would derive design principles from the analysis.

1.9 Method

Figure 1.2 shows the method followed during the course of the research work:

1. As practitioners of ICT design, we had some idea regarding Technology Adoption. We have enlisted our initial understanding of the issues in Section1.7

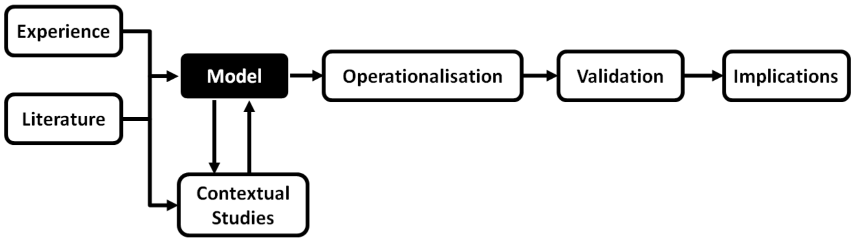

Figure 1.2: Workflow of the Thesis

2. We visited the existing literature (Chapter 3) pertaining to Technology Adoption, which made us aware of the issues pertaining to Technology Adoption from different perspectives. It also made aware of some of the constructs that we used to build the model.

3. An additional literature study was done to understand the general issues pertaining to ICT usage by users. It included topics like tasks, mental models and skill acquisition (Chapter 4).

4. As Technology Adoption by Emergent User is a unique domain, we wanted to explore the underlying issues. We conducted three qualitative studies, which provided us with additional constructs for the model (Chapter 5). Additional literature was utilised during the analysis of the studies. Both gaining and contributing, the User-Usage model evolved simultaneously with the studies.

5. The User-Usage model was developed (Chapter 6).

6. The model was quantified by operationalising the constructs gained through literature and the field studies (Chapter 7).

7. The model was validated by using it to explain the successful adoption of WhatsApp (Chapter 8).

1.10 The User-Usage Model

The primary contribution of this work is the User-Usage model (U2 Model), which is schematically shown in figure 1.3 and is expanded in Chapter 6. Based on the premise that user-related constructs define usage behaviour, it addresses the issues related to Technology Adoption by the Emergent Users while keeping sight of the discussion in Section 1.8.

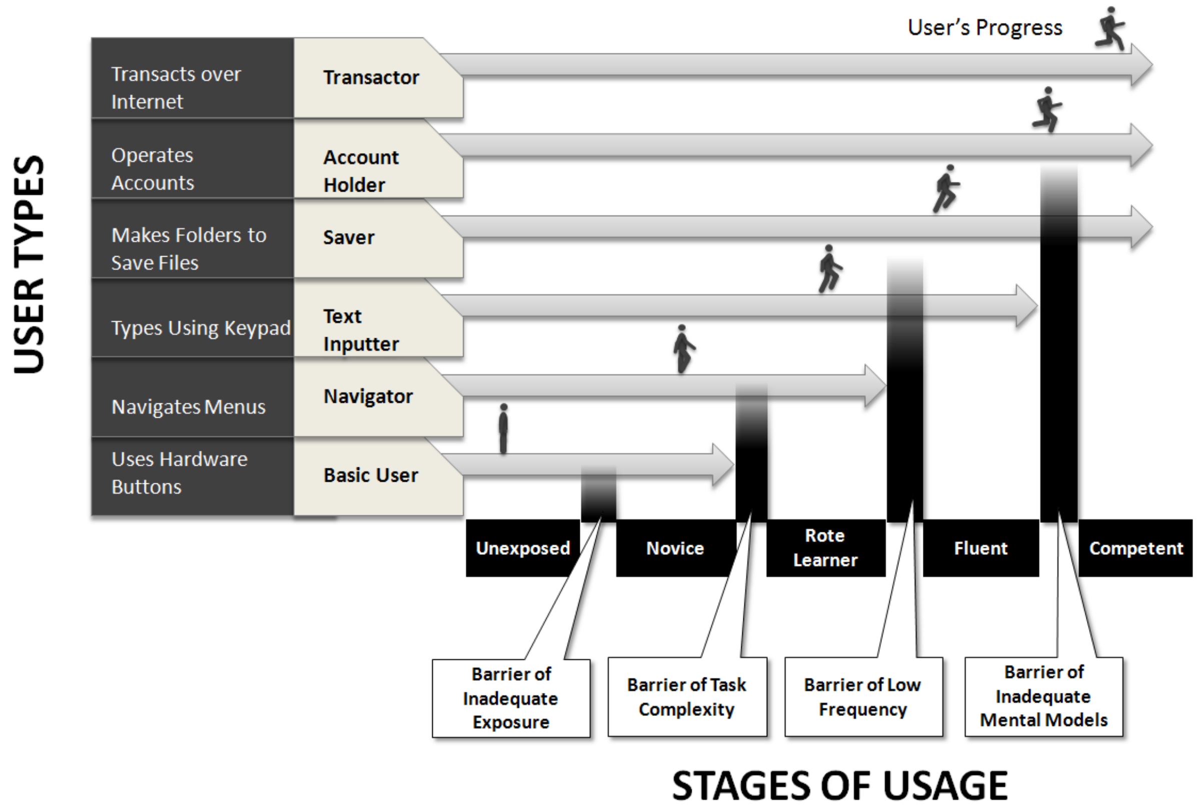

Figure 1.3: The User Usage Model

The various User Types, the archetypical categories of users based on their usage-patterns, are shown on the vertical axis.

Stages of Usage, typical interaction-behaviours, are shown on the horizontal axis.

The Stages are acquired as part of a user's journey in acquiring adeptness at using an artefact. The journeys, which could range from minutes to years, are interspersed with barriers which a user may face. The barriers divide the progress into Stages of Usage. The resistances of the barriers vary from one User Type to another. Depending upon user-related factors such as Age, Gender, Education level et cetera, a user's User Type and Stage of Usage could be decided. Both together would inform about the extent and manner of Technology Adoption.

We conducted systemic qualitative studies (described in chapter 5) to identify the user types, the barriers and the stages. We detail out the model itself in chapter 6. We also quantified the model (described in chapter 7). The model was validated by using it to predict the distribution of various User Types and Stages of Usage for a portion of the Indian population, and by analysing the widespread adoption of Whatsapp in India in 2015-16.

1.11 The Organisation of the Thesis

The chapter wise break up of the thesis is given below:

1.11.1 Chapter 1: Emergent Users and Related Issues

We have provided a working definition of the Emergent Users in this chapter. In this effort, we have rationalised our use of this term over traditional term such as 'bottom of the pyramid' (Prahalad [2006]) or 'tech-(un)savvy'. This is followed by a description of ICT and how it differs from other forms of technology. We also describe how ICTs have a positive role to play in human development, and how they are relevant to the EUs.

1.11.2 Chapter 2, 3 and 4: Literature

We have visited three types of literature. The first one is about Technology Adoption research (covered in Chapter 3). It includes Technology Acceptance Model by Davis [1986] and Diffusion of Innovation by Rogers [1962]. The second set of literature (covered in Chapter 4) contains general issues regarding usage such as tasks, mental models and skill acquisition The third type of literature, pertaining to the particular issues related to Technology Usage by the EUs, is embedded in Chapter 5 that is primarily about the field studies to explore the same issues.

1.11.3 Chapter 5: Field Studies

In our attempt to search for the issues related to ICT usage by the EUs, we had conducted three qualitative studies. This chapter reports the analysis supported by the literature related to the same issues.

1.11.4 Chapter 6: The Model

This chapter describes the User-Usage model in detail.

1.11.5 Chapter 7: Operationalisation of the Model

We have operationalised the User-Usage Model. Many constructs from Chapters 3, 4 and 5 were converted into independent variables. User Type and Stage of Usage were converted into dependent variables. A questionnaire was prepared and the data was collected from 85 users living in rural and semi-rural locations in India. Statistical methods were used to quantitatively define the relationship between the independent and the dependent variables.

1.11.6 Chapter 8: Validation of the Model

We have validated the model by explaining why WhatsApp has become very successful in terms of its adoption by the Emergent Users in India.

1.11.7 Chapter 9: Implications

We have summarised the key insights of this work followed by guidelines for designing ICTs for the EUs.

Chapter 2

Emergent Users and Related Issues

2.1 Defining the Emergent Users

The usage of digital technology has been traditionally limited to a particular set of users —they are likely to reside in urban areas and are more likely to work in offices. They probably live in western countries, or in a 'westernised' setting in an underdeveloped Asian, South American or African country. These users are likely to be globalised—an upper-middle class office going person in Kolkata might have many things in common (like awareness of Hollywood gossip) with a similar person in Kuala Lumpur or Cologne. With a good level of education, income and social power, these users are represented as 'mainstream' in social and political discourse, and that is exactly opposite to what we would describe as the Emergent Users' (EU) descriptions. For the sake of contrast, we define this type of users as the non-Emergent Users (non-EU) of ICTs.

Defining EU, in contrast, is difficult. Firstly, unlike the non-Emergent Users, they are heterogeneous. The response to the question–'*Who is an EU?*' would include a farmer from a rural hamlet as well as a rickshaw puller dwelling in a poor urban settlement. It could include a low-literate high-caste elderly woman as well as a moderately literate low-caste young man. The space occupied by an EU cannot be divided into binaries like urban-rural, rich-poor, uneducated-educated because many combinations of user's traits place barriers against a user's access to technology and the opportunity and capability to master it. A city based young and less-earning person is as disadvantaged as a not-so-poor older person in a remote village away from a major city. While the former might not be able to buy a new phone easily, the latter might not have the need and motivation to do so. The disadvantages accruing from various factors can differ in degree, for example, the urban poor may still have an opportunity to climb up the social ladder, the rural person may not have the motivation.

One way to define an EU would be in terms of user characteristics. It can be conceived in terms of the following probabilities. Thus, the probability of a person being an EU increases with

- Decreasing levels of education
- Decreasing levels of income
- Increasing distances from urban centres.
- Decreasing social and political power.
- Increasing age.
- Decreasing probability of being male.
- Increasing levels of disability.

The list provided above is relevant for India in the second decade of the 21st century with respect to ICT. It is neither exhaustive nor fixed—it cannot be because the criteria for being an Emergent User would change based on place and time. For example, material security may add to the list in case of some cities of the world because that would affect the total time of interaction with ICT artefacts. Still, we could identify a few meta-issues by de-constructing the meanings connoted by the above list. The first issue that becomes apparent is of prevention, hindrance and discrimination. All the factors mentioned above reduce the chances of a person to access, use and learn ICTs. However, why would a person desire to use them? What would be the motivations? A person might be denied access to a gaming console, but in order to qualify as an EU, he should not only stand to benefit personally but also share the potential with a large group of people. Therefore, the other issue is of potential benefit, which could be tangible such as increased income or intangible such as being respected by the others.

From a different perspective, the word 'Emergent' may be applied to all the users. It signifies the gap between a useful technology and the capabilities that help a user own, learn and use it. An urban, educated person with adequate income may also find it difficult to buy or use a particular artefact, which may be of use, at some instance of time. However, the difference lies in *the level of disadvantage*. The likelihood of a young, urban, well-educated man from London of owning and using the latest iPhone may be comparable to that of an aged, low income, uneducated and rural Indian woman of owning and learning a basic mobile phone. However, the former might add to his already high level of advantage, the latter might start with the basic benefits.

As discussed in section 1.2, the connotation of 'emergence' is not far from the term 'socio-economic development'. Both are concerned with the same set of things. The causes of '(non-)emergence' are indeed developmental factors like material poverty, lack of education and social inequality et cetera. However, there is a difference between the two terms. The former has a feeling of hope. It takes its impression from the term *'emerging markets'* which was formed by van Agtmael [2007] (p5), because 'developing economy', the term it replaced, did not consider the possibility that such economies could become fully developed in the future. He states:

> "Third world" suggested stagnation; "Emerging Market" suggested progress, uplift and dynamism.

The same thought applies to the Emergent Users as well. The ones who have been deprived of the fruit of ICT, are now in a position to expect, and perhaps demand their share. One reason is *the democratisation of ICT* as suggested by Friedman [1989]. Economies of scale and advances in semiconductor technologies have ensured that the prices drop continuously (Doms [2005]). In case of India, a large, complex and comparatively free market ensured that mobile phones and networks were made available cheap and wide through a good mix of government policies, product placement, marketing mechanisms, pricing and sales. As the phones came within the reach, there was an increase in the volume of usage as well as the number of individual handsets.

The word ‘emergent’ stands in contrast to other terms like ‘less educated’, ‘rural’, or ‘poor’ because they do not signify optimism, positivity or a sense of dignity. Moreover, as discussed earlier, they signify one aspect at a time. ‘Poor’ connotes material deprivation and has a baggage of (someone in need of) charity. ‘Rural’ separates people geographically and economically. Given the fact that not every urban person has benefited from ICT, this lens leaves many out of the scope. Even the term like ‘bottom of the pyramid’ falls in the same category because it relegates the users (merely) as a market to be made profits from. On the other hand, ‘less educated’ implies dependence on one type of education system–the formal.

With debarment, benefits and hope for the future as meta-issues, we could define the Emergent User (EU) from the point of view of the relationship between the user and technology, and that is,

> *An Emergent User is a person belonging to a group of people that has been significantly disadvantaged in terms of access to a given type of technology, and opportunity, capability and motivation to learn it; who stands to benefit in the long term with respect to various human needs by using that technology; and can expect design and innovation to reduce these disadvantages in its favour in the future.*

2.2 Scoping the Context of the EU

Due to the above-mentioned problems in the definition of an EU space, we need to restrict it in order to do justice to the research. Therefore, we have scoped down both the questions—what are the artefacts we should analyse as well as who are the users? We have focussed primarily on the rural and the semi-urban India. As of 2018, rural India lags behind ICT usage than urban. The teledensity of rural India is still around one-third of that in the urban parts (56% versus 159% according to Telecom Regulatory Authority of India [2018]). The penetration of the Internet is 60% for urban and 20% for rural India (Agarwal [2018] cites the data provided by The Internet & Mobile Association of

India-IAMAI). The number of ATMs in rural India remains 20% of the total (according to Jain and Mervin [2016]). With only 40,000 of them in rural India and the fact that approximately 0.8 billion people, out of a total of 1.2 billion, live in rural India (according to the 2011 census, as reported in Press Trust of India [2013]), the per million people availability of ATM comes to be 48.01 for rural India as compared to 530.50 for urban.

In spite of the difference, the growth of mobile phones in rural India has been spectacular. 2 million mobile phones were added in the month of June 2017 (which was still lesser than the urban addition though). In March 2017, the rural teledensity grew, on a yearly basis, by 10.77% closely chasing the urban 11.55% (Telecom Rgulatory Authority of India [2017]). A greater impact was seen in the mobile Internet which had attained a growth of 60% (year on year, June 2016 according to Neeraj [2016] based on the data provided by The Internet & Mobile Association of India-IAMAI) and had surpassed the growth for urban India. The usage of other ICT artefacts, too, grew in rural India. For example, Notebook and Desktop sales had grown at the rate of 11% and 33% respectively (year on year, in 2015, according to Bhargava [2015]). However, with a base of 0.32 million, that hardly compares to mobile phone growth.

The context of rural and semi-urban India is appropriate to study because ICT provides a hope for overcoming long-standing structural and infrastructural problems. As argued by Sood [2006], rural India is experiencing rapid informationalisation, which holds a hope for overcoming them. This process is primarily led by mobile phone technology, as can be sensed from the data provided in the earlier paragraphs. Mobile phones have become primary movers because, in the end, they are cheaper than many other forms of ICT. In April 2018, a Nokia 105 basic phone was available for INR 929 (USD 14.25). This is about four days of work for an agricultural labourer (on the basis Sharma [2017]). In comparison, the cheapest notebook cost around 10 times of that. In addition to that, mobile phones require minimal infrastructure for their support. They do not need to be connected to a power supply, nor do they occupy a large space. Being portable, they provide more time for interaction and could be owned discretely and exclusively, reducing chances of remitting control due to power dynamics. Therefore, we have focussed on mobile phones.

We have further reduced the scope by focussing on persons who had only completed the higher secondary school. Graduate colleges are more likely to be situated away from rural areas. The quality of the rural schools, too, is not adequate. Deshpande and Banerji [2017] document how low-attendance and dropping out are commonly experienced. Therefore, going to college is a capability in itself and signify that structural (for example, not sending girls away from the village) and economic (for example, inability to pay for fees and books) issues are involved.

We have also restricted the age to be between 25 to 55 years. As much of the data was collected during 2013-2016, a person below this age at that time would have grown with an adequate exposure to ICT. The upper bound was fixed because the age related barriers, as well as high level of unexposure might render the usage to a minimal or non-existent level.

We have also included semi-urban areas because the cities have been growing rapidly and many areas on the fringe of cities abut the rural areas.

2.3 Information and Communications Technology (ICT)

'Information' means facts, or things that could be converted into symbols–words, icons, numbers, gestures, expressions, emotions–that carry shared meanings. 'Communication', on the other hand, means the transfer of information. These are two words with different connotations but their meanings are entwined. Actually, 'Communication' will lose its meaning if there is no information. On the other hand, a piece of information would not be of much use if it is not exchanged amongst people. Thus, it will be appropriate to define ICT as:

> *Any technology that stores, processes, transfers and presents information.*

This definition is not very far from the other definitions. For example:

> Information and communications technologies (ICT) are a diverse set of technological tools and resources used to communicate, and to create, disseminate, store, and manage information. (Blurton [1999])

and,

> ...combination of manufacturing and services industries that capture, transmit and display data and information electronically. (OECD [2002])

Still, the definition of ICT could be problematic if its boundaries are not marked out properly. The term ICT could include many things that do not match its commonly understood meaning. For example, the earliest clay tablets could be considered as ICTs, because they did store information. Many things from the modern times are indeed ICTs. Modern-day newspapers and televisions play their roles as ICTs by storing and disseminating information. One resolution is to fix the limits of the definition in accordance with the commonly understood meaning–the one that points at modern digital devices like mobile phones, tablets and computers that have the following characteristics:

- They require a power source, and therefore an electrical infrastructure, to operate. From this perspective, a newspaper cannot be considered ICT unless it is distributed through a digital device.

- They are programmable, which has serious implications–it divides them clearly into software, the malleable part, and hardware, the physically fixed part. A programmable machine can do many more things than is possible with a non-programmable one. A typewriter produces only text, a gramophone cannot do anything except producing sounds. A mobile phone can do both because both the functionalities could be programmed into it. Thus, ICT artefacts can be made to do a wide variety of tasks simultaneously that the other machines handle only exclusively. Adding new tasks to the repertoire is easy. In fact, instructions in the form of packaged programs can be added or removed by the users themselves. Moreover, as the hardware limits the software to a lesser extent, the complexity of the latter is determined by a programmer's ability to write the programmes. The result of all this is that ICTs are potent and flexible but complex to operate machines.

- They require memory devices. ICTs are good at storing information. The data is in the form of numbers. Any signal that could be converted into electrical energy, could be handled by a computer by converting it into numbers, and back. This

> means, the flexibility and capacity of a computer to store and process various types of data—voice, image, text— is enormous. This gives it an advantage over earlier communication media like newspaper and radio, which could hold limited type and amount of information.

Restricting the definition in the above-mentioned way would keep it close to the commonly understood meaning. For example, digital radio is excluded because though it has communication ability, it does not allow a user to add programs.

2.4 ICT for Emergent Users

As argued earlier in section 2.1, 'development' is latent in ICT4EU. Therefore, we shall attempt to understand what 'development' stands for. Then we shall try to build a case for research in the field of development, and by implication, support for this work. Subsequently, we shall see how ICT helps in development.

2.4.1 What is Development?

To understand development, we take help of various development related objectives, measures and definitions. For instance, Sustainable Development Goals (SDG) by United Nations [2017] pertain to–*Poverty, Hunger, Education, Water & Sanitation, Equality, Health & Well-being, Justice* among 17 different items. On the other hand, Human Development Index (HDI) (in Anand [1994]) uses the following measures–*Health, Education and Standard of Living*. It also takes into account *Gender Equality* and *Income Distribution*. In terms of 'proper' definitions, in the words of Nyerere [1990] (p10), development is, essentially:

> ....a process which enables human beings to realize their potential, build self-confidence, and lead lives of dignity and fulfilment...which frees people from fear of want and exploitation... away from political, economic, or social oppression. Through development, political independence acquires true significance...it is a process of growth, a movement essentially springing from within

the society that is developing.

Sen [2001] provides a very concise definition by considering development as freedom:

> Development can be seen...as a process of real freedoms that people enjoy....development requires the removal of major sources of unfreedom: poverty as well as tyranny, poor economic opportunities as well as systematic social deprivation, neglect of public facilities as well as intolerance or overactivity of repressive states.

From the above-mentioned definitions, we note that development has been envisaged in a holistic manner, in terms of enhancing 'quality of life'. This perspective concerns not only human well being but also pleasure, affluence and realisation of human potential. At a basic level, it means assuring basic requirements of life so that a person lives her life without hindrances. That includes food and shelter. Over that, it means the provision of a set of conditions which enables people to live as 'fuller social persons' [ibid., p15]. These conditions include the guarantee of physical safety (in terms of both security & health care). Finally, it is also about raising human potential in terms of enriching further her own life and others around her. That can be guaranteed by social participation & dignity in terms of self-expression, non-discrimination, freedom of expression and political choice.

Development, expressed as 'quality of life', has an element of hope because it does not merely highlights the human miserabilities but also recognises the potential to get over them. Additionally, it could (and should be) seen as a set of rights. Every human being should not only have a reasonable amount of socio-economic safety but also the right to information and to participate in the civil society (Hunt et al. [2004]). Unless a person is guaranteed these rights, the probability of realising one's potential diminishes greatly. And, indeed, development establishes favourable conditions for them by making it easier to meet the ends–by making voices heard, and by enabling access to the fruits of the modern economy.

A large part of the world's population still does not have many of the above rights. According to WFP [2017], one in nine persons on this planet, 795 million, sleep without food. 17 % of the global adult population is illiterate (UNESCO [2016]). To make matters worse, two out of three of them are women. According to WHO [2016], 1.8 billion people do not have access to clean water

As collective human responsibility, there has been a continuous effort to improve the quality of life. The recognition of the problem was evident as far as in 1948 when the U.S. President Truman spoke about "the people of the world (who) are living in conditions approaching misery." The task has been, nevertheless, complex, and so it has given birth to a scientific understanding of the issues to be tackled. The domain is called Developmental Studies and has been an important research area for more than half a century.

Technology has been always an important component in developmental research and intervention. The confluence of Technology and Development has happened due to a reason which is idealist in nature–it is the optimism that *technology can help development* (for example, see Batchelor et al. [2005]; Duncombe and Heeks [2005]). Institutions, both governmental and non-governmental often include ICT as an important component in their development agenda. This should give way to a more basic question–*why do we want to discuss development?*

A moral position could be taken first. Empathy, a natural human instinct, is an important basis of morality. It makes humans try to reduce the suffering of the others. Poverty is a big contributor to human suffering (for example, Hough [2014]; Bono in Sachs [2006]). It contributes in a major way to the world's disease burden. It is the prime contributor to early deaths especially those of children. It is a big cause of hunger. It is but natural that poverty has remained important on the developmental agenda–it is simply too difficult to not affected by observable poverty.

Even without a moral position, particularly when one is not a potential beneficiary of development, one would be hard-pressed to not ignore the issues of development primarily, because the world is heavily interconnected, and thus a particular individual has a potential of impacting another one. Consider, for instance, the causality between crime and poverty. It is quite often that extreme want pushes a person to satisfy itself in ways which might be injurious to the society at large.

From an economic perspective, development creates an equitable distribution of resources, which in turn, helps an equitable capacity of demand (Serr [2006]). In fact, economists (for example, Gailbraith in Dunn [2010]) suggest that equitable distribution is 'economically highly functional'. This 'functionality' resides in the fact that access to resources builds individual human capabilities. These capabilities, in turn, help an individual play the role of an economic participant better, and that pays back to the economic system.

2.4.2 The Promise of ICTD

As has been discussed many times earlier, ICTs hold a promise to help in the efforts for development. Developmental aspects related to better health, livelihood, safety, well-being and social belongingness could be enhanced by ICTs. ICTs are able to play their developmental roles because of the following reasons:

- Speed: They are fast in the transfer and processing of information, which in turn, gives them an advantage over the non-ICT means. For example, agricultural advice provided by a government office over the phone is much faster than by post. While the former can deliver timely information, the latter could result in a delay which could be detrimental because climate and market prices change within hours and not weeks. The time-saving characteristics of ICTs can avert a lot of situations that may result in high cost on getting out of control. For example, a timely advised first aid instruction provided over the phone could save a life or a timely detected disease, whose image has been sent to a government office through WhatsApp, could save a season's crop.

- Geographical Transcendence: ICTs help offset the disadvantages arising due to geography. A trained rural midwife, who could use her phone to connect to the nearest health care centre that is too far or inaccessible, is as critical to her community as a driver with a car. A critical childbirth may not be helped by the availability of transportation as it would carry both delay and physical discomfort. However, the right information may save lives in such a case.

- Efficient: ICTs reduce human effort (which is often time-consuming) required in dealing with information–either presenting it for somebody's benefit or searching for it. With a non-digital ICT like a newspaper, it becomes difficult for governments to disseminate information. With digital ICTs like SMS and WhatsApp, it becomes much easier. On the beneficiary's side, for example, in a rural setting, a person may find very difficult to avail a government scheme if he does not have access to ICT. In such a case, he would be required to collect fragmented pieces of information. He might try to inquire about the procedures and eligibility from acquaintances. Alternatively, he could go to the nearest governmental office which might be far from his village. This comes with an additional challenge to visit the right office and meet the right person. On the other hand, an executive at an e-kiosk can assist the person by searching the Internet or accessing a government portal. This might not completely remove the burden of searching and finding but can reduce it to a great level.

- Low distribution costs: Many times ICTs turn out to be cheap because reproducing information is cheaper. However, it is to be noted that ICT infrastructure itself could be expensive. Nevertheless, publishing newspaper requires that papers be printed and transported every morning. While a piece of information over the Internet is available to anybody who could connect to it. Using another example, teachers are rare assets. However, a centralised video lecture greatly increases the availability of a teacher to many students.

In the following paragraphs, we describe in detail how these characteristics of ICTs make a long-term developmental impact.

Skills and Asset Development

ICTs increase human capabilities (e.g. education and skills) and assets (such as money and social capital)[1]. The greatest impact of ICTs in terms of assets or capabilities is in the development of human and social capital.

Education is an important example (Tinio [2003]). Firstly, ICTs improve the access to education by reducing the distribution cost and increasing the ease of access. Secondly,

[1] Capabilities and assets themselves are tightly related. A set of capabilities would result in human assets. Assets, in turn, could be used to increase the capabilities.

they improve the quality of learning. Thirdly, they are highly customizable to the individual needs. Fourthly, learning about computers themselves gives an advantage in terms of employment.

Governance, the mechanism through which the vision of state and institutions is translated into action, is another example. Good governance means that resources are fairly distributed, rights are ensured, policies are well implemented, and citizens are allowed to participate in the political process. It is achieved by providing mechanisms for, firstly, decentralisation of power, allowing the citizenry to give effective feedback and debate out their perspectives. ICTs can help good governance (OECD [2002]) in many ways. Given that governance systems are big and complex in size and transaction costs are enormous, ICTs reduce the inefficiencies. Secondly, they improve the quality of service, for instance, by providing an integrated point of contact (such as a web portal). Thirdly, they help in policy effectiveness. Any policy intervention runs with the help of a human organisation. Organisations benefit from the ease of communication, situational awareness and help in decision making, all of which ICTs aid.

(Reduction of) Corruption is an important aspect of governance. It demands a section of its own. Corruption most often hits the poor and the unprivileged the most. Chetwynd et al. [2003] show that corruption hinders economic growth. In particular, it increases the cost to enter into the market, which affects the small entrepreneur adversely. Secondly, it reduces the governance efficiency and affects the timely and adequate provision of services and rights. ICTs can help reduce corruption in multiple ways. Automation inherent in ICTs help reduce the intervention of human agents at many levels, and hence the possibility of personal benefits. Secondly, ICTs help introduce transparency. Transparency is the dissemination of information and the resulting power to question. A website of a department is easier to implement than to provide access to the records or publish in newspapers. Thirdly, ICT data is difficult to manipulate as compared to physical data. It needs a high degree of technical sophistication, which is normally not available. It also becomes easy to trace back any manipulation that might get committed. Fourthly, ICTs not only reduce the barriers of geography but also those of hierarchy. A politician can easily check his Twitter account rather than be available on phone. Nor does he need to go through a pile of mails. The information in form of Tweets does not interrupt his routine,

is easily available on the go and is easy to access and read. Therefore, ICTs provide a good way to report matters to superiors, which in turn improves accountability. Finally, ICTs help increase awareness regarding the peoples' rights and the duties of officials.

ICTs can also help increase the *social capital*. Social capital has been defined as 'features of social organisation, such as civic participation, norms of reciprocity and trust in others that facilitate cooperation for mutual benefit (Putnam [1995]). With the advent of cheap and widely accessible technologies, like mobile phones, it has become easier to maintain familial networks (Zinnbauer [2007]), especially the ones which are spread geographically. That helps because, firstly, the benefits are passed down from those in more advantageous situations to those in lesser ones. Secondly, the sense of belongingness that one feels with one's kith and kin transcends the geography. Another way in which ICTs help social capital is through the development of the communities of practice which help in redistribution of advantages across community lines. For example, people in similar professions (for example, working for the same organisation) or pursuing similar passions (like artists) often connect with each other.

Reducing Vulnerabilities

ICTs help the Emergent Users by reducing vulnerabilities. Their impact can be controlled if they could be identified beforehand. For example, a forthcoming reduction in demand, an impending shortage of raw material or a looming draught–if these are known beforehand, strategies could be devised for dealing with them. Moreover, ICTs provide enough time-window for a response. Examples of these roles are weather services, market price services and SMS broadcasts.

It is necessary to note that the criticality of information enhances vulnerabilities. For example, health care-related communication is specialised as well as critical. One can imagine how a lack of health care can result in increased levels of poverty given that health care is an important aspect for ensuring the productivity of an individual. Moreover, delay in diagnosis and treatment aggravates the situation over time. Also, a bad health in a family saps away energy, money and resources of the other family members as well.

Increasing Efficiencies

The potential of ICTs for development can also be appreciated by treating livelihood activities (for example, agriculture) as enterprises. Any entrepreneurial activity stands on efficient communication and information management. Gaps in communication, lack of accurate and timely information, and geographical distances act as serious impediments against doing business. Additionally, enterprises themselves generate and consume data, which need to be managed. In any enterprise, a good portion of the effort goes in communicating with various stakeholders–labour providers, service providers, sellers and buyers. The information also takes the form of the know-how that must be applied to the process of production itself. Thirdly, the health parameters of an enterprise are also a form of information and need to be monitored. Fourthly, the underlying factor of any enterprise, money, by its nature, needs a fair amount of data processing.

A specific way in which ICTs help in running enterprises is by reducing transaction costs. Transaction cost is the cost of 'using the price mechanism' (Coase [1937]). Price mechanism is the complex phenomenon through which demand and supply arrive at an equilibrium. A seller may quote a higher price while a buyer may insist on a lower. It is a complex system of negotiation, competition and contracts which helps a buyer and a seller come to an agreement which is reflective of the actual worth of a commodity in a free market. Transaction costs include searching for the right prices, arriving at an agreement and enforcement of the agreement. In any market, finding the right buyer and the right price requires a fair amount of effort. Not only accurate information needs to be procured, communication channels are needed for engaging the buyers and the sellers. A major portion of transaction costs for the EUs lies in the searching and dissemination of information. A seller has to search for new customers and a buyer has to find a seller and the right price. Mobile phones have become a tool for searching. Sellers and craftsmen distribute their phone numbers through a network involving other sellers and buyers. Social networks mediated by mobile phones allow a seller to find new buyers. The mobile phone acts as a touch-point for a seller who may not even have a fixed address. In this way, it also reduces the dependence on intermediaries. Mobile phones also help in the engagement between a seller and a customer. The ability to inquire about produce and price, and convenience of ordering helps retain customers on a long-term basis.

2.4.3 Technology Adoption and Development

Given that ICTs hold promise for development, their adoption is important. Of course, technological intervention could be 'pushed' from the top. In that case, the recipient of such an intervention may have to comply. However, if he could not use the technology effectively, there would be breakdowns at the level of interaction between the user and the artefact. This would magnify many times on a larger scale. In those cases, vast efforts would be needed to train the users, or employ persons to assist them. In many cases, the persons assisting the EUs would themselves be the EUs (*who would operate an e-kiosk in a village, except someone in the vicinity of the village itself ?*) which would not improve the situation.

2.4.4 Human-Computer Interaction for Development

As discussed in Section 1.4, this work is concerned with usage but oriented towards the EUs. Therefore, it is situated under the larger umbrella of Human-Computer Interaction for Development (HCI4D), which focusses on particular aspects of ICT. According to Ho et al. [2009], HCI4D is concerned with:

> ....understanding how people and computers interact in developing regions, and on designing systems and products specifically for these contexts.

HCI4D may look like a shared concern between ICTD and HCI. Ho et al. [2009] report that 2006 was an important year when important conferences of both the fields became interested in accommodating each other's issues. This finds a resonance in the work of Dell and Kumar [2016]:

> Some [researchers] described it as HCI research that had a focus on development, low-resource settings, and/or marginalized groups. Others viewed it as ICTD research that carried the distinctive flavour of HCI.

However, it could also be said that HCI4D uniquely focusses on the concerns that are not primary to either field, and could complement both. As discussed in Section 1.2, ICTD would benefit more from focussing on the user and her/his context. On the other hand, '4D', when added to HCI, brings in the constraints posed by the context of the EUs (Dell and Kumar [2016]).

The actual history of HCI4D could be traced back as far as 1982 when the World Center for Computer Science and Human Resources in France attempted to design computers for the developing world. However, it was in the 1990s that HCI4D had gained importance. The early years were dominated by the personal computer (PC). By the late 1990s, the mobile phone had become important.

HCI4D is an amorphous field. It is a domain with varied concerns (Dell and Kumar [2016]; Ho et al. [2009]), owing to the fact that the contexts of its beneficiaries are complex and require efforts to understand. The concerns include:

- Understanding in what ways the contexts of the EUs are different from the non-EU ones.
- Knowing about the constraints that would affect the usage of the ICT artefacts.
- Employability of HCI methods (for studying users, their needs and contexts, designing for them and evaluating the designs) for the EUs.
- Evaluating the ground level impact of the implemented ICT4EU interventions.
- Employing ICTs for justice and equality.
- Improvement in HCI4D methods.

The strength of HCI4D interventions lies in their ability to complement developmental intervention in general. HCI4D research shares its objectives with developmental research. However, it focusses on some very critical and complex aspects—the interface between the artefact and the user, the user himself in terms of capabilities and attitudes, the social, cultural, technological and political context of the user. Given that design (in the form of homes, habitats, products, implements, tools and ICT systems), is an important form of developmental intervention, these aspects become paramount. Additionally, as it draws from HCI, it is capable of converting difficult to comprehend problems into product specifications.

2.5 A Brief History of Design of ICT for EU

Using the approach of Heeks [2009], in which the history of ICTD is traced into different historical phases, ICT based interventions for EUs could be divided into the following categories.

ICT4D 0.0 or Institutional Computing: The first type of ICT is where ICT systems do not interact directly with the EUs but, rather, are built for the institutions working for them. Primarily built for scientific calculations or as administrative aids, they are used exactly in the manner an institution would use any such machine. The difference lies in the objectives that the institution aims to achieve—a large scale computer could be used to model the dynamics of a large aircraft as well as to map the genome of a food crop. Here, the ICT does not have an interface with the developmental beneficiaries. It is used only to aid the institutions 'responsible' for development, such as policymakers, bureaucrats and scientists. Given that India was one of the first countries to decolonise and its early emphasis on using science and technology for development, it is quite natural that first instance of ICT4D anywhere in the world could be found at the Indian Statistical Institute (ISI) in 1955 in Kolkata, where an HEC-2M, a computer designed in the U.K., was set up. It was followed by fully home-grown TIFRAC in 1956, which was developed at Tata Institute of Fundamental Research (TIFR). These were later supplemented by many such projects, both self-developed by institutions and bought from commercial enterprises such as ISIJU-1 (ISI and Jadavpur University, 1962), CDC 3600-160A (at TIFR, manufactured by Control Data Corporation, 1963), IBM 1620 (IIT Kanpur by International Business Machines, 1963). The first commercially produced computer in India was TDC-12 by Electronics Corporation of India, Limited. All these machines were installed at institutions and acted as computing hubs and were used for various purposes. P.V.S. Rao[2] , one of the designers of TIFRAC, recalls:

> TIFR teams ran special computer programming courses all over India for a

[2] one of my mentors

> variety of user groups: users from government, universities and R and D organizations; all of them used TIFRAC for a wide variety of applications. I recall that well over fifty different user organizations were using the computational facility of TIFR! TIFRAC was the single factor that introduced the culture of using computers for scientific research as well as governance.

Still, rest of the world largely ignored the Indian example. In many of these countries the Industrial, Bureaucratic and Military applications, rather than human development, prompted the first computers. Some of the exceptions, apart from India, were Malawi (population census, 1966) and Sierra Leone (population census, 1963).

ICT4D 1.0 or Telecentre: The second type is where ICT is established by the institutions but they have an interface in the form of a physically fixed artefact mediated by a service person. Termed as telecottages/telecentres which were 'a physical space that provides public community-based access to ICTs for educational, personal, social and economic development' (in Harris [2001]), these started to appear in the western world in the 1980s. The first telecentre was established in Sweden in 1985. In the developed countries too, telecentres were put in the rural areas with low purchasing power and poor telecommunication infrastructure. Telecentres had many connotations (including public call office, PCO, of India). We are concerned with Multi-purpose Community Telecentres (MPT) which–

> may provide video conferencing, distance education, training in ICTs, telework, telemedicine, telehealth and even telebanking and e-commerce....also function as community information centres, providing access to databases and receiving and posting information of general interest to local people (e.g., government notices, information on the spread of diseases, weather information, prices of farm products, educational opportunities). (Latchem and Walker [2001])

With the objective of delivering services with greater efficiency, accessibility and transparency, MPTs started appearing in the developing world, which happened mostly during the 1990s. During the 1990s, entrepreneur driven e-kiosks, both in the urban and the rural areas, started appearing (see Rangaswamy [2006] and Rangaswamy and Nair [2010]) in

India. These served as telecentres but were driven by the individuals. These individuals served the users, whose contexts they shared, by providing the relevant services. Major institution driven examples from India include Gyandoot (started in 2000, Jafri et al. [2002]) which was initiated in Dhar district of M.P. to provide services like land records, information about government programmes and grievance redressal. First Rural Knowledge Centre (M.S. Swaminathan Research Foundation) was established in Pondicherry (started in 1998, Senthilkumaran and Arunachalam [2002]). It provided information related to drought, climate and other agro-information. E-Choupal (started in 2000, Bowonder et al. [2002]) was an initiative by the ITC limited which had established 5100 kiosks to provide farmers across 15 states with information related to market prices, farming knowledge and acting as a direct marketing channel. Drishtee (started in 2000, Bhatnagar et al. [2003]) provided e-Governance, education, health, insurance and local services. Tarahat started (in 2000, Malhotra et al. [2009]) by the NGO Development Alternatives, provided information regarding health, livelihood, governance, water, education, entertainment and best agricultural practices.

As the operator of the telecentre is likely to be an Emergent User from the beneficiary community, there is a greater design challenge as compared to ICT4D 1.0. However, as the model was centralised, such an operator could be trained to use the interface.

ICT4D 2.0 or Mobile ICT4D: The advent of mobile phones and expansion of related infrastructure changed the delivery models of ICT4D. While the e-kiosks were manned by an institutional representative or a local entrepreneur, the mobile phone based application is in a user's private space. This also makes it accessible most of the times. This phenomenon had started after the year 2000 and is continuing. A focus on devices which are more in the control of the beneficiary rather than an institution, highlights the importance of HCI4D during this phase. The end user could not be trained or selected in the way an intermediary could be in the case of ICT4D 1.0. As the level of interactivity has increased, there is a greater need for a designer of the interface, and it is where this work becomes more relevant.

Projects of this type include mKrishi (started in 2006, Mittal et al. [2012]) platform[3]

[3] I have been a part of the project.

that provides a variety of services including agricultural, weather and government related information on mobile phones, Avaaj Otalo (Patel et al. [2008]) that employs interactive voice for delivering relevant information to farmers, and Digital Green (Gandhi et al. [2007]) that provides information in the form of videos produced by both farmers and experts. Nokia Life Tools (2008) came bundled with every basic phone by Nokia in India, China and Indonesia. It provided agriculture, (including animal husbandry and fishery) related information. E-sagu (Reddy and Ramaraju [2006]) by International Institute of Information Technology, Hyderabad and Media Lab Asia provided query less advice to farmers.

Text entry in Indian languages, which had been difficult to do as a task, needs a mention. Swarachakra (Joshi et al. [2014]) and Google Transliteration tools were steps in this direction. On the other hand, there had been attempts to avoid text altogether. For example, text free interfaces (Medhi et al. [2006]) tried to avoid the need for text entry. Digital Green used videos and Avaaj Otalo voice to avoid text entry. Krishipustak by Medhi-Thies et al. [2015] attempted to help low-literate users to network using voice. Text was not used, therefore, it required innovative strategies to design the User Interface. I also had contributed to a similar mobile-based app, Gappa-Goshthi (Lobo et al. [2010]), where similar principles were used.

2.6 Summary

Emergent users have not been able to benefit from ICTs till very recently. An Emergent User could be anyone disadvantaged by either low level of education, low income, socio-economic disparity or geographical remoteness. The Emergent User represents both the traditional lack of access to digital technology and the promise new paradigms of ICT holds for them. The promise is of a better life in terms of livelihood, health and civic participation. The optimism rests upon the fact that ICTs being fast and efficient in the transfer and processing of communication, a critical element of human transactions, can bring about efficiencies of business, spread information. knowledge and education, reduce the disadvantages of geography and bring transparency and efficiency in governance– all of which have a potential of poverty reduction and redistribution of rights. The design of ICTs for emergent users, because of their complex context, is likely to be challenging, and it is where new models and theories can be of help.

Given the fact that ICTDs are now driven by mobile phones, which give more control to the emergent user. However, it also poses the challenge because the EU might not be capable to use the traditional interaction paradigms. This work extends the research effort to make user interfaces that could be used by EUs in spite of the barriers they face in terms of low education, low incomes and low exposure/access to technology.

Chapter 3

Literature Survey: Technology Adoption

3.1 Introduction

In the last chapter, we have framed the objectives of our study. In this chapter, we situate them in the larger context of Technology Adoption. As we have stated earlier in section 1.6, adoption of ICT by the EU is an important issue to be studied within the ambit of ICT4D. We started our literature search with three terms: "Adoption" (from Davis et al. [1992a], "Acceptance" (from Rogers [1962]) and "Technology". The first two terms are used interchangeably and form the central theme of this work. The third term is "Information & Communication Technology", and we did focus on it. However, we did not abandon a generic view of Technology Adoption.

A snowball search strategy was adopted, which resulted in a large set of topics ranging from models of Technology Adoption to the philosophical issues underlying technology usage. In the convergence process, the relevant information was assimilated around the core objectives of this thesis (Section 1.8), while a large subset of the accessed literature was discarded.

In this chapter, we present a survey of the earlier work related to Technology Adoption. This exercise has helped us situating our research question and identifying the issues and parameters that were later used for theory-building. We have covered two major streams of Technology Adoption. The first is represented by Diffusion of Innovation (DoI) by Rogers [1962], the other by Technology Adoption Model (TAM) by Davis [1989]. Apart from these two, there is a section on Task-Technology Fit (TTF) by Goodhue [1995].

Discussion of DoI starts with a seminal work by Tarde [1903], which appeared in 1890 in France. We have dealt with it in detail because it is one of the earliest detailed work on the spread of technology. Written in the tradition of social philosophy, it dissects the idea of the spread of technology. By examining this work, we are acquainted with many finer aspects of Technology Adoption, which will illuminate the rest of this work. In the survey, we have included modern three avatars of Tarde's work that have been contextualised in the domains of agricultural research, general Technology Adoption and marketing.

The other stream is represented by Technology Adoption Model Davis et al. [1992a], a work situated in the Management Information System (MIS) tradition. It is a frequently used theory for predicting and explaining technology usage. However, this work is a derivative of Theory of Reasoned Action and Theory of planned behaviour, both derived from social psychology tradition. These theories examine the role of attitudes on the actual behaviour.

The third, Task-Technology Fit Heeks [2002], also belongs to the MIS domain. This approach is not contented with the user's intention to use a technology but attempts to unearth the underlying linkages with design as well as user characteristics.

3.2 Laws of Imitation

The earliest conceptualisation of Technology Adoption is found in the 1890 book of Tarde [1903] (the 1903 English edition is used as reference). A French sociologist, criminologist and social psychologist, he employs the term 'Laws of Imitation' which was published as a book with the same title in 1903. He does not talk specifically about technology, but rather about social changes which include many things such as, *"language, religion, politics, law, industry, or art."* (p2). The later Diffusion of Innovation (Rogers [1962]) model's philosophical lineage could be traced to Tarde's thoughts. Tarde's thesis could be summed up as follows: innovations may appear suddenly, but their success lies in their widespread adoption over older or competing ideas. The adoption process is a diffusive one involving imitations that happen amongst the members of a population. Each imitation is a mental process, which takes place over a period of time within an individual's mind, of comparing and evaluation concurrent ideas, and which decides whether a given idea will be taken up or rejected. Tarde provides the characteristics of the diffusion process in the following way. Firstly, novel ideas or inventions occur as disruptions to continuity though they may not be perceived as such because their diffusion in the society happens in a gradual manner. Secondly, diffusion is a systemic process. It happens at a systemic level, the system being the human society itself. For Tarde, new ideas diffuse within a society *'as a light wave or a family of termites'* starting at a core and spreading outwards as individuals continue with a trail of imitations (p3). Which leads to, thirdly, the critical fact that primary cause of diffusion are imitations. It is the individuals who imitate an idea and become agents of diffusion in the process.

How would Tarde explain the success of a software product (for example, WhatsApp amongst the EUs in India)? For him, the interaction between two friends would be an interesting phenomenon to analyse. One friend might inform another about the availability of the application. The act of informing might be preceded or succeeded by an evaluation of this product with respect to some goals (for example, being in touch with friends). Either its fitness with respect to the goals is recognised at the first time encounter, or its gradual usage provides an impetus to the recognition of needs. Adoption is weighed against the other ways of achieving the same goals. In the case of WhatsApp, these other ways are physically meeting friends, calling them up or using other prevalent applications to connect with them. The ease of learning and using the product has an important role in the decision. If the user finds the product too difficult in comparison to the advantages it would offer, it will not be used.

As indicated earlier, the vehicle of imitation is human interaction. Ideas get either refined and strengthened, or diminish into non-importance due to peoples' interactions. The absence or presence of coherence among various competing ideas becomes apparent only when people interact. During an interaction, various ideas come face to face with each other. The result of such a confrontation is that the ideas clash and negotiate with each other. In a society, numerous such micro-duels keep happening all the time. These micro-duels collectively manifest at the macro-level as a whole. Imagine many young people using technology–in colleges, at social gatherings, in buses and trains. One could think of many such interactions happening over a period of time. At every interaction, a comparison is likely. During such an interaction, a technologically lagging individual might give a thought about adopting a new artefact. If the new artefact wins over an older one over a number of interactions, it would get reflected on a larger scale. Gradually the newer artefact would become a norm and force the older one into abandonment.

Interestingly, these micro-duels are not only between two inventions but also between two different needs or opinions that may manifest as inventions (p158). Why would one watch movies on a phone rather than on a TV connected to a DVD player? One offers entertainment on the go, the other a larger screen and a bigger sound. Both the options would be put against each other. The ultimate battleground of such a duel is an individual's mind, which hesitates to adopt a new idea. However, this very individual duel is nothing but a reflection of the larger society-level conflict of ideas, where a new idea slowly tries to challenge an incumbent one. While one opinionist may say,*"What would you do with such a tiny screen? I bet you cannot see even the face of the actors. It is a waste of money."*, the other would opine, *"Look, you are travelling in a bus, and it is a long journey, what would you do? I must say it is not a waste of money."*. Then, how exactly would an idea win over the other? We can take help from the work of Mantovani [1996], where he has integrated social-context, situation and human-artefact interaction, to understand. According to him, a social context determines actions—in terms of what is possible, and how and why an action is to be done in a given situation. Situations, on the other hand, offer opportunities that actors can pursue depending on their interests. It is in a situation that a user decides to use or not use a new artefact to achieve a goal. Let us consider the situation of 'travelling in an intercity bus' which is a frequently occurring one. The recognition of this situation is shared amongst the actors in a context (for example in and around Gwalior in M.P). Now, the possibility or precedent of someone watching movies while travelling in a bus may start up a duel—between the use of a mobile phone or that of a DVD player—either in one's own thought or through a dialogue. This duel, then, may extend to the situation of the home where already a DVD player sits. There, the conflict becomes multi-corner (it does not remain a duel) involving the following position:

- Does one need to watch movies while travelling, at all?
- Would one watch a movie on a tiny screen at home as well?
- To what extent would one disregard the difference in experience between watching on a large screen and a smaller one.
- To what extent would one disregard the cost (in terms of effort and money) of watching a movie on a mobile phone and a DVD player.

Finally, a user may choose either of the following:

- Not using a mobile phone at all, travelling without an entertainment device.
- Using a mobile phone while travelling and DVD player at home.
- Start using a mobile phone at home as well as while travelling, forsaking the DVD player for good.

The conflict within an individual, preceding the act of imitation, happens because an individual, as part of society, has some support for the prevalent idea. However, at the same time, (s)he has seen someone else adopt a rival idea. As the number of successful imitations grows, there is a tipping point in history when it becomes clear that a new idea has been favoured over a rival old one. In this way, society acts as a large complex mind in which new ideas grow. Tarde says:

> Progress, then, is a kind of collective thinking, which lacks a brain of its own, but which is made possible, thanks to imitation, by the solidarity of the brains of numerous scholars and inventors who interchange their successive discoveries.

Tarde also describes laws governing the rate of spread of new ideas. He asks–*"why some innovations spread faster than the others?"* He provides two types of causes. The perceived advantages that an innovation may offer over a prevalent way of accomplishing an objective come under *logical causes.* Booking a train ticket by standing in a queue is indeed more difficult than doing so using a smartphone application, provided the effort at using the application is less demanding than standing in the queue. However, logical causes are not enough to completely explain imitation. The earlier discussion on micro-duels leads to the fact that an act of imitation is not just about an innovation. It is also of the values, sentiments or desires that are attached to it or are the reason for its being. Adoption of a new application could be thought of as a representation of a thought or a desire. Therefore, personal desires and beliefs are larger forces in the acts of imitation. These set of causes are termed by Tarde as the *extra-logical causes* (p141). He describes them as:

> The thing which is invented, the thing which is imitated, is always an idea or a volition, a judgement or a purpose, which embodies a certain amount of belief and desire. (p145) [1]

In this regard, Tarde also raises questions regarding who imitates and whose values, desires and sentiments get imitated? In reply, he states that it is always the more powerful and influential who lead the chain of imitation:

> ...the court looks up to the prince, the city looks to the court for its model, and the poor man gazes upon the rich man and wishes to share in his luxury.

It is where the influencers or opinion leaders play a role. Due to their position of power or prestige, they can take chances with something new and untried. At the same time, it is also true that imitation cannot happen if the social distance between the imitator and the imitated is large.

Tarde improves upon these premises further by suggesting that the phenomenon of diffusion could be modelled in a macroscopic manner.In fact, he suggests using statistics to analyse social phenomenon, quite in the way it is practised today in service of social sciences. In particular reference to innovations, he suggests that statistical methods be used to (i) determine the diffusive (imitative) power inherent in an invention and (2) predict its beneficial or harmful effects (p111). In this manner, he suggests that qualitative

[1] Here, we find an earlier trace of what has been expounded as Socio-Cultural Activity Theory

social phenomenon should be expressed in terms of formal sciences so that analysis and synthesis of knowledge could be done more vigorously. It was later that Tarde's desire was put to practice in a rural setting of the USA to study the diffusion of hybrid corn among farmers (described in the next section).

'Laws of Imitation' constitutes many premises needed to understand Technology Adoption by the EUs. Firstly, Tarde relates the social phenomenon of Technology Adoption to the individual phenomenon of imitation. Indeed, if we want to study if and why a large scale adoption of technology happens, then we *do* need to examine if and why individual adoption occurs. This is because the individual is the constituent unit of a society. From this perspective, it becomes natural to investigate how (the nature of) a user's agency affects his decision to adopt. It implies that instead of merely assuming how an artefact might be advantageous or disadvantageous to a user, one is required to think how does a user perceive it, and how does he evaluate those advantages with respect to his own objectives and his context. In this manner, the locus of analysis shifts from the artefact to the user without losing the sight of the artefact.

An important aspect of imitation is trialability. A user would like to observe someone else using, or try himself. Without trying, it is difficult to fully assess the benefits and disadvantages. An innovation in use would raise the level of acceptability. This is where usage becomes important, more so in the case of ICT artefacts. One may like WhatsApp, for example, but one would like to try it, or at least see someone else use it. In this manner, usage becomes a critical link at the level of individual imitation, which is also the focus of this thesis.

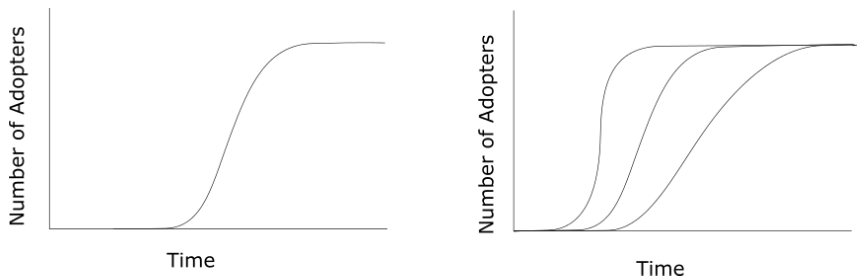

Figure 3.1: Cumulative curves for Adoption of Innovation: Gabriel Tarde (left) does not consider subtypes of the population while formulating spread of innovation. In the case of Technology Adoption by the Emergent Users (right), it becomes important to recognise that there are many subtypes with individual rates of adoption

There is also a need to differentiate (see Figure 3.1) one user from another because the rate of diffusions will not be the same for everybody. In the case of the EUs, where user heterogeneity is a salient issue, we have considered that to be an important fact.

3.3 Diffusion of Innovation

The first seeds of Diffusion of Innovation (DoI) theory could be found in the work of rural sociologists in the USA. It could be traced to Gross [1942] who had researched about acceptance of hybrid corn in Iowa state of the USA. Gross's work was an empirical research where the adoption of a new idea was measured and related to various parameters that were supposed to have affected it. An important insight from the work was that the rate of adoption depended on 'personal, economic and social' characteristics of the individual adopters.

DoI by Rogers [1962], built on the same foundations, deals with the issue of adoption of an innovation[2] at the societal level, where adoptions happen in a 'diffused' manner over a period of time. The adoptions do not happen at a uniform rate. At the start, very few people would attempt to use it because its benefits are not observable. The rate of spread slowly builds as people see others accrue its benefits. However, when a majority of the people have done so, the rate starts slowing down in a gradual manner[3].

DoI rests on four pillars as indicated by Rogers while defining it. According to him:

> Diffusion is the process by which (1) an innovation (2) is communicated through certain channels (3) over time (4) among the members of a social system. (p5) Rogers [1962]

The first term, innovation, signifies the attributes of an innovation that affect its adoption. The second is about the communication channels through which the awareness about the innovation and its use is known. The third is about the patterns followed by diffusion

[2] An innovation could be anything–a physical artefact, a piece of knowledge or a way of doing things

[3] As had been validated by Ryan and Deci [2000a], the cumulative rate of adoption follows an 'S' shaped curve, whose 'curviness' (denoting how fast the adoption happens) and height (to what extent it happens) may vary.

process over time. It is concerned with how fast the diffusion happens, and who adopts first and who later. The fourth pillar is about the social system in which the innovation is diffused. In the following, we detail out the issues regarding each of these, though in a different order.

3.3.1 Time

Rogers uses the term 'time' in three different ways. The first describes the journey of an adopter. The second is the user type with respect to the majority of the population. The third is about the rate of adoption by the population as a whole. We describe the three in detail:

Innovation-decision process The *adopter's journey*, also termed as innovation-decision process, happens in the following way:

1. Knowledge: Knowledge happens when a user knows about an innovation and its possible utility with respect to some objective. According to Rogers, though knowledge about an innovation pervades around users in the form of social communication, they may ignore it until it is *"in accordance with their interests, needs, or existing attitudes"* (p166).

2. Persuasion: The next step towards innovation happens when a user forms a favourable attitude. Attitude formation is a mental activity where, according to Rogers, a person actively seeks more information. The user performs mental trials of the innovation with the help of the collected information. Attitudes are reinforced or attenuated by projecting such information into anticipated situations. Mental trials have a degree of uncertainty, therefore Rogers notes that social reinforcements play a role in persuasion. The users own predispositions and beliefs also contribute to his inclination to engage further with the innovation.

3. Decision: The decision to adopt rests on sufficiently favourable attitudes, formed during the persuasion stage. However, favourable attitudes are not enough. A user needs to try an innovation out by himself. While the persuasion stage is concerned

with mental processes, this stage is characterised by actual trial. Instead of 'running in the mind', a user actually engages with the innovation on a trial basis. In case, the user himself could not do the trial, then vicariously observing others helps in the decision.

4. Implementation: This stage is the actual usage stage which signifies that user has successfully adopted the innovation. Many nuanced issues regarding the usage are discovered as the user fully starts using the innovation. Moreover, as Rogers states, the user actively adopts an innovation to new usage rather than being just a 'passive acceptor' (p176).

5. Confirmation: Rejection can happen any time during the innovation-decision process if the long-term usage does not reinforce the decision to adopt an innovation. During this period a user may want supportive messages from others. It could also happen that the user discovers a better innovation. It may also happen that a user becomes less satisfied with the performance or a situation occurs which suddenly changes the attitudes towards the innovation.

Innovativeness/Adaptor Categories: The second way in which time helps is in deciding at what stage a user is within the life cycle of adoption (by the society) of an innovation. There are 5 of these stages:

1. Innovators: They are venturesome by predisposition. Seeking newness is a personality trait. Trying new innovations is an obvious behaviour. One effect is that they connect with the other innovators. Often, as Rogers states, they do so over geographical distances. Actually, they are often disconnected from their local (social) context. Being an innovator is financially risky too. A new idea is more likely to fail and not give any returns. Therefore, the innovators need to have substantial financial resources. Additionally, trying an innovation and coping with uncertainty also calls for high motivational levels.

2. Early adopters: Rogers suggests that innovators are less connected to their immediate social context, but are entrenched in a network of innovators. In contrast,

early adopters are locally situated. This is why they are able to provide opinion leadership, which is not possible in the case of the innovators. An early adopter strives to win the respect of his peers and therefore judiciously manages decisions regarding an innovation. Nevertheless, he is not an innovator to risk his money before anyone else has.

3. Early majority: They adopt just before an average member of society does. They also interact within their social context but do not command leadership. Additionally, they deliberate more than the early adopters before completely accepting an innovation.

4. Late majority: They adopt ideas after everybody else has adopted. With caution and scepticism, these users adopt when many people around them have already adopted so that they could be assured of an innovation's utility. This is partly due to scant resources which could not be risked for a new idea. For them, adoption is not for the sake of adventure. Rather, they are compelled to adopt because of increasing social pressure or due to necessity. As other people have already adopted, the perceivable risks are minimised and the patterns of utility have evolved, and so technology could be put to 'a proper use' rather than acting as an experimental or novel artefact.

5. Laggards: They are exactly opposite of innovators. They are situated in their local contexts. The decisions are made in terms of tradition, or in Rogers' words, *"in terms of what has been done in previous generations"*. They are reluctant to change and also are highly suspicious of the pioneers and the change agents.

The Rate of adoption: The *relative speed* at which an innovation is adopted is called the rate of adoption. The rate of adoption is an S-shaped curve. It means that initially very few people adopt, then the rate of adoption rises quickly only to be saturated at the end.

3.3.2 Innovation

According to DoI theory, an important factor in the adoption of an innovation is the innovation itself. How does an innovation affect adoption has to be evaluated against the following criteria:

1. *Observability* is defined by Rogers as the degree to which the results of the innovation are observable to the potential users. A directly observable innovation has much more information than a mere description of it. It 'stimulates peer discussion of new idea' (p16). It also helps in the evaluation of the needs. Observability is important during the knowledge and persuasion phase of the adoption process. The probability of adoption increases in accordance with its observability.

2. *Trialability* is defined as the extent to which an innovation could be experimented with in order to assess its fitness for achieving goals. The evaluative advantage of an observable innovation further increases if it could be experienced first-hand, although on a limited scale. Triability is critical for the decision phase of the adoption process. It becomes particularly important in the case of ICTs which, being cognitive artefacts, cannot be understood easily through observation and need to be tried.

3. *Relative Advantage* means that an innovation is more likely to succeed if it offers a relative advantage over older ways of doing things. Observability and triability can ensure the communication about the innovation. However, an innovation is unlikely to be adopted if it is not advantageous with respect to other ways of achieving goals.

4. *Complexity* decreases the probability of adoption. For us, complexity can affect both observation and trial. We would like to suggest that as diffusion is about communication, the perception of the level of complexity of an innovation is as important as the actual complexity.

5. *Compatibility* with existing values, past experience and needs of the potential users makes an innovation more likely to succeed. We find a perspective on compatibility in the work of Tarde [1903]. He suggests that an innovation is shrouded in a thought

process, a way of thinking and is a manifestation of beliefs and desires. Therefore, the novelty of an innovation is actually testing a thought system against a prevalent one. If both are compatible, the adoption is likely to find less resistance.

3.3.3 Communication

An important factor aiding the diffusion of innovation is the nature and quality of communication channels (within a social system). In our opinion, the evaluation of an innovation cannot take place unless there is a way to know about it. In this way, diffusion is essentially a communication process because it forms the link between one user with another. There are many channels of communication including the mass media. However, the most basic type of communication, face to face, plays a crucial role in the context of the Emergent Users. In the context of this work, we have found that peer groups influence the spread of technology. The importance of the peer group is also highlighted by Rogers (p18):

> most people depend mainly upon a subjective evaluation of an innovation that is conveyed to them from other individuals like themselves who have previously adopted the innovation.

In the case of the EUs, who are more likely to be collectivist rather than individualistic, social systems (discussed in the next section) play an important role. Some of the scenarios of communication are the village meeting places (see Figure 5.5), common living spaces of migrant workers or neighbourhood groupings of women that takes place after the household work is finished in the afternoons. Mass media also play a role. Newspaper, particularly in local languages, has already been an important medium for the EUs in India (see, for example, Ninan and Malaviya [2004]). Of recent, satellite television has established its hold, especially in domestic space where family-oriented television programming covertly introduces many novel ideas while reinforcing many older ones [4].

[4]For a contrast between the two positions compare Moon [2016] with Roy [2012]

3.3.4 Social System

The fourth factor in the diffusion of innovation is the social system which is defined by Rogers as, *"a set of interrelated units that are engaged in joint problem solving to accomplish a common goal"*. Social systems affect the diffusion process in many ways. Firstly, the *social structure*, which is the way the social units in a society are patterned or arranged, is responsible for behavioural conformance. The social structure should be seen in conjunction with *social norms*, which decide the expected behavioural patterns arising out of one's position in a social structure. In simpler words, a person's 'place' in a society will determine whether she could depict a particular behaviour regardless of her choices and intentions. For example, an adolescent woman in a rural family might be barred from using a phone because of the norms related to gender. The same woman, on being married, could be allowed to own one. In this situation, when social structure and norms could act as a deterrent to diffusion, informal *communication structure* plays a facilitative role. These structures constitute the communication channels across which communication actually happens. These structures are formed across what Rogers terms as homophilic groupings–groups of people who have some affinity in terms of beliefs, education, social status etc. For example, in the case of migrant workers, the groupings are likely to be based on cultural affinities. Another example of homophilic grouping is of the truck drivers who form social networks based on the profession generated affinities.

In a social grouping, a particular role is played by the *opinion leaders* and *change agents*. An opinion leader is a person who holds influence on the other members of society. It is a person to whom the social members look towards for direction and advice. The influence can result from not only social power but also from personal competence or social accessibility. Patronization for an innovation by an opinion leader helps lower the inhibitions among potential adopters. Many a time, an opinion leader makes a position for herself/himself by gradually pursuing, over years, his expertise in a particular direction, for example as an expert of technology. On the other hand, an adopter who is not an opinion leader might be looked with suspicion, especially, when a new innovation challenges the social norms.

Change agents are from outside the social group, who want to push the innovation into a society. Governments and entrepreneurs come in this group. When change agents do not share much with the society (that is, they are heterophilic), it is very difficult to push an innovation. Often, the help from opinion leaders is sought, who on account of their being embedded in the society, make the transition easier.

Employing DoI for Design for the EUs DoI indicates that a population is composed of many segments with respect to adoption, and each segment will have a different attitudinal and behavioural response towards an innovation. However, DoI is more amenable to a systemic level analysis as it gives importance to social systems and communication channels. It does not inform how to design ICT artefacts.

Designing for the EUs would require an understanding of the user-related constructs that may affect the usage. In order to do so, we need to answer the following questions:

- What is the set of user-related constructs, whether demographic, psychological, or environmental, that make a person belong to a particular user category?

- If the user-related constructs are understood, then how would they affect the decision making process?

- How innovation could be designed, using the principles of trialibilty and observability et cetera, if one could predict a decision making process for a user belonging to a given category?

Using these questions we have been able to arrive at a typology of users that not only informs how early or late a user would adopt an innovation but rather to what extent (s)he would. It distinguishes between a user who fully embraces a technology by eagerly trying to master everything, the one who learns only the tasks relevant to her, the one who is not able to learn and the one who discards it altogether. Subsequently, it also integrates these aspects with the design of the innovation. Of course, all of it is situated in the contexts of the EUs. Thus, building upon a particular facet of DoI, our work acquires a different approach, which focuses closely on the relationship between a user, his behaviour and design.

3.4 Moore's Chasms

Moore [2002] accepts the five user categories but adds that certain chasms exist between the different categories. The first and a minor one exists between the innovators and early adopters. The reason being the difference between the nature of innovators and early adopters. Innovators use technology for its sake. For these people, the prime concern for using a technology is its being, in terms of novelty and design intricacies. The main motive of these persons is *"to see how it works"*. Essentially, they are risk takers. They are actively seeking something new, and willing to take a risk with an untested product and put it to use. Innovators form a very small chunk of an adopter population. Innovators may explain the in and out of a technology in terms of its specifications and performance, but they may not be able to provide many examples of how does it fit into the larger set of goals. This objective stands in contrast with the early adopters who want to pioneer a technology's use, not for its sake, but for their own productive goals. Technology becomes a means rather than an end. Their enthusiasm lies in achieving their business goals and they are the first one to recognise how a given technology can help in that. The chasm between the innovators and early adopters may mean that the latter cannot recognise that a technology can help in achieving their objectives. If the early adopters cannot see any benefit, they would not adopt. In this sense, the chasm characterises the difference between the attributes of a product and the potential real-life use it can be put to.

The second chasm, and the wider one, arises between the early adopters and the early majority. The early majority, like the early adopters, also focus on putting technology to work. However, they are reluctant to do so unless there is an appreciable mass of other users who have already used it. Thus, the visibly adequate performance of a product is a prerequisite to adoption. They see others fail or succeed before they decide to proceed. Another difference between the two is that while the early adopters put it into new usage and finding alternative uses for them, the early majority are content with a few dominant tasks. One may say that late majority want their things simpler.

The chasm between early and late majority may arise if the success of a product is not visible. The early majority would not actively seek something new. It will adopt a product only when it is assured of its benefit.

3.5 Technology Adoption Model

Technology Acceptance Model (TAM) was proposed by Davis [1989] as part of his Ph. D. at the Sloan School of Management in 1989. It attempted to understand the process of user acceptance and use it to inform design. TAM was later modified by Venkatesh and others as TAM2 and TAM3 (see Venkatesh and Bala [2008b]; Venkatesh and Davis [2000]).

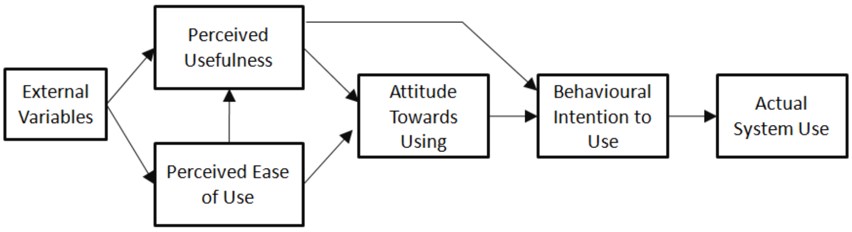

Figure 3.2: An earlier version of TAM as proposed by Davis et al. [1992b].

TAM was based on the Theory of Reasoned Action (TRA) by Fishbein [1979], which postulated that any behaviour is a result of an intention to operationalise it. The intention, in turn, depended on two variables–the attitude towards that behaviour and the subjective norms governing that behaviour. Attitude was defined as:

> the learned predisposition to respond in a consistently favourable or unfavourable manner with respect to a given object. Ajzen and Fishbein [1975]

Attitude was operationalised in the following way:

$$A = \sum b_i * c_i$$

where, of all possible salient beliefs about the potential consequences of a behaviour, b_i is the i_{th} belief, and c_i, the consequence of carrying out such a belief.

Similarly, subjective norm was given by

$$S = \sum n_i * m_i$$

where, n_i is the perceived expectation of other people regarding ith belief , and m_i, the motivation to comply.

TAM is situated in Management Information System (MIS) tradition. It is, therefore, primarily concerned with the usage of technology-based systems within the organizations. Davis, in his Ph. D. thesis, had set two goals:

- Understand how users accept technology in order to design better systems

- Predict user acceptance by examining only the design

TAM had been envisaged as a classical stimulus-response model. The technological system's characteristics acted as the stimulus and the users' behaviour of using the system was the resultant response. In between lay the organism, the human user himself, which mediated between the two. The user represented the internal processes going on in her mind. This was important because positive behavioural response depended on favourable motivations and intentions. Capturing the motivations had an impact on the design in the following way. Much time and effort were expended for system implementation. These became wasted in case of users' non-adoption of a system. Therefore, it was desired, based on just the descriptions of design, to assess the users' intention to adopt a potential (still to be constructed) artefact.

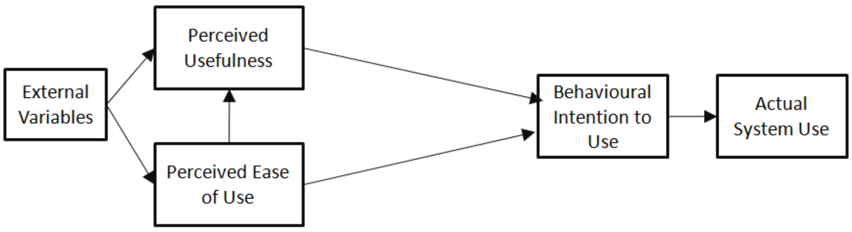

Figure 3.3: Final version of TAM as proposed by Davis and Venkatesh [1996].

Davis had considered only the attitude, and not the subjective norm, for his model. Further, keeping in view of Technology Adoption, and based on the existing literature, he reduced the salient beliefs to only two in number–perceived ease of use (PEOU) and perceived usefulness (PU).[5]

Perceived ease of use was defined as:

> The degree to which an individual believes that using a particular system would enhance his or her job performance.

[5] Later researchers Chuttur [2009] confirmed the appropriateness of these measures.

Perceived usefulness was described as:

> The degree to which an individual believes that using a particular system would enhance his or her job performance.

As TAM evolved, Davis et al. (in Chuttur [2009]) found that perceived ease of use and perceived usefulness had a direct influence on the intention to use. At the same time, Attitude, which used to exist as a mediating variable could be dropped.

TAM has been an influential model within the Management Information Systems (MIS) domain. Lee et al. [2003] have identified four different stages of its development. During the initial phase (1986-1995) of 'model introduction', there were attempts to determine the factors feeding into 'beliefs and attitudes' on the IS acceptance decision' (p754). The period of 1992 to 1996 is termed as 'validation phase'. One example was the attempt by Hendrickson and Latta [1996] to measure of reliability and validity of TAM. The next, between 1994 to 2003, the 'extension phase', extended the model by adding various new constructs which would act as inputs to PU and PEOU. For example, Petter et al. [2007] studied e-mail and FAX usage in the U.S. and Japan and found culture to be an important variable. The fourth phase, the 'elaboration phase' (2000-2003), was about a synthesis of the previous effects and resolution of the limitations. TAM2 and TAM3 were developments in this direction. In TAM 2, Venkatesh and Davis [2000] tried to increase the granularity of PU by adding constructs such as voluntariness, experience, subjective norm, image, job relevance, output quality, result demonstrability. Later, Venkatesh [2000] introduced input variables for PEOU based on the concepts of anchors and adjustments. Anchors were general beliefs about computers that were used when specific knowledge was unavailable. Anchors were more important during the initial phases of use. Anchors included self-efficacy, computer anxiety, and computer playfulness. Adjustments were the beliefs that were shaped due to direct involvement with computers. Adjustments happened as the person started interacting more and more with the system. Adjustments included perceived enjoyment and objective usability. The anchor/adjustment based model was integrated back with TAM 2, which gave rise to TAM3, which introduced experience (for example between computer anxiety and perceived ease of use), and voluntariness as important mediating variables.

In its final form, TAM has been used in a large number of studies. As reported by Marangunić and Granić [2015] in their survey paper, the researchers have incorporated new constructs such as cultural diversity, gender, usage perception, risk, trust etc. Others have used it to predict usage of a wide variety of technologies like Internet-supported medical procedure, digital library system, search engine systems for seeking information on Web, Internet banking system, e-learning etc. Surendran [2012] has reported other researchers adding constructs like compatibility, playfulness, social influence, perceived risk and cognitive absorption. There are many studies based on TAM within the Indian context as well. These pertain to the adoption of mobile internet, Internet banking, e-learning, and of IT among organizations. Kesharwani and Singh Bisht [2012] have used TAM to study the role of perceived risk and trust on Internet banking adoption, Gangwar et al. [2015] have combined TAM with TOE (technology-organization-environment) framework to find out the determinants of adoption of cloud computing in the corporate sector. Thakur and Srivastava [2014] have studied the mobile payment adoption. Gupta et al. [2008] have used UTAUT (the Unified Theory of Acceptance and Use of Technology, an extended version of TAM) to study ICT adoption in a government department. Fusilier and Durlabhji [2005] have used TAM for studying student Internet use. Suresh et al. [2016] have used TAM to investigate the factors responsible for the acceptance of information systems in the context of the private hospitals. Ratna and Mehra [2015] have studied the adoption of e-learning among the university students. Dixit and Prakash [2018] have studied the social networking usage patterns.

TAM is helpful as it helps relate the usage behaviour with the design aspects of ICT artefacts and highlights many important constructs that determine Technology Adoption by users. However, in our opinion, TAM might not be able to explain and predict the ICT adoption by the Emergent Users. This is because, firstly, TAM was envisaged in the non-Emergent contexts. TAM has been used for corporate employees (Gefen and Straub [1997]: USA), university students (Pavlou [2003]: USA), 2003) and online customers in the developed countries (Koufaris [2002]: USA, Wu and Wang [2005]: Taiwan). Because TAM has been limited to a very small set of participants, such as knowledge workers or MBA students, (Hendrickson and Latta [1996]) it does not do justice to the EUs. An alternative could be to incorporate the EU specific parameters that could act as input to PU and PEOU. However, we believe that operationalising such constructs in isolation from their contexts would affect their validity. Therefore, it would be desirable to conduct contextual field studies to identify the constructs for their subsequent operationalisation (which we did and have detailed in Chapter 5). This becomes important due to the complexity inherent in the EU contexts. For example, we have noticed that young males who had a broader peer group and were in non-sedentary jobs such as driving, seemed to adopted ICT artefacts easily. Further, these constructs could not be generalised, because the nature and relative importance of these parameters might change with place and time. For example, in one society access to technology (product and services) might be more critical than access to education in determining Technology Adoption. Therefore, we posit that for every context these parameters have to reconsidered afresh. This is something that applies to our model as well.

Even if the context-specific parameters are adequately operationalised, TAM might not effectively predict ICT adoption by the EUs. TAM is based on the premise that prediction and explanation of Technology Adoption could be done by estimating the perceptions about its usefulness and ease of use. However, the Emergent Users have several barriers in terms of actual technology use. These barriers are directly related to the complexity of design as well as the user-related constructs such as literacy and income level[6]. In case of non-Emergent users, the ability to buy a mobile phone and read the operating instructions might be irrelevant as almost all of them have economic and educational capability to do so, and therefore parameters like self-efficacy and computer anxiety could make a significant difference. In case of the Emergent Users, though, personal (in)capabilities such as low income and educational levels, as well as contextual barriers such as access, exposure and infrastructure, become deciding factors in technology use. The perception about ease and usefulness, in that case, would be less critical if the user *struggles during the actual usage.*

TAM based approaches are built upon self-reported quantitative measures and are summative in nature. They might not be helpful in the design of appropriate ICT artefacts for the EUs. In fact, contextual observations become indispensable because many aspects could be ill-understood or may remain camouflaged owing to the sociocultural difference

[6]these barriers are discussed in detail in Chapter 6

between the designers and the beneficiaries. For instance, we have seen during our field studies that users would often claim to do a particular task, whereas on being asked to actually do, they either failed or did with errors. As compared to self-reported measures, observation of behaviour also gives a window to the inner dimension through errors committed or anomalies. This, in turn, could be used to elicit the thoughts and feelings. Observation has another advantage. It helps probing deep regarding the conditions and situations surrounding a particular behaviour. For example, we found that some users claimed that they had made online purchases. However, probing resulted in the fact that these purchases were done, using users' own phones, by someone who was technologically adept enough to purchase. Also, it was done only once and twice for a premium item which was cheaper than what would cost in a physical store. In this manner, a detailed narrative based description aids in a rich understanding, which can help in deriving design principles. In fact, in TAM3 it is acknowledged that design will have an impact on the system use:

> We urge IS researchers to examine the influence of design characteristics on user acceptance, particularly on the determinants of perceived usefulness and perceived ease of use (Venkatesh and Bala [2008a])

TAM works well with concrete singular goals. Very specific questions could be asked regarding the achievement of concrete goals like *'getting a photocopy done'*, *'typing a report'* or *'purchasing a dress'*. However, the actual technology usage, as it happens in the daily lives of people cannot be defined in simplistic terms in the form of a well-defined path that starts and ends unambiguously. People use technology to achieve, on one end of the spectrum, very clearly defined goals such as finding a restaurant. On the other end, the artefacts are also used for 'continuous social engagements', which are fluid and amorphous in their objective. Could one say, *"Facebook helps me in doing my task..."*, when the goal is to just be in the company of friends? Take the case of WhatsApp. The goals underlying a chat sequence or a shared video are amorphous. A chat or a shared video is part of a continuous social engagement, and not accomplishments of well-defined jobs. In the emergent contexts, the issues become more complex than what these examples could convey. While mobile phones are used for livelihood purposes, they are also used for maintaining social relationships, which call for a layered and nuanced understanding. Let us take an example about the role of the mobile phone in maintaining the relationship between a married daughter and a mother. A typical TAM response would be, *"Mobile phone helps me in finding well being of my daughter..."*. These type of responses would only measure the extent to which mobile phone helps in nurturing the relationship. However, it does not answer what goal is accomplished by a mother who bought a phone to talk to her recently married daughter? Is it the reassurance of her well being or the emotional nurture that is derived from the parent-offspring communication? Another similar response is *"Mobile phone helps me in my 'getting' and 'holding on' clients"*. Engagement with customers does not have concrete beginnings and ends (as in the case of 'typing a report'). It is a continuous process where one client leads to another, and in the process, one leverages a growing network of clients, which further helps in foraging for new clients.

Limiting the goal of technology to productivity is not in harmony with the aims of ICTD research (see discussion in Section 2.4). Emergent users, being human individuals, also strive for freedom, cultural expression and civic participation. Goals pertaining to these aspects, for example, the practice of downloading and sharing regional language songs, cannot be characterised fully with the help of concepts like efficiency and job-satisfaction.

Further, in case of the Emergent Users, the *capacity* to use ICT, in general, is more important than the use of ICT for accomplishing specific goals. Hence, usage like entertainment and social- engagement are as important as those concerning productivity.

3.6 Task-Technology Fit

Goodhue [1995] proposed that user evaluations of information systems were insufficient for measuring its efficacy. He was critical of user evaluations, that is, measuring some quality of an information system through response to a question, because, according to him, user evaluations largely 'elicited beliefs and attitudes about something '(p1828) and lacked strong theoretical underpinnings. He was anxious about the use of constructs lacking theoretical foundations, which according to him, affected objectivity. Therefore, in this work, he attempted to identify-some theoretical perspective that can usefully link underlying systems to their relevant impacts. (p1828)

Goodhue further argued that, given that this work belongs to the MIS domain, business productivity was an important aspect, and therefore a task-technology perspective would be appropriate. In this case, technology was the information systems and tasks were the actions 'carried out...in turning inputs into outputs'. From this perspective, three dimensions were found–the Information System, Task and the Individual User. The individual user was characterised by his capabilities and needs. The objective was a fit between the technology and the task which would happen only if individual capabilities and needs matched the task requirement posed by (the design of) information system.

Goodhue enumerated measures for the three dimensions. An *Information system* was characterised by the ease of learning to use, the degree of confusion, ambiguity in meaning, accessibility and locatability (of data), assistance available, reliability, currency and accuracy of data, and the presentation of data. The *Tasks* were of two types: routine and non-routine. Routine tasks were repeatable and, thus, offered less effort to attempt. Non-routine tasks were rare or/and varied in nature. They offered more resistance to a user. Individual *users* were characterised by their computer literacy based on their ability to use various software.

Our approach is similar to the Task-Technology Fit (TTF) Model. We also focus on the relationship between the artefact (the information system according to TTF), usage (task) and user. However, many studies that we have come across which use TTF, are situated in the non-EU domains. Moreover, they rely upon user reported measures regarding the task. Gebauer and Tang [2008] have investigated the role of mobility in task-technology fit. The dimensions of the tasks were non-routineness, interdependence (of various tasks within an organisational context) and time-criticality. The study used data from business users and employed self-reported measures such as, "My job is interdependent with the jobs of other individuals and organizational units' ' (for interdependence). Klopping and McKinney [2004] have used TAM in conjunction with TTF to model E-commerce with respect to undergraduate students. It used questionnaire around the activity of shopping such as "On average, how frequently do you use the Internet for your shopping activities?” On the other hand, there is an instance, in the work by D’Ambra et al. [2013] where they evaluated the adoption of e-books by academics, where factors governing the task-technology were identified using qualitative studies.

In order to study Technology Adoption by the Emergent Users, and design meaningful artefacts from them, a focus on the triad of User, Artefact and Usage is required. However, that would not be sufficient. It would also be required to understand *exactly* in what manner these three affect each other. It is to ask, *“What makes a specific user not being able to use a particular artefact?”* The answer would require characterisation of the usage as well as the user and the artefact. Doing so would need a context-specific understanding of the issues. For example, asking *“Why an illiterate user is not able to use Account based applications?”* or *“In what manner a user with a given education level would use an Account based application?”*, would require us to understand the cognitive challenges presented by the application, and the role of education in the development of the capabilities to meet them. As the EUs contexts are varied and their issues are likely to be unprecedented, it is also important to investigate which issues are important for a particular context, and which are not.

3.7 Summary

Diffusion of Innovation (DoI), Technology Adoption Model (TAM) and Task-Technology Fit (TTF) are three important theories of Technology Adoption. The roots of DoI are found in the work of Tarde [1903]. His ‘Laws of Imitation’ provide a basic idea about how new ideas spread within a society. These ideas were employed by rural sociologists in the 1950s to study how corn producers in rural Iowa in the USA had adopted new varieties. These later formed the basis of the DoI theory according to which, diffusion occurs in the fashion of an S-shaped curve. It starts slowly, speeds up in the middle and then attenuates again. The whole span could be divided into categories where each category could be associated with a particular user-type. The users who adopt earlier are risk-taking individuals while the later ones are risk-averse. Often one category of users adopts a product by imitating an earlier category. However, there are chasms at one or two places where the transition becomes difficult.

TAM model is based on the premise that a positive intention to use an artefact is a fair indicator of future adoption. The intention is a result of two factors–perceived ease of use and perceived usefulness of the artefact. These two factors depend on many measurable self-reported factors like (but not limited to) self-efficacy, subjective norms, computer anxiety and result demonstrability.

According to TTF, a fit between the technology and the task (necessary for successful adoption) would happen only if individual capabilities and needs of a user matche the task requirement of the artefact.

Chapter 4

Literature Survey: Interaction and Expertise

4.1 Introduction

As we have discussed in section 1.10, different users are likely to achieve different levels of Technology Adoption. Some are likely to be skilled, some novice and many in between. Therefore, it becomes important to understand what helps a user acquire a particular level of proficiency, and what impedes her progress beyond that level. To do that we take help from established models of Skill Acquisition and Skillful Behaviour. We have considered three. These are the SRK model of Rasmussen [1983], the generic model of Dreyfus and Dreyfus [1980] and the HCI-oriented framework by Hackos and Redish [1998]. These three models have contributed strongly to the User-Usage model proposed by us[1]. However, in order to have a good understanding of these models, we deem it important to discuss a few additional concepts. The first of these is Task, followed by Cognitive Architectures and Mental Models.

In this chapter, we have remained limited, more or less, to explaining and describing the topics. We would delay the critiquing of these issues from the viewpoint of ICT usage by EUs until chapter 6 when we define the User-Usage model and where we have the

[1]It is detailed in chapter 6

advantage of insights from the analysis of the contextual user studies (chapter 5).

4.2 User-Artefact Interaction

The core of ICT usage is the interaction between the user and the artefact. Therefore, for understanding usage, we need to understand the interaction between the user and the artefact. At this level, the concept of task becomes important. Task has its own details—within the realm of task, its own planning is an important aspect, and to understand that we have discussed the two concepts, Cognitive Architecture and Mental Model.

4.2.1 Task

> ...artefact reveals itself to us fully only in use. (Carroll [1991] - p237)

ICTs are artefacts and therefore meant to be used. Using an artefact requires human action. For example, using a light bulb requires physically pushing a switch. An action is an outcome of some desire which could be expressed in form of a concrete goal. In this example, the goal is to have (more) light. Most goals cannot be fulfilled by a step as simple as putting on a light switch. They are fulfilled by executing sequences of discrete steps. Each step in the sequence could be accompanied by some cognitive effort such as evaluation of a state or taking a decision. For example, sending of an SMS requires many steps—navigating till the 'Create Message' item from the menu, checking the position of cursor, formulating the text in the mind, finding the right key for a given letter, checking if the character is correct, and once the typing is complete, searching for a recipient's name, inserting it and then pressing the send button. This sequence of steps, including both physical and cognitive actions, for fulfilling a goal, using a tool is called a *task*.

Tasks involving ICTs are inherently very complex. This is because, ICT artefacts like computers and their derivatives, including mobile phones, ATMs, Set Top Boxes, IVRs etc., are basically cognitive artefacts, that is, they are:

> ...(an) artificial device(s) designed to maintain, display, or operate upon in-

formation in order to serve a representational function. (Norman in Carroll [1991]–p17)

ICTs, as cognitive artefacts, are highly representational in nature. They either represent a virtual world having its own architecture (for example, a spreadsheet), or representations of a real world (for example, an aircraft's head-up display). Whereas in the case of non-ICT artefacts, there is a sense of 'reality' involved, with computers, everything depends on how coherently the representations are understood. Moreover, the internal architectures of computers are structured according to abstract mathematical principles, which may not have a physically representational equivalent. The internal architecture is separated from a human by a representational layer called *conceptual model*[2]. It can make tasks easy if designed well, and vice-versa.

Discussing task is important from the perspective of Technology Adoption. As has been discussed in section 1.5, adoption is nothing but a sustained usage. Then, what is usage? Usage is the execution of the tasks for achieving the goals. Therefore, task becomes a critical unit of analysis of Technology Adoption. Tasks inform about usage in many ways. Tasks, firstly, illuminate the relationship between the user, the artefact and the situation/context. This is because tasks are tightly connected to all of these (see figure 1.1). For example, analysing *'how and why someone uses WhatsApp'* would bring forth the design of the artefact, the human capabilities and dispositions, and the socio-cultural context. Secondly, tasks could be 'walked through'. By doing so, they could provide a richer understanding about artefacts, their users, usage and contexts than those provided by simple observations and interviews. Thirdly, tasks provide valid signs of artefactual failings. It is because the performance of a task is the dynamic behavioural dialogue between the user and the artefact. It is as direct as it could be and is difficult to fake. The failings themselves may reveal deeper issues pertaining to the misfit between a given design and a user, his needs, capabilities and context. Finally, It is very difficult to ascertain a user's level of competence—important in the context of this work—without actually observing a task. Only through task-observations, the breakdowns and resistances in usage could be ascertained. Other ways, for example, examination of artefacts or self reported perceptions might not be as valid.

[2]We term it Designed Conceptual Model (DCM) as has been described in section 5.3.2 of this chapter.

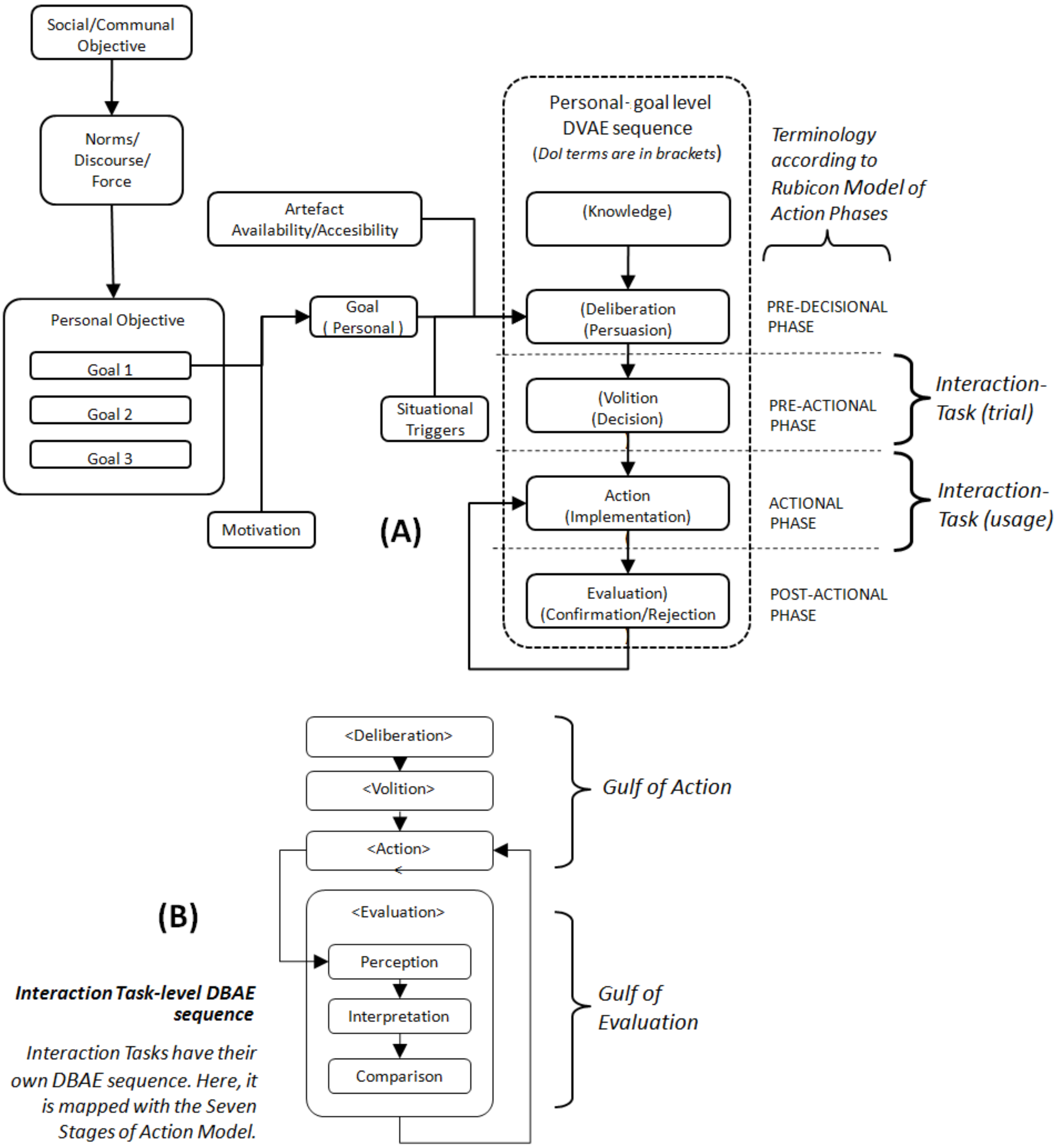

Figure 4.1: The context of a Task

Tasks do not exist on their own per se (see figure 4.1). They are embedded in a person's life objectives, which in turn, in the social context. A student paying college fees using a banking application would be doing so because he has a life-objective to acquire education. Life goals are often derived from the objectives of the society and the community, and are mediated through the norms, discourse or force. In the student's case, for example, acquiring an education is important in order to be able to live and function in a society.

A particular personal-objective may be composed of many goals. For example, acquiring education would consist of goals such as financing, studying and logistics. Personal-goals are strengthened and sustained by motivation (we detail out motivation in chapter 5). Each of the goals could be broken down into a hierarchy of sub-goals. The lowest level of goals would be the ones which could be converted into tasks, which in turn, may require an artefactual mean[3].

How is a goal (that is, a personal-goal) achieved by using an ICT artefact? How is it formulated as a task? Are their any mental processes involved? To understand we take help from innovation-decision process under the DoI model of Rogers [1962] (explained in section 3.3.1) and from the Rubicon model of Action Phases by Achtziger and Gollwitzer [2008]. We have reformulated our readings as Deliberation-Volition-Action-Evaluation (DVAE) sequence and it is explained as follows (please refer to (A) in figure 4.1) :

Deliberation The implementation of a goal requires that the user has a knowledge about the artefact. The knowledge could happen over a large period of time through a social network or other channels such as mass media. However, the process of the actual decision-making starts with a deliberation (it is termed as the persuasion stage in DoI model) over the artefact and its fit to the goal.

[3]According to Activity Theory (see Kaptelinin et al. [2003]), the entities related to the sense of doing are conceptualized as a three-level structure. Activity is at the highest level and is directed at towards the collective objective such as paying fees, which involves by the parent, the student, the college staff, all of which will be interested in 'paying of the fees' to be accomplished. Action is at the next level. It is conducted by an individual. The act of transferring funds by the student is an example Actually, Activity is composed of many and, more importantly, coordinated actions. It is directed at goal (paying the fees), which is more concrete (less fluid) than an object (getting educated). At the lowermost level are Operations, which are discrete procedures driven by the conditions and tools of action.

The deliberation phase maps to the pre-decisional phase of the Rubycon model. In this phase, according to it, the user weighs many questions such as the feasibility and consequence of the desired outcome, the comparison between alternative ways of achieving the goal, and the availability of efforts and resources. Completion of this phase results in the formation of an intention—a favourable attitude towards using the artefact for the goal.

Our field-studies have informed us that the deliberations about using a particular ICT artefact to accomplish a goal are initiated due to *triggers*. Arising out of a particular situation, a trigger (also discussed in section 6.1) could be defined as a state in which a person realises that he needs to accomplish a goal through a given mean. For example, the student may realise that the last date of payment is the next day, which is a holiday too. That means, the banks would not open before the last day. This may trigger the usage of a banking app. We have observed[4] triggers during the contextual studies. For example, the marriage of the daughter triggered the decision of a mother (user UJN05 [60, F, illiterate, Elderly Housewife] [5] to buy a mobile phone for herself rather than keep using the family phone. The need for one-to-one talk between the mother and the daughter was suddenly brought forth by the changed situation resulting from physical separation due to marriage. Availing a personal phone had surely defeated many other possible options, like personal visit or letters, or using the family phone.

An important component of the deliberation phase is the *method-uncertainty resolution* (our term). In Section 3.2, while discussing 'Laws of Imitation' by Tarde [1903], we have mentioned that 'micro-duels' happen in the mind before a decision to adopt a new idea. It is the same thing but with respect to the initiation of a task (achievement of a goal through a given mean) for the first time. The uncertainty is between finding a new way to accomplish a goal (if attempted for the first time), carrying on with an old way, or opting for an alternative. In the case of money transfer scenario, there would be an uncertainty if banking app and the bank's branch both offer a similar advantage. Let us assume that the younger son of the person (who sent money to the elder son) is tech-savvy and can operate the banking app for his father. On the other hand, the bank branch has a staff who is

[4]please refer to chapter 5 for a detailed discussion

[5]The contextual examples are from Chapter 5, see Table 5.2 for the particulars.

friendly to the person. As methods are weighed against each other, the one that weighs better in terms of effort-efficiency will be taken up. Method uncertainty resolution is not a one-time process. This is because situations keep changing. Firstly, the goal itself may transform. User DVG05 [36, M, X^{th}, Politician][6] had used a voice recorder on the mobile phone for the first time when his child had started babbling. Becoming a father must have transformed many of his life goals. Secondly, the effort-efficiency of various means might also change over time. User AMB09 [27, M, VII^{th}, Woodwork painter] had bought a new phone (from a different company than the older one). Because of the unfamiliarity with the new device, he found it difficult to delete SMS which he could do with ease in the earlier one.

Volition Once method-uncertainty is resolved in the favour of a given artefact, the user needs to plan how to procure and use the artefact. According to Zhu [2004], the intention is merely a favourable attitude towards an activity, while volition is actually 'trying it out'.

This phase is termed as Decision in the DoI model, and according to it, in this phase, the user attempts to use the artefact by trying on its own or by observing others. It maps with the Pre-Actional phase of the Rubycon model, according to which it is a 'no going back' stage, in the sense that the user has committed to a particular means of accomplishing a goal and would now seek formulation of a plan to do it.

This is the phase where the task will appear for the first time because it involves trials. Trials are actions, though exploratory. 'Trial' also indicates that a user is likely to be a novice and would struggle during this phase. For example, user PDR05 [30, M, IX^{th}, Worker], a Tamil speaker, had tried to change the phone language from English to Tamil but ended up with Arabic. He was unable to change back to English for the next 10 days. User DVG08 [39, M, X^{th}, Hotel Owner] had to 'catch' a 5 AM bus so for the first time he tried to set an alarm. He had set it for 3 AM. The alarm had started ringing at 3 AM. However, he was not able to snooze it. So, he had switched off the mobile and removed the battery.

[6] Refer to Table 5.2 in Chapter 5 for a concise description of this user and others mentioned henceforth in this chapter.

Usage of ICTs is our focus. Therefore, in the rest of the section, we would differentiate the tasks pertaining to *goal-oriented user-artefact interaction* from the other types by specifically terming them as 'Interaction-Tasks' (see figure 4.1). Interaction-tasks need an expansion of their own and that has been done using Seven Stages of Action Model of Norman [2013] in Section 4.2.1.

Action This phase, called Implementation (DoI) or Actional Phase (Rubycon), involves enactment of the plans formulated in the last phase. This is the phase where the interaction-tasks will actually be performed. In Figure 4.1, they have been attributed with the word 'usage' to indicate the actual usage. This phase does not ensure adoption of the artefact, it only means that the user has accomplished the goal for the first time in a meaningful way using the artefact. The ultimate adoption would depend if the user sustains its usage over a long term. As has been briefed in section 1.3, only a sustained usage would ensure the proficiency required for the fullest meaning of usage.

Evaluation DoI terms it as Confirmation stage and Rubycon model as Post-Actional. However, it would be appropriate to think it as Reinforcement or Attenuation stage. This is because it signifies the strengthening or weakening of the attitudes towards the interaction-task due to repeated experience with the tasks. If the task fails to deliver value with respect to the efforts, the attitudes would worsen. Otherwise, they would help sustain the usage. For example, user DVG04 [45, F, VIIth, Tailor] did not sustain the usage of Marathi, her mother tongue, as phone language. Her phone had English as the default phone language. She had tried to change it to Marathi once but reverted back to English very next day. She had found that she was comfortable with English.

Seven stages of Action

The interaction between the artefact and the user is central to our approach towards Technology Adoption (see Section 1.6), therefore we would detail the interaction-tasks. We would do so using the Seven Stages Model (7SM) of Norman [2013] which is based on a cognitivist view of task. It is important to distinguish between the higher level personal-goal (such as transferring money), and the lower-level task-goal (actually using an artefact to transfer money). While the latter is embedded in the former, it is exclusively related to a user's interaction with an artefact. Therefore, the scope of this model is limited to user-artefact interaction and leaves out the broader details of the situation.

One should also note that a task is made up of sub-tasks in a hierarchical fashion. Transfer of money online, for instance, consists of many sub-tasks like logging into the account, checking balance, and making actual payment by specifying the recipient and the amount. A sub-task would have its own sub-tasks. Making a payment would further require selecting the recipient's name and typing in the amount. The tasks, as well as the sub-tasks at various levels of the task hierarchy, will have their own deliberation-volition-action-evaluation (DVAE) sequence. (Interaction-)task level DVAE sequence should be differentiated from the DVAE sequence existing at the personal-goal level (compare(A) and (B) in figure 4.1).

According to this model, any task involves two distinct phases. The first phase leads to execution, while the second involves evaluation of the success of the execution. Both the phases are made up of three steps each. The difficulty of completing the former is called the *gulf of execution* and the latter, the *gulf of evaluation*.

The first step in the execution phase is the *'formation of a task-goal'*. The task-goal results from the user's personal-goal. In an example provided by Norman himself, if a user, while reading a book, finds that the light is not adequate, he will form a task-goal—how to get adequate illumination. In the case of the student's example, it will be how to transfer money using a mobile phone application. Within this task, a sub-task would be to select a beneficiary's name.

Subsequent to task-goal formation, the second step is the formation of an intention (we could say *'task-level deliberation'*), and that is to identify the possibility of accomplishing that task-goal. In this example, a user finds that there is a lamp beside him (though he could have found other possibilities, for example, noticing that there is a window). In the case of the student, it will be trying to find out the best way to complete the task and its sub-tasks through the artefact. In the trial stages, he could take help of somebody else or try figuring out by himself. Suppose, the student has his own smartphone, he will have to figure out whether to use the banking application or the web portal, or he could deliberate between applications from two different banks. At a subtask-level of selecting a beneficiary, the user could deliberate between typing in a search box or selecting from a list. By the time the user reaches the usage stage, he should have sustained the usage for a sufficiently long time period (for example, months). Then, because the user would have learnt the task well and therefore the habit would have set in, the intention is likely to be instantaneous. However, this could change due to a novel situation (for example, the given bank's application fails), or the user could is motivated enough to explore more efficient and creative ways.

Just identifying the possibility to accomplish something would not complete it. The intention must be translated into a sequence of loco-motor actions. But even before that, these very sequences of actions need to be simulated in the mind. Therefore, the third step before the execution of the task-goal is the specification of the actions (task-level volition). In the case of Norman's example, the user identifies that he needs to walk up to the lamp, identify the switch and press it. Using an ICT artefact, such as a mobile phone banking application, is more complex than lighting a lamp because the sequences and the rules involved are complex and would result in a fair amount of cognitive load.

Once the action (or, rather the sequence of actions) is accomplished, the user must evaluate whether that has resulted favourably or not. He must enter the execution phase. The first step is perceiving the state of the world. A user recognises that something is changed. In our example, he sees a change in the illumination level. Still, whether that change is favourable or not requires making a sense of the new world which is presented by perception. Therefore, the second step is called interpreting the world. In case of an electric lamp, the leap between perception and cognition is instantaneous; it may not be that simple with ICT artefacts. For example, while navigating a menu when one selects an option, there is a change in the status of the machine and we are taken to a different state. However, merely the perception of a changed state is not enough–we have to put some effort (often in terms of reading) to understand where we are.

Finally, when the state of the world is cognised, it is evaluated against the original task-goal. Thus, a user tries to evaluate whether the light is still amenable to reading or not.

Or, he ascertains whether a money transfer has happened or, at a sub-task level, the right beneficiary has been selected or not.

The most critical and complex step in the execution of a task is the formation of task goals. It results in a high amount of cognitive load. The users' ease or difficulty in doing tasks depends largely on his ability or inability to formulate the task in mind. How does that happen and what types of barriers are encountered in doing so? Cognitive architectures and Mental models may help us understand better.

4.2.2 Cognitive Architectures

ICTs are 'cognitive artefacts'. An understanding of cognitive load is necessary. To do that we take help of formal models of information processing called Cognitive Architectures. We discuss three of them.

Model Human Processor (MHP) According to Model Human Processor (MHP) (of Card et al. [1986]), the cognitive faculty of a human being could be considered to be analogous to a modern computer. It consists of memories, processors and their interconnections. The memories are of three kinds. The first kind, the long-term memory, stores information for longer periods but (like a hard disk) accessing it is slow. The second, the working memory (WM), is (like a RAM) where information is temporarily stored for processing. Access to this memory is fast but the information cannot stay permanently. The working memory communicates with the long-term memory (LTM) whenever it needs some information for processing or has to store some other for a long term. The third type of memory constitutes very small and volatile buffers associated with processors which are of three types. The first, the perceptual processor, converts the auditory and visual input into internal (that is, mental) representations. Both types of information pass through separate channels to reach separate visual and auditory image (buffer) stores of the working memory. The second, the cognitive processor, does problem-solving. It takes help from rules or schemas stored in the long-term memory. The third, the motor processor, controls the muscles. In an MHP, a sensory input coming to the sensory system is converted into an internal representation and buffered in the sensory information store. It is then passed on to the working memory for meaning-making. The capacity of the working memory is limited. Therefore, the meaning-making process has inherent constraints.

Adaptive Control of Thought–Rational (ACT-R) ACT-R of **?** envisages the cognitive apparatus as a set of modules, each responsible for a different cognitive function. The core of the apparatus is the *procedural* module which is responsible for production-rules which are algorithmic in nature. This module stores procedural knowledge as well as coordinates all the other modules. As for the other modules, the *control* or goal module keeps a track of current state of a task. It informs 'where one is', 'how much remains' and 'what next needs to be done' within a task. The *problem state* (or imaginal) module stores intermediate pieces of information. The *declarative* module processes declarative (fact oriented) knowledge. In addition to these, there are two modules for *perception*—one each for visual and aural. The two modules produce the *response* to the environment. One is vocal (responsible for speech) and the other is manual (the one controlling muscles).

There are two types of units of knowledge. Chunks are units of declarative knowledge, while (the algorithmic type) productions-rules represent the procedural knowledge. The latter type is responsible for action. Each module, except the procedural one, which is the coordinator, is supplied with its own buffer. The buffers temporarily store declarative-chunks, communicate with other buffers and relays information to their respective modules.

By analysing the examples provided by Anderson [2005], we can demonstrate how a task is processed according to ACT-R. A task is loaded as a production-rule in the procedural module. Every statement in a production-rule results in some action such as decomposition into sub-task (by the procedural module itself), identification and recognition of an object (by the visual module), storing of a temporary result (in the imaginal module) or an action (by the manual module). As the plan is executed, the control module keeps monitoring it. Meanwhile, depending on the need, declarative-chunks are retrieved from or stored in the declarative module.

Executive Process-Interactive Control (EPIC) The core of EPIC (by Kieras and Meyer [1997]) is a production-rule based cognitive processor. It is made up of a working memory and a production-rule interpreter. The working memory is the temporary memory needed by the interpreter. To assist the cognitive processor, there are two long-term memory stores as well–one for declarative knowledge and one for procedural. The cognitive processor is the heart of the system and is connected to different kinds of perceptual and motor processors. The perceptual processors deal with data received through ears (auditory), eyes (visual) and touch (tactile). The motor processors are manual-motor (controlling muscles of hand), ocular-motor (controlling muscles of eyes) and vocal (for processing speech). The motor processors also have feedback loops to central cognitive processors. That means, if the central processor commands a motor processor to move a muscle, it also gets to know how it was moved. All the processors (including the cognitive) can run in parallel and process various message pipelines simultaneously in a multi-threaded manner. In this architecture, the interfaces with the external environment— for vision and sound (such as displays and speakers) and motor activity (manual control and input devices)—are also represented as processors.

The cognitive processor works in cycles. At the start of a cycle, the inputs from perceptional processors are loaded into the working memory. At the end of the cycle, the commands are fired to the motor processors.

4.2.3 Cognitive Load

Cognitive load is the total effort at mental processing required to complete a task. It becomes a concern when it exceeds the capacity of the cognitive apparatus to process information. With the help of the above three cognitive architectures and two theories (following below) of Cognitive Load, we try to understand cognitive load.

According to Sweller (in Sweller [2014]), working memory (WM) has inherent limitations. Firstly, as Miller [1956] had discovered, WM can only hold 7 chunks of information at a time. Secondly, the content of WM decays in 20 seconds. However, these limitations only concern novel information received through perception and not that retrieved from the long-term memory (LTM).

Other modalities of cognitive load are discussed by Mayer and Moreno [2003]. There are

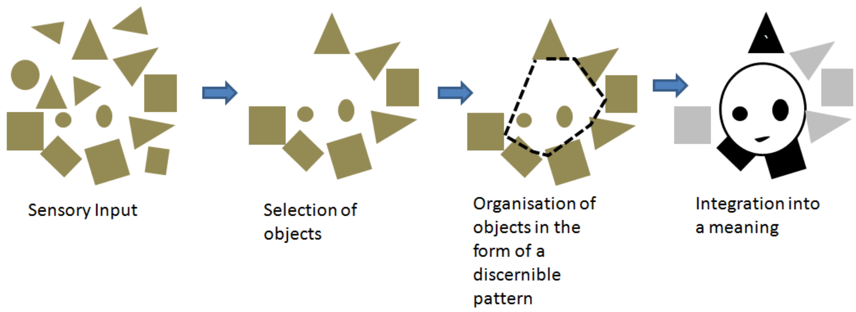

Figure 4.2: Sense-Making

three types of information processing. *Essential processing* is related to sense-making of the material presented. It includes sub-tasks such as selecting, organising and integrating items. For example, while seeing, depending upon the task, some objects are focussed upon, while others are neglected. Subsequently, the selected items are related to each other as patterns and their meanings are interpreted (see figure 4.2). *Incidental processing* is a non-essential one that happens because some extra but non-essential perceptional cues (visual or aural) are present. For example, for a person writing a letter, two other people talking might induce additional but unnecessary processing. *Representational holding* is needed to hold the perceptional cues in the working memory. A cue is first converted into a representation (for the sake of efficiency, our interpretation). For example, a person reading a book has to 'hold' the representation of (the information contained in) the current paragraph when he leaves the page to find the additional reference. Cognitive load happens when the sum of the three types of processing exceeds the capacity of the cognitive system. The capacity of individual perceptional channels are also limited, and all the three type of processing can overload them.

We use cognitive architectures (mentioned earlier in this section) to understand (and reframe) Seller et al's as well as Mayer's analysis. We list all the possible sources of cognitive load:

- Buffer Overload: The individual buffer memories which constitute the perceptional processors are overloaded, resulting in corrupted or no information reaching the working memory.
- WM Overload: The working memory cannot handle the number of symbolic representations reaching from perceptional processors.

- WM Choke: The information arrives too fast to be processed by the working memory.

- Schema Inadequacy: There is no or inadequate schema to convert the perceptional cues to symbolic representation (to be passed on to working memory). In that case, many arbitrary schemata would be retrieved from the long-term memory and tried against the perceptional cue one after the another till one of them fits in some manner. If no schema is found, or at the junctures where a schema fails, production-rules shall be sought (see, Rule Inadequacy below).

- Rule Inadequacy: There are no production-rules in the long-term memory, so arbitrarily rules need to be generated by the cognitive apparatus. Also, every arbitrarily generated production-rule has to be simulated in mind or tried out as actions. Needless to say, it will be a trial and error process.

4.2.4 Mental Models

Mental models play an important role in the learning and usage of ICT artefacts. A mental model is a schematic representation, drawn up in mind, of a problem space (either an environment or an artefact).

Mental models are not limited to the usage of artefacts. They are quintessential cognitive mechanisms important for functioning[7]. The problem spaces that an organism deals with, such as a forest environment, a political scenario, a scientific problem or a piece of machinery, are complex, dynamic, and many a times novel in nature. Mental models are mechanisms for operating in these problem spaces by helping in their description, explanation and prediction. According to Rouse and Morris [1986]:

> Mental models are the mechanisms whereby humans are able to generate descriptions of system purpose and form, explanations of system functioning and observed system states, and predictions of future

Norman showed the relevance of mental models in the following way–

[7] Tolman et al. [1948] had demonstrated that rats use 'cognitive maps' for survival

> people's views of the world, of themselves, of their own capabilities, and of the tasks that they are asked to perform, or topics they are asked to learn, depend heavily on the conceptualizations that they bring to the task

Actually, mental model research occupies the larger sphere of reasoning. Reasoning is normally associated with mental logic. However, Craik [1967] suggested that reasoning is carried out with the help of small-scale models of reality that are constructed by mind. He stated that such a model–

> ...works in the same way as the process it parallels ...need not resemble the physical model pictorially...(p51)

Later, Johnson-Laird [1983], too, adopted a similar view:

> If you know what causes a phenomenon, what results from it, how to influence, control, initiate, or prevent it, how it relates to other states of affairs or how it resembles them, how to predict its onset and course, what its internal or underlying "structure" is, then to some extent you understand it......The psychological core of understanding, I shall assume, consists in your having a "working model" of the phenomenon in your mind.

We shall attempt to exemplify mental models through this scenario—an animal hunting in the forest. In such a scenario, 'What to do next'–is a recurring question in the quest for survival. This question would have extensively numerous number of answers because the shape of the environment changes continuously. One way would be to remember all the answers that have been gathered through experience or learnt from the others. However, that will result in too many answers to be of much use. Another strategy, remembering a set of rules will be futile either because it can be inadequately small or too large to be processed. A lion in a complex and shifting jungle environment can neither afford to learn all the rules of engagement with its environment nor it can operationalise such rules efficiently. This is where a mental representation of the environment becomes helpful. During a hunt, it helps the animal coordinate with its peers simultaneously dealing with a treacherous physical setting and with a quickly changing scenario. Mental models provide the animal with an efficient mechanism to 'model' the situation in such a way that it can *mentally manipulate* it to arrive at his next course of action. Craik [1967], states the same phenomenon but in the following way–

> the organism carries a 'small-scale model' of external reality and of its own possible actions within its head, it is able to try out various alternatives, conclude which is the best of them, react to future situations before they arise, utilize the knowledge of past events in dealing with the present and future, and in every way to react in a much fuller, safer, and more competent manner to the emergencies which face it.

Obviously, mental models are employed in modelling of the human environments which are much more complex than those of animals. When Toffler [1990] states:

> every person carries within his head a mental model of the world – a subjective representation of external reality (p. 139)

it is about contexts that go beyond immediate physical environments and include social, cultural and political ones.

The 'material' for building up a mental model comes from known domains. A person seeing a text editor for the first time would scan in his memory to find 'what it is like?', and might end up with a typewriter. Thus, mental models depend on mind's contents, not it's structure[8]. A purely structural perspective of cognition would only tell how much difficulty a user would face in typing the next character on a text editor, it would not inform what would the user make out of a text editor if he has never seen a typewriter.

Because mental models depend upon known domains, they run a chance to be incomplete. A typewriter would never completely describe a text editor. For example, a user would be perplexed to find that some keys erase instead of adding a character. As a result, the user has to fill the gap with some other model. Often, users employ many fragmented models[9] to deal with a novel artefact. A text editor could be understood, depending upon what aspect is to be understood, to be like a typewriter, a typesetting chase (frame) as

[8] Being based on an agent's experience, beliefs and knowledge, they are not simply cognitive architectures (like the way formalised by SOAR (Laird [2012]) or ACT-R (Anderson [1996])

[9] See Collins and Gentner [1987]. They have demonstrated how people combine many mental models to understand and explain physical phenomenon.

well as a writing scroll.

In this work, we are more interested to study mental models from the perspective of ICT artefacts. Mental models of ICT artefacts could be understood better by imagining a problem space (which is essentially the artefact) consisting of many states. Every state is a configuration of various elements and their interdependencies. A desktop calculator has various types of memories and (arithmetic) processors. At any instance during its operation, each of them would store a number or be empty. The overall configuration of its memories and processors and their content at a given time during an operation is an example of a state. The inherent rules would govern whether a state will remain static or change to a different configuration, both on its own or as a response to an action by a user. For example, a number punched on the calculator would change the value stored in some position in the memory, thus changing the overall state.

Now, the criticality lies in the fact that actual arrangement of a system (interdependencies, configuration and rules) are opaque to a user as the artefact is manipulated via an interface. Therefore, the user cannot deal directly with the problem space. It has to deal with it via an interface. However, an interface, too, could be cryptic for a user. If it is indeed, then, how does the user achieve a goal? One way is to memorise a rule, which could be as simple as remembering a set of sequences or remembering an elaborate and complex 'if-then-else' rules. However, memorising rules does not prepare a user to meet with unexpected contingencies or explore the usage in a creative manner. Moreover, elaboration of rules increases cognitive load manifold. Therefore, the other option is to form a mental model of the device. Formation of mental models helps a user understand an artefact much more comprehensively than is possible through rules. It also helps her predict its behaviour and explore possibilities. For example (see Figure 4.3), a simple rule-based routine for sending an e-mail does not allow a user do anything beyond its limits, whereas a user with a good mental model can ask and answer questions like, 'Could the mail get stuck at the post-office?' or 'How can an older message be searched?' When a user with a good mental model is offered a similar but novel ICT artefact, he would not have to learn a fresh set of rules because the existing mental model would provide him with an initial understanding to start with.

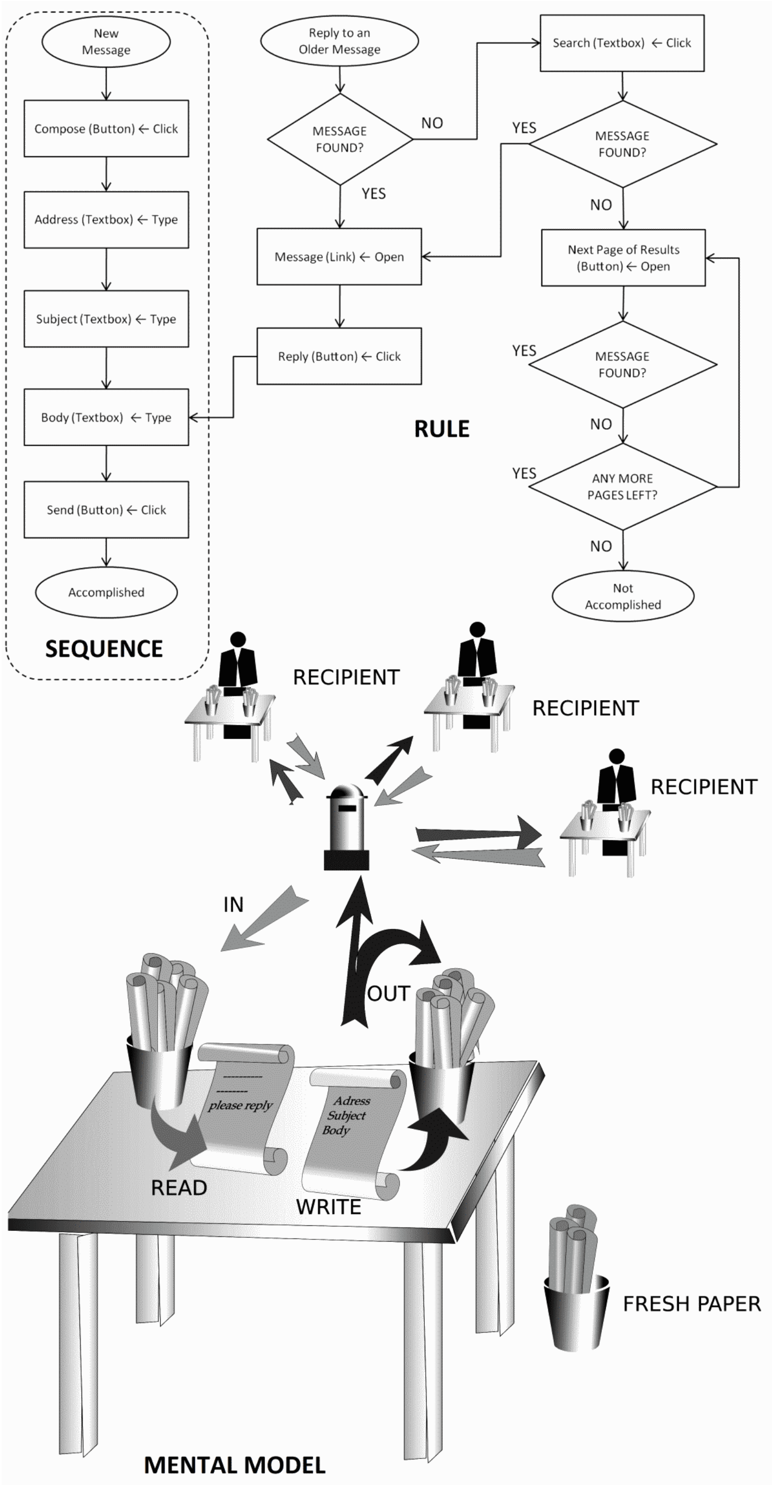

Figure 4.3: Difference between sequence, rules and mental models: At a basic level, users memorise the sequence of steps in order to accomplish a task. In this case, therefore, there is no real mental model. At a still better, level the user can memorise rules which help in deciding course of action when choices are available and are recognised. However, the cognitive complexity will increase with more rules. Mental models provide a richer detail without increasing cognitive complexity.

Design of an interface plays a role in the formation of mental models. Here, the differentiation (see Norman [1983]) should be made between the three variations of mental models[10]–

- Mental models in a generic sense.

- User's self-conjured representation of an artefact resulting from her experience, beliefs and knowledge.

- Representations consciously constructed by a designer that is communicated through design or help material.

To avoid confusion, we will use a different terminology than used by the other researchers. For the generic meaning, we will continue with the word 'mental model' (MM). With respect to a user's self-conjured mental model, there could be two cases. In the first case, a user deploys a fresh but random model on encountering a new design. We term this type as 'Arbitrarily Imported Model' (AIM). If the user has domain experience, the AIM has a better chance of fit, because domains determine the tasks and so are reflected in the design. In the second case, the user has the benefit of a mental model resulting from experience with an artefact that was similar to the one in hand. This we term as 'Device's Experienced Model' (DXM). Finally, for conceptual models designed by designers and which becomes apparent to a user before he could project any other model is to be called 'Designed Conceptual models' (DCM). A DCM could be a result of a non-deliberate and arbitrary process or it could be designed consciously employing principles of usability. DCM mediates between the domain of the user and the internal representation of the artefact (see YSS model below in this section). If a DCM is inappropriate a user would not be able to fit his knowledge of domain over it and would have to bring in his own scheme for mediation, increasing the cognitive load during learning.

There are many perspectives regarding how mental models are constructed. According to Johnson-Laird [1983] (language like) prepositional representations give rise to (picture

[10]The words 'mental model' and similar terms like 'conceptual model' and 'cognitive model' have come to ambiguously represent many things. Staggers and Norcio [1993] inform that many times these are used synonymously.

like) mental models (for example, see Figure 4.4).

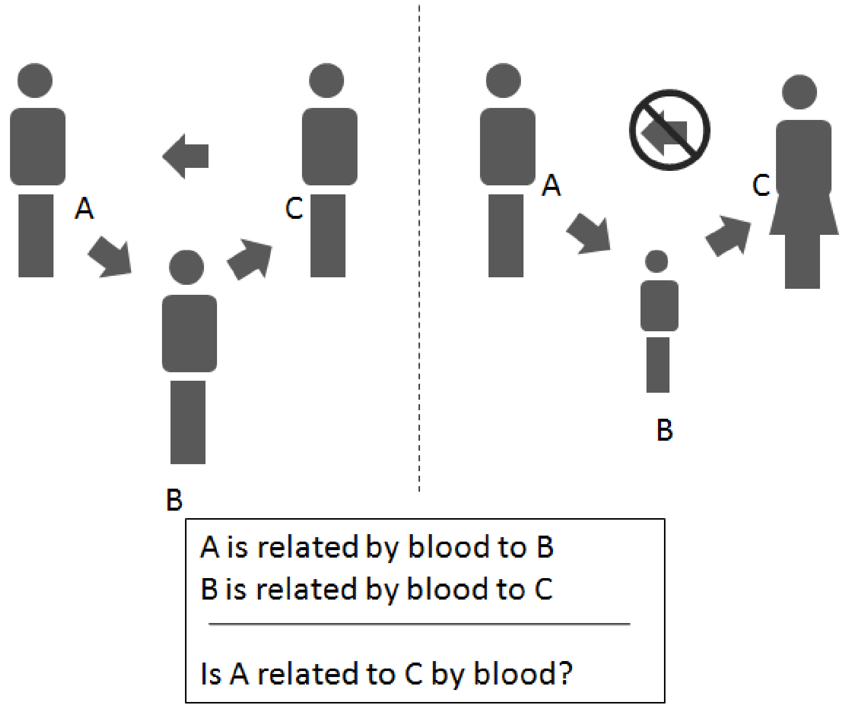

Figure 4.4: According to Johnson-Laird [1983] semantic prepositions are used to construct mental models. Mental models have an advantage over logical reasoning because they are based on knowledge. A simple proposition (as shown above) would yield in two mental models depending upon the nature of the relationship. (example from Johnson-Laird [2010])

Collins and Gentner [1987] have found that generative analogies play a large role in the construction of mental models. According to them, there is a mapping function that happens from a familiar (base) to an unfamiliar (target) domain. This involves mapping of the objects as well as their relationships. Using verbal protocols, they have demonstrated how subjects use the knowledge about fluid flow or objects moving through a chute (base domain) to answer questions about voltage and current in electric circuits (target domain).

According to Young [2014], mental models are constructed in eight ways. In his typology, a mental model could be based on a *'strong analogy'* if there exists an artefact (À) which looks and works in a way similar to the one in question (A). Therefore, the mental model of the former (À) could be used to operate the latter (A). An example of this kind is when a text-editor is considered to be like a typewriter. In the case where such a substitute is absent, then an analogous model, either physical (like a scaled version) or notational (as a schematic representation on paper), could be built to emulate the working of the artefact in question. In that case, the model is termed as *'surrogate'*. In a different manner, the substitute model, instead of representing the working of the artefact, models the users' tasks. This is termed as *'mapping'*. When the model of a text editor is described in terms of paragraphs, words or sentences (the task domain) rather than keys and cursor (the device domain), we find an example of this kind.

The above three models take a 'mapping' approach. Young describes other perspectives as well. Drawing upon schemata theory[11], he suggests that a person cannot remember accurately a set of incoherent facts. Instead, over a long time, the facts get structured in form of a schema. A schema is a general structure. The facts may be distorted to fit into a schema, or forgotten altogether. A schema-based model is termed as *'coherence model'*. We exemplify schema in HCI in the following way. A user striving to learn a text editor would find many new facts, some of which may appear incoherent. For example, one common learning would be that pressing a key prints a character and moves the cursor ahead. He would develop a schema around this 'fact'. However, later he would find that some keys do exactly the other way around. Then, there are some keys which do not do anything on the screen but act as modal and function keys. Therefore, the schema would have to be changed to incorporate the fact that keys have different characteristics and need to be differentiated into broad categories. For the next model, the *'vocabulary model'*, Young uses Physical Symbol Systems (PSS) of Newell [1980]. PSS suggests that learning a new concept which fits well into an existing 'vocabulary' is easier than one that does not. Whereas the former is a matter of assimilation and recognition, latter may result in misinformation of various levels of subtlety. Another model, based on the idea of Problem States suggested by Newell et al. [1972], is called the *'problem space'* model. According to it, the problems regarding the device usage are formulated in a formal sense. Here, the mind is considered to be an information processor. Starting from *initial* and ending into *goal* states, the problem-solving process passes through numerous possible intermediate states. The change from one state to the other is done through a set of operators but with certain constraints (for example, one cannot hold many chunks of information in the working memory). The representation of a task in terms of the initial and the final state

[11]schema theory is discussed in section 4.3 which is about skilled behaviour

depends on the capability of the individual. The next model termed as *'psychological grammar'* considers behaviour as a grammar with its own syntax. (see Reisner [1981] who employed Backus-Naur Form as a language to represent tasks). Like one can use a language to express a large number of ideas, 'behavioural grammar' could be employed to deal with many new situations. A person speaking or writing a language employs phonetic units and combines them in a hierarchical and modular manner to convey complex ideas. Similarly, behavioural grammar uses simple actions to solve complex problems. The last model is 'commonality model' which is the perspective of a psychologist, and is employed for explaining and predicting user behaviour, and is not aimed at making the task easier for the user.

Using yoked state space (YSS) hypothesis, Payne et al. [1990] state that the users maintain two spaces–the goal space and the device space. Goal spaces represent what a user would like to accomplish with a given artefact. In other words, it is concerned with the domain of the artefact itself. For a text editing task, the concepts of paragraph, sentences and words pertain to the goal space, while the device space covers characters, cursor and buffers. Both the spaces need knowledge, the former about the task and goals that need to be accomplished, and the latter about how a given device could be controlled. In order to accomplish a task, a user should be able to map the goal space to the device space. The goal space cannot be manipulated directly; it can only be controlled by using the device as a proxy. Therefore, the user tries to understand how a device could be controlled in order to manage the goal space.

Mental models provide important insights into the adoption of ICT artefacts by the Emergent Users. Mental models depend on earlier knowledge, experience and beliefs. If a user has less exposure to ICT artefacts because of lack of access, then he would be forced to use non-ICT domains to understand ICT artefacts. Exposure is a critical issue because it is through the struggle that a user starts to develop a model. This helps him in his subsequent use of the current artefact as well as any similar one encountered later.

The role of socialisation, especially schooling, cannot be understated in the development of mental models. Many formal concepts learnt in school, for example, tables and graphs, are used as informational-objects within the domain of ICT artefacts. A well-educated user is well exposed to these concepts and thus has a repertoire of ready-made models.

Given that the designers of ICT artefacts are not EUs, it is natural that often the conceptual models designed (DCM) by them are drawn from their own knowledge, beliefs and experience. This may result in inadequacy in terms of quality and range of the mental models that the EUs could draw upon. We shall deal with mental models and EUs contextually in the discussion of the user usage model in Chapter 6.

4.3 Models of Expertise

Any user who is offered a novel ICT artefact has to go through a journey (refer to Figure 1.3 in Chapter 1) from knowing nothing about it to being able to use it with some level of (whether low or high) proficiency. In this section, we seek to identify and characterise different stages within such a journey. For this, we take help from earlier works that look at the problem of expertise from three different perspectives. SRK framework of Rasmussen [1983]) is a typology of performance behaviour of operators in complex man-machine systems (such as power plants). The Skill Acquisition model of (Dreyfus and Dreyfus [1980]) is a generic model of skills and expertise acquisition by a skilled person (such as pilots and chess players). Stages of Use model by Hackos and Redish [1998] is particularly oriented towards proficiency of usage of ICT artefacts.

It is important to reflect that when we discuss skill acquisition, especially at high levels of expertise, we simultaneously deal with two very different, and to an extent antagonistic perspectives of human thinking and behaviour. The first—*cognitivist*—represents human thinking and behaviour as a rational and formal process that could be represented as symbols and rules. This theoretical perspective is highly influenced by theory of computers and asserts that all human thinking and behaviour could be represented in terms of processors and memories, just like modern computers. On the other side is the *phenomenological* perspective. According to it, human thinking and behaviour could not be reduced as the sum of parts. Rather, they are of the nature of being whole and in-the-world—they are "engaged, embodied and knowing-how, rather than knowing-that." (Darbyshire [1994]-p756). From such a perspective, expert thought and behaviour does not use calculative rationality but employ ‘intuitive response’ (Dreyfus et al. [2000]-p36). The thinking and behaviour are results of past experience at recognising archetypical situations. Dreyfus [1972] provides an example:

> as the learner experiences or studies many instances of weakness on the king side embedded in various contexts, each of these experiences producing activity patterns in the brain. The brain’s pattern of activity when the subject consciously assesses a situation as weakness on the king side, then probably resembles what is common to its activity during each of these concrete experiences. This commonality might be called the concept “weakness on the king side” and it may well admit of no higher-level abstract description.

This description is very different from that coming from the cognitivist perspective. A cognitivist would envisage chess playing to be devoid of context. Every move would be an independent entity involving a mental traversal through a vast decision-tree made in order to find an optimal path towards victory.

In the context of skill acquisition, the debate is not between whether it employs rule-based processes or ‘intuitive’ ones but around the position that *all* the thinking could be explained using rule-based models. The theory of skill acquisition (as we shall see further in this section) relies on both the modes–the earlier phases tend to be rule-based, while the advanced ones are intuitive.

Then the question arises–what are the mechanisms of intuitive thinking? How does it differ from rule-based thinking? In answer, researchers have attempted to differentiate between the nature of the two types. In the analysis of Kahneman [2011], the two types correspond to two simultaneously existing ‘systems in mind’ (ibid.) which he terms as System-1 and System-2. System-1 is fast, involuntary and intuitive, while System-2 is slow, voluntary and deliberative. Both the systems differ in their mechanisms. While system-2 works in an instruction based manner–it ‘can follow rules, compare objects and make deliberate choices’ (ibid.), System-1 works through ‘coherent association’. According to the author, we make associative linkages between the concepts and events that we encounter. The linkages between these concepts and events are then synthesised or engineered by the mind to fit into a ‘coherent schema’ (our words). The schemata subsequently become the framework for making sense of any future event or concept. For example, the combination of two words 'steel' and 'bird', though very different in their meanings could be brought together to mean a sculptural bird, a robotic bird or an aircraft amongst other things. However, the context would decide which schema will be selected, out of many, to interpret the combination. In the context of the superhero comics, 'steel bird' could mean the protagonist with his suite; in an aviation-related context, it could be an aircraft.

Another description of System-1 type thinking and behaviour is provided by Stanovich [2005]. He suggests that System-1 processes are not governed by a single system but by a set of multiple systems that he terms as 'The Autonomous set of Systems' (TASS). TASS works independently from the central system (conscious decision-making system) and can often override it. TASS automatically responds on receiving a domain related stimulus. This is because it relies upon associative and implicit learnings from the domain. When a stimulus is encountered, it independently (of the central system) executes a stereotypical small subset of knowledge. This is much efficient in terms of cognitive load than conscious processes.

It is also important to discuss schema theory of Bartlett [1995]. His concern is the act of remembering and how past experiences and reactions play a role in it. Schemata, according to him, are dynamic models built from past experiences and reactions against which new ones are evaluated. Interestingly, the new ones also mould or reinforce an existing schema, depending upon how consistent are they with the schema at hand. Any given schema is a result of reinforcement by experiences that are similar to an older one in some way. Schemata are general representations of experiences and reactions in the sense that individual details are lost over time. Schemata are not governed by central consciousness and they help an organism see a situation as a whole.

At this juncture in the chapter, we would combine two threads. The first one is about the unconscious and intuitive mental processes evident in expert behaviour, the other is the theory of mental model. From the previous discussion, we find that schema theory resonates with the description of System-1 thinking provided by Kahnemann as well as Stanovich. Interestingly, schema being abstract and dynamic mental representations are also congruous with the idea of mental models. (see Winn and Snyder [1996]). On the other hand, it has been shown that mental models, too, are built upon past experiences. Thus, with fair confidence, we could use both of the concepts synonymously. This implies that *the acquisition of appropriate mental models* is a key to expert behaviour. Now, it is pertinent that higher level skill should be in terms of fast and non-deliberative actions. In addition, it should be able to deal with a wide variety of situations and confront new situations with confidence. This could be only guaranteed by implicit and unconscious thinking and behaviour as guided by System-1. However, System-1 thinking & Behaviour depends on mature mental models which take time to develop. In absence of such schemata, a performer only has System-2 at his disposable. Hence, if we look at the journey of a person acquiring a new skill, we would find him progressing from stages devoid of mental models, through intermediate ones, to the ones which have mature mental models.

4.3.1 Skills, Rules and Knowledge Framework

The Skills, Rules and Knowledge (SRK) Framework of Rasmussen [1983] is an explanation of performance behaviour within complex man-machine systems. A premise of this work is that human behaviour differs in familiar and unfamiliar situations. Based on levels of familiarity, the SRK framework categorises human performance behaviour in three types. These are:

Skill-Based Behaviour (SBB)

In a familiar situation with anticipated events, a Skill-Based behaviour is employed. The environment is sensed through continuous (as compared to discrete) indicators of the time-space behaviour of the environment[12]. Performance does not rely on feedbacks, that is, it does not depend on the motor response resulting from the observation of the difference between the actual and the intended state. Rather, it depends on feed forwards—an anticipation of the events well in advance.

This type of behaviour becomes possible by 'a very flexible and efficient dynamic internal

[12] A car driver's awareness of the inter-vehicular distance could be considered as a time-space signal.

world model' [ibid. p259] . During this behaviour, there is no conscious control of the action and is characterised by smooth, automated muscular actions. The body act as a multivariate continuous control system that is able to synchronise its behaviour with the environment. As a result of all that, there is wholesomeness and integrity in the performance.

According to us, familiarity is a result of repetition. Repetition also establishes and reinforces appropriate mental models, which are amenable to System-1 processes. Therefore, familiarity with a situation obviously involves unconscious but cognitively efficient behaviour.

Rule-Based Behaviour (RBB)

Rule-Based Behaviour is employed when a situation is familiar but the events are unanticipated. It involves conscious problem-solving. It is characterised by stored (production) rules that may have been learnt through earlier experience or communicated as instructions. Often there is a repository of rules, out of which an appropriate one is selected based on a reading of the situation. Feed forward operation is employed in this case too but is based on the stored rules.

In absence of a mental model, the only recourse to being able to deal with tasks is to remember rules. In absence of rules, the execution of tasks would become prone to errors and breakdowns.

Knowledge-Based Behaviour (KBB)

In case of an unfamiliar situation for which no existing rules are known, plans (to achieve goals) are explicitly formed. A user, being aware of her goals, formulates several plans. Every plan is tested for its efficacy by either running in the mind, or by formulating a mental model[13].

[13] an Arbitrarily Imported Model (AIM), we would say because in an unfamiliar situation there is no analogous model to start with.

We would like to add that formulation of an appropriate mental model is highly improbable. As a user is dealing with an unfamiliar situation, the fitting of a mental model gained from earlier experience is an intensive task. In case an appropriate model is not found and the performer did not have enough exposure or learning needed for rule-formation, the completion of the task becomes error-prone and cognitively intensive.

4.3.2 Dreyfus & Dreyfus Model of Skill Acquisition

The authors of the five-stage model of skill acquisition (Dreyfus and Dreyfus [1980]) were from two very different backgrounds. One was from operation research and mathematics, the other from philosophy's phenomenological tradition. This work was a result of an investigation into the problem of skill acquisition by military pilots. It was initiated by a military officer who believed that emergencies could not be dealt with by remembering a set of rules, rather skills are needed to be 'acquired' (Zsambok and Klein [2014]). The authors argue that skill acquisition is a process that could not be studied in its completeness in a controlled laboratory set-up because the role of context and its experience on skill acquisition is too important to be neglected.

According to the authors, there are two types of skilful behaviour–*situational* and *non-situational*. In case of a non-situational behaviour, the situation is not comprehended as a whole but as a fragmented collection of individual cues and features (for a car driving scenario) such as the speedometer reading and the distance from the car ahead. The features are recognised individually and no underlying relationship is sought amongst them. In order to make meaning out of the individual features, descriptive categories are assigned to them. For example, if the speedometer reading of the car is below 10 kilometres per hour, it may be categorised as 'too slow'. The resulting response to the situation would be in the form of 'if-then' rules based on a reading of the individual features and not of the situation as a whole. For every change in the descriptive category (for example, the car is too fast), an operator takes a conscious decision in the form of a rule (for example, what to do if the car is too fast but the distance from the car ahead is comfortably large). The cognitive load of such a conscious decision making would indeed be high and the physical actions would be discrete.

In a situational scenario, a user has learnt to respond with respect to the whole situation. This learning becomes feasible through the availability of a large number of archetypical situations acquired over time through experience. A driver in a situational mode would deal with different features, for example, the speedometer reading and the distance from the car ahead, simultaneously but in a relaxed manner. Any change in the distance or the speed would be anticipated well in time and the response would be in terms of smooth actions of feet on the pedal.

The Dreyfuss model relates to the SRK model in the following way. The situation for a novice learner is unfamiliar and unanticipated giving rise to Knowledge-Based Behaviour. As the learner practices, he would face more and more situations leading to the acquisition of better mental models[14]. However, till appropriate mental models are formed, rules are used to accomplish tasks. Rules also take time to be remembered and are not available for an absolute novice. They are available in the intermediate stages and give rise to Rule-Based Behaviour. When the person reaches the level of expertise, he must have experienced a large number of situations and acquired appropriate mental models. An expert would deal with a familiar and anticipated situation in a relaxed and unconscious manner where he would depict Skill Based Behaviour. The behaviour could become conscious during the unanticipated sections of a situation but mental models of situations ensure that those moments are overcome easily as compared to a novice.

According to the Dreyfus model, a person acquiring skills starts in a non-situational mode and reaches a situational one. This process passes through many stages which can be categorised on the basis of behaviour. The authors have identified five stages–Novice, Competent, Proficient, Expert and Master–which are described as follows:

Novice

According to the authors, a novice performer[15] behaves in a completely non-situational way. The state of the system is recognised in terms of basic cues or 'features' that are discrete and disjoint. The meanings of the features are in the form of descriptive

[14]The Device's Experienced Models (DXM) type
[15]term used by Dreyfus

categories. The behaviour is in the form of application of rules that have been explicitly learnt by the performer. Benner [1984] who uses Dreyfuses' model for nursing practice, emphasises that though the work always exists in a situation, novices have no idea of a situation. They do not have enough experience to deal with it. To operate they rely upon context free rules often stated in terms of attributes of a situation.

There is a mapping of rules to the descriptive categories of the features. In a car-driving scenario, a driver would change the gear whenever the speed crosses a range. The pitch of the engine's sound acts as a feature which may be divided into descriptive categories like very slow, slow, medium, fast, very fast.

Competent

The authors inform that a competent performer rises above the rule formation mode but still works at a sub-situational level. He does not recognise a situation as a whole but does so in terms of 'aspects'–archetypes of interconnected patterns of features. Aspects could be pointed out by an instructor or recognised by the performer himself. The response to the aspects is not in the form of detailed rules but are in the form of 'guidelines' which take the manner of a more general 'rule of conduct'.

For example, 'avoiding collision' is an aspect of driving. If this parameter goes out of hand, a driver knows that he has the objective 'to bring it in control'. A combination of a low inter-vehicular distance and a high engine pitch (denoting speed) would bring this aspect into the frame, and in response, trigger the guideline 'reduce the distance' into execution. The difference between a guideline and a rule could be ascertained from the fact that there is no specific recipe to deal with 'avoiding collision'. A driver may simply put off his foot from the paddle or he could press the clutch or apply gradual brake depending upon how the aspect 'plays out' in front of him. In contrast, if the driver were behaving in an aspect-less manner, there would've been a possibility that he would have known only one sequence of actions. In that case, at a given instance he might focus only upon the vehicular distance and execute the sequence based on a very narrow set of criteria.

Proficient

As a performer progresses, he is able to identify whole situations. Aspects (archetypes of interconnected patterns of features) too 'become' integrated with each other and are now recognised as the components of a situation. Such a person in a given situation would be able to prioritise amongst various aspects. The behavioural response would still be a conscious affair because the goal planning (termed as maxim) for a given aspect within a situation is done in a deliberate fashion.

A competent car driver now recognises the complete situation on the road consisting of many aspects such as 'avoiding collision', 'curve of the road', and 'the errant drivers' in a holistic manner. He keeps on prioritising amongst various aspects, for example, at one time he might be focussing on 'avoiding collision' while at other, 'taming a curve'.

Expert

At this stage, a performer had experienced a large number and variety of situations. He does not require rules, guidelines or maxims anymore. His response to a situation is intuitive and unconscious. An expert car driver would be able to drive a car naturally and spontaneously.

Master

Dreyfus & Dreyfus state that this category goes beyond the highest level of mental capacity. It is characterised by moments of intense absorption in the work. A driver who finds joy in the art of driving and finds creative ways of driving as self-expression would belong to this category.

4.3.3 Hackos and Redish's Stages of Use

Hackos and Redish [1998] are HCI practitioners. They have adopted the Dreyfus model based on their HCI practice and on the work of researchers working in the domain of user-designer collaboration[16]. It agrees with the Dreyfus model on the account that users change over time as they acquire skills. However, it differs regarding the fact that in the case of ICTs, the progress might not reach its perfect conclusion. A user may stop at an earlier stage and remain there for a long time, or forever. From the perspective of this model, there is a significant role of design as the complexity of design will affect how a user progresses in her journey.

Dreyfus model considers only the first time learning. However, in the case of ICT usage, the earlier experience is an important factor. Moreover, domain expertise is not taken into consideration in the Dreyfus model. In the case of ICT artefacts, a user may or may not have exposure to a domain and that would have a bearing upon skill acquisition.

Novice

The authors categorise those users as Novice who encounter a new product[17]. A novice user has hardly any idea regarding what to do with an ICT artefact.

How long does a user remain a novice depends upon whether he has any familiarity with the product in terms of experience with similar products. A user with a very good understanding may cease being a novice user within a few minutes, while another one may remain forever so.

According to the authors, being a novice is cognitively intensive for the users who find the product unfamiliar. This may lead to futile attempts to succeed which, in turn, may result in frustration. Users may develop a fear of the product because of the inability to handle it may make them appear inept. Moreover, novices are more concerned with accomplishing their goals and not with learning the product.

The behaviour of novices would differ depending upon their knowledge of the domain, their experience with technology and their experience with a product. Domain experts

[16] The User-usage model has a strong resemblance with this model.

[17] the authors being design consultants use the terms 'technology' and 'product' in a different manner. A product is considered to be a particular software application, such as Microsoft Word or VLC player. Technology is used in terms of an environment, which we understand to be the operating system and probably the hardware, in which a product runs such as PC-based Windows or smartphone-based Android

would be highly influenced by their earlier way of doing tasks. A user who is strong on all the three fronts is most likely to move on to the next stage. At the other extreme, a user who does not have the knowledge of any of the above is likely to be a novice for a longer time.

According to us, a completely new user would find himself in an unfamiliar situation. The level of familiarity or unfamiliarity would differ depending on the exposure to domain or technology. Users who do not have any kind of experience, would not have any appropriate mental model to deploy and thus would depict knowledge-based behaviour (according to the SRK model). Their behaviour will be explicit and conscious. From the point of view of the Dreyfus model, this type of users would belong to the earlier stages of novice users who have not even started forming the rules.

If users have recourse to mental models, they will start employing them—it depends on how appropriate the models are—and get out of this phase quickly. If the arbitrary models (AIM) based on knowledge of domain are available, the user would have a less difficulty because then the effort will remain limited to yoking the device and goal states (see YSS model in section 5.3.2). The yoking effort will be more if the designed conceptual model (DCM) of the artefact does not reflect the domain. A user who also has experience with similar type of device will simply project the device's experienced model (DXM) on the given interface and learn it still more easily.

Advanced Beginners

When a user 'begins to use' a product rather than struggling with it, he becomes an Advanced Beginner. This type of users use their products either infrequently and incidentally or perform only one or two tasks repeatedly.

Advanced Beginners who are domain experts but less versed with technology would try to figure out the interface on their own. They will seek the assistance of documentation and other people only when they fail. On the other hand, people who are not domain experts would concentrate on only a few tasks that they need to perform.

Advanced Beginners' behaviour should map to Rule-Based behaviour (RBB) of the SRK model. However, this is more true of people without domain and/or technology expertise. The other type of people would migrate away from this stage quickly. It is because the presence and strengthening of mental models result in Knowledge-Based Behaviour (KBB). Within the Dreyfus model, this stage should map to the later stages of Novice who has not started to understand situations but is dependent on discrete rules.

Competent Performers

These users have learnt a sufficient number of tasks. They have strong mental models of the tasks. Competence is the result of the experience of doing the task and understanding how it fits into the whole. This means that to become competent both the frequency of and the variety of tasks has to be large.

For competent performers, tasks are not individual pieces but fit as a whole. Owing to good mental models, they are able to plan their tasks and are able to diagnose and recover from errors. Competent users, especially the domain experts and the ones well versed in technology, are willing to learn more about the interface. In the process, they understand the working and consciously develop good habits.

From the perspective of the SRK model, these users depict Skill Based behaviour. However, in the Dreyfus model, they could be anyone from Proficient to Expert. It depends on their ability to understand a situation.

Experts

This group comprises of highly motivated persons. Their experience is rich and the mental models are robust. The usage of an artefact becomes an important and frequent activity and fits well into their life goals. They use their products to the fullest extent. Often these persons become experts of the artefact itself and become both active learners of advanced concepts and teachers for the other users.

They have an understanding of the larger picture into which their tasks fit. Therefore, they can find out innovative and efficient ways of performing the same task. In order to increase their knowledge, they experiment with the product, refer technical literature and establish a dialogue with technical professionals. According to us, his stage maps to Skill-Based Behaviour in the SRK model and Master in the Dreyfus model.

4.4 Summary

Artefacts could only be understood well when we could see them being used. This is why analysis of task is important to understand technology adoption. It is especially true in case of ICT artefacts which are cognitive in nature. Tasks exist in a larger sphere of a users' individual life-objectives and his social context. These two give shape to user-artefact interaction goals, which are to be accomplished through tasks. The interaction goals are converted into tasks through a cognitively intensive task-planning process before they could be committed to action. The cognitive effort depends on the inherent constraints of the cognitive architecture, which might be overloaded with complex rule-based thinking. A mitigatory mechanism against that is the employment of mental models. Mental models are dynamic and operational representations of the problem space. This problem space exists in the form of an ICT artefact. Mental models have an advantage over rule-based thinking. They are cognitively less intensive and can simulate a wide variety of situations. A person trying to acquire skills actually employs both rule-based and mental model based thinking. The result of the former is conscious and cognitively intensive operation and the latter, relaxed and unconscious. The former is used in the early phases when situations are novel while the latter during the later stages when the user has acquired the experience of many situations. In case of ICT artefacts, a user in the earlier stage is fearful and focussed exclusively on the primary objective. During the latter stages, he is creative and proactive in the usage of the artefact.

Chapter 5

Constructs that could Explain Technology Adoption by the Emergent Users

5.1 Introduction

As stated in Section 1.2, our aim is to develop a model[1] which could describe and predict ICT usage by the EUs. What input should the model accept in order to do so? This chapter describes the search for constructs that could act as input to the model. The identified constructs were later operationalised and used for building a quantified version of the model[2].

The potential constructs were identified in the following manner:

- From literature (Shown as a cognitive map in Figure 5.1.) .
- Through a contextual study done in December 2012 (The users and the method of data collection and analysis are described in Section 5.2.2.).

The reporting is done primarily from the point of view of the constructs and therefore

[1] Described later in Chapter 6

[2] in Chapter 7.

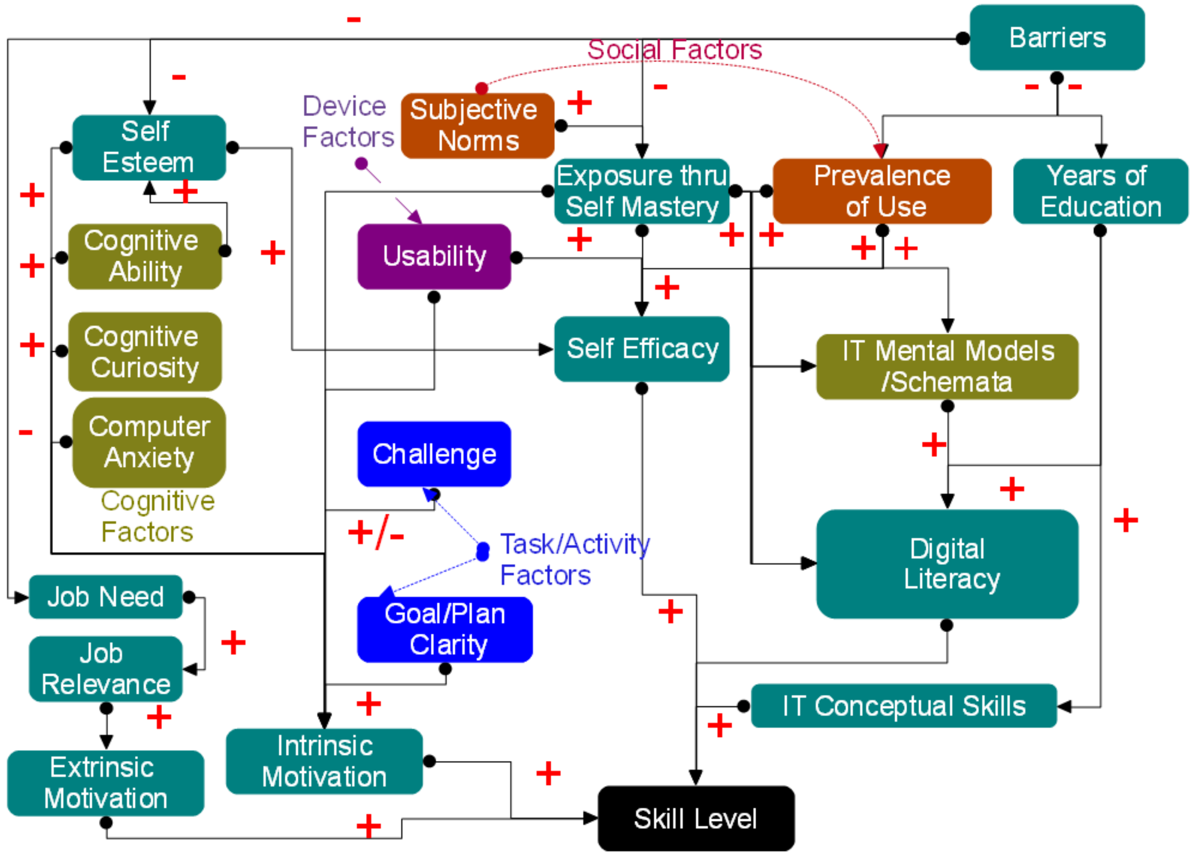

Figure 5.1: Cognitive map of literature. The arrowheads point towards dependent constructs while the arrow tails are attached to the independent ones. Positive and negative signs signify directness or inverseness of the relationship.

the discussion involves both the sources mentioned above.

5.2 Field Studies

5.2.1 Preliminary Studies

Two preliminary studies were done. In the first, 10 persons were interviewed in Mumbai in December 2011. All of them were males. The mean age was 27.8 years (SD=7.05 years) and the mean number of years of schooling was 9.9 years (SD=3.9 years). The occupations included a carpenter, members of the house cleaning staff and cafeteria workers at a technical institute. They were interviewed out of their contexts. Only those persons were interviewed who had phones with them. The method used was unstructured interviews.

It tested the following aspects:

- Prevalence of use (around a user in his social context)
- Exposure to ICT such as mobile phones, ATMs, DVD players et cetera,
- Skill level
- Frequency of Use
- Self-efficacy
- Anxiety
- Usefulness (Perceived)

The second study involved 5 persons. All were males. The mean age was 38.0 years (SD=5.7 years) and the mean number of years of schooling was 13.2 years (SD=1.6 years). All belonged to two locations—Babiyal, a town of 26,412[3] people in Ambala, and Piran Kaliyar Sharif, a town of 10,043 people in Roorkee in north India. The occupations were a bicycle mechanic, a priest in a local temple, a small-time entrepreneur, a card-board factory worker and owner of a small-scale manufacturing set-up. The method used was semi-structured interview. The questionnaire used is provided in Appendix E. The understanding from the preliminary studies were used to design the main field study.

5.2.2 The Main Field Study

Users

We conducted, in December 2012, a contextual inquiry (CI) (as prescribed by Beyer and Holtzblatt [1997]) of 50 users in 7 locations in India. Table 5.2 provides the details of the users interviewed.

[3] According to the census of India, 2011

Code	Location	Population[4]	District	State	Type	No. of persons interviewed	No. of Interviewers
UJN	Tajpur	7,789	Ujjain	Madhya Pradesh	Village	12	3
DVG	Kunkeshwar	1,829	Sindhudurg	Maharashtra	Village	08	3
PDR	Manjakuppam	173,636	Cuddalore	Tamilnadu	City	08	3
KLR	Piran Kaliyar Sharif	10,043	Roorkee	Uttarakhand	Census Town	04	1
AMB	Babiyal	26,412	Ambala	Haryana	Census Town	11	1
AMO	Boh	8,482	Ambala	Haryana	Census Town	01	1
AMT	Tundla	5,658	Ambala	Haryana	Census Town	01	1
MUM	Mumbai	18,394,912	Mumbai	Maharashtra	Metropolitan Region	02	3
CHN	Chennai	8,653,521	Chennai	Tamilnadu	Metropolitan Region	02	3
					Total	**50**	

Table 5.1: Particulars of the Locations (Main Field Study)

ID	Age	Gen	Education (in years)	Occupation	Location	Income group	Language	Phone language	Detailed Reference (page)
UJN01	50	M	12	Village Elder	Tajpur, Ujjain	Upper Middle	Hindi	English	132
UJN02	45	M	12	Tuition Teacher	Tajpur, Ujjain	Low	Hindi	Hindi	114,140
UJN03	45	M	11	Shop Owner	Tajpur, Ujjain	Upper Middle	Hindi	English	
UJN04	40	M	10	Sales Agent	Tajpur, Ujjain	Middle	Hindi	English	114
UJN05	60	F	0	Elderly Housewife	Tajpur, Ujjain	Lower Middle	Malwi	Hindi	118
UJN06	45	M	6	Sweetmaker	Tajpur, Ujjain	Lower Middle	Hindi	Hindi	129
UJN07	35	M	3	Farmer	Tajpur, Ujjain	Lower Middle	Hindi	Hindi	134
UJN08	50	M	10	Shop Owner	Tajpur, Ujjain	Middle	Hindi	English	
UJN09	33	F	8	Housewife	Tajpur, Ujjain	Low	Malwi	Hindi	120
UJN10	29	F	8	Housewife	Tajpur, Ujjain	Upper Middle	Hindi	English	
UJN11	45	F	8	Housewife	Tajpur, Ujjain	Upper Middle	Hindi	Hindi	
UJN12	22	M	14	College Student	Tajpur, Ujjain	Upper Middle	Hindi	English	128,141
DVG01	43	M	9	Carpenter	Devgad, Sindhudurg	Low	Marathi	English	
DVG02	40	M	9	Worker	Devgad, Sindhudurg	Low	Marathi	English	
DVG03	39	M	9	Goldsmith	Devgad, Sindhudurg	Upper	Marathi	Hindi	
DVG04	45	F	7	Tailor	Devgad, Sindhudurg	Low	Marathi	English	
DVG05	36	M	10	Politician	Devgad, Sindhudurg	Middle	Marathi	English	

DVG06	41	M	9	Worker	Devgad, Sindhudurg	Middle	Marathi	English	
DVG07	45	M	10	Farmer	Devgad, Sindhudurg	Low	Marathi	English	
DVG08	39	M	10	Hotel Owner	Devgad, Sindhudurg	Low	Marathi	English	
PDR01	48	M	5	Property Agent	Manjakuppam, Cuddalore	Low	Tamil	English	
PDR02	31	M	7	Tailor	Manjakuppam, Cuddalore	Low	Tamil	English	
PDR03	32	M	5	Painter	Manjakuppam, Cuddalore	Lower Middle	Tamil	English	
PDR04	28	F	9	Housewife	Manjakuppam, Cuddalore	Upper Middle	Tamil	English	
PDR05	30	M	9	Worker	Manjakuppam, Cuddalore	Lower Middle	Tamil	English	
PDR06	22	M	7	Informal Worker	Manjakuppam, Cuddalore	Low	Tamil	English	
PDR07	55	M	7	Worker	Manjakuppam, Cuddalore	Low	Tamil	English	
PDR08	55	M	3	Worker	Manjakuppam, Cuddalore	Lower Middle	Tamil	English	
KLR01	50	M	0	Dairy Owner	Kaliyar Sh., Roorkee	Low	Urdu	Hindi	
KLR02	40	F	0	Housewife	Kaliyar Sh., Roorkee	Low	Urdu	Hindi	112
KLR03	40	M	7	Farmer	Kaliyar Sh., Roorkee	Lower Middle	Urdu	English	
KLR04	45	M	4	Laborer	Kaliyar Sh., Roorkee	Lower Middle	Urdu	Hindi	
AMB01	50	M	0	Dairy Owner	Babiyal, Ambala	Low	Hindi	English	119
AMB02	33	M	8	Worker	Babiyal, Ambala	Lower Middle	Hindi	English	
AMB03	48	F	5	Housewife	Babiyal, Ambala	Lower Middle	Urdu	Hindi	
AMB04	48	F	0	Housewife	Babiyal, Ambala	Middle	Hindi	English	
AMB05	45	F	0	Housewife	Babiyal, Ambala	Lower Middle	Hindi	English	

AMB06	25	F	5	Housewife	Babiyal, Ambala	Middle	Hindi	English	
AMB07	40	F	0	Housewife	Babiyal, Ambala	Lower Middle	Hindi	English	
AMB13	62	M	8	Farmer	Babiyal, Ambala	Lower Middle	Hindi	English	
AMB08	45	M	10	Labourer	Babiyal, Ambala	Lower Middle	Hindi	English	
AMB09	27	M	7	Woodwork painter	Babiyal, Ambala	Lower Middle	Hindi	English	
AMB10	28	F	9	Housewife	Babiyal, Ambala	Lower Middle	Hindi	English	
AMB11	32	F	9	Housewife	Babiyal, Ambala	Lower Middle	Hindi	English	
AMO01	40	M	10	Bicycle Repairsman	Babiyal, Ambala	Low	Hindi	English	
AML01	45	F	6	Housewife	Babiyal, Ambala	Lower Middle	Hindi	English	
MUM01	40	M	10	Auto Rickshaw Driver	Mumbai		Hindi	English	
MUM02	20	M	10	Housekeeper	Mumbai		Hindi	English	
CHN01	44	F	7	Housewife	Chennai		Tamil	English	
CHN02	42	M	7	Small businessman	Chennai		Tamil	English	

Table 5.2: Particulars of the Users (Main Field Study)

The details of the locations of the interviews are given as Table 5.1. The locations were spread in the northern, central, western and southern India. The interviews were conducted by the researchers in the languages spoken in these locations. The researchers were trained in a 3-day workshop in the methods used in the interviews and analysis.

The criteria for selecting the users were based on education levels (having less than 12 years of education, one user in his final year of graduation was an exception), age (between 25 to 60 years) and familiarity with mobile phones. 24 users were males and 16 females. 8 users were below 30 years, 10 were between 30 and 39 years, 24 between 40 and 49 years, and 8 above 50 years. 7 users were completely illiterate, 7 had studied till primary school (1-5 years, equivalent to level 1 of International Standard Classification of Education, ISCED 2011 published by for Statistics [2011]); 15 had reached middle school (6-8 years, level 2 of ICSED); 17 high school (9-10 years, level 3) and 3 had senior school (11-12 years, level 4). All the users had used a mobile phone for at least 3 months.

Method: Data Collection

The data was collected by a team of 10 researchers (including myself), who had come from technology and design backgrounds. They were either professionals or university students. The interviews focussed on studying the usage of mobile phones. We looked at the journey of usage from the time a user procured his first mobile phone. During the interviews, where relevant, the users were requested to perform tasks such as finding or responding to missed calls, using media, saving contacts, changing ringtones or desktop backgrounds, connecting two phones by Bluetooth, writing or sending SMS etc. Observations of the tasks (and talking about them) probed the following aspects of the usage: the level of difficulty in doing the task; whether the task was rote-learnt or conceptually understood; how was the task learnt? Depending on the users' experience, the interviewers expanded their focus to include the usage of other ICT objects such as DVD players, TV remotes, and ATMs. During the interviews, we looked for the barriers that continued to hinder and the facilitators that had helped the users in the usage of a given ICT artefact.

Method: Data Analysis

Coding for the data was done iteratively. Few sessions of the coding following the data collection were done collectively where all the researchers deliberated over the data. The rest were done solely by me. Coding was done by investigating each of the user statements and the observations from various angles. A statement or an observation was, firstly, examined by comparing with the other statements and the insights that had emerged from the interview. Secondly, they were looked from the perspectives of the theoretical concepts collected during the literature study. Thirdly, questions were asked regarding the user's intention and motivation for uttering a statement or depicting a particular behaviour with respect to the usage. Generic concepts, representing the abstract of the statement, were derived for each statement. Over many iterations, a hierarchy of concepts evolved.

As the cycles of coding progressed, the User-Usage model (described in Chapter 6) evolved. Gradually, the categories of user types and usage behaviour (termed as stages of usage) became clearer.

5.3 Potential Constructs Identified for the User-Usage Model

5.3.1 Barriers

We have defined (in section 1.6) Technology Adoption as initiation, learning and sustenance of usage. Therefore, the study of the constructs that reduce the chances of a users' access, learning and usage of a device is important. We term these constructs as barriers.

Total time of interaction (TI)—is a meta-construct that we would introduce before proceeding. That would help in the discussion of many barriers. It is the total time for which a person has dealt with ICT artefacts. It is important, because, as we have seen in chapter 4, the expertise of using an artefact is built through practice. Total time of interaction should include both the total time elapsed since a person started using ICT artefacts and the frequency with which he has been using one.

Low Income

Low levels of income act as barriers. Not owning a device implies zero (in the case of non-ownership) or reduced (in the case of shared usage) total time of interaction. The later a user starts using an artefact of his own, the lesser is his total time of interaction.

Low income was found to be a reason for a low TI for the members of a household. The household constituted user KLR02 [40, F, illiterate, housewife][5] and her husband (also in his 40s, illiterate and a cycle-rickshaw driver). They had been using a mobile phone only for a year (on the date of interview-December 2012). It was given to them by their employer. They were given the responsibility to look after a property (a rest-house for pilgrims at a shrine). They were also provided shelter in a part of the property. The phone that was provided to them was an old basic phone. It was given so that they could coordinate the management of the property. The users never bought any talk time. The phone was used only to receive calls from their benefactor. This arrangement made the phone a receive-only device, rendering it virtually unavailable for anything else. A very low TI may have been the cause of extremely low levels of proficiency. The users remained almost uninitiated–they could not (even) dial a number.

Non-Proximity

TI is not only affected by lack of exclusive ownership. It could also be affected if the artefact, especially a fixed one, is not physically proximate. Consider, user UJN08 [50, M, X^{th}, pesticide shop owner]. He had a (desktop) computer at home, while he spent most of the day in his shop. He had reported that he could not learn to use a computer. A few meters away from this person's shop was user UJN06 [45, M, VI^{th}, *halwai* (sweetmaker)] who was able to start using a desktop, in a very rudimentary manner, because a computer had been around in his shop for two years (that is, since 2010).

[5] See Table 5.2 for user-details. We will follow the following convention, in the subsequent chapters as well as the current, to describe the users: User_ID [Age in years, Gender (M/F), years of education, occupation]

In the user UJN08's example, he was non-proximate due to the fact that the artefact was fixed and the user was away from where it was placed. It could also happen the other way around when the artefact is mobile but the user's spatial freedom is limited. For example, in the case of user UJN11 [45, F, VIIIth, housewife], we have found that a single shared mobile phone was taken away by whoever went out of the home. The husband went out more than the wife, reducing her total time of interaction.

Infrastructural Barriers

There are other types of barriers beyond proximity and ownership which affect the total time of interaction. The first of these barriers work by affecting the working of the device. It is not sufficient that a device is available, it should also work properly and without interruption. An interrupted usage has a negative effect on the TI. Infrastructural barriers play a large role in these type of interruptions. Primary are those of energy (to run the device) and the carrier signal. The electrical power supply is often erratic in the rural areas with cuts going up to 12 hours a day (for example, see Athar [2017]). User UJN04 [40, M, Xth, sales agent], who had to travel a lot, insisted on a large battery. He desired to have a phone which could work without the traditional source of power because the village 'did not have electricity'. If the mobile phones have to be carried to the fields (or for business, as was in the case of UJN04), the window for recharging them becomes very small. When the battery-power is meagre, a person is likely to ration its usage, affecting the total time of interaction.

The problems of the carrier signal are no less. User UJN04 [40, M, Xth, sales agent] had to change his service provider because he found that the coverage was inadequate to satisfy him as a frequently-travelling person. He told, "I am happy with <*his current provider*>. Wherever I go, I get the network."

The mobile signal coverage was still inadequate in 2017[6]. A mobile phone was rendered unusable in absence of signal, or due to a weak or an erratic one. User DVG02 [40, M, IXth, worker] told, "People in Kunkeshwar [his location] started using mobile extensively

[6]As this India Today report by Anwer [2017] showed when a minister had to climb up a tree to get the signal.

only 5 years ago when [the only service provider, a government owned] built a mobile tower in their village."

Interestingly, the power cuts themselves have an effect on the signal. User UJN04 [40, M, Xth, sales agent] reported, "Sometimes power supply to the tower is interrupted. The signal comes back only when the supply is restored". I had also witnessed the same phenomenon. While staying in a remote area for data collection (Railmagara, Rajsamand, Rajasthan in 2016), I found that whenever the power went off, the signal also did. This implied that the nearby tower (and perhaps the only one in the vicinity) did not have an adequate power backup.

Physical Disability

Physical incapabilities, which arise due to old age as well as disabilities, could act as barriers. They manifest in many forms such as reduced eye-sight, inability to reach a service point (such as a mobile shop), inability to access an electrical recharging point, low finger dexterity et cetera. User UJN02 [45, M, XIIth, tuition teacher] had a locomotor disability. He had a problem with accessing electrical points as he could not move easily. As a remedy, the charger was hung over the blackboard where he could reach easily without moving from his normal sitting place while teaching. For many tasks, such as getting the phones recharged[7] and saving contacts, he sought others' help. In his social context, asking for help was not difficult. He would sit on a platform[8] in front of his house during the day. In case he needed help, he would ask any passer by—he had many acquaintances on account of being a teacher—for a favour.

Age

We found that elderly users used their artefacts to a lesser extent than the younger ones. For example, user AMB02 [33, M, VIIIth, Worker] and user AMB13 [62, M, VIIIth, Farmer]

[7] Sending someone to the mobile-recharge shop with the number written on a piece of paper was still the best way of availing a recharge.

[8] An essential element of rural architecture. It served as an informal connection between the interiors and the street. It is commonly used to interact with other people. See Figure 5.5

differed in age (they were from the same place and had attained the same education level) which reflected in their level of usage. While the younger user was able to send SMSes using the phone, the older one used it mostly to make calls and receive them. The same difference was discernible in another set of users (from a different place)—user PDR03 [32, M, V^{th}, Painter] and user PDR01 [48, M, V^{th}, Property Agent]. The younger one, though could not read properly, saved contacts using numerical codes. He could also navigate songs using (some sort of) a conceptual map. He had claimed to have explored the features of his phone. The older user used his phone only to make and receive calls. He could not lock his phone. He could not save contacts. He took help of a physical diary instead.

The differences are possible because, firstly, the physical challenges increase with age, which may affect technology usage and learning (Smith [2014]). Secondly, as the learning abilities decline with age, and because digital technologies are cognitively intensive, exposure to technology in early childhood gives an advantage (Ching et al. [2005]; Li and Atkins [2004]).

In addition, there are other reasons for age to have an effect on technology use. Access to computers has been shown to be negatively correlated with age (Morrell et al. [2000]). We have not found support for that. For our users (barring two), the correlation between the Age and total time in years since they started using a mobile phone was found to be -0.03.

Computer anxiety has been shown to be positively related to age Ellis and Allaire [1999]; Laguna and Babcock [1997]. We have not found support. There were very few users who reported fear or anxiety from mobile phones. (See Section 5.3.2 for a discussion on Computer Anxiety.)

Age has also been demonstrated to affect attitudes towards computers (Smith [2014]). However, we have not found a support for it either. Both user UJN01 [50, M, XII^{th}, Village Elder] and user UJN07 [35, M, III^{rd}, Farmer], though of different ages (from the same place), showed a negative attitude towards phone usage. Both the cases have been discussed under the section on Attitude (Sectio 5.3.2)

However, we found that age had an effect on self-efficacy (detailed in Section 5.3.2). Elderly users would attribute their inability to learn ICT to age. For example, user UJN05 [60, F, illiterate, Elderly Housewife] told, “Now I am 60 years old. My mind does not work.”, and user PDR01 [48, M, Vth, Property Agent] told, “I am not at the right age to learn.”.

Education and Literacy

User UJN02 [45, M, XIIth, Tuition Teacher] and user UJN06 [45, M, VIth, Sweetmaker] (from the same place) differed in their technology usage. The more-educated user was able to type messages, set language, set alarms and inquire for balance using USSD code. The less-educated user only received and made calls (he could use the number-pad but would mostly reply to the missed calls, as his customers would often leave a missed call for him to contact back). In another location, user AMB05 [45, F, illiterate, Housewife] would delegate the task of making and receiving calls to her sons. In the same district, user AML01 [45, F, VIth, Housewife], also used a shared phone but fared better. She could capture images, check balance using USSD code and listen to songs. However, there were cases where educational difference did not reflect in usage. User PDR07 [55, M, VIIth, Worker] and User PDR08 [55, M, IIIrd, Worker] had acquired different levels of education, but their capabilities were the same. Both performed only receiving and making calls (with the help of a physical diary).

How does going to school help in ICT usage? Are there any specific capabilities that schooling provides? To investigate, we turn to literature. There are multiple perspectives regarding the influence of education on Technology Adoption. From a generic perspective, technology usage should be positively related to general intelligence, which may be dependent on years of schooling. Ceci and Williams [1997] have demonstrated that continuous schooling for a large time has a positive relationship with general intelligence. However, they have used IQ scores to measure general intelligence, which has come under criticism. It has been questioned whether the set of skills measured by the IQ tests—verbal (for following instructions) abilities, pattern recognition, logical reasoning, perception and classification—are sufficient and appropriate for measuring intelligence in general, and by implication, the proficiency in using ICT artefacts. Gardner [1999] has questioned a single measure of intelligence. For him, there are multiple intelligences whose combinatorial interplay is employed in dealing with life situations. He has listed them as—Verbal/Linguistic, Logical/Mathematical, Visual/Spatial, Bodily-Kinesthetic, Musical, Interpersonal, Intrapersonal and Naturalistic (ability to identify species). In a similar vein, Sternberg [1985] does not support a definition of intelligence based on measurable criteria, but frames as an ability to achieve life goals within one's socio-cultural context through a combination of capabilities. He lists three types: Analytical capabilities are those which help a person analyse, judge, evaluate or compare/contrast. Creative abilities help in coping with novelties. Practical capabilities pertain to applying the other abilities in real life situations. Thus, one can argue that ability to use an ICT artefact has aspects which go beyond the ability to read/write and to do logical deduction. For example, figuring out how something might work requires an ability to form proper mental models which might not be dependent on the number of years in school.

However, in spite of these objections, there is empirical evidence which relates the difficulty of using ICT artefacts to the lack of formal education. For example, van Linden and Cremers [2008] have found that functionally illiterate people have difficulty in following instructions and in having mental spatial orientation. They also have lower visual memory skills, Medhi et al. [2013] have demonstrated that low-literate users have difficulty in navigating hierarchical interfaces. What could be the reasons? Does it happen, in line with the pro-IQ position, because the school-based education imparts some capabilities that help in learning ICT? Or, are there other factors that schooling helps in?

Chipchase [2005] suggests ways in which low levels of education dissuade the adoption of ICT. Firstly, low levels of education result in other incapabilities, such as low-income, which affects technology adoption in ways that are mentioned in Section 5.3.1. Secondly, many abstract concepts might be far from a less educated user's worldview. A good example of this occurs in the work of Medhi et al. [2006]. The text-free interface designed for the job seekers for household work was not understood by the users when it was presented as a 'two-dimensional matrix' of the type of work (brooming, mopping) and the type of room (living room, bedroom). They understood it only when the work was explicitly mapped to the room.

Thirdly, the cognitive nature of the user-interfaces means that the 'constituent items' (such as 'menu') are abstract in nature, and therefore their meanings have to be understood and retained. Icons may not solve the requirement of comprehension of abstract concepts, as Chipchase, citing Wiedenbeck [1999], suggests:

> Icons by themselves are not the answer. For starters, the meaning and subsequent use of icons are best understood when initially accompanied by textual descriptions. Understanding can be improved by successfully completing tasks, which implies an understanding of the textually annotated steps that make up a task, exploration and a degree of prior device understanding.

It should be noted that (as of in 2018) ICT artefacts have been textual in nature. As we have mentioned a while ago, they require the ability to read and to comprehend the 'content' semantically. As a result, a low level of education may shrink a user's choice to a few core essential tasks, which signifies a low level of adoption. User UJN05 [60, F, illiterate, Elderly Housewife] had retorted, on being asked whether she could browse a message list, "If I cannot read why I should be bothered about messages?" In fact, she was not 'bothered about' most of the things on her phone. How could she be? She could hardly read what appeared as text on her phone. Indeed, she used her phone only to receive call and dial selected contacts through the aid of icons set by her son; she could not use the number pad.

Even if a user rote-learns the tasks, inability to understand semantic meaning would hamper learning. Rote-learning would be limited to simpler tasks because more complex tasks would require a written record of instructions, either in the form of a manual, or hand-written instructions. User UJN05 [60, F, illiterate, Elderly Housewife] had to rely upon her memory to remember the instructions. It is anybody's guess that she had a hard time recalling how to navigate to reach the media player. She reported,"Sometimes I remember, sometimes I forget".

Schooling might also impact a user's self-efficacy to use an artefact. As we will cover in the section on self-efficacy (Section 5.3.2), many of our users had reported low self-efficacy attributed to the inability to read.

As we have already indicated, knowledge of English was a prime concern. Given that Indian language interfaces used highly formal language[9], made it no easier for low-literate users. This would be clear from the case of user DVG04 [45, F, VIIth, Tailor] who had set English as phone language. She had earlier tried Marathi for a day but reverted back because she had found it difficult. Difficulty in using Indian language was the reason why we found that often the teachers (of ICT within the community), too, were comfortable with English language version rather than an Indian one. User AMB01 [50, M, illiterate, Dairy Owner] had 16-22 years old as his ICT teachers. He could barely read Hindi, but no English. However, his friends insisted that he switched to English as they themselves were not conversant in using Hindi language interface. As an interesting result, the learner was contemplating about learning the English alphabet from her sister.

It should be noted that in these cases, English was used only as the language of the interface, not for the content. This was because the users' comprehension of the English language was inadequate and so they were not able to communicate in it. It was sufficient, given the difficulty of using an Indian language, to be used as the language of the interface. The interface required memorisation of merely a few words whereas communication would need a bigger vocabulary. As a result, people did not read or write messages in English, rather they used rudimentary Roman to frame their messages in the Indian Language. For example, 'please come' would be spelt in Romanised Hindi as '*a jao*'. In other cases, which were very rare, they would use Indic keyboards if they could.

Users had found solutions to their inability to read and write. This shows how important the tasks were for them. User PDR03 [32, M, Vth, Painter] saved his contacts in the form of numeric codes. In the case of user UJN05 [60, F, illiterate, Elderly Housewife], the contacts were saved by her sons. However, they were tagged with icons so that she could identify who had called. User UJN06 [45, M, VIth, Sweetmaker], in order to watch movies, navigated the directory on the PC in a rote-learned manner, using visual signs (such as 'shape' of the folder layout) as guides.

An important role of schooling is to socialize a person and provide an expansive environment away from the confines of the family, neighbourhood or place of work. This should

[9]Localisation in Indian language has issues and for a reference, one could see the work by Welankar et al. [2010] where they have raised issues regarding localisation of user interfaces in Indian languages.

Figure 5.2: User UJN09 reached the bust stand while the family members searched for her for hours at the railway station. Being disabled with luggage had increased her difficulties. That was the trigger for her to avail a mobile phone.

be considered along with the fact that much learning happens during the early years. These two might have an impact on the ability to learn ICTs. A person who can go far away from home and has a wider social network is likely to have a varied repertoire of mental schemata and models, which may be put to use in the learning of ICT artefacts.

Power and Gender

A person could be barred from accessing ICT artefacts through (configurations of) social power. The role of power on the usage of ICT artefacts can be exemplified in detail through the case of user UJN09 [33, F, VIIIth, housewife]. She was disabled and married in a rural household. Some members of the family were agricultural labourers. Her husband (the eldest son) and father-in-law remained in the village, while two younger brothers-in-law worked in a nearby city. She was the main caretaker of her house, because her mother-in-law, a matriarch, although assisting in the housework, would do many tasks that required her to go out of the home. The other woman in the household was the user's sister-in-law, a college student.

Figure 5.3: ACE and Maxicab are the brand names of small vehicles that connect rural areas to the cities.

The user felt the need for a mobile phone whenever she visited and returned back from parental home in a nearby town. As it happens in India, a married woman often carries gifts from the parental home to the matrimonial one. Being disabled, she and the gifts needed to be carried to and fetched from the bus or train station. Fetching required coordination–the people at one end would inform the other end the number of the bus or the name of the train she was travelling in and the time the bus/train would start. Someone at the other end would accordingly go and fetch her.

Once the coordination broke down because she was assumed to be coming by train while she did by bus. This made her strongly feel about having her own phone. However, due to lack of money (she did not have much money of her own) she was not able to buy one at that time. Instead, she procured two SIM cards through her college-going sister-in-law. She would later use those SIM cards by asking strangers to insert SIMs in their phones and let her talk. Soon, she found out that the solution was too cumbersome. Finally, she bought her own phone when she could save some money by working for a few months in a nearby glass factory (commuting by Maxicab/ACE[10] service) where the job did not require her to stand.

[10]a six-seater vehicle often connecting rural regions to cities. See Figure 5.3, it cost her Rs 15 per day to commute

She was the last one in the home to get a phone. She told that she had pleaded her family members to get her a phone without any avail. Actually, her mother-in-law got her own phone as soon as she had demanded. It is also important to note that this was a rather poor household and the resources were prioritised. However, power certainly had a role in deciding how they were.

This example shows in sufficient detail the role of power in Technology Adoption. The role of power in restricting, interrupting and resisting the usage of ICT artefacts within a social system could be comprehensively understood through existing theoretical lenses. From a Marxist perspective, power is a reflection of the underlying infrastructure of economic production. Housework has a use value, but no exchange value because it is used as a supportive function to the household and could not be exchanged with another commodity in the market. This results in household work to be considered as labour with no exchange value. As the household work has been traditionally ascribed to women, rural women in collective families are unlikely to control the cash flow. This curtails there ability to buy a relatively expensive item such as a mobile phone. We have noticed that the employed sons (as in the case of user AMT01 [45, F, VIth, Housewife]) had more freedom regarding technology buying and usage behaviour. They were more likely to buy a new smartphone. Sisters and wives were likely to work at home and did not earn money as men did. If they needed a mobile phone they had to request men in the household.

For Weber [1978], on the other hand, power is not merely an economic phenomenon, but rather a social phenomenon. According to him, it is the probability that one actor within a social relationship will be in a position to carry out his own will, despite resistance, regardless of the basis on which this probability rests. Though power can have economic bases, in the form of incentive and punishments, its real potential is derived from legitimacy[11], without which it could not be exercised. Legitimacies, ultimately, are socio-cultural in their form. Thus, Weber would question—Why was a woman's work relegated to the status of unproductive labour? For him, the division of labour itself arises from the legit-

[11]Weber defines three types of legitimacies. The first type, 'rational-legal', is based on statutory. A soldier obeys his officer due to written down national and institutional rules. The second type is traditional legitimacy, which is based on social customs. Monarchs and landlords get their legitimacy in this form. The third one is charismatic, which arises due to the personal qualities of the leader.

imacy of the roles ascribed to the genders. The sons had power because of the legitimacy attributed to the power invested in male gender as well as in their role of earning cash.

For Foucault [1977], power pervasively flows in the society in the form of social architecture, with people acting as its elements :

> Power has its principle not so much in a person as in a certain concerted distribution of bodies, surface, lights, gazes, in an arrangement whose internal mechanisms produce the relation in which individuals are caught up.

From this perspective, every social actor draws power from his social situatedness and from a variety of sources like legitimacy, perception, norms, laws etc. Thus, power is not something that is merely experienced or applied, it is exercised in the form of "...dispositions, manoeuvres, tactics..." In essence, power is not "...a property, but...a strategy" where the social situation of the person allows him to see things at his disposal which could be used to further his will, and also how to employ them to achieve that. Needless to say, owing to exercise of power by all the agents in a system, the situation itself keeps on shifting and emerging.

For UJN09, a mobile phone became one of the 'things at her disposal' to negotiate within the power structure. It allowed her to talk to her paternal home in privacy. It also helped her offset disadvantages of disability. Probably, equally important was to undo the perceived discrimination (we did not probe about it) of not having a phone–an artefact worth owning–while everybody else in the family had.

We have seen how power affects the access and usage of artefacts. However, artefacts are not inert entities. They play an active role in the mediation of power. The role of the artefacts comes from their ability to *represent and transform the social and cultural meanings*. Consider the comments of user AMO01 [40, M, X^{th}, Bicycle Repairman] who stated that he disliked the migrant workers (from Bihar in Haryana) listening to Bhojpuri (migrants' language) songs over their mobile phone speakers at high volumes while at work. The attitude signified many things. Firstly, by owning feature phones with media players, the migrant workers challenged the perceived economic disparity between this commentator (who still had a basic phone) and themselves. Secondly, the notion of

Figure 5.4: Spaces are socially controlled. They may bar access to an artefact.

a person not eligible for entertainment (owing to his role of labourer) was questioned. Additionally, a Bhojpuri song in Haryana might look like a cultural intrusion, which was facilitated by mobile phones.

Artefacts can *disrupt the norms* that have evolved *around them.* The norms are dependent on the social discourse and who controls the social discourse. For example, the role of spatial definitions as carriers of social discourse, hence power, has been made evident by Bourdieu [1970] in his analysis of a tribal house. The men's spaces have the attributes of dryness and lightness where women's darkness and wetness, for instance. For us, it was interesting to see who got a personal phone (earning sons) earlier and who did not get at all (young daughter in law). As an instrument of communication, it was supposed to be needed by sons as they ventured out to earn. On the other hand, a daughter-in-law was supposed to stay at home. Therefore, she was probably supposed not to be in need of communication. Even her need for talking to her own parents, a 'valid' one, might not have been of importance to the family. In the case of the migrant workers, owning of phones 'with camera and songs' (in 2012) disrupted the norms. A migrant worker was not supposed to aspire for anything over basic subsistence, surely not for entertainment.

Artefacts also play their role by *subverting and moulding the networks of power* through their ability to speedily, efficiently, and most importantly, covertly process and communicate information. This is apparent in objections, in the rural areas, against the use of mobile phones by young people, particularly women[12]. The fact that young people are more adept at using ICT artefacts gives them a personal power to form social networks with their peers which often spread across caste and gender lines. This disturbs the social order which looks down upon such alliances. Many users had shown their dislike for mobile phones because it helps 'boys and girls fall in love' (for example, user AMO01 [40, M, Xth, Bicycle Repairman] and user UJN01 [50, M, XIIth, Village Elder]).

Artefacts can help accentuate or mitigate power asymmetries. The prevalence of non-accessible buildings and transportation bars disabled people from the opportunities that might have been available otherwise. Lack of access to ICT similarly acts as a disadvantage in terms of economic growth and thus social equality[14]. In UJN09's case, she was seeking artefact to deal with the power asymmetry arising due to disability. However, the effort itself had become difficult due to the structural power asymmetries arising due to gender and disability.

A special form of power configuration occurs due to gender. Technology plays its role because it is gendered (see, for example, Wajcman [2010] and Bray [2013]). Both technology and gender have bearings upon the social structure. Both are intertwined (Cockburn et al. [1992]) to the extent that, "we can never fully understand one without also understanding the other." (Lohan and Faulkner [2004]). The barriers to access and use of digital technology arise due to the defined societal roles and the resulting conditions (Antonio and Tuffley [2014]; Johnson [2012]). These can happen in myriad ways: lack of access to technology, education and economic backwardness, power bias and exclusion, limited free time, gender-related vulnerabilities etc.

The genderation of technology acquires new forms in response to a given milieu. Washing machine is a good example for the industrial age. Poutanen and Kovalainen [2017]) argue:

> Despite the assumed entry of technology into the household and the assumed masculinity of technology.....did not change gendered household work....women

[12]In the second decade of the 21st century, there have been many reports of village *panchayats*[13] banning jeans and mobile phones for women (Khan [2017] lists a few).

[14]We have discussed the promise of ICTs for development in section 2.4.2.

are still more likely to deal with the laundry than the men are.

It is worth examining how ICTs have been gendered in the context of the EUs. If we look at the case of User UJN09 (at the start of this section), the genderation may not be apparent initially. There seems to be no issue at all regarding whether a woman can own a phone or not. After all, when she had bought her own mobile phone, no one in the family had objected. However, we can argue that genderation is present in a subtle form: she was the last one in the family to get a phone of her own. Let us try to understand—the power configurations (arising due to gender or otherwise) are deeply entrenched. A woman's position within this configuration is defined clearly which gives rise to factors–direct and indirect–that bar her ability to access, learn and use a digital artefact. Firstly, we had observed that the finances were mostly controlled by men. A woman could have cash of her own if she had an employment (a role that had to compete with that of a home-maker) or if she was a matriarch. In the case of UJN09, her lack of education (women are likely to be given less priority for education, after all they will be married off) and her role as a home-maker made it unlikely that she had an income. Interestingly, her college-going sister-in-law not only had cash in her hand but had purchased her own phone much earlier. As a college-going woman, she had become at par with her working brothers which user UJN09 as a housewife could not. Secondly, her spatial freedom was limited. A woman whose primary responsibility was to take care of house ventured out at a much lower frequency. This hampered her chance of learning the artefacts. Thirdly, a woman might feel subdued because of her socially defined position. In many cases, the subjugation could be consciously operated, for example, user PDR04 [28, F, IXth, Housewife] told that her husband would scold her if she touched the PC kept in a shop owned by them. In another case, a young man had the power to check the phones of his mother (user AML01 [45, F, VIth, Housewife]) as well as his sisters, but not the opposite.

To conclude, the role of social power and gender in ICT usage is critical. It could bar a user accessing, learning and usage of ICT artefacts like any other barriers such as income and education. However, understanding the role of power and gender is difficult due to its complex and nuanced nature (as has been discussed above). It becomes more arduous to investigate the role in the contexts of EUs, owing to the historical and local facets.

5.3.2 Individual Dispositional Constructs

We had examples of people who were ahead in terms of the ICT usage than other people having similar demographic profiles. On probing, we discovered the role of inner processes like motivation, attitudes and self-efficacy. It was evidenced in utterances like, "I keep trying on my own" (said by user AML01 [45, F, VIth, Housewife]), or "Though I am less educated, I can challenge an architect" (user AMB09 [27, M, VIIth, Woodwork painter]). On the contrasting side, we also encountered persons who told, "I do not waste my brain" (user AMB02 [33, M, VIIIth, Worker]), or, "(mobile phones) do not contribute to anything if humans do not contact each other" (user UJN01 [50, M, XIIth, Village Elder]).

These constructs—attitude, motivation and self-efficacy—are termed as individual dispositional constructs because they are dependent on an individual's makeup and disposition. They are dependent on fluid and transformable aspects like emotions, beliefs and desires. They are not concrete and un-mutable in the way are the ability to read or lack of infrastructure.

Motivation

Engagement with an activity depends upon the motivation. Davis et al. [1992b] talk about two types of motivations—intrinsic and extrinsic. Intrinsic motivation relates to the performance of an activity, while extrinsic motivation is concerned with its outcome.

Intrinsic Motivation Intrinsic motivation, as the name suggests, is intrinsic to a person. It explains what 'pushes' a person from within, towards a goal. One source of intrinsic motivation is the enjoyment of using an artefact for its own sake. What makes a user enjoy learning an artefact for its own sake? Is there any pleasure to be derived from that? The answer has two facets (Malone [1981])–curiosity and challenge. Human mind derives pleasure in discovering new things. Curiosity is evoked when an information seems to be 'incomplete, inconsistent, or unparsimonious' [Ibid. p363]. The mind spontaneously strives to remove these deficiencies. On the other hand, challenge enhances a user's self-esteem.

There were users who enjoyed or derived pleasure in using their artefacts. For example, user CHN02 [42, M, VIIth, Small businessman] was a 'self-explorer'. User DVG03 [39, M, IXth, Goldsmith], on seeing his friend's new Sony Ericsson phone with features such as Camera, Music, Bluetooth, had wanted to explore it. The role of intrinsic motivation reflected in the level of ICT usage for both the users. The former was able to store songs in SD card, set alarm, capture videos & images and navigate to the call-register. The latter could capture images both from the mobile and a digital camera, save contacts (in Hindi as well as in English) and operate Facebook account (from a cybercafe).

The role of self-identity in contributing to Intrinsic Motivation was evident in the case of user UJN12 [22, M, XIII, College Student]. Being knowledgeable about ICT enhanced his self-identity. As a result, he actively tried to gather more knowledge. The push was strong enough for him to seek it from different sources, for example, from the village mobile shop, where young men like him would hang around. User UJN12 had neglected his study due to 'helping' others regarding technology. He stated that he tried figuring out things by himself–"I keep on tinkering with the things". He took particular pride in telling that he had taught many people and was elated that he had been given a nickname that announced his technological knowledge–'*Net*'– by his peers. Between 2012, when this interview took place, and 2016 he had progressed significantly. Whereas in 2012 he was not able to operate an e-mail account, in 2016, he had a Facebook account from where he had announced that he would be able to open the lock of any system (that is, mobile phone), "....whether an Andrioid or a 'simple' [phone which may cost anywhere] from [INR] 1000 to 60000..."

Self-identity could also be projected through the artefact itself which, in turn, motivates a person to perform the tasks. Show-able aspects, such as ringtones, caller tunes, wallpapers and even the artefact itself, were changed frequently to project self-identity. User UJN04 [40, M, Xth, Sales Agent] (he too was a regular at the mobile shop) reported that he changed the ringtones very often. He argued, "When we change clothes every six months, why not the ringtones". However, there were users for whom 'show-ability' did not matter. For them, owning a phone was strictly a utilitarian affair. For example, when asked why would not he change his phone model, user UJN02 [45, M, XIIth, Tuition Teacher] quipped, "Who needs to put a show?"

Another factor helping intrinsic motivation was cherishing of the personal memories. Photographs of the children, as they grew up, was a dominant form for the parents. Many users had only images of their children in their phones. The photographs were shared with the other members of the extended family, in a way similar to paper photographs. Either they were sent over WhatsApp, or, they were shown-off the phone itself. The other types of photographic memories included those of the important events which involved the family and friends as groups. When user UJN08 [50, M, Xth, Shop Owner] showed the photographs of a family trip to Kullu-Manali[15], he was, in some way, sharing the experience of being in Kullu-Manali with the family.

Memorable experiences could be had without groups also. User DVG03 [39, M, IXth, Goldsmith], showed us the photographs of various places[16] he had travelled[17].

Cultural practices also contributed to intrinsic motivation. We found that consumption of songs (both in audio and video format[18]) and movies were important activities. The content was both secular and religious and contained items in both the dominant language (for example, Hindi) and the local dialects (for example, Malwi).

Intrinsic motivation certainly 'pushed' a user to use an artefact. Users who had faced barriers (see Section 5.3.1) devised new ways to deal with them. We have an example of user UJN06 [45, M, VIth, Sweetmaker] who was provided with a personal computer by his engineering student sons. The user used the computer only for watching movies. Not being able to read English, he navigated in a visual sense—the shape of the visual layout of the folders in a particular screen gave him an idea about where he was in the folder hierarchy. In the final screen, where the video files were supposed to be, the sons had set thumbnail view. As every movie was represented by small thumbnails (depicting one of the frames), it helped him recognising a movie. In between his work, he would put on the computer, a complex task in itself but rote-learnt by him, to watch movies. Though he

[15]In Himachal Pradesh, India, a famous hill town in the Himalayas.

[16]That included the famous temple of Thirupathi in south India, and Ramoji film city, a large film studio near Hyderabad.

[17]Interestingly he also told that he had ordered 60 of them to be printed on paper. This showed not only the importance of capturing his experience but also towards the fact that device based photographs were volatile by nature (amenable to be destroyed easily) while paper-based were not.

[18]Songs form an important aspect of narrative in Indian cinema.

took two months to learn to watch movies, the fact was that he did.

UJN06's example indicates the role of entertainment in intrinsic motivation. He had long stretches of no-work when he did not have customers and neither was he was working but had to stay in his shop. It was during these moments he would watch movies. Entertainment was required not only during long stretches of loneliness but also during monotonous work routine such as spraying in the fields (as it was for user DVG05 [36, M, Xth, Politician] when he sprayed insecticides in his mango orchards).

Extrinsic Motivation Extrinsic motivation arises due to an external situation. However, accepting or declining of an opportunity is still an internal process and depends on the desires and beliefs of an individual. The desires and beliefs are integrated into a person's overall world-view and life-goals.

Livelihood is a prime contributor to extrinsic motivation. A detailed discussion on livelihood and ICT has been provided in Section 2.4.2. We have discussed there that ICTs, by providing timely and accurate information, help reduce *transaction costs*. Effort expended in fixing a meeting between two persons is a form of transaction cost. It could be reduced by using mobile phones as was evident in the statement of user UJN03 [45, M, XIth, Shop Owner]:

> Landlines were nice if one remained at home. They are not when, for example, someone goes to the market and he does not have a phone then whom would you contact.

For this user, going to the city and not being able to contact a vendor was a waste of effort. The mobile phone provided him with the ability to compete with a businessman who was based in the city market. Interestingly, mobile phones acted as both address books and (virtual) addresses. User AMB02 [33, M, VIIIth, Worker] remarked, "Nowadays, even people who do not own a phone ask for phone numbers."

Often businesses benefit by reducing transaction costs for the customer. Mobile phones provide opportunities for that too. User UJN06 [45, M, VIth, Sweetmaker], who also served tea to the nearby shops, did not want his clients to call. It was an understanding between them that the customers would use missed-calls to signal the seller to take an order. This is an interesting case because missed-call has been used as a valid communication mechanism with zero cost burden. Though a missed call[19] could carry messages of limited scope (for example, 'yes/no', 'call back'), it was a sufficient and zero-cost way to signal a request for an order.

Effort expended in the coordination is another form of transaction cost. Mobile phones helping its reduction was evidenced in a non-business scenario. Two sons of user UJN06 [45, M, VIth, Sweetmaker] studied engineering in the nearby city. The family was able to send fresh home-made meals twice daily by sending the meal-boxes through the Maxicab/Ace (six-seater vehicles connecting rural areas see Figure 5.3) service. The coordination was done using a phone. The family would communicate the vehicle number, as it started from the village, so that the meal-boxes could be retrieved at the other end. The phone made the coordination between the two ends possible. Without the phone, either a person would have to travel with the meals or the idea would have been impossible.

Mobility in communication contributes to extrinsic motivation. In this regard, mobile phones have an advantage over landlines. It becomes particularly useful for professions that require mobility, such as a travelling salesman or sales agents. User UJN04 [40, M, Xth, Sales Agent] told, "landlines remain at home, the mobile phone goes with you." It became handy while in the fields, which are often far away from the settlements. User UJN07 [35, M, IIIrd, Farmer] told, "If you are near the well [in the field] and you want something from the home, you can call them to carry."

Belonging to a community is an important motivation. *Social communication* plays a role, which has undergone a quantum change after the advent of mobile phones. The communication that used to happen through postal letters or through physical visits, has become less frequent. The mobile phone has facilitated social communication to the extent that *geographical distances have become neighbourhoods*. User AMB02 [33, M, VIIIth, Worker] had lamented about the womenfolk in his family who would often discuss with the women relatives in the other cities 'trivial things' such as, "What is being cooked in your home[20]?" This type of conversations signifies the fact that the mobile phone has

[19] Donner et al. [2008] tell how missed-calls are encoded into messages.

[20] Inquiring about 'what has been cooked' not really a question, it is more like a conversational enhancer.

brought the immediacy of the neighbourhood to the long-distance communication.

Social communication takes a special variant when seen through the lens of *migration (and globalization)*. As the families are split apart, whether it happens through marriage or through requirements of employment, mobile phones become an important way in which the familial bonds are maintained. We have reported earlier that user UJN05 [60, F, illiterate, Elderly Housewife] bought her own mobile when her daughter was married. Similarly, user AMB04 [48, F, illiterate, Housewife] had to learn to operate a mobile phone when her son went abroad for employment. There were things common to both the users. In both the cases, there were alternatives to personal mobile phones. The former user could have used other family members' mobile phones, the latter the landline in the house. However, both had availed their own devices. Both were elderly mothers whose children were away and had desired to communicate in privacy. Also, both of them used to frequently move out of the home, which required a mobile device.

Social communication also becomes a *professional necessity* for many people. The people who have many customers and followers would need to be in touch with them. A typical case is of the politicians. User DVG05 [36, M, X^{th}, Politician] would send an average of 15 to 25 messages to the people connected with him. Disconnection is costly for in politics and as this person was a young politician of some local influence, that was his way of remaining 'connected' with his people.

Attitudes

Attitude is defined by Allport [2018] as 'a mental or neural state of readiness for a mental or physical activity'. In the same work, he cites other definitions which make attitude as readiness or predisposition towards an action as well as 'feelings, desires, fears, convictions, prejudices or other tendencies' that make it up.

We demonstrate the role of attitude by citing the case of user UJN01 [50, M, XII^{th}, Village Elder]. He was the patriarch of the household as well as the community. A son in civil services and belonging to a higher caste meant an adequate level of social power. He was retired, in the sense, that his sons were now primarily responsible for the economic activity. His main focus was on the community level affairs. He interacted in person with the community almost daily.

User UJN01 had negative attitudes regarding mobile phones. At a very basic level, *non-utility* contributed towards it. As mentioned earlier, he met people in person. Being in a time-rich society, he could afford to walk around in the village and talk to people. In fact, face-to-face communication was important in his context, because as a village elder, he needed to be visible and present in affairs of the community and the village. He conveyed to us that was he not concerned with the connectivity advantage offered by mobile phones. Phones, in a sense, were redundant for him. He told, “These [the phones] are of no use—things don’t happen until you meet a person face to face.” He did not need the phone to help in running the affairs of the house or business. He had passed on the responsibilities of home and livelihood to the sons and their wives. The utility of the phone reduced further because there was already a landline in the household. According to him, he did not need the phone (we could see it was an old basic phone), rather, it was ‘forced upon’ by his eldest son.

Attitudes are about emotions and convictions. Therefore, attitudinal dissonance arises when a set of *beliefs* stands opposite to the meanings carried by artefacts. One set of these meanings arises due to the loss of social control and resulting disruptions in power structures that technology suddenly brings in (also see Section 5.3.1). As also discussed with reference to power, persons from the younger generation communicate with each other to a greater degree and often discretely, and many a time, across the communal and gender boundaries. The result is, the technology is ascribed with a share of the blame. User UJN01 said, “People chat unnecessarily, waste money. People keep on buying new mobiles.”. The ’people’ in question were the ‘others’—the younger adults, the women and the marginal. It resonates with the example of user AMB02 [33, M, VIIIth, Worker]. He blamed the ‘womenfolk’, He complained, “[My] mother first asks [over the phone while talking to relatives]—*What have you eaten? How is the child? What did you do in the morning?*—[on the other hand,] when an ‘educated person’ talks, he finishes off with either a ‘yes’ or a ’no’.” The attribution of the elderly woman as ’uneducated’ was used to delegitimise her social behaviour (depicting her concerns of the well-being of the others), and thus raise objection against her technology usage.

The negative attitudes are also formed because of the institutional *distrust*. Technology is often taken to represent the people who make, manage and maintain technology. We found that mobile phones were taken to be the representatives of the companies who manufactured them or who provided services for. The level of trust went down whenever there was some breach of promise or a sense of being cheated. User UJN07 [35, M, III^{rd}, Farmer] distrusted the people selling mobile phones and services. He had bought a SIM card through a marketing representative who had been able to convince him to buy. Later, during the use, he had unknowingly subscribed to a caller-tune, which had reflected later in the cost. He had not found the online representatives to be helpful. His problem had been resolved only after talking to an offline representative, that too after he had 'warned' that he would not only "stop his SIM" but also ask 100 other people to do the same". He had gotten the refund.

Institutional distrust was also felt while interviewing user UJN01 mentioned above. He told that the companies were 'money-minded' and kept on coming up with 'new schemes'. He said, "people who are smart enough [the executives of the companies]—they [only] earn money." Interestingly, we, the interviewers, were also considered to be the part of some big and monolithic institution, appearing not different from the rural marketers, who frequently thronged the villages. He told us that, "Companies are looking after their own benefits...People like you misguide [us] through sweet words."

Attitudes can also be formed due to the earlier *experience* with the same or similar artefacts. A wrongly done billing or repeated calls by tele-marketers impressed a negative attitude towards the usage of the artefact. Marketing messages were typical irritants. Many users viewed them negatively. User UJN07 [35, M, III^{rd}, Farmer], as a complain, showed how his message box was filled with unnecessary messages. User UJN04 [40, M, X^{th}, Sales Agent] told that he had conveyed to the 'company' in clear terms that the Do Not Disturb (DND) should be taken literally.

Self-Efficacy

Self-efficacy (Bandura [1978]) is the expectation of a positive outcome before the task is initiated. Self-efficacy is indicative of the usage of an ICT artefact in many ways. Firstly, it indicates successful early experiences with the artefacts, both direct and vicarious, which is indicative of the level of exposure with ICTs. Secondly, it has a dependency on encouragement by others, indicating the level of prevalence of the ICT usage within the social context of the user. Thirdly, it is also related to anxiety and outcome expectations that affect the usage.

Self-efficacy, both low and high, was commonly ascribed to the level of education by the users. The users with low self-efficacy thought that their education was insufficient, while the ones with high self-efficacy thought that their education was adequate to help them use ICT. Many of the users with low self-efficacy were educated below class 5th. For these users, often ICTs were supposed to be the domain of 'the educated folks'. In contrast, the people with high self-efficacy drew it from whatever education they had received. For example, user AMB03 [48, F, V^{th}, Housewife], who was not much adept with technology, told, "It is not that I won't [be able to] learn. If I try, I will learn. Less educated [persons] than me do better. [Don't they?]"

English proficiency was a particular form of education based self-efficacy. Users expressed that if they were good in English, they could have handled their mobile phones better. User UJN04 [40, M, X^{th}, Sales Agent] told, "I would need to learn English in order to be able to [manage these technologies]." According to user AMB02 [33, M, $VIII^{th}$, Worker], "Today the kids are very advanced. One reason is that they are taught in English."

We also have evidence in support of Bandura's second assertion that self-efficacy is enhanced by the community's support and encouragement. User AML01 [45, F, VI^{th}, Housewife] was continuously supported by her school going daughters. We found her having a high level of self-efficacy. She asserted, "if somebody shows the way once, I would be able to do it.....when I intend something, it does not take me [even] a day to learn."

We have also found an additional insight. We found that if a person was adept in some other technical skill, his self-efficacy at handling ICT was enhanced. In other words, the proficiency in one domain automatically gave the confidence to try out in another. When user AMB09 [27, M, VII^{th}, Woodwork painter] told, "Though I am less educated, I can challenge an architect", he was drawing from his ability to deal with a technically challenging job of painting woodwork in newly constructed modern apartments.

Computer Anxiety

We found very few users who were anxious or afraid of their devices. This may be because a mobile phone is a 'personal' artefact and has a 'small' size. ATM's appeared exactly opposite—impersonal, complex and 'power-laden'. User PDR02 [31, M, VIIth, Tailor] had a savings bank account but could not go to ATM as he had a fear in his mind. He told that it was not feasible for his height (he was a disabled person). His being disabled, low-income earner (for him, money was a problem in buying of a new phone) and less educated may have contributed to the fear. (De Angeli et al. [2004] also have talked about social constraints that barred users with less social power from ATM usage.).

The physical size of the artefact did affect one user. User PDR01 [48, M, Vth, Property Agent] was scared of a big T.V. He thought something might happen to it if he pressed 'something wrong'. He didn't mind operating a smaller T.V. He said, "Nothing will happen to it."

For another user, even the mobile phone had elements of uncertainty. User CHN01 [44, F, VIIth, Housewife] was afraid of the (unknown, uncontrollable) mobile phone charges. She was a basic user. She used the mobile phone very minimally—she received calls, made them using speed dials and sequentially went through the address book. However, she was confident in using a landline.

Mental Models

A combination of many user-related constructs will determine if a user has adequate mental models to deal with the ICT artefacts. User UJN05 [60, F, illiterate, Elderly Housewife] was surprised at being told by her grandson that her mobile phone had a radio. In contrast, user UJN04 [40, M, Xth, Sales Agent], who was from the same village, not only knew that the phones had radios, but could also provide an evidence by informing, "The mobile, indeed, has a radio. One needs an antenna for it. The cord becomes an antenna." In the case of User UJN05, buying a phone was highly utilitarian. It was used for talking, primarily to her married daughter. For her, the initiation to an ICT artefact had happened at a very late age, when learning abilities decline. Her social circle was limited to neighbourhood women. In contrast, UJN04 had good spare time and hanged about, notably at the village mobile shop. He had been using a mobile phone for 8 years. His usage was not utilitarian. He would explore features on his phone, for example frequently changing screen-savers and ringtones.

Users who had adequate mental models were able to do the tasks well. They often spoke aloud as they demonstrated the tasks. Interestingly, they conceptually knew about the features and functions of their devices even if they did not know the terminology. For example, one person[21] did not know the word for 'home screen' but could point out that it contained all the items together. Persons with good mental models also doubled up as teachers for the other users. User CHN02 [42, M, VIIth, Small businessman] considered himself to be a 'self-explorer' and could do a wide variety of tasks on his phone (for example, using the alarm with advanced option). He was likely to have acquired adequate mental models. He told us that he had, "Taught [many] people [on the other side of the phone call how] to view and tell the contact number without disconnecting the call."

5.3.3 Socialisation and ICT Usage

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Users do not learn ICT usage in trade schools, they learn it in the day-to-day social context from each other. For the users who are barred in some form from access to the services or devices, the social system helps cross over the barriers. What are the conditions that facilitate or resist this type of assistance? The following may help understand:

Types of Communities: Family, Neighbourhood and Friend Circle

Firstly, the family itself became a social unit where learnings happened. Often some members of a family would be more adept at ICT usage. These were often the younger members (the college goers, for example), or the ones who went out of the home more often (the ones who went out to work, for example). The less adept persons within the

[21] context lost

home learnt from the ones who were better. A parent could command a child to teach something. User AML01 [45, F, VIth, Housewife] told, “I can read in English but if I find it difficult, I ask the kids.” User UJN09 [33, F, VIIIth, Housewife] would often take help from her younger nephew-in-law (who studied in the college as well as worked in the mobile shops). It should be highlighted that assertion could happen only when the seeker had equal or more power than the teacher. In one example, where a brother had much power over the others in a family, the younger sisters would not seek any assistance in spite of him being more ICT-proficient.

The neighbourhood was another social system across which learning happened. In the case of user UJN02 [45, M, XIIth, Tuition Teacher], he would often ask a passing-by person to get the talk-time-recharge done from the village mobile shop. If he felt any difficulty in usage, then too, he would stop a passing-by child, most likely one of his students, to help. Learning from neighbours was particularly helpful for women as they could take help from a female or a younger neighbour. It helped them when, due to power disparity or gender-based boundaries, they could not seek help within their family. In that case, the seeking would be across the household boundaries through relationships that were free from these bounds. For example, UJN09 had learnt a few things from (presumably a female) neighbour.

The third type of community developed due to friendship. It could happen at the place of study. It could also develop at, in case of men, at ‘meeting places’ like village squares, mobile shops, card-players groups (who would play cards at any convenient place) and temple courtyards (which did not bar people). Most importantly, friendship based communities developed at the place of work. For example, drivers (for example, [M, 26, IXth, from a later study]) had ample time in between their work shifts to be able to interact with and learn from the other drivers. We found that young mechanics in a small workshop (such as [M, 26, Xth, from a later study]) taught their elder colleagues. Similarly, we found that the volunteers from a non-governmental organization (NGO) (like [F, 31, XIIth, from a later study]) learned the use of ICT from their more educated colleagues at work.

Initiation

Initiation is the first step towards adoption. Initiation has been discussed in this section because for initiating ICT usage, the EUs are likely to seek help from each other. Many users informed that they had learnt to use the mobile phone initially from a relative or a friend—user DVG02 [40, M, IXth, Worker] had learnt the basic functionality (receiving and making calls) from his friends; user DVG04 [45, F, VIIth, Tailor] had learnt to use mobile phone from her nephew and user CHN01 [44, F, VIIth, Housewife] had learnt to call using the saved contacts from her daughter.

Any artefact poses an initial challenge. This challenge is greatest when a particular design is to be used for the first time. For example, a person switching from feature phone to smartphone would face an initiation challenge. A non-EU often deals by reading the information in the form of manuals or accessing through other channels such as the Internet. An EU depends upon other users in his community who could teach him. Additionally, there could be one-time but complex tasks required for the initial run such as installing applications, configuring the settings and configuring user accounts. For these tasks too, an Emergent User turns to the helpers within the community.

It is important to note that if the level of expertise in a community is low, then it greatly affects initiation. We encountered this, in the case of user UJN12 [22, M, XIII, College Student] who acted as a knowledge leader within the community. He had an e-mail account that was initiated by a friend who had visited from city. However, as the friend had stayed for only a few days, the usage of e-mail could not be initiated. With UJN12, the leader, remaining uninitiated himself, nobody else in the village could be initiated regarding the use of e-mail.

The Role of the Physical Environment

The role of the physical environment in facilitating socialisation (that helps the learning of ICT) needs to be appreciated. Much learning and help happened among friends (For example, a shopkeeper friend of user UJN04 [40, M, Xth, Sales Agent] taught him how to delete messages). Often friends were made at common meeting places like *chaupal* (village

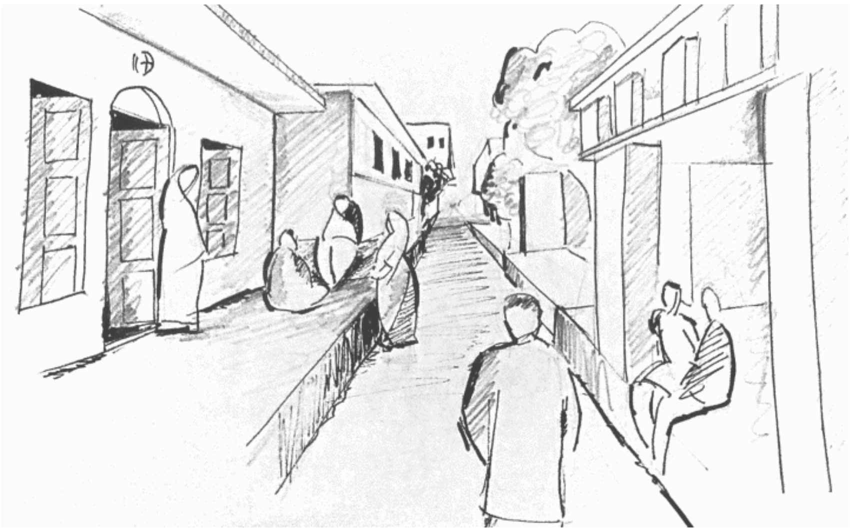


Figure 5.5: The physical spaces have a role in socialisation which may help in learning the usage of the ICT artefacts.

square) or tea shops. It did not matter if the technology savvy friends were younger. User UJN02 [45, M, XIIth, Tuition Teacher] could seek aid from the passers-by because he sat on the platform (like shown in Figure 5.5) outside his home which was connected to the street as well as other such platforms of the neighbouring houses. These spaces provided a lot of opportunities to interact. Actually, it was quite common to see the social lines blurred (though not completely). This was more evident in case of immediate female neighbours who would often enter each others' inner quarters in a rather informal manner[22].

The shops selling mobiles and recharge cards need particular mention. They turned up as learning and help centres. Often the customers would not be around merely for business. These shops turned up social spaces where people chatted with the owner. The handlers of these shops were more tech-savvy, because apart from selling SIM cards, handsets and accessories, they downloaded songs, videos (and perhaps games) and loaded them on the individual phones. As the communication barriers were low, people could turn up to seek help regarding something they faced difficulty with.

[22]such as calling out, 'Is anybody at home?', as an announcement rather than a permission.

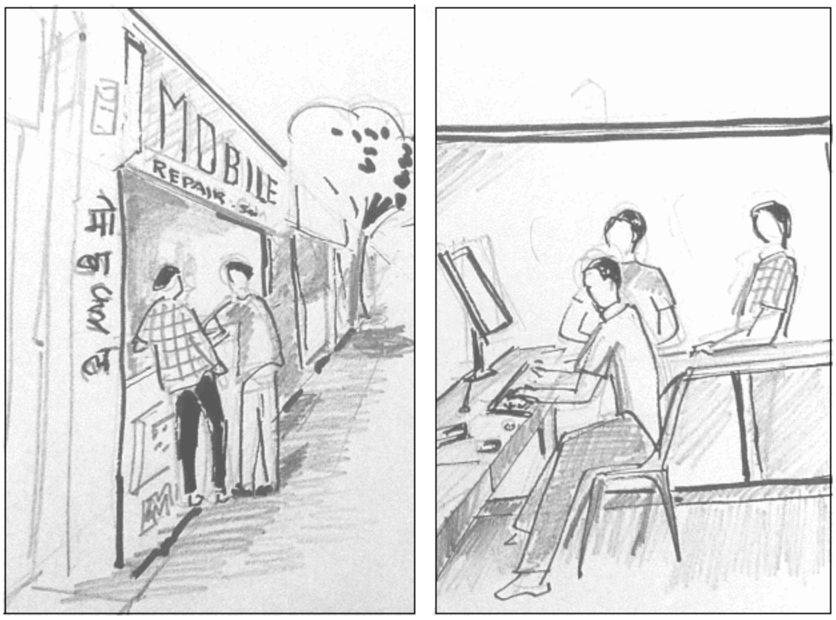


Figure 5.6: Mobile shops play an important role in the spread of ICT usage.

Social Approachability

There was also the role of high social approachability. User UJN02 [45, M, XIIth, Tuition Teacher] would not hesitate to ask for help from someone passing through the street. User UJN09 [33, F, VIIIth, Housewife], when she did not have a mobile phone and carried only a SIM card, could ask a stranger to insert her SIM card in his mobile phone and let her call home. However, it should be noted, that though approaching a stranger was part of the social norm, its propensity might change individually or might be affected by another social norm. For example, a woman might not take help from a male stranger in some situations. Due to the normative power-distance, a woman *might* also hesitate seeking help from her father-in-law.

Technology Leaders

The presence of 'technology leaders' seemed to be a positive phenomenon. These classes of people, like user UJN12 [22, M, XIII, College Student], would actively go out and teach others, sometimes at the expense of their own work. For these people, the notion of being technology-adept drove their self-identity and they took pride in being able to project their skills. The result was that not only these people were highly approachable, they were well versed with ICT too and made sure that the learning was transferred well. As mentioned earlier, much of UJN12's time was passed ('wasted' according to his parents) in teaching others about technology. The neighbourhood mobile shop was, of course, a place to hang out for him.

Technology leaders in some way set the benchmark for Technology Adoption. They, being ahead of the curve (they could be termed as early adopters for the community), are able to teach others. Their knowledge, through interaction within the community, reaches others. Therefore, the levels of adoption within a closed community is unlikely to be more than that of the technology leaders. We found that UJN12 was struggling to enable e-mail on his mobile phone. We did not find anybody in his village who had reached to that level.

5.4 Conclusions

We have attempted to identify the user-related constructs that might affect Technology Adoption by the EUs. By stepping into the EU contexts, we observed directly the constructs that acted as barriers and facilitators in Technology Adoption. Our aim was to use these constructs for potential operationalisation of the model. However, the focus during the contextual studies was, firstly, to identify as many constructs as possible, and secondly, on the nuances of the issues that surround these constructs. Many of the issues (such as power) are difficult to operationalise. They become more so in the EU contexts. We have been able to operationalise only a few of them (in Chapter 7)

5.5 Summary

In accordance with the twin research questions—'What defines a user?' and 'How does a user behave with a given artefact?', we needed to identify constructs that could inform technology adoption. As the literature was largely situated in western-urban-educated contexts, it was appropriate that we conducted detailed contextual studies to understand issues which could be converted into constructs. Our field studies informed us of many aspects related to technology adoption by emergent users. Firstly, there are barriers emanating both from physical infrastructure (such as lack of electrical power) and social structure that negatively affect, sometimes in an absolute sense, the time available for interaction with an ICT artefact. A reduction of that would directly affect a person's learning and usage of the artefact. The second set of factors affecting a person's learning and use of an ICT artefact arise from a person's internal makeup. These comprise of aspects like motivation and attitude. Thirdly, the role of the learning eco-system, in terms of community and the socio-physical environment is also important.

Chapter 6

The User-Usage Model

6.1 Introduction

In this chapter, we describe the User-Usage model of information and communication technology adoption by the Emergent Users. It is based on our practice as HCI professionals, the learnings from the fieldwork (chapter 5) and literature review on Technology Adoption & expertise (chapters 3 & 4). The User-Usage Model is an attempt to respond to the twin questions—*'who is the user?'* and *'what does he do?'*.

The first question—*'who is a user?'*—could be answered in many ways. A simple way is to specify it using the demographics, for example, user X [50, M, $\mathrm{V^{th}}$, Farm Worker]. However, this concise description is not very informative unless we project the original question on it, and ask *'How does one describe a 50 years old and V^{th} educated male farm worker (in India)?'*. The answer could be in terms of his physical appearance, his social context and the activities he is likely to do. A 50 years old, $\mathrm{V^{th}}$ educated, male farm worker is, *archetypically*, likely to have grown up children. He is not likely to own land and work in others' farms in his own or nearby villages. He is likely to be active, as a responsible member, in the community and the family affairs.

Now, for the purpose of understanding Technology Adoption, we can describe the user purely from the perspective of ICT usage. We can ask *'What can one tell about ICT usage of a 50 years old and V^{th} educated male farm worker (in India)?'* This will result in an

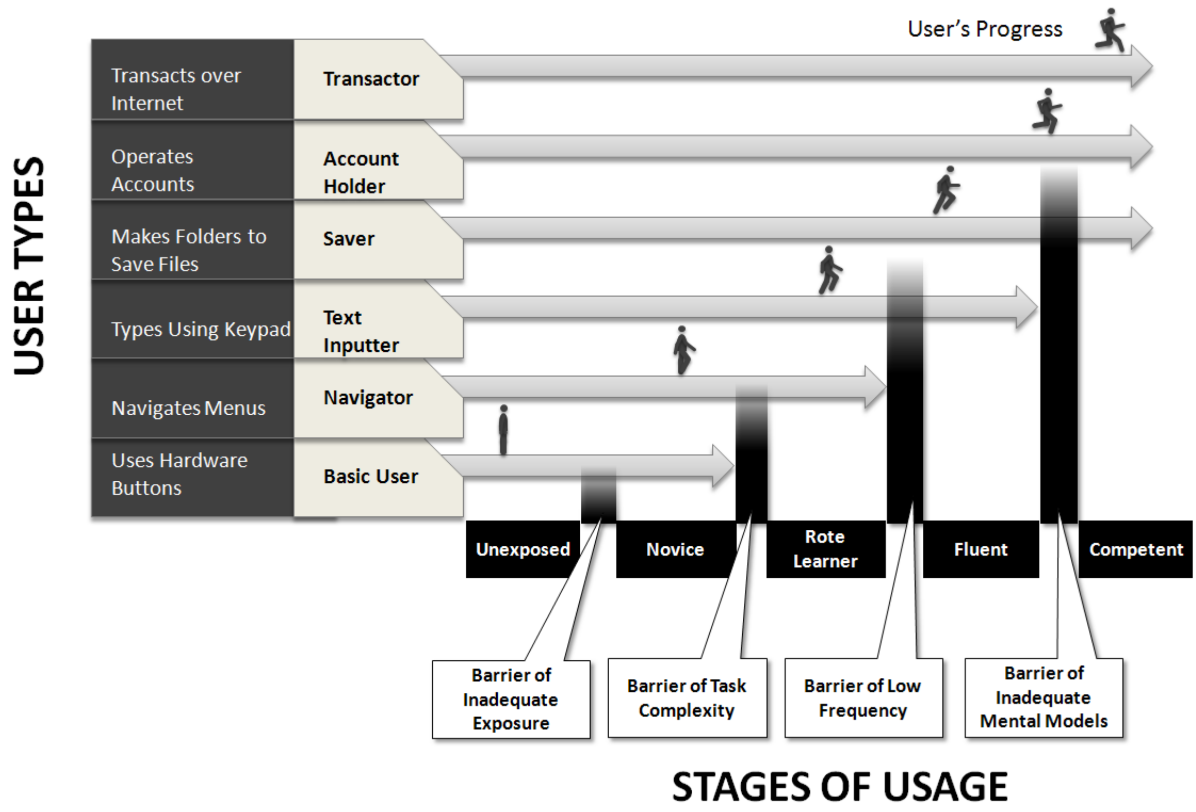


Figure 6.1: The User Usage Model

archetypical description such as:

> He is a reluctant user of the mobile phone. He would use a phone only for the tasks that require a single press of a button (for example, answering a call). Often he delegates the complex but infrequent tasks (like saving contacts) to the others. Beyond that, he avoids mobile phones and opts for the ways that do not require him to use ICT. (He goes to the bank in person rather than inquiring over the phone.).

Interestingly, the same description is also likely to be true for a user Y [35, M, IIIrd, farmer] as well as another user Z [40, F, illiterate, housewife][1]. The description of usage in this manner describes the usage-pattern common to many people. That allows the user population to be divided into categories based on the common usage-patterns. We have identified five such *archetypical categories of usage* (marked on Y-axis in figure 6.1)—*Basic Users, Navigators, Text Inputters, Savers, Account Holders and Transactors.* We call these categories the *User Types*. Each of the User Types has one-to-many mappings

[1]actual examples.

with the multidimensional demographic space[2]. Each mapping answers the following question—*what kind of usage-pattern a user with a given demographic description would depict?* As usage has strong connotations of tasks (as discusses in section 4.2.1), a given User Type is defined in terms of the types of tasks that she would do. This is reflected in the naming of the User Types. For example, 'Navigators' are the users who accomplish their goals through navigational tasks. We detail the User Types in Section 6.3

For every User Type, there are differences at the level of actual interaction with a given artefact. Suppose, there are two users, A and B, who connect with their friends through social networking. However, they use the social networking applications, such as Facebook, differently. User A is an extensive user who knows about and is able to set her privacy settings. User B merely forwards the posts on his wall. Clearly, the former is much adept than the latter. In this regard, we can ask—*How do we characterise the level of adeptness for a given User Type?* To answer, we adapt Hackos & Redish's model (from section 4.3.3) as a basis, and describe the adeptness-levels in terms of the user's behaviour with respect to an artefact (the interaction-behaviour) of a given design. Using the example of the two Facebook users, we would say that User A is more adept than user B. Not only that, we would also inform that User A does not deal with the complexity inherent in using Facebook, while User B does it easily.

Interestingly, inherent in a user's current adeptness-level is her *journey* of gaining adeptness with respect to (a particular application within) the artefact. In other words, an expert must have been a novice. She must have passed through a journey where she must have started at a low level and reached at the current level. For some users, the journey may last for a few minutes—they may take very less time in getting acquainted with the artefact. For some, the journey may be a long one involving arduous struggle—they may remain at a low level for years. It is also possible, at a given instance of time, that her journey is still continuing. Her level at that instance could be just a snapshot of her journey and she may be able to advance further in future. Along with recognising a user's current adeptness-level, it becomes also important to ask questions regarding the journey–In what manner has the user progressed to her current level since her first exposure to a given type of artefact? How long has her journey been? Has it taken minutes,

[2]In other words, users X, Y and Z, all of them map to the same category

days or years? What were the milestones in the journey? Which of the milestones were more difficult to cross, which were less? Can she progress beyond her current level? What are the chances of that?

As the above questions highlight, users' journeys are likely to be dissimilar in many ways. Firstly, a user would have progressed more than another. For example, two users who lived in the same locality[3], had progressed differently. The first, user AMB08 [45, M, Xth, Worker][4]), had been using a mobile phone for 6 years but used it only for receiving and making calls. He also could not search for a contact by typing. The other, user AMB09 [27, M, VIIth, Woodwork painter] had been using a phone for 5 years but, apart from making and receiving calls, could do things like deleting SMS, saving contacts (using the first couple of letters of contact name) and checking the balance through USSD. Secondly, different users would take different time to reach the same level. For example[5], one user, [40, M VIIth, driver], took a few weeks to learn sending SMS. Within the same context, another user [36, M VIIIth, driver] took a few days (in 2016). Thirdly, two users doing the same task may depict two different types of interaction-behaviour. For example, if provided with a mobile phone different from his own, one user could re-contextualise his knowledge to send an SMS comfortably, the other would do the same task only on his own phone, that too, in an interrupted and error prone fashion.

The above discussion provides guidance for operationalising a user's interaction-behaviour. We can consider a given level of interaction to be the current state of a user's journey. This journey is interspersed with barriers (see figure 6.1). Each barrier comprises of a set of challenges, when conquered, introduce positive changes in the interaction-behaviour. Therefore, across a barrier, on its two sides, the user's interaction-behaviour is markedly different. Conversely, in between two barriers the behaviour, we assume, is constant where a user would depict a typical interaction-pattern (for example, error prone and interrupted operation).

Each barrier offers different resistances to different users. A barrier offering greater res-

[3]The examples are taken from the contextual study described in Chapter 5. If they are from a different source, then it is specified explicitly.

[4]Refer to Table 5.2 in Chapter 5 for a concise description of this user and others mentioned henceforth in this chapter.

[5]this example is from the data collected for quantitative study reported in Chapter 7

istance will slow down the progress of a given user more than one that offers lesser. For some types, a given barrier can be so steep that a user's journey is curtailed midway. For some User Types, the curtailment happens earlier, for some later.

The space between two barriers is termed as a *Stage of Usage*. We have identified four types of barriers that inhibit a user's progress from one stage of usage to the next: *Inadequate Exposure, Task Complexity, Low frequency, Inadequate Mental Models*. The resulting Stages of Usage (depicted on X-axis in figure 6.1) are five: the *Unexposed*, the *Novice*, the *Rote Learner*, the *Fluent* user, and the *Competent* user. (We discuss the barriers, triggers and Stages of Usage in Section 6.2.)

Users might appear to be passive agents but they are not because they constantly interact with their situations which change from time to time. As discussed in Section 4.2.1 (see Figure 4.1), a user is pushed by the criticality and utility of individual life goals and the motivation needed to accomplish them through the ICT artefacts. We have also discussed that these factors keep on changing with time. These situational-factors (criticality, utility and motivation) act as forces against the resistance of the barriers. Whenever the situational-factors breach the barriers, usage is initiated. We call these instances of breach as *triggers* (also mentioned in the same section). We had many examples of triggers from our field studies, where the user needed an ICT artefact to accomplish a life-goal to the extent that she was able to breach a barrier. For example, UJN09 had to demand a mobile phone because of an incident where her journey could not be coordinated and as a disabled person, she had to suffer.

In the rest of the chapter, the two dimensions of the model–User Types and Stages of Usage–are presented as a two-dimensional matrix.

6.2 X-Axis : The Stages of Usage

As suggested earlier, the Stages of Usage are divided by barriers. The interaction-behaviour within a given Stage is considered to be uniform. The barriers are important because it is across them that the behavioural changes occur. In this section, we describe various barriers as well as the Stages of Usage.

6.2.1 Unexposed

A person is said to be unexposed to a given ICT artefact when he has either not encountered it at all, or encountered but decided not to use or has abandoned it after extremely limited use.

Using a city-traveller analogy, an unexposed person would never have stepped out of her home. She might not know how cities are configured or how they function. If, hypothetically, this person is left alone in a new city, she will find it extremely difficult to deal with the situation. She would know nothing of reading landmarks or figuring out streets and lanes.

Every person is unexposed to a given ICT artefact at some point in time. Once enough exposure (in terms of usage) is maintained, one is ready to cross over to the next stage. A person remains unexposed due to the barrier of *inadequate exposure*. It is the most basic barrier because for using or learning an artefact, a user should be able to access it first. We have discussed many constituents of this barrier in chapter 5. For example, low income, physical proximity with an artefact and power configurations can bar a user's access to an artefact. A user may not have enough money to buy a mobile phone. Another user may not be allowed to use one based on gender or social status. The physical distance between the place where a person dwells normally and the place where the ICT artefact is kept can arise both from social norms as well as compulsions of livelihood. We had encountered the instances of these barriers. For example, we had found that a shop owner (user UJN08 [50, M, Xth, Shop Owner]) was not able to access a computer kept at his home because of work. In another case (user UJN11 [45, F, VIIIth, Housewife]), a shared phone was often taken away by the husband, depriving the wife of usage. The other factors that negatively affect, and in some cases totally block, access to an artefact are physical disabilities and functional inadequacies. Internal factors such as motivation and attitude have roles too. As we have seen in the case of user UJN01 [50, M, XII$^{th,\ \text{Village Elder}}$], a person who does not enjoy or has negative attitude towards mobile phones, accomplishes life goals through other means such a physically reaching and talking to a person instead of using a mobile phone. As a result, he is likely to remain unexposed for a longer time. A contributing factor to this barrier is non-awareness. A user might be completely unaware of an artefact and/or its functions. for example, user UJN05 [60, F, illiterate, Elderly Housewife] did not know that her phone had a radio.

6.2.2 Novice

Even if someone has started using ICT artefacts, he may not be able to handle the task complexity. He may accomplish the tasks using only one or two simple steps. In this way, he minimises the cognitive load. This stage is characterised by slow and discrete movements during usage. If a task is complex (if it requires more than a few steps or is rule-based), then it is liable to be error prone.

In the city-traveller analogy, being a Novice is akin to a person who is absolutely new to a city. As she steps out, she would avoid venturing very far because she fears that she would not be able to recognise her way back. If she tries to do so, she will have a high chance of getting lost. Therefore, she will try to hire a taxi or take help from friends.

In the case of mobile phones, representative tasks under this stage are: making and receiving calls, answering a missed call from on-screen notification (as compared to doing the same through a call log), sequentially scrolling through lists etc. Though there are many ways of doing these tasks, Novice users perform them in a simple manner.

For example, making a call is most easily done by going to the recent calls (by pressing the left function key) (see figure 6.8) then pressing the call button. This operation may be as simple as selecting the topmost missed call, or it may involve scrolling down one or two steps. A user, especially if he cannot read (such as user AMB01 [50, M, illiterate, Dairy Owner]), may forego the effort needed to (1) recognise the name, and (2) decide whether to call back or not. In that case, the user would take his decision to continue or disconnect after, through the talk, the called person's identity and purpose have been established.

Another manner of making a call is through searching a name using sequential navigation. Sequential navigation may look like a complex task but it is actually multiple iterations of a basic task comprising of (1) recognizing, and (2) moving a step down the list (Figure 6.3). This method is much easier than searching a name by typing (figure 6.4) that involves typing and reading abilities which are more cognitively intensive.

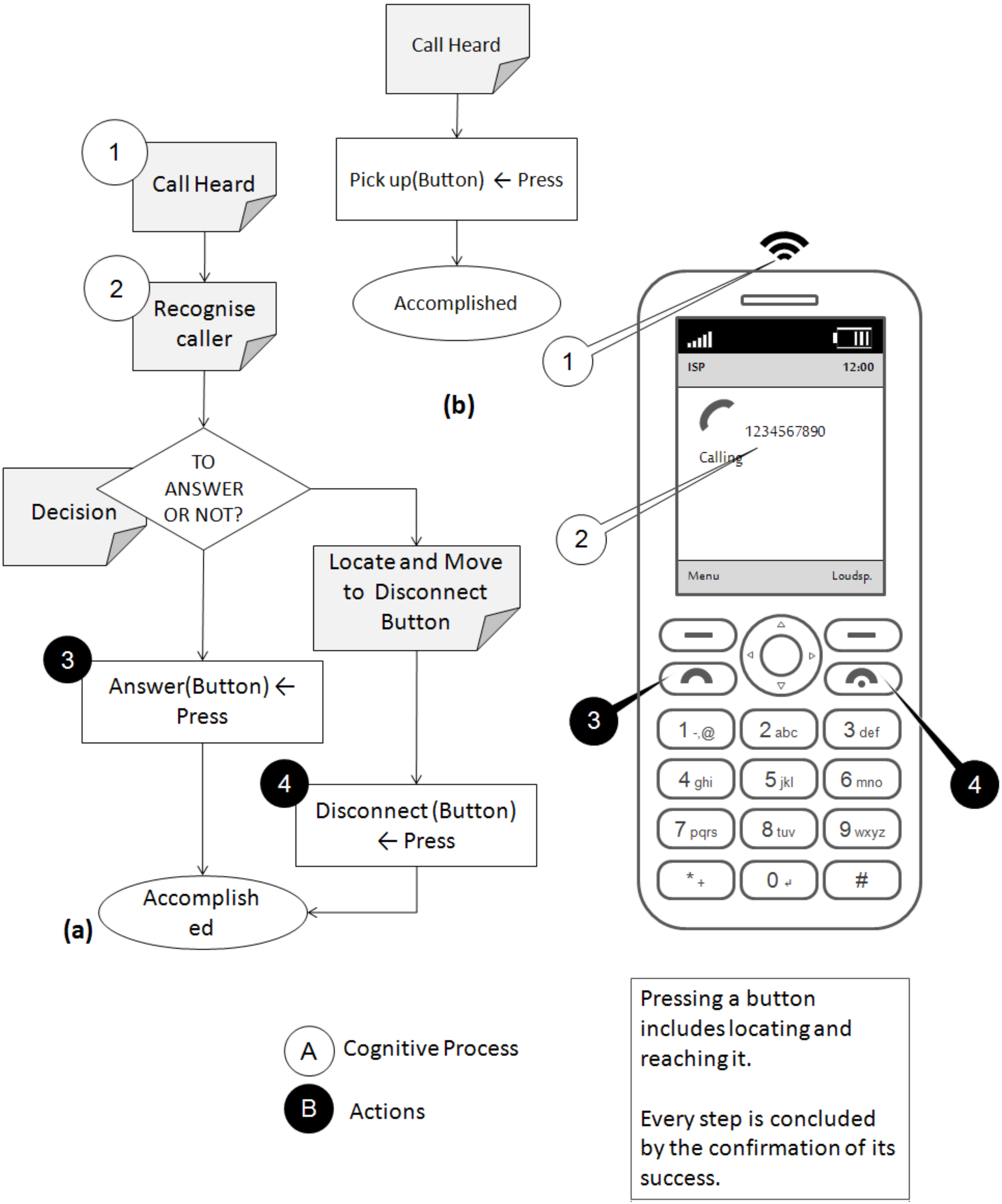


Figure 6.2: Receiving an incoming call. (a) It includes cognitive actions such as identifying a number and deciding to accept the call or not. In the cases, where a user can not read and is not able to handle cognitive loads, especially during the early days of usage, (b) he will avoid these steps altogether.

The main *behavioural* characteristics of this Stage are:

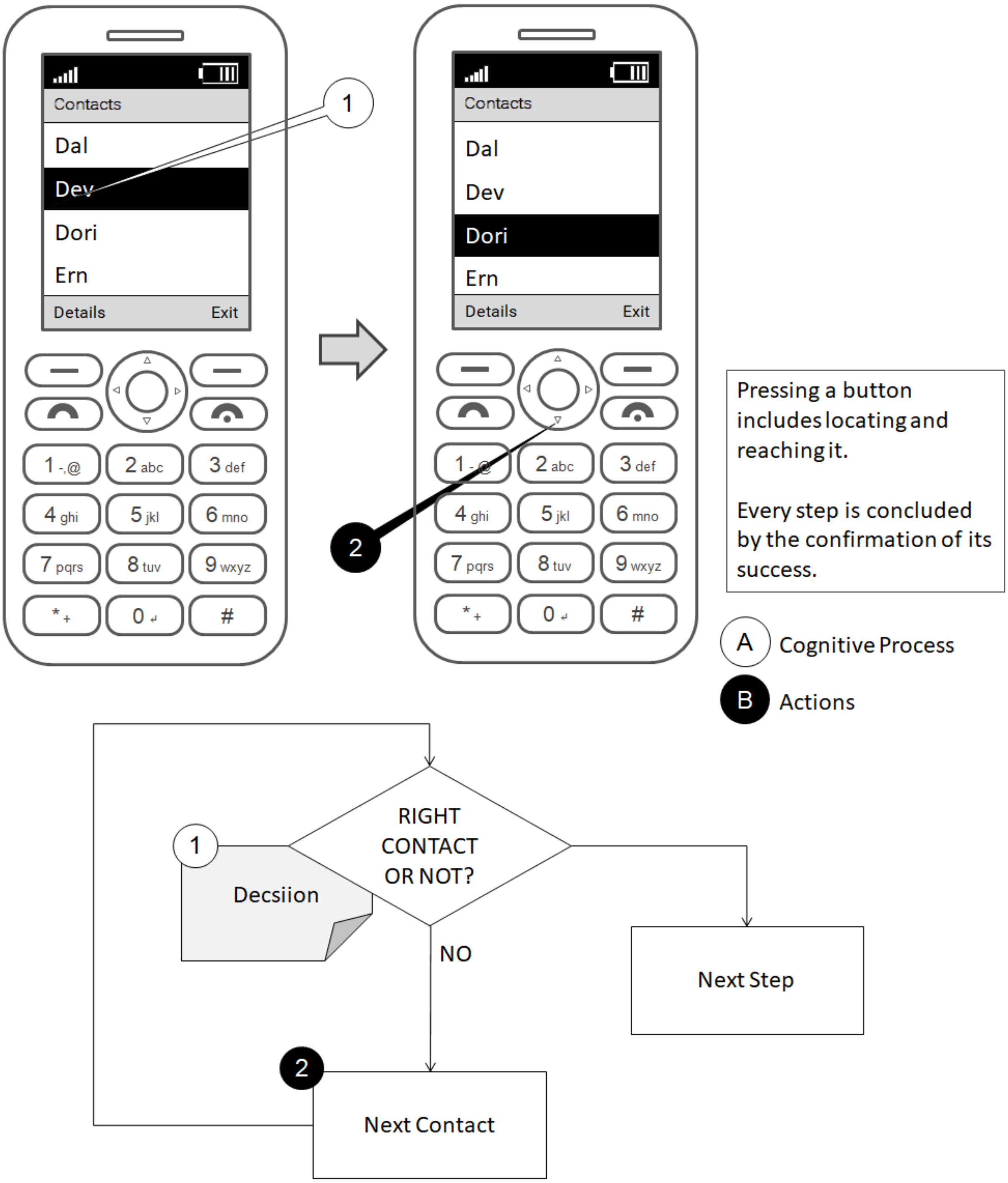


Figure 6.3: Sequentially navigating through a list.

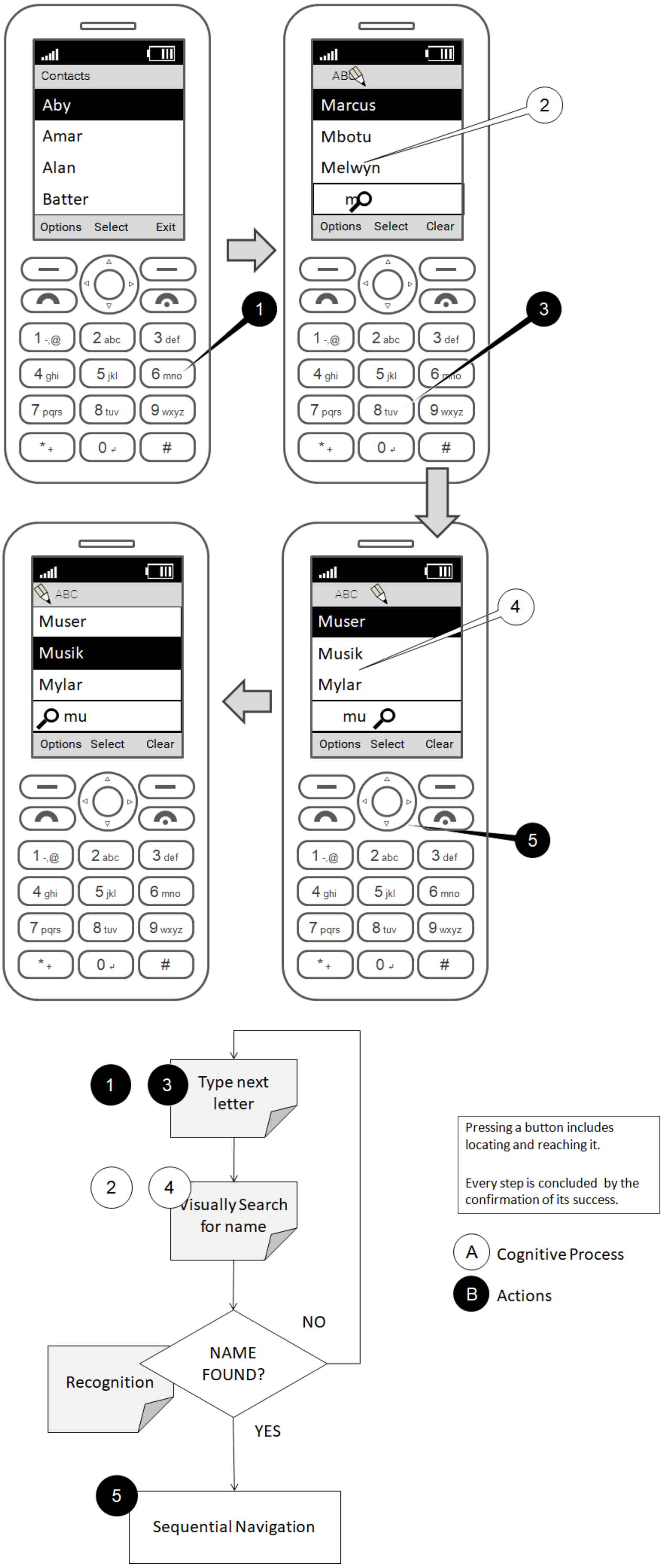


Figure 6.4: Searching through a list by Typing.

Use of Hardware Buttons or Desktop Shortcuts Novice users can easily learn to use hardware buttons that are mapped to specific actions, like that for ejecting a CD. A push of eject button results in the ejection of the disk. There is no intermediate stage for recognition and decision making. This reduces the cognitive load to a minimum. A short-cut set on the desktop does away with the need for menu navigation, and works similar to a hardware button. Short-cuts are often set by someone else in a user's context. For example, they were set by the sons for user UJN05 [60, F, illiterate, Elderly Housewife] to help her accomplish tasks she would otherwise not.

A Restricted set of Objectives Persons do not desire much from their artefacts. For example, user UJN07 [35, M, IIIrd, Farmer] did not attempt much except making and receiving calls on his phone. His lack of desire was reflected in a reluctance to learn from son, who was eager to teach.

Dependence on Physical Aids As complex tasks like saving contacts are not possible, Basic Users, like UJN07, use external aids such as pocket diaries.

Inability to solve problem A user struggles to learn an artefact. Using it purposefully in new situations would be far off. Doing so requires mental models, so this characteristic behaviour will appear in the next few stages too.

A person remains in this stage because of the *barrier of task complexity*. Why does this barrier arise? Using chapter 4 as support, we can say that a first time user of a given artefact, if he is dealing on his own, has to make a sense of it. If he does not have experience with a similar device, he would arbitrarily import a mental model (that is, he will rely upon an AIM[6]). If that does not map well with the designed conceptual model (DCM) of the artefact, the meaning-making process will add to the cognitive load as the user searches for employable mental models in the long-term memory.

Interestingly, even with lack of an appropriate model, a user can deal with complexity. He may be able to work around if he could avail somebody to instruct a procedural rule

[6] see 5.3.2 for differentiation of different types of mental models

(and could advance to the next Stage of Usage, Rote Learner). If the user does not have such a teacher in his immediate context, the task will remain complex. However, even if a teacher has been availed, the complexity of the task may arise due to the inability of the user to *follow the instructions*. The task complexity may also increase if rules become long and complex (that is, they contain many decision-making rules).

The factors that contribute to this barrier of task avoidance are low levels of education and higher age. As discussed in sections 5.3.1, these affect abilities such as acquiring new knowledge. On the other hand, section 5.3.1 also informs that instructions pertaining to ICT normally have textual bases. Therefore, a low literate person may find it difficult to comprehend the terms. Also, low levels of education also work by reducing self-efficacy, which affects a person's engagement with the artefact. This has been supported by the quantitative studies (in Chapter 7) where it was found that the elderly or the less educated users were more likely to be Novice users than the younger or the more educated ones.

6.2.3 Rote Learner

Even if a user can perform somewhat complex tasks, he can still lack appropriate mental models and fluency. As discussed in the earlier section, a person desirous of tackling tasks, that require more than a few steps, can take recourse to learning sequences of those steps, which have to be carried out in the right order. The sequence may have a minimal number of recognition and decision making steps.

While the number of steps to complete a task is limited to one or two for the tasks manageable for Novice users, for Rote Learners, they are significantly more. Rote learning has its limits, though. A much larger and more complex sequence cannot be helped by rote learning and would need a mental model for its representation. It is important to add that Rote Learning requires that a user should have a teacher in the immediate social context and he should be able to follow instructions.

Rote Learning is adopted when the criticality or the utility of a fairly complex task forces a user to deal with it. For example, playing songs is a highly desirable task. If a user does not have a mental model of a media player, then because of his need for entertainment,

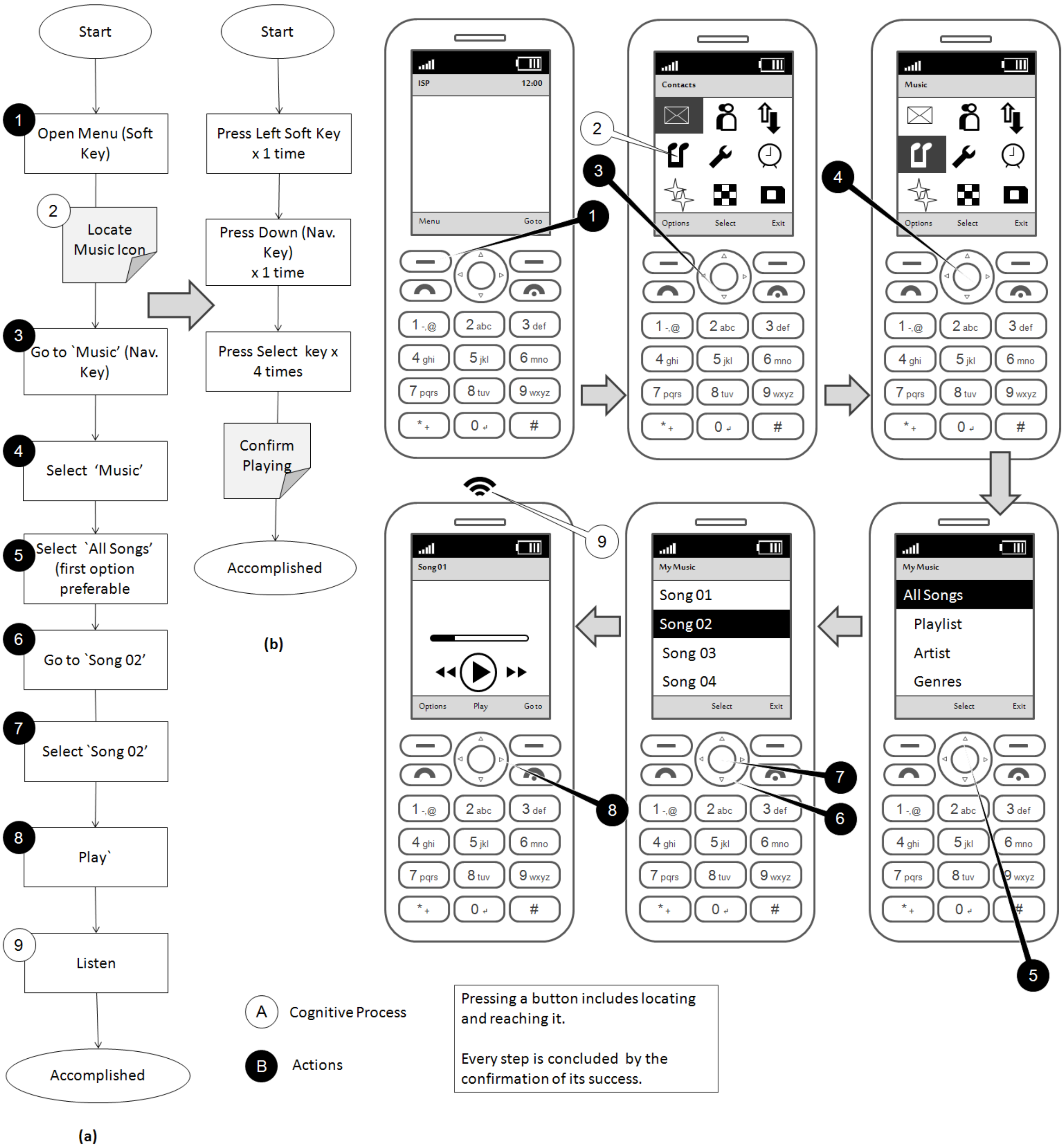


Figure 6.5: Playing a song from the menu (a) Accomplishing this task requires a sequence of steps, which need to be memorised. (b) With the practice of use, the sequence could be condensed into a smaller one by 'touch-going' some of the states.

he may use a sequence of steps, as shown in figure 6.5 (b), to accomplish the task.

Rote learning may come in handy in dealing with navigational tasks. These type of tasks require to understand the tree-like structures and therefore cognitive load might become difficult to handle. In the case of navigational trees, which are large in both breadth and depth, or in the cases where a user does not conceptually understand or abstract[7] the individual items, an easy option is to remember the sequence of steps as a recipe or routine. A user can learn to delete a text message by rote, without understanding the full navigational space (see figures 6.6 and 6.7).

To summarise, the Rote Learner stage is characterised by a lack of adequate mental models and a low frequency of usage but the presence of a routine/recipe. At this stage, a person would follow a sequence of steps and would be able to follow them without necessarily understanding how the steps relate with each other and with the whole task. The result is that such a user would be able to do tasks of some complexity but not of those requiring good mental models. Being a Rote Learner expands the repertoire of tasks available, however, it is an error prone method. If any step of a task is forgotten, it is difficult to recover from the resulting errors. In the case of very less frequently done tasks, there is a risk of forgetting them altogether. Moreover, the lack of mental models means that the user would not be able to execute the same task in new situations. For example, if a user is able to delete messages by rote on a familiar device, he might find it difficult to do so on an unfamiliar one. He can do that only after developing a general conceptual understanding of the information architecture of the messaging applications.

There is a nuance to rote learning. During the initial phases, or in the case of low frequency of usage, the user will follow the recipe or routine in a conscious way. For every step in the sequence, he would need to ascertain if he is right or not. After enough repetition of tasks, the sequence would be well memorised and the whole sequence would be carried out fluently. Eventually, the user enters next stage of usage, Fluent, described in the next section. Users who do not do rote learnt tasks frequently enough will not graduate to the next stage.

In the city-traveller analogy, a Rote Learner is equivalent to a traveller who has started

[7] This point is discussed in detail in section 6.3.2

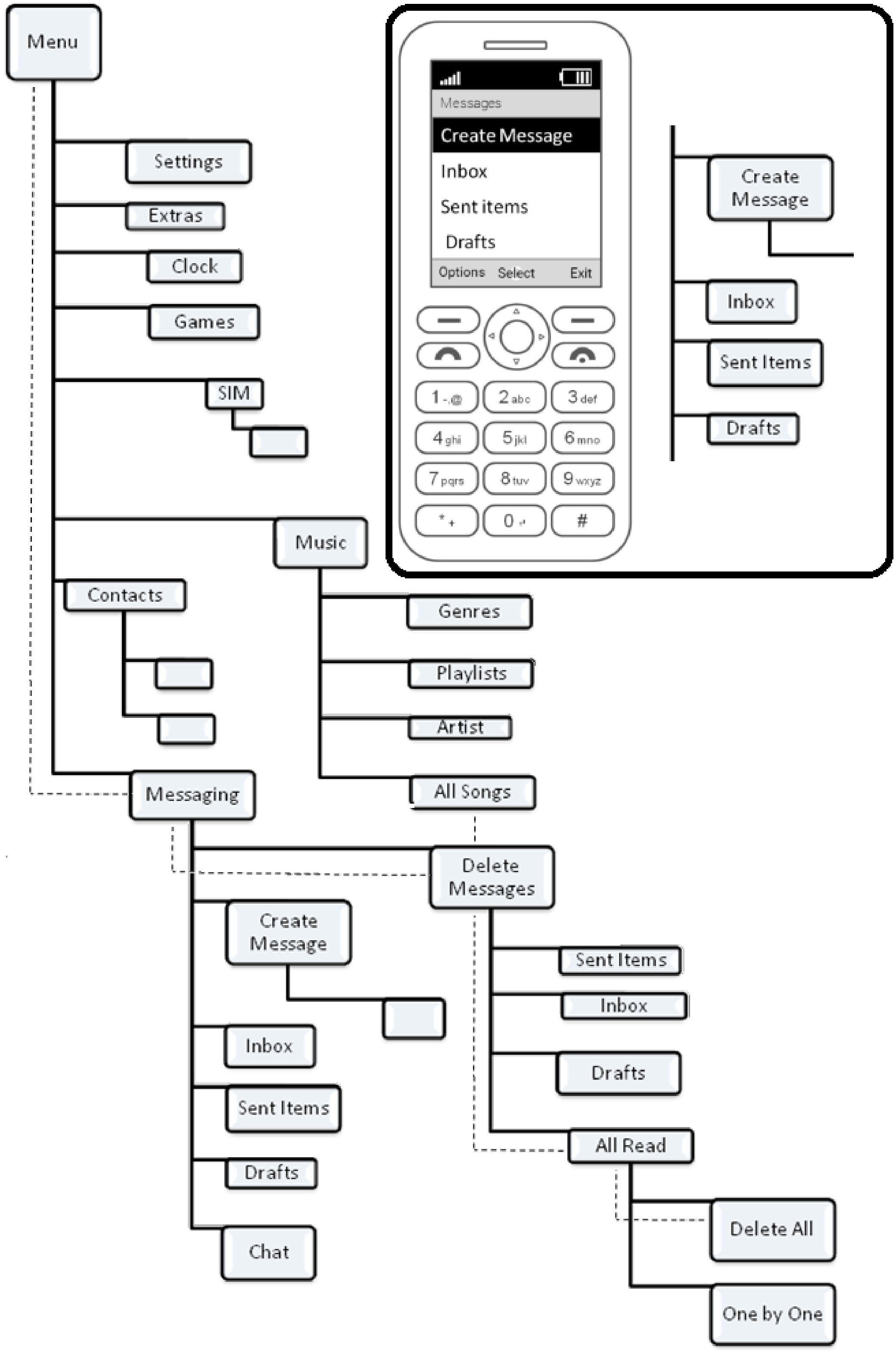


Figure 6.6: A part of the navigational structure for messaging in a simple phone. (a) Dotted lines show the path for deleting messages, which could be memorised in the form of a recipe/routine. (b) A particular screen and the corresponding visible portion of the navigational structure.

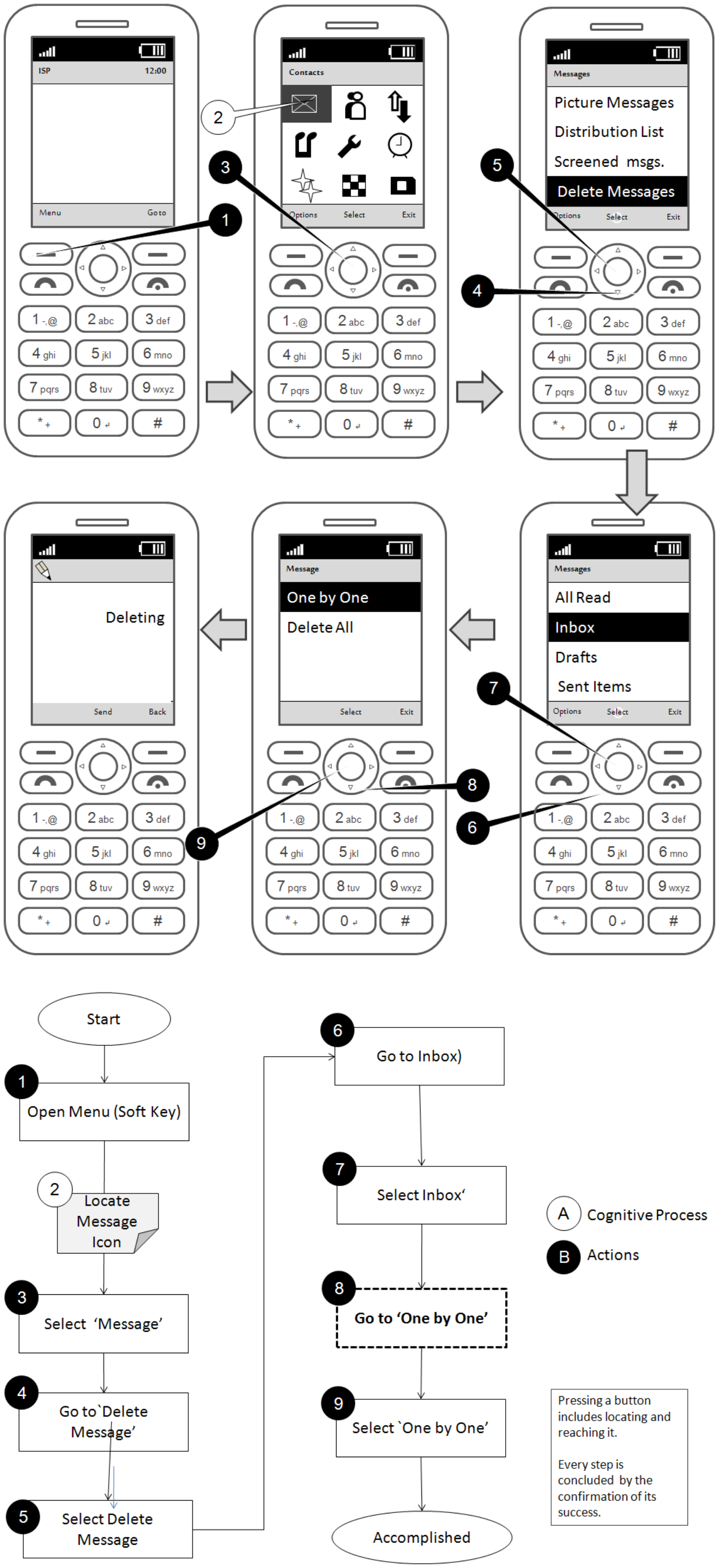


Figure 6.7: Deleting a message.

venturing out but still travels to very few selected paths. She has no idea of the general map of her surroundings. She has rote-learned the few paths. If she veers off from the remembered path, she would not know what to do because the new place does not figure in her remembered path. In such a case, as she does not have a conceptual model of how cities are configured and work, she will behave like a novice.

Typical rote learnt tasks are navigational tasks such as deleting messages, looking up missed call through the menu, saving contacts, listening to songs from the menu, starting camera from the menu, and saving contacts. Deleting messages is a very typical task for rote learning. It cannot be done using one or two steps and thus needs to be converted into a sequence. It is not too complex to require anything more than remembering a sequence.

The main behavioural characteristics in this Stage of Usage are:

A Restricted set of Objectives The extent of usage of a Rote Learner is more than that for a Novice. This is because, though these users do not have appropriate mental models, they can still handle tasks of some complexity by converting them into a memorised sequence. For example, many Basic Users listen to songs through a shortcut button from home screen (like user UJN05 [60, F, illiterate, Elderly Housewife]), while Rote Learners (like user UJN06 [45, M, VI$^{\text{th}}$, Sweetmaker]) use menu (as shown in figure 6.5).

Chance of Errors While a Novice may be able to attempt only very rudimentary tasks, a Rote Learner is able to do a little more. However, as the sequences of steps are committed to memory without any mental model to support, there is a chance of the memorised sequence becoming fragmented or corrupted. For example, in the sequence depicted in (a) of figure 6.5, if a user selects a wrong icon in step 2, she will land on a wrong screen. In absence of a mental model, she would not be able to comprehend the state of the interface and would not be able to recover. It is like a Rote Learner city-traveller, who while returning back to her hotel takes a wrong alley and then finds it difficult to make a sense of her situation.

Lack of Confidence Persons at this stage lack the confidence and could be identified by their slow pace. They lack confidence to explore around by themselves because veering off from the recipe/routine means landing into an unknown situation from where a recovery is impossible.

Slow Speed A Rote Learner executes the process cautiously, so the speed is slow. This is because the user has not internalised the sequence and has to be cautious at every step. A misstep would translate in non-recovery and would mean that sequence has to be restarted. User UJN08 [50, M, Xth, Shop Owner] deleted messages very slowly, which betrayed his caution in doing the task.

The Role of Active Teachers A person, in the likeliest of cases, learns the recipe/routine from others. In our studies, we found that often these were friends and other family members. The teaching was often sought from a person equal or low in the power hierarchy. For example, a father (like user UJN07 [35, M, IIIrd, Farmer]) could command his son to teach. The aspects of teaching and assistance have been discussed in detail in section 5.3.3.

Low Self Efficacy A Rote Learner would have low self-efficacy so she still struggles in usage. User UJN06 [45, M, VIth, Sweetmaker] who had learnt to visually navigate the folder structure in the PC, could not do it on his phone. This because the task was formed as a recipe or a routine. At the same time, there was no mental model to transfer to the new situation, and that affected the self-efficacy.

Inability to solve problem As indicated above, a Rote-Learner would not be able to deal with novel situations, and thus many of the (unseen) problems.

A question could be asked—'What type of a person would remain in this stage? Firstly, the motivation to accomplish the tasks that could be done by rote learning needs to be present. Intrinsic motivation could be present, for example, in a desire to listen to songs. Many users had reported that they bought a better phone only to listen to songs. On the other hand, extrinsic motivation, such as compulsion to delete the older messages on account of memory remaining unavailable for the other tasks in older basic phones, made users rote learn the tasks.

Rote learning is a cognitively intensive process. However, it is easier than the formation of mental models. As discussed in section 4.2.4, mental models require exposure to a domain. Many of the EUs, which we had interviewed (Chapter 5), did not have adequate domain exposure. How did that affect the formation of mental models? Example of an e-mail application may help. An email application could be better understood with the mental model of an office secretary's desk (Figure 4.3). For a user who has not worked in an office, would not have access to this model. One who has, can use it as a surrogate. Otherwise, a user would arbitrarily use mental models available to him.

A mental model could also be formed is through earlier exposure to similar artefacts. For many of the users in the field study, mobile phones were the first ICT artefact. They were trying to understand the usage of ICTs for the first time. As the mental model formation would happen after over a period of time, the only recourse, for a user, to accomplish her many goals was to rote learn the tasks.

6.2.4 Fluent

A user reaches this stage after crossing the barrier of low frequency. This stage is similar to the rote learning stage, except that, with frequency, the routine/recipe is now well memorised, and a person could attempt a task in without much cognitive load. He will be fast and confident in her behaviour but if anything goes out of the way of a rehearsed script, he still would not be able to recover from it. As the steps are internalised, it helps in doing task fast and with confidence. One characteristic of Fluent users is that they can teach with confidence. However, it is limited to only what they know well. The list of typical tasks remains the same as of in the Rote Learning stage. However, the more complex a task is, the more difficult would be encountered to reach this stage.

Fluent users do the same tasks as Rote Learners do. However, they contrast with Rote Learners on three accounts—the spontaneity of doing the tasks, doing them without much cognitive load and the confidence in doing. A Rote Learner has to consciously use the recipe/routine. A Fluent user has it internalised. He would not be conscious of using it. However, as the recipe/routine is well committed to memory, a Fluent user can teach it to others (the teaching process is a conscious activity in contrast to the usage.)

The cognitive load is eased through the contraction of the recipe/routine. A user would bypass many intermediary stages requiring cognition because over time he would have learnt them to be inconsequential. Compare, for example, (a) and (b) in figure 6.5. A Rote Learner might need to 'watch the step' after every action, such as the evaluation at step 3 when it needs to be ascertained whether the music menu has been launched. On the other hand, a Fluent user has 'internalised' that step 3 will certainly lead to the music menu, and therefore the need to evaluate the state is bypassed (or evaluated cursorily). Contraction does not mean that the user has forgotten the original recipe. When we asked Fluent users to teach us, they explained the whole recipes in a conscious manner ("First press this button, then go down...."). However, when doing on they own they would use the more efficient form.

In the city-traveller analogy, a fluent user would take a few well trodden paths. He would still, not understand the working of the city. However, the path is so well internalised in his mind that he would not be conscious of his traversal.

The main behavioural characteristics at this Stage are:

Confidence People execute tasks with confidence. They are able to 'look ahead'–they anticipate the next step. Many users would show on their phones how to accomplish a particular task with ease. On another phone, they would not be able to because though the task is well learnt, lack of mental model means the there was nothing to transfer to the new situation.

Start Explaining Because, the task is so well rehearsed, there is very less chance of errors. That makes the Fluent users formulate the task for instruction. This an important leap because a teacher in a community can instruct many others to graduate towards slightly complex tasks, thus raising the skill level of the community as a whole. However, that could be done only using the type of device on which the task is done frequently.

This is because due to the lack of a mental model, a user would not transfer his learning to a new device. User UJN02 [45, M, XIIth, Tuition Teacher] only did tasks that could be converted into recipe. However, he thought them aloud when we asked to teach and did with a spontaneity depicting deep memorisation.

Still Error Prone Fluent users would not commit frequent errors in the tasks they do. However, the lack of an adequate mental model means that they would not be able to understand if an error happens.

Still Limited in Scope Fluent users cannot explore beyond what they have memorised. That is why they are limited in their scope. In the case of user UJN02, he was able to delete messages, even set the phone language. Both of these tasks could be done through the recipe/routine. On the other hand, he had tried many times to send the messages but he could not complete the task.

6.2.5 Competent

This stage could be reached after barrier of inadequate mental models is crossed. When a person has a right conceptual model, she is able to handle a device in a much better way. As discussed in section 5.3.2, there are many mechanisms of development of adequate mental models—such as, having an adequate repertoire of models for making analogies, acquiring them from an earlier exposure to the devices of the similar kind, having enough exposure to the current artefact, understanding of domain and socialisation.

When a person has a right conceptual model, she is able to handle a device in a much better way. She will be able to have a holistic view of her device and knows how her current task fits in the whole schema. As a result, she would know how to recover from the errors, that too in the rare cases she commits them. She would be able to put her knowledge to novel situations and be able to accomplish a goal in hand in creative and unforeseen ways. In all, she would act as a problem solver, and not merely as a device operator. The device becomes a means to fulfil life objectives. She would certainly be able the teach others in a way more comprehensive and holistic than the Rote Learners and help them recover from errors.

Competent users can perform complex tasks that require coordination, such as, sending messages, operating e-mails, searching and transacting on the Internet.

The main behavioural characteristics at this Stage are:

Confidence and Enjoyment in Usage A Competent user can plan ahead a task before executing it in accordance with a situation. On the other hand, Rote Learners cannot deal with new situations. Actually, Competent users are comfortable in and even enjoy doing complex tasks. User DVG05 [36, M, X^{th}, Politician], a Competent user, could organise his photographs and songs by putting them in different directories and giving them unique names.

Creative Usage Competent users have the ability to solve problems. Very often they put these abilities to fruitful use. DVG05, the young politician mentioned above actively pursued ways to find out new uses. For example, he could set up, through a USSD code, a functionality so that a caller could not know whether his mobile was switched off or he was out of coverage area. He did this when he desired to avoid interruptions in his work and at the same time, being a politician, could not let a caller feel bad.

Ability to teach comprehensively A Competent user can explain the intricacies of use. A user with appropriate model understands an artefact in its completeness, therefore he is able to have a holistic view which a Rote Learner cannot.

Plan Complex Tasks A user with a good mental model would be able to formulate ways to accomplish a novel and complex task.

Solve Problems Good mental models helps in a holistic view of a problem. It helps a user ask the appropriate question. Solving problems requires that knowledge is transformed for dealing with new situations. Mental models help a user apply known knowledge to new situations. The analogous linkages between two solutions help a user ask appropriate questions and seek explanations about novel situations.

To be a Novice is like being in a new city and not venturing out of the house. To be a Rote Learner is like remembering ones way back (and there is an ample chance that one may get into a side lane once in a while). To be a Fluent user is to have travelled the trodden path enough to be able to walk without being conscious of it but to be a Competent user is to know the city–not only which road will branch out where; but also to be able to plan the shortest path between point A and point B. A Competent traveller understands how a city is configured and works, and therefore, would be able to explore around with relative ease in a new city.

6.3 Y-Axis: The User Types

As discussed in section 6.1, User Types are archetypes of users describing their ICT usage pattern. Tasks being central to ICT usage, description of tasks done by a user type become a unit of analysis for User Types. We have also constructed personae to capture the characteristics of each User Type. The following sections describe the different User Types:

6.3.1 Basic Users

Persona of Basic User (Novice)

T. Suryanarayanan, or Surya, 40 years old, was a tailor. His wife, two daughters, (aged 10 and 13) and 60-year old mother shared a three-room house in a small town 30 km away from Pondicherry. Surya had gone to school till class 4th but dropped out and joined his father as an apprentice. In 2018, he made around INR 25,000 (around USD 300) per month.

He had started using mobile phones in 2007. Before that, he was dependent on a coin-operated land-line phone owned by an adjoining shop. Making calls was easy and cheap but sometimes the shop attendants would not inform him about the received calls. At the insistence of his wife, he purchased a mobile phone, a Nokia 1110, that cost him about INR 1500 (USD 30). Very few people around him knew to operate a mobile phone at that time. Initially, he learnt to use his new phone from a friend. Since then, he had bought two more phones as the older ones had stopped working. Even in 2018, he was using a simple phone in the form of a Nokia 105.

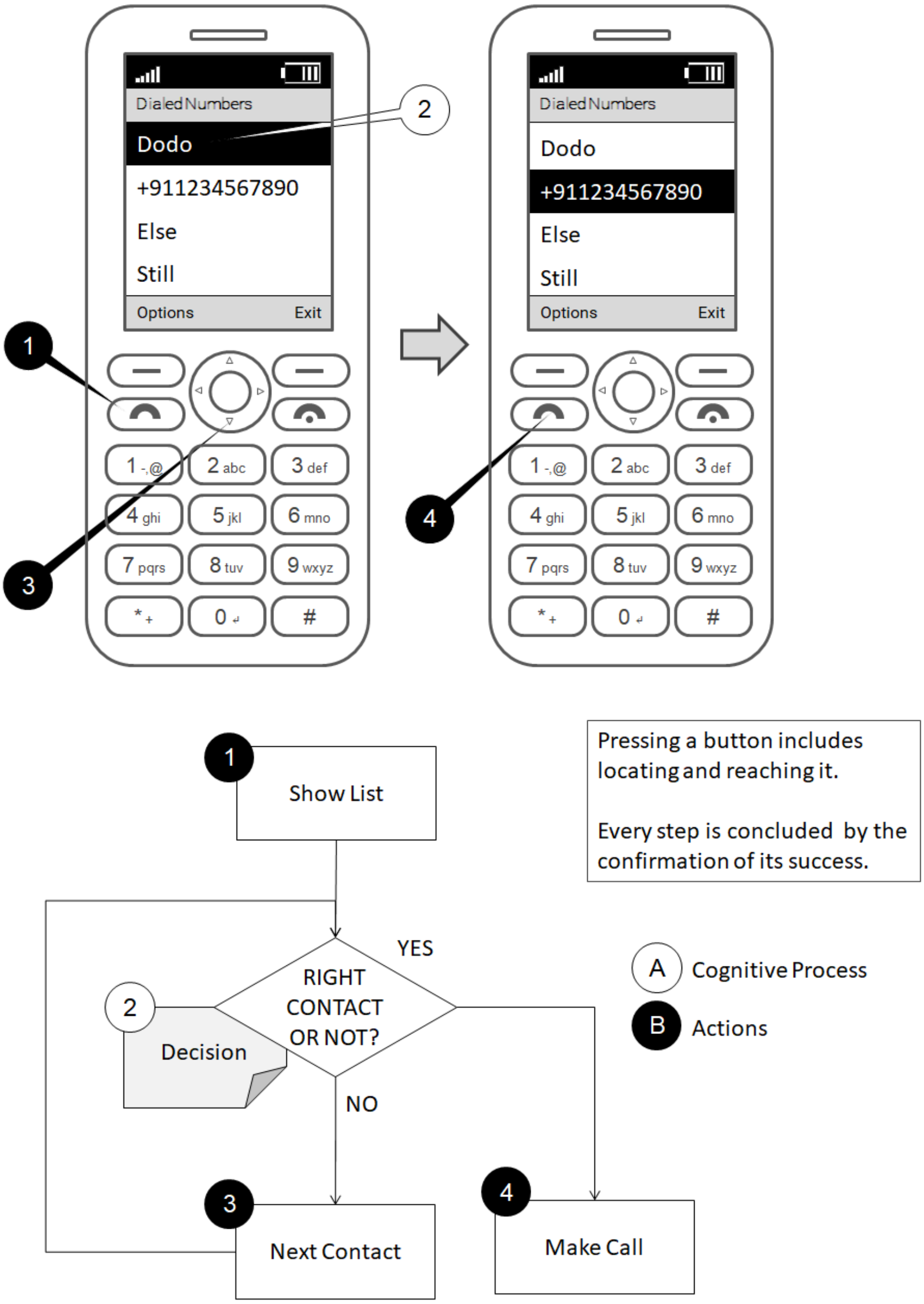


Figure 6.8: Calling through recent calls.

His phone use too had remained as basic as his phone. His shop assistants used to pull his legs by suggesting that he should buy a smartphone, which he shrugged off simply by smiling. It was true that his phone usage had remained very limited even after 10 years of usage. He did tasks that could be completed just by pushing the buttons without bothering much about what appears on the screen. What could be possible when you do not want to look at the screen? He could only receive calls, make calls from the list of the recently dialled numbers (in a manner similar to shown in figure 6.8, or from sequentially navigating the contact list (like shown in figure 6.3). He could also dial numbers from his phone directly, just like a coin-operated land-line phone (see figure 6.2). Navigating menus, or do any text input task was out of the question. Whenever he needed to save a contact, for instance when a customer would give a number, he would write in a small pocket diary, which surely looked much older than his mobile phone. It is not that his phone was bereft of any contacts. The frequently used ones could not be read off every time, so he had about 10 contacts stored on his phone, all of which have been stored for him by someone else.

One day he faced a network problem. So, he borrowed a phone from one of his assistants. It was a slightly different model than his. As he held his addressed diary in one hand and the phone in the other, he realised that he could not make any head or tail of that device. So he asked the assistant to dial on his behalf.

Actually, Surya was extremely reluctant to learn something new with respect to his phone. He would say, *"What am I going to do with more?"*. Many times his daughters had tried to teach him to delete SMS but were unsuccessful. He would respond by saying that *"When you are around (to assist me) why should I bother?"* He thought that phones should be used for bare necessities and not for extravagant things like SMSes or songs. He thought that these services were pushed by the companies, who were interested in profits only and not about the fact that children are getting misguided.

Even when he tried to learn a task such as deleting SMS, he found it very difficult. His daughters tried to teach him how to save contacts. Firstly, he was not well versed with typing on the phone, though he could manage reading and writing Tamil and a little English. When he tried to save contacts, he did so by using mnemonics (for example, 'Sd' for 'Sundaram). However, the real issue was that even with the daughters' guidance, he could barely complete the task. His reluctance seemed to be an excuse for the difficulties he faced. The difficulties often hid potential fear and shame of failure. Perhaps, that is why he would often say, *"One should not interfere with a thing which one does not understand about"*.

He knew that unnecessary SMSes clogged the phone memory. He had come to know about that one day when a 'squarish' symbol started blinking on his phone. It was the time when he had bought his first phone. That time he was working for someone else. He had inquired from a colleague and come to know about the phone's memory being full. It needed to be emptied—he hardly understood what it meant but since then he would ask someone to delete the SMSes whenever memory became full. This was the reason that he opined that SMS was a nuisance. He had never read an SMS, let alone sending one. He would pass on the phone to one of his assistants or his daughters to delete the old messages.

Characterises of Basic Users

Surya is a Basic User. He (only) does the most basic tasks—the ones which are very simple in nature. They do not require multiple steps or elaborate mental models. They can be accomplished by one or two presses of a button, therefore, learning and memorising them becomes very easy. All his tasks, calling from last calls, calling through number pad or through sequential navigation involve minimal steps. Sometimes, there is only a single step, for example, answering a phone call (see image 6.2 (b)). Others involve more than one but still very few steps.

Basic tasks also reduce decision making to a great extent. Answering a call (Figure 6.2 (b)) involves almost no decision making. Compare them to navigational tasks, such as deleting a message (see figure 6.7), where each intermediate step requires interpretation and selection. With minimal cognitive demand, basic tasks often deal with only the initial and the final states of the system. That means, pressing the 'call' button on a phone would, in its most likelihood, lead to connecting up of a call. There are no multiple possible states. Further, the states themselves do not offer much challenge for recognising them. For example, recognizing the voice (on the other end of the line) do not entail elaborate interpretation. Thus, for these tasks, gulf of execution and gulf of evaluation (see Section 4.2.1)–both are shallow. In other words, the cognitive work required in breaking down the goals into individual steps and that required for interpreting the state of the device and evaluating it vis-a-vis the goal is very little. The result is that these tasks are very easy to learn and retain.

Surya also makes a call by sequentially going through the contact list. We classify this as a basic task. Or rather, multiple iterations of one basic task (see figure 6.3). In a similar vein, a navigational menu with only two levels also becomes a basic task because the task cannot go beyond two steps. These type of tasks, however, may involve a little more effort, as compared to the single-step tasks, in terms of evaluation of the states. The effort increases when the recognition needs literacy.

Surya is a *Novice* and has remained so for a long time. This is because he lacks the mental models that he can employ in order to understand the more complex tasks on mobile phones. He has not seen much of the world, nor he is educated. His social circle is also limited. Secondly, because of his age and lack of education he finds it difficult to follow instructions, both in the form of reading and through following instructions from a teacher. Additionally, he has ready helpers to whom he can delegate the tasks. Without mental models, and due to conditions that help him to avoid learning, he would continue doing the basic tasks for a long time.

Basic users are strongly mapped to the Novice stage of usage due to the non-requirement of recipe/routine or mental model. It is difficult to distinguish the other higher Stages of Usage for a Basic User. The cognitive complexity of tasks is so small that there is hardly any need to 'remember' the 'recipe' of the tasks. Additionally, the schemata of the tasks are rudimentary, so there is no need to conjure complex mental models. In other words, the mental model required to complete these tasks are too rudimentary to need special consideration.

The question arises, why does a Basic User, who likes to avoid task complexity, does not abandon using ICT artefacts altogether? The answer lies in the criticality and utility of the task that may have initiated the user to do the task. The user may have been forced to achieve a goal using the ICT artefact. In other words, the task was triggered due to a situation. However, in spite of the criticality and utility, a Basic User avoids complexity higher than he is compelled to deal with. If he accepts, the (more complex) tasks would not remain complex for a long time. Such a user may be driven by lack of motivation or negative attitudes towards the artefact. This type of user would delegate the task (for example, user UJN07 [35, M, IIIrd, Farmer]) if possible, and if not, then try to avoid as much as possible.

6.3.2 Navigator

Persona of a Navigator (Rote-Learner)

Fathima, 40 years old lived in a village near Kamareddy, Telangana along with her husband, sister-in-law and mother-in-law. She had two children—a 20 years old son and a 15 years old daughter. The daughter was studying in a nearby so-called 'English medium' public school. She was also sent for the tuitions in the evening. Fathima was educated till class 6th. She could read a little Telugu and Urdu. She had not seen much of the world. She was married at 18 and had mostly worked from home. The family owned a small shop, attached to the home, which was manned by the whole family in turns, including the son. In the extra time, the whole family rolled *beedis*. Her husband was responsible for outdoor work such as going to the wholesalers. The family owned one scooter and a cargo auto rickshaw. Inside the home, they owned a refrigerator, a cooking gas connection and a television. The shop earlier had a coin-operated PCO phone, that added to the income, whose demand had dried down eight years ago.

Fathima had been using her own mobile phone since 2008. Since then she had changed two phones. On both the occasions the older one got damaged. She still uses a basic phone, not unlike the first one she had bought. *"These ones are good enough for me"*, she told. While Surya, the Basic User, was extremely reluctant to use the mobile phone; Fathima was not. She deleted the messages in her inbox. Her daughter had told that they were nuisance and should be cleared away. She did this task quite slowly and infrequently. She would empty the inbox whenever she could remember, and that would be once a week or two. Actually, in 2012, after a few weeks of buying her first phone, just like Surya, she had found the envelope icon flashing and came to know of 'memory being full'. Initially, she would ask her son to help out. However, gradually she realised that she had to be on her own because many times she was alone with no help. So, slowly she learned how to delete messages on her own. That was really a difficult thing which took many days. She did not have the luxury of aides like Surya, who had many people around him to help both at home as well as at his shop.

She could conquer the challenge of deleting messages but faltered at another important task. She could never learn to save contacts. She could hardly manage reading, leave alone typing. If she needed to add a contact, she delegated to her son or someone who could help. Suppose, she was in a marriage reception, she would summon a cousin who might be around. In any case, her circle of contacts was limited to her close relatives and a couple of friends in the neighbourhood.

She did not listen to songs on mobile phones, *"Isn't television enough?"*. Often tuned to Hindi or Telugu entertainment channels, the television provided constant companionship. She was aware of WhatsApp and Facebook. Her son had bought a smartphone in 2016.

She was reluctant to learn anything regarding technology unless there was a critical need. Like Surya, the reluctance was due to inabilities resulting from low education and lesser experience. However, unlike him, they were also due to the attitudes with respect to technology. For her mobile phones looked like necessary evils. On one hand they were needed for communication, on the other hand, they generated so much ill in the society. *"Look at today's children, they are all watching 'useless' things"*, she would lament. That is why she did not allow her daughter to buy anything more than a basic phone. That was why she told that she had kept her usage to bare essentials—*"only making and receiving calls."*

Persona of a Navigator (Fluent)

B. Navinkumar, 45, lived in Manjakuppam near Pondicherry. He owned a small grocery and grain shop. He had attended the school till class 6th. However, he was quite a knowledgeable person because of his experience. He was respected in the local business committee. In addition, he was a community person. Being the eldest son, he was often supposed to be present at the caste gatherings.

In 2018, he held a feature phone. He had used mobile phones for 10 years. He had used many phones during that time. In 2018, he did many navigational tasks, like deleting messages (which he did faster than Fathima), listening to songs and using the camera. Like Fathima, he delegated to the others the tasks that involved typing. For example, he generally asked his elder son Srikumar, 17, to transfer all the contacts from his small pocket diary to his mobile phone at the end of the day.

He liked Tamil songs, which he listened on phone. He navigated through the menu to reach the playlist. After that, he would sequentially go through the list to reach the right song. He would generally remember which song is in what place in the list. He also captured images with his phone. He would open camera by going to the menu. However, he was not a frequent user of camera.

He did all his tasks with ease and speed. In fact, if any of his friends asked him to teach something involving phone, for example deleting messages, he was able to explain on his own phone. However, it was difficult for him to do so on the unfamiliar ones.

When he bought his first phone, he would use it for only calling and receiving calls. Over the period of time, he could do many other things as well. Just after a few days of buying his first phone, he had learnt to delete the messages from one of his acquaintances because the latter had found out that memory was full. Navin understood the importance of deleting the messages and was able to learn to do this task within a few days. Later, he bought a phone with more memory but he still deleted the messages out of habit.

He had been listening to songs since 2009 when he had bought a feature phone for the first time. In fact, he bought the feature phone so that he could listen to the songs. He had given INR 100 to the neighbourhood mobile shop to fill the SD card. He had been seeing many people in the neighbourhood and among the relatives whose phones would blare out songs on their phones. He thought that was nice. He could just get his most favourite songs and be on the go. After all, he was quite fond of Tamil movies. During his younger years, he would watch the first show of his favourite star. The television at his shop was mostly tuned to a music channel, giving out Tamil film songs the whole day.

For him, learning things was never difficult. He was able to pick the instructions quite fast when he started using his phone. He had teachers available too, like his friend who taught him to delete messages. However, when it came to doing something more than what is needed, he was simply uninterested. This was partly due to the fact that he was a busy person, partly because learning technology per se is not a priority for him and partly because he was comfortable doing only those tasks that are instructed in the form of a recipe, (e.g. *"press the green button, then press the left key twice...and, so on."*). Moreover, there were some things that he wanted to do the traditional way only. For example, he never sent an SMS. He would ask, *"If I want to talk to somebody, won't I simply call up?"* Still, tasks like looking for missed calls had been mastered by him because, being a businessman, he could not afford to miss a call. However, he would not leave his comfort zone–he would not do something where he had to figure out something by himself. For example, once his youngest son had set his phone on silent mode. He was irritated but did not try to figure out how to come out of it till his son helped out.

Characteristics of Navigators

Like Fathima and Navinkumar, Navigators do the tasks that require navigation. These are in addition to tasks done by Basic Users. Tasks that require more cognitive load than navigation, they are delegated. Navigators have a limited set of goals that they want to accomplish through technology though there is a lot that can be accomplished just by navigation. For example, both Fathima and Navinkumar can do a little more than merely receiving and making calls. Like basic users, they depend on physical aids such as pocket diaries.

Navigation could be hindered by lack of literacy if the content is in the form of text. However, illiterate users try to overcome that by employing the error prone 'visual recognition' of landmarks as was the case of user UJN06 [45, M, VIth, Sweetmaker]. To find a movie, he navigated with the help of the position on the screen, of the folders. It was quite tedious to remember something like "...third folder in the middle row on the second screen, then fourth in the top row on the third...” If the right sequence was missed, the user was prone to select a wrong folder because all of them looked alike.

Unlike Basic Users, a Navigator does not reach her final state in one or two steps. Often she has to navigate through a series of intermediate stages. At each stage, there are multiple options to choose from. The cognitive complexity of a task increases as the number of intermediate stages increase. This is because evaluation (whether one has arrived at the right juncture) and execution (knowing the options and selecting one of them) happens at each junction. To be able to accomplish this, a user needs to be able to be aware of the semantic value of all the available options. Semantic awareness helps the user to explore a menu structure by herself. What would a user do if she does not understand the idea of an inbox (see figure 6.6). Similarly, it is unlikely that Navinkumar could have understood the meaning of a ‘Playlist’ in a media player menu. It is natural for him to rote-learn the steps to reach to the state where a song actually starts playing. The barrier is not only of an inability to read ‘Inbox’ or ‘Playlist’ but of understanding what they stand for. After semantic understanding, ability to abstract comes to the picture. In absence of an understanding of relationships amongst the various items in a navigational structure, navigation is possible in a rote learnt fashion only. Each element in a navigational structure is related to an adjacent element in terms of parent-child/abstract-concrete/generic-specific (for example, vegetable and tomato) relationship, or sibling relationship (for example, brinjal and tomato). Therefore, a menu item often encapsulates the meanings of the options hidden under it. A person, in order to have a better awareness of what lies beneath, needs to be able to abstract the meanings of the underlying items (child-items-for example, brinjal, tomato et cetera) into its encapsulating concept (parent-item–for example, vegetable). It requires finding a unifying theme amongst all the child-items and relating it to the parent item. In other words, while navigating a menu, one needs to be able to *abstract*, that is, understand the relationship between the generic and the specific meaning. For example, if somebody is navigating under a node called ‘vegetable’, one should be able to tell that the sub-nodes under ‘vegetable’ are related with each other, in spite of their differences, due to ‘vegetableness’–a unifying idea binding them together (see for example, Rashinkar et al. [2011] (p276). If a person is not able to do that, then for every menu item, she would have to investigate out all the options. For example, if a person is not able to see the thematic relationships between 'Sent Items', 'Inbox" and 'Drafts', she would not be able to recall that these operations would be hidden under 'Messages' menu.

Thus, the users who are able to make up a comprehensive unified form of a navigational structure would do on the basis of semantic understanding and the ability to abstract. It could be supported from the discussion in Section 5.3.1 that both of these capabilities have a dependency on education. Therefore, it seems likely that persons who are less-literate would do navigation on through forming recipe/routine (as shown by dotted lines in Figure 6.6.) We have already discussed Rote Learning in section 6.2.3. Fathima and Navinkumar both execute the tasks using a recipe/routine. However, Fathima has lesser exposure to technology and is required to do tasks less frequently, therefore she does it in a conscious and slow manner. On the other hand, Navinkumar has been doing more frequently and has well memorised the tasks and therefore can do them much faster.

6.3.3 Text Inputters

Persona of a Text Inputter (Rote Learner)

Rajaram was 40 years old and lived in a village near Mhow, M.P. He was educated till class 7th. He had a fertiliser shop. He had been using mobile phones since 2005. He had to start using a phone because he had started working in a factory near his village. Since he started his shop in 2010, the utility of the phone had increased for him. Earlier it was necessary for keeping a contact with home, later it came in handy for the business. He had used many phones since he had started using them. Initially, he used simple phones but later graduated to feature phones because he wanted to listen to music. In 2014 he had bought his first smartphone.

He had very few contacts on his phone. He put new names quite infrequently. Mostly, he would take assistance in saving a contact, often from the person whose contact needed to be saved. However, on some occasions, where the other person was worse in technology skills, he would do by himself. He could manage to do on his own by using a rudimentary English spelling. This skill was learnt from the friends at the factory. It so happened that one day he forgot the diary, in which he wrote the phone numbers, at home. He had realised that because he needed to urgently call someone. That day he had realised that at least some of the important numbers should be there on the phone itself. So, he had asked one of the friends to teach him how to save a contact. Thus, on rare occasions, he was able to save contacts but because of low frequency, he would do it slowly and consciously. Interestingly, he saved the contacts using numbers instead of alphabets. Thus, one could identify from his address book the ones saved by others (as words) from those saved by him (as numbers). He avoided any other text entry task. That explained why he would not send any SMS. On a rare occasion, he had sent “Happy Diwali” to his friends but had to ask for assistance.

Actually, he could read and write in Hindi. He could also write in rudimentary Romanised Hindi. However, typing was a little difficult for him. This was reflected also in how he searched the address book. It was using only the first letter of a name to reduce the number of search items. For example, to search ‘Rakesh’, he would only press the letter ‘R’. Doing so would list only the names starting with an ‘R’—‘Rahul’, ‘Rajesh’,‘Rajkumar’ etc. He would then sequentially navigate till the desired name.

He used to listen to songs by going through the menu. He was also able to search a particular song by typing the first letter. However, on most of the occasions, he would let the songs play by themselves. His first feature phone was bought because he wanted to listen to songs like many other workers around him did. In the factory, the workers often shared songs with each other, either through Bluetooth or by exchanging the SD cards. He would get to listen to the latest songs as soon as they appeared in the ‘market’. Later, when he started the shop, he exchanged songs with people who would hang out at his shop, especially the younger employees from the neighbouring shops. However, it was the others who would push songs to his phone. He himself would avoid asking for. *“Uncle, have you listened to this new song?”*, someone would question and then ask him to pass on his phone so that the song could be transferred.

The people around him would also use WhatsApp and YouTube. Many times they would show him a joke or a song. His friends had installed WhatsApp on his phone but he hardly operated it. Sometimes, the friends would complain that a message which they had sent had not been seen. In general, he was disinterested in doing such things on his own. He would say, *"There was a time when I was of your age, I would do all this. Not now."*

Being surrounded by people who were active in using technology was beneficial to an extent. If he needed to know something, which he did only when he considered something to be very important, he could turn easily to someone. Though his low education hindered many things he could have learnt, he was a fairly good learner. Therefore he was able to do many tasks that were important such as deleting messages or listening to songs.

Persona of a Text Inputter (Fluent)

Ramkishan, was a 40 years old lathe operator in Rajsamand in Rajasthan. He was educated till class 9th. He went to the nearby town to work in a workshop that machined spare-parts for the mining industry in the Chittaurgarh district. He had been using phones since 2000. He had switched to a smartphone in 2015.

He lived a very busy life because of the fact that he was crucial for running the business. He reported that he did not get much time to learn anything, nor did he need to. At the same time, he was a good user of WhatsApp. He could do things like searching by typing for a name in the address book or a particular song to play. A reluctant learner, much of his knowledge regarding phone usage had come from his younger colleagues at work.

He had many contacts on his phone because it was him who managed the business. Often customers would talk to him directly. He had to save a new contact every two to three days, which was different from Rajaram who would do so in months. He could do the task very easily on his own phone. However, on someone else's phone, he found that difficult. He had learnt saving contacts much earlier. As his responsibilities in the machine shop grew, he had started to deal with more number of clients. That was around 2005, 5 years after starting to work in the current establishment. He used to carry a pocket diary for writing down contacts. Slowly, he found that to be cumbersome, so he graduated to asking others to save contacts for him. Even that did not work satisfactorily, as many times there was no one else around and he could not ask the person in front of him, for example, a Korean engineer, to do it. Slowly and gradually, he managed to do it on his own.

He had been deleting SMS since he had bought his first phone. Not needed much on the smartphone, in the earlier phones it was a nuisance as it would consume up memory quickly. He had learnt that from his colleagues. In 2007, he bought a feature phone for listening to songs. That was the time when everybody else around him already had one.

He also had a good collection of songs as his subordinates, similar to Rajaram's case, often brought new songs and shared with him. He had seen his younger colleagues neatly divide different songs into categories but he did not feel a need for that.

He started using WhatsApp in 2015 after he had bought the smartphone. In fact, WhatsApp was one of the reason to buy the smartphone. His younger colleagues were using WhatsApp and would show him jokes and other shared content. They were pushing him to get on WhatsApp so that he could also be part of the group. Once he had bought the smartphone, his colleagues had installed WhatsApp on the phone, which he had taken a few days to learn. He mostly forwarded the content on WhatsApp. Sometimes he wrote a message using rudimentary Romanised Hindi in the form of very short sentences like *'kaisa hai'* (how are you?).

He was not much into sending messages before WhatsApp. There used to be SMS but he found it a little cumbersome. He actually attempted to learn it many times but somehow did not develop a feel for it. With WhatsApp, as we have seen above, the situation became quite different.

He knew how to use ShareIt. He has also searched film songs using Romanised Hindi. However, he had been reluctant because they used to cost a lot. There had been a reduction in the data rates in late 2017. He had acquired a plan which costs very less in early 2018. Still, in 2018, he did not do much on his smartphone beyond WhatsApp.

Persona of a Text Inputter (Competent)

Shriram Patwa was 30 years old and lived in Tajpur village near Ujjain in Madhya Pradesh. He was married and had two sons aged 5 and 2. He lived with a big joint family. He was a cement dealer. He had studied till class 10th. He had bought his first mobile phone in 2007. He claimed to have changed his phone many times since. His first phone was Nokia 3310 bought for INR 3500 (USD 87). In 2017, he had a smartphone, which he had bought in 2013. He was very choosy regarding what he bought. Often he looked around before he changed his model. Mobile phones were considered to be important by him because as a businessman he needed to travel to Ujjain city to meet the big dealers or be in touch with his big clients in neighbouring villages. When he bought his first mobile phone (on being persuaded by his elder brother), he already had exposure to using mobile phones because many of his friends already had phones. He had also learnt the use of SMS, along with most of the other functions, during that time. He was fairly adept because, according to him, *"I try out things on my own."*

As of 2018, Shriram was heavily dependent on his phone. He was in constant touch with his friends, many of whom had migrated away. He was mostly on WhatsApp, where he not only forwarded messages but many a time, using Romanised Hindi, wrote on his own. Unlike Ramkishan who could manage only small sentences, he could write longer sentences. He had started using WhatsApp in 2013 when he had bought his first smartphone. How could not he? Many people around him had started using at that time. The son of the *sarpanch*[8] had come showing-off one a day. He had decided he would buy one. WhatsApp was not far behind. *"What do you use a 'touch-phone' if you do not have WhatsApp?"*, he already knew about WhatsApp and Facebook (The latter he could never understand.) Learning was not a problem, he had seen some of the friends using and he picked up fast.

Even before WhatsApp, he used to be a proficient SMS user. He had been using SMSes since he had bought his first phone. Just like WhatsApp, he kept on forwarding SMSes that he received from his friends. According to him, *"...anything, like SMS, would exist because of some utility, and when one is educated, I suggest, one should use it."*

He was fond of listening to songs. He had bought a feature phone, with the camera and media player quite early. He always desired to have the best of what the others had started acquiring. He often exchanged songs using Bluetooth devices. He was able to save the

[8] a village head

contacts by himself but he did not care where they were getting saved–whether in the SIM card or the phone memory. Apart from contacts, he had never "saved" anything else. Like the contacts, he also did not care where the songs were getting saved. Afterall, *"One has only to listen to songs. Why these botherations?"*. The 'botherations' were some peoples effort in organising songs neatly into folders. He knew that having an e-mail account is good for business. However, he had not given much priority to this issue.

In 2018, he would search for songs on YouTube using Romanised Hindi. He had apps installed (by himself) for Hot Star or Voot[9] to watch missed episodes of his favourite TV programs. His mobile phone usage was heavy. He kept a supplementary battery charger with him. When the data rates were reduced greatly, he had availed one. In fact, during the free period of his service provider, he had extensively used his phone for entertainment. Whenever he could find free Wi-Fi, for example, on the railway stations, he would connect to it.

Characteristics of Text Inputters

Text Inputters are able to type text, in addition to the tasks done by Navigators. There are three issues involved—the first is the ability to write itself, which involves structuring the thoughts and conjuring up letters, words and phrases to convey something. The second is the motivation to write. We have observed that many people with low levels of literacy are able to read and write, though using a very rudimentary language, while, many times, better off people are reluctant. The third is the complexity of the text input task. Typing a message, searching for something or saving a contact—all these are cognitively intensive tasks. Firstly, depending upon the complexity of the text entry mechanism, entering text poses cognitive load. Apart from that, there are additional tasks involved. For example, to send an SMS (see figure 6.9), one needs to navigate till the typing screen, and then again navigate in order to reach the screen where the sending action could be committed. In particular, the designed conceptual models of the messaging applications can become complex (for example, that of an e-mail application, see figure 6.10) and, thus, can pose difficulties for the EU. The total complexity of a text input task may vary. Some could

[9] TV Channel's mobile portals and apps

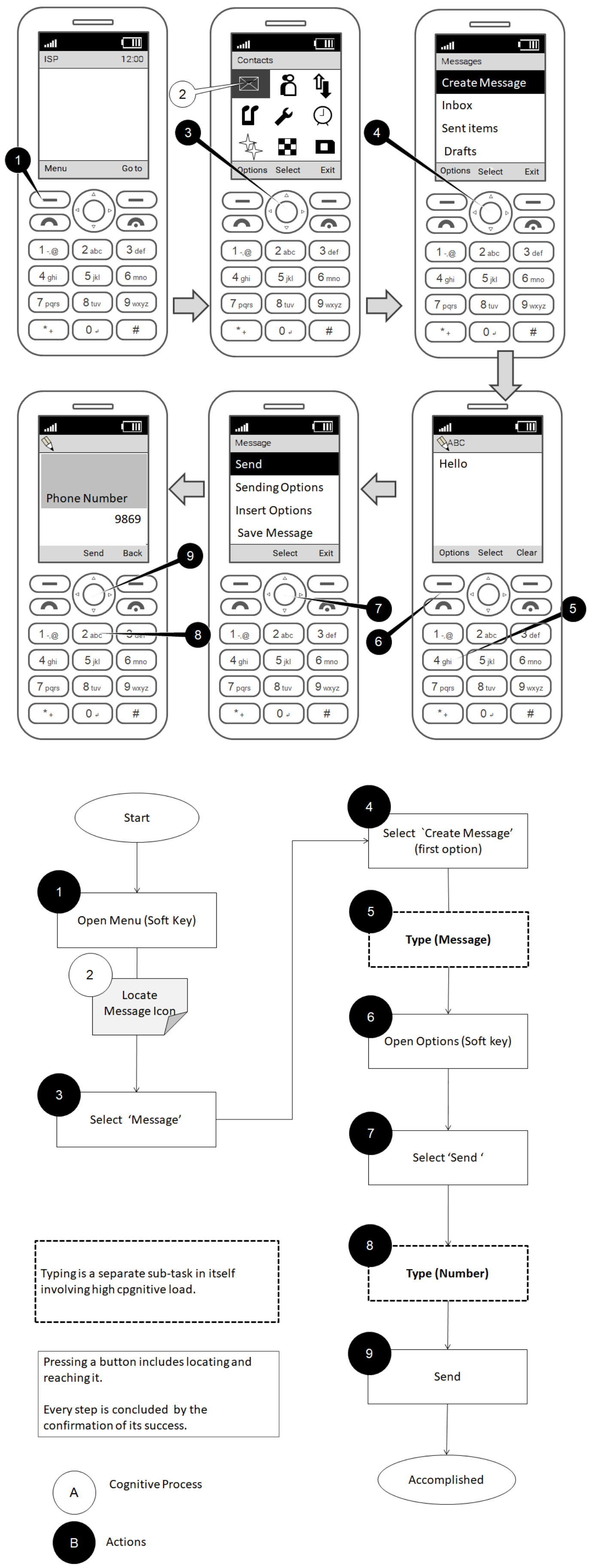


Figure 6.9: SMS.

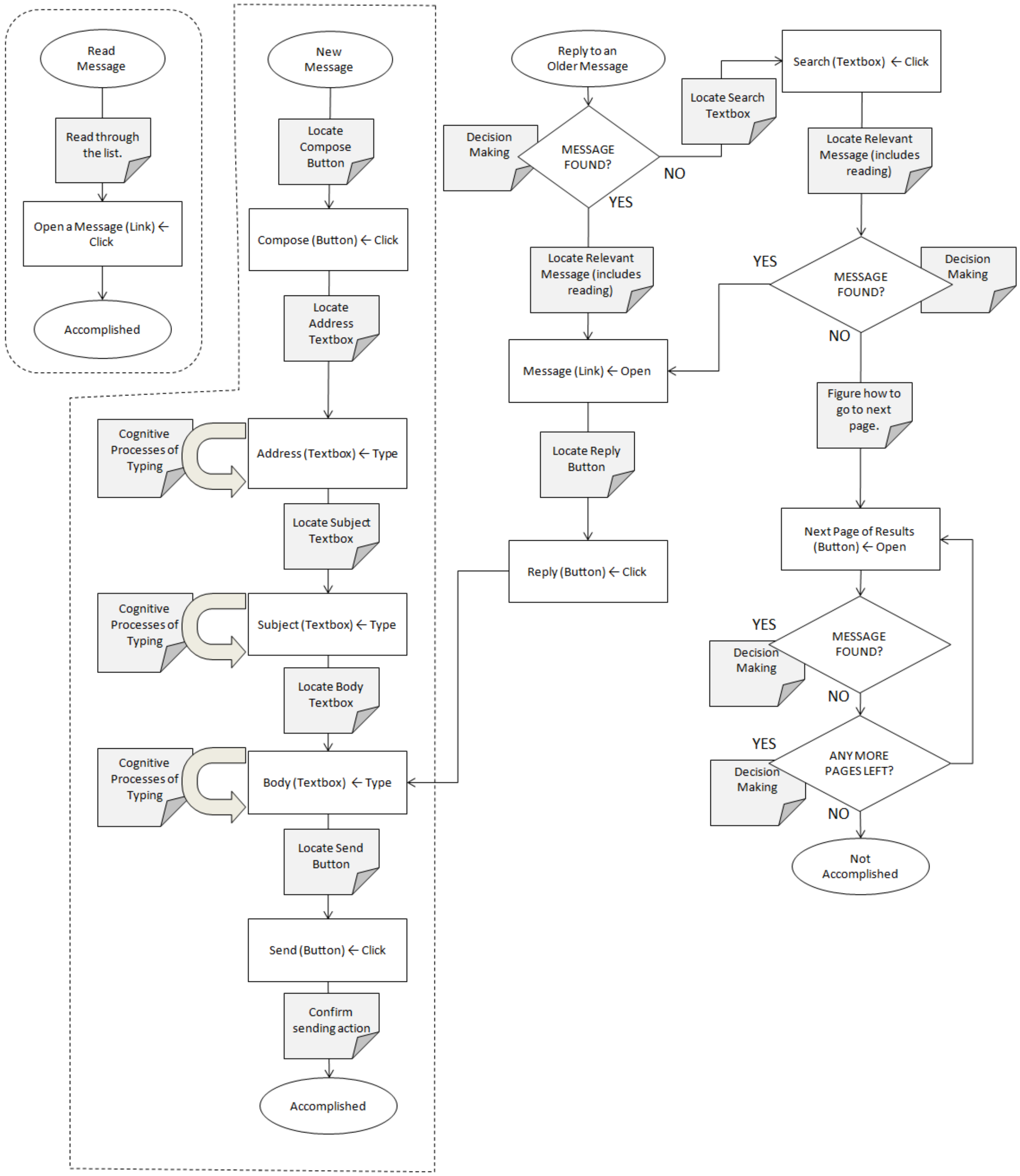


Figure 6.10: Menu Structure of E-Mail.

be rote-learnt, others might need mental models. For example, saving contacts becomes much easier if a person could learn to type in a minimalistic manner (for example, using numbers). On the other hand, sending SMS is more elaborate and would need a mental model.

Text Inputters are also able to act as an information forager, that is, actively search for information through typing text. For example, an information forager actively searches the Internet, browses shopping sites, or, using a mobile-based Internet browser or the YouTube application, searches for songs. Information seeking activity tries to fill the gaps in existing knowledge structures. That implies that one would attempt to search for something one already has a little idea about. It is essentially an iterative process where the new information is continuously assimilated in the older structures (at the same time giving birth to new questions).

Text Input tasks could only be attempted by the users who are at least in *Stage of Rote Learning* because it is a fairly complex task and would need at least rote-learning, in absence of mental models. Among the personae, Rajaram would like to avoid a text entry task but still has to form a recipe/routine to at least reach the screen where the task of saving a contact can be initiated. Ramkishan has enough experiences with the contact saving task and can do it with ease but due to lack of mental model, cannot deal with more complex tasks such as sending SMS. For these people, WhatsApp has been an enabler (see chapter 8). On the other hand, Shriram is using text-based tasks very efficiently because he has good mental models of them.

6.3.4 Savers

Persona of a Saver (Competent)

Pratik Rao, 28, educated till class 10th, was a young and rising politician in a village near Devgad town in Maharashtra. He was prosperous by local standards. His social circle was very large as his father was also a politician. He was often on the move, sometimes for the (political) party related activities, sometimes for meeting with the electorate and sometimes to the administrative offices with people's grievances. He had love of good things that made him change his phones very often, sometimes even in 6 months. He gave away his older phones to the relatives.

He was gifted his first phone by his father in 2000. At that time very few people around him had phones. Initially, he learned the basic operations present in the mobile phone from his elder brother. He later explored on his own. As of 2017, he had a good conceptual understanding of how mobile phones worked and often helped others in solving their problems. Actually, he actively sought knowledge and indulged in self-exploration regarding the use of mobile phones.

He was both a heavy SMS as well as WhatsApp user. He not only forwarded bulk jokes but also wrote messages in Romanised Marathi. He kept the important numbers in both the phone and the SIM memory so that they were not lost when the phone was changed. He was very concerned about his privacy and kept the screen password protected. He was an extensive user of phone camera too, which he had, in 2006, started using to take pictures of his newborn son. He was able to change the desktop background and ringtones, which he did quite frequently, almost twice a month. He was able to set the date and time. He also had a large collection of Hindi and Marathi songs. He kept his songs, videos and pictures into a neatly designed folder structure. He started doing so because his song collection had grown large and according to him, *"All songs got mixed up"*. So he asked his friend at the village mobile shop who taught him to make folders. He had not been able to figure out how to set up an email account on his phone because there was no one who could have taught him.

Like Shriram, the Text-Inputter, he was (in 2018) also a heavy user of his phone. He used WhatsApp and ShareIt frequently. He watched movies on YouTube and TV programs on Hot Star and Voot. His smartphone had become his primary means for entertainment. He even read various Marathi and Hindi newspaper online. He was a heavy user of data even before the data rates were reduced. In 2018, due to heavy use, he had subscribed to the plan providing 2GB of data daily.

Characteristics of Savers

Saving requires an understanding of the directory structure. The concept of a "virtual space" needs to be understood by a user. In this space, a user is able to store, organize or move around things (video clips, songs etc.). It is a highly abstract concept and would be available to only those Emergent Users who have a high exposure to ICT artefacts, or are instructed explicitly during a computer course. We found very few savers during our field study.

The moment a person saves a piece of work in some form, the notion of ownership becomes concrete. This is because the saved entity has the signature of the user in terms of labelling and annotation. While saving, a user makes a conscious decision about where to place the entity in the device-space. In other words, saving requires navigating to a particular place in the device-space and positioning the saved item. In fact, Savers, like Pratik, organize their device-space itself by designing the directory structure. This is different from the 'Gallery' concept of a smartphone, where saving and retrieval happens automatically without the user being conscious of it. In our observations, we found very less number of instances where users made folders and labelled them to store files. However, a rudimentary form of saving was apparent during the saving of contacts by a user. He had assigned different ringtones for different contacts, thus assigning attributes to the saved entities.

Saving requires the ability to read and write. There is a need to label the things. Both the folders and the files are to be named. Similarly, navigation of the folders also require some amount of semantic knowledge, which in turn needs reading. Some people do navigate folders visually, by identifying clues such as shapes but that way is slow and error prone. In any case, merely navigating does not fulfil the requirement of saving.

There is a fine line between a Text Inputter and Saver. A Text Inputter, many a time, is not conscious of where the saved entity would be placed in the device-space; neither would he take a conscious decision about labelling and annotating the saved entity. A Text Inputter does not expect a saved entity to be in a particular place. The result is that a Text Inputter would just go along with the default option. The Saver, on the other hand, would decide where to save the entity, and would even choose the name of a folder carefully so that he can inform about the 'things' contained by it. For example, users would name the folders for the songs based on the language of the songs. This implies that a Saver needs to have a good mental model of digital artefacts in general. That, in turn, means that people hitherto unexposed to digital artefacts would find it difficult to become Savers.

Saving tasks could only be attempted by the users in the *Stage of Competency* because saving is a complicated task; it cannot be accomplished through memorizing routines. It requires robust mental models.

6.3.5 Account Holders

Persona of an Account Holder (Competent)

Amol, 27, educated till 12th class, was a goldsmith by profession. He was from a rural area 20 kilometres away from Kolhapur which he travelled to frequently for business purpose. He had purchased his first mobile phone, a simple phone in 2006. He had bought the mobile phone so that he could connect to his home telephone while travelling. By nature he was a tech-savvy person. He had done a computer certificate course. He liked to own the latest devices. He had tried 17 handsets of different brands till 2018.

He had a natural curiosity to learn. He would often consult anybody regarding 'difficult things on the phone' whom he could ask, many of them during his visit to Mumbai or Begaluru. He was ahead in terms of phone-related knowledge than most of the people around him. Many a times, he would solve complex problems for others. For example, he had helped many of his friends wanting to install WhatsApp on his phone.

He was a heavy user of the camera. He had started using the camera for business purpose. He used images mostly as reference for designing gold ornaments. He took images of necklaces so that he could get the designs done from a Kolhapur vendor. He also took images of leisurely excursions. For example, he had visited the holy city of Tirupati, and Ramoji film city in Hyderabad and the Golden temple in Amritsar. In each case, he had extensively used his camera to take photographs.

He had bought his first smartphone in 2007. He already had two email accounts–a Yahoo mail from his earlier days of learning computers and a Gmail account made later on the insistence of friends. The latter came handy while starting to use the smartphone. He was able to initialise his use of the smartphone with the help of a friend. He was able to use the smartphone to a good extent. He was able to install many apps from the Play Store. He would often go to YouTube to search for his favourite songs. He used YouTube, ShareIT, Hot Star and Voot very frequently. He was a heavy user of data regardless of the data cost.

He also had a Facebook account which he operated from a cybercafe earlier. After buying the smartphone he switched to the phone. He was an extensive user of WhatsApp as well as Facebook. He posted and forwarded (content) frequently.

The only thing he did not do on his smartphone was using Amazon or Flipkart (the m-commerce platforms). He knew that goods could be ordered using their apps. However, he was sceptical about money transactions. Though he had an ATM card, he had not considered it for online use. He had come to know of about cash on delivery option and, in 2018, was considering trying it out. His rationale was, *"If I do not receive (something), I do not lose anything."*

Characteristics of Account Holders

Typical examples of Account Holders are e-mail account holders and Facebook account holders. Account Holding tasks are demanding. Firstly, they require the capabilities of all the User Types mentioned earlier. The account holding comprises of Navigation, Text Inputting and Saving too.

A digital account involves the idea of digital assets, which by nature differ from physical assets (see Section 2.3), and that changes the way their security could be breached. For example, while theft of a physical asset is known by its absence; a stolen digital asset, because it is simply copied, does not leave a trace. Understanding digital security requires mental models unique to ICTs, which many EUs would not have. As result, an Emergent User may not have a comprehensive idea of digital security.

Account holding requires that concept of networked spaces to be understood. Because the networked space transcends the geographical limitation, an Emergent User might not have an appropriate mental model to understand the same as well.

Account holding also entails the idea of digital identity. It not only means that one has a distinct presence in the networked space (on a shared computer, a LAN or Internet) but it also means that such a presence is private in nature.

The design of security mechanisms has been situated in the traditional contexts of ICT. The specificities and capabilities of the EUs have been neglected. As a result, the EUs struggle at initialising and maintaining security-related tasks. For example, A typical way for initiating an account requires that a user creates a unique login ID and passwords. In order to do that, he has to design, remember and change passwords. Not only the passwords are to be written in English, a non-native language, they are also needed to be entered using by typing.

Account Holding has an initiation challenge. Starting an account in itself is a cognitively intensive and a multi-step activity. A typical account requires the first name, last name, chosen username, chosen password, re-entry of the password, date of birth and gender. The process is exacerbated by the need for unique user names and complex passwords, which often results in multiple attempts to enter them. Additionally, some pieces of the required information may not be available at all. For example, e-mail ID is required by many platforms, which many Emergent Users do not possess. Adding contacts, an essential procedure in account holding, is another cognitively demanding task because it requires writing and saving.

Savers can be only in the *competent* stage because saving tasks need complex mental models, which cannot be rote learnt.

6.3.6 Transactors

Persona of a Transactor (Competent)

Suresh, 25, lived in a village near Indore. He was a graduate and ran a mobile shop in the market area of the village. After his graduation, he attended a mobile repairing course, which taught him basic computer operations too. He not only sold SIM cards but also mobile phone sets of the cheaper variety. Very often he had to go to the city to buy material. Generally, he was accompanied to the city by one of his two brothers who worked as drivers. He often filled his customers' memory cards with songs which he downloaded from the Internet. He was considered to be an expert, to whom everybody came with queries regarding mobile phone usage. Most of the times, young men hanged around his shop, where often the discussion turned towards technology. He was an expert user of WhatsApp, Facebook and Hot Star. He had many friends on the former two. In 2015, he had also started booking train tickets for a fee. He had learnt that from one of his relatives who studied in another city. He had also bought a few things from the shopping sites. He had an ATM card as well as an online bank account from the State bank of India. He did transactions with ease using the State Bank of India app, although when he had started, he was a little apprehensive about the money. Once while booking a ticket, his transaction was not complete and he had thought that he had lost the money but after two days he had received a message telling that his amount was reimbursed. In 2017, he had also started a PayTM[10] seller account which many customers used to pay for mobile phone related services.

He was not an expert before his graduation. He did know basic operations such as adding contacts and writing SMSes. However, his real expertise was developed during his stint at the mobile repairing institute. Two of his classmates were really good at the devices. They could manipulate the operating systems. He also learned some theoretical aspects which helped him understand how things work. For example, he knew that transactions done over the Internet were encrypted.

[10] mobile payment app

Characteristics of Transactors

Transaction is about buying something over the Internet. Firstly, a Transactor has to be an Account Holder. Transaction over the Internet would require an account with the e-retailer, which is very different from buying from a brick and mortar retailer. Secondly, there is a perceivable risk with the money involved as the payment is in an intangible form unlike hard currency. For a new Transactor, this may create anxiety, therefore a Transactor needs to have a disposable income. Moreover, one needs to have an Internet connection and a competent device. One also needs an online banking account, a credit card or an e-wallet.

Trust on the transaction process is critical for the initiation and sustenance of a Transactor role. This includes trust in technology as well as the institution with whom the transaction happens. A person who does not trust an entity might not initiate a relationship with it. It can also happen if a particular technology (for example, the Internet) or people operating it (for example, the Internet Service Provider) do not evoke trust. It should be noted that trust takes time to build, whereas it takes only a few bad experiences to be broken down.

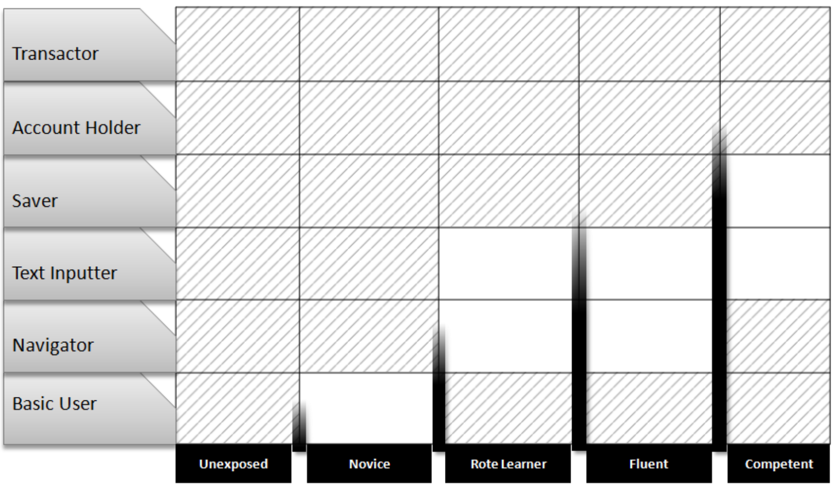


Figure 6.11: Possible combinations of Types and Stages. The combinations which are (i) theoretically impossible (ii) have less than two data points in collected data (iii) or, are not to be found amongst the Emergent Users are hatched out.

6.4 Additional Discussion

6.4.1 Potential for Quantisation

Users differ from each other in terms of attributes such as attitudes and capabilities, which themselves are functions of user related factors such as gender, age and education level et cetera. A given user will possess a particular combination of the above mentioned attributes, and therefore would depict a particular usage pattern described by one of the User Types. Further, the same combination of factors will also define how much resistance each of the four barriers offers to him, which will define the stage of usage. If the relationship between the factors and the User Types and Stages of Usage could be decided, a user's placement on the User-Usage matrix could be determined. This is what we have attempted in Chapter 7 In this chapter, we have referred to a small set of factors (age, gender, education level), we have used many in Chapter 7 which was based on our investigation of the constructs affecting Technology Adoption by the EUs (in Chapter 5). The larger set includes the prevalence of ICTs in the social space around the user, attitude, power, self-efficacy etc.

6.4.2 Comparison of User-Usage Model with SRK, Dreyfus and Hackos & Redish Models

We would compare stages of usage in (the User-Usage Model) with the stages of the earlier models (see figure 6.12) from literature. From the perspective of SRK model (see section 4.3.1), a Novice user depicts a Knowledge-Based Behaviour (KBB) because he does not have any rule (or recipe/routine) to deal with the task. It is more difficult to map the stages of usage in the User-Usage model to Dreyfus model (see section 4.3.2) because the latter focusses on professional training, while the former is concerned with the ability to accomplish tasks using ICT artefacts. Dealing with novel situations is important in the latter's case. For the former, ability to accomplish tasks in creative and efficient ways is sufficient. However, we can still say that absence of a mental model stops a person from creatively dealing with novel situations. Therefore a Novice in the User-Usage model maps to novice of Dreyfus model. From the perspective of Hackos and Redish model (see section 4.3.3), a Novice (from the User-Usage model), maps to the Novice (of H & R model) because unexposure to similar artefact or domain means lack of an appropriate mental model, which is certainly present in this case.

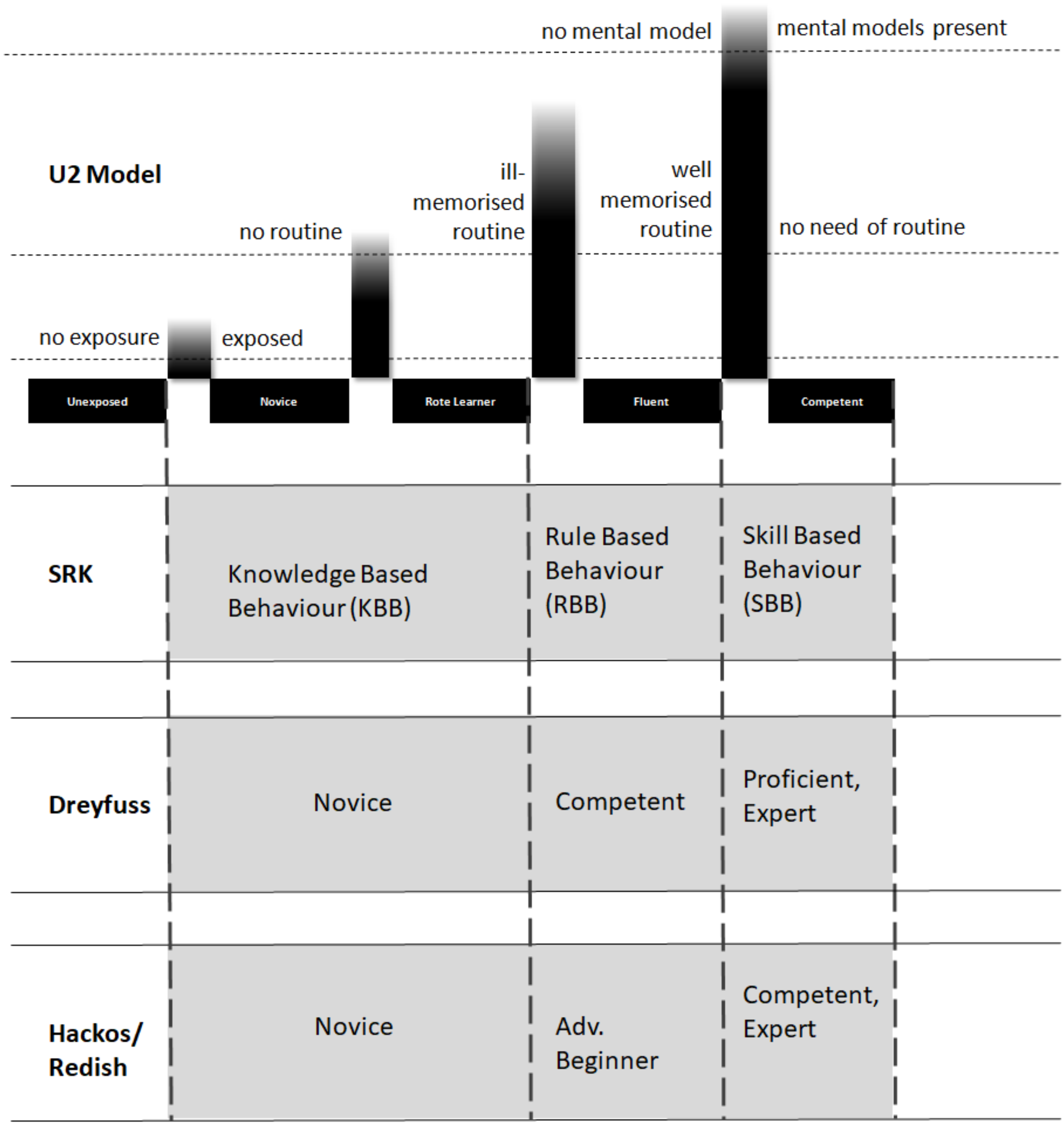


Figure 6.12: Mapping of the stages of usage with earlier models.

The Rote-Learner Stage should certainly map to the Rule-Based Behaviour (RBB) of

SRK model because the rules are used effectively. As rules have been well internalised, they pose lesser cognitive load than explicitly rules in a conscious manner.Therefore, it is more likely that a person can afford a larger repertoire of rules. A person may also use two sets of rules to deal with two different situations. For Dreyfus' model, this stage should map to Competent (of Dreyfus model) stage because, with a larger number of internalised rules, a person may be able to select which rule to employ. For example, a person in order to make a call may use three explicit rules each for calling through a list of last calls, through address book and by typing the number. In the case of H & R model, as the person has started using artefact effectively, it should map to Advanced Beginner stage.

A question could be asked—'Why does a person becomes a Rote Learner does not remain a Novice user but still not progress further? In other words, what type of person would remain in this stage? Firstly, the motivation to accomplish the tasks that could be done by rote learning needs to be present. It could be intrinsic motivation such as in the case of a desire to listen to songs. Many users had reported that they bought a better phone only to listen to songs. On the other hand, extrinsic motivation, such as compulsion to delete the older message on account of memory remaining unavailable for other tasks in older phones, made users learn tasks in the form of recipe/routine.

Rote learning is a cognitively intensive process. However, it is easier than the formation of mental models. As discussed in section 4.2.4, mental models require exposure to a domain. For many EUs in our field study, appropriate domain exposure was absent. For example, an email application could be better understood with the mental model of an office secretary's desk 4.3. For a user who has not worked in an office, would not have access to this model. One who has can use it as a surrogate. In the former case, a user will arbitrarily use mental models available to him. A mental model could also be formed is through earlier exposure to similar artefacts. For many of the users in the field study, mobile phones were the first ICT artefact. They were trying to understand the usage of ICTs for the first time. As the mental model formation would happen after a long usage over a period of time, the only recourse, for a user, to accomplish her many goals was to rote learn the tasks.

It might look appropriate to map Fluent stage with the Rule-Based Behaviour (RBB) of SRK because of the presence of rules. However, as the rules have not been learnt well, and their application at each step is a conscious effort, they cannot be used in a feed-forward fashion. Therefore, this stage should be still mapped to the Knowledge-Based Behaviour (KBB). For Dreyfus' model, the lack of mental model means that the user cannot deal with new situations. Also, the effort is clearly conscious. It implies that, it should map with the Novice user of Dreyfus model. In the case of H & R model, as the user still struggling, it should map to the Novice (of H & R model) .

As the presence of a mental model allows a user to be able to deal with newer situations. Therefore, Competent Stage maps to Skill-Based Behaviour (SBB) in SRK model and all the stages after Competent in Dreyfus' model. For H & R model, it should map to Competent Performers and Experts.

6.5 Conclusion

User Types and Stages of Usage both together define the level of technology adoption. Some of their combinations are theoretically impossible or are not supported by evidence from the field studies involving the Emergent Users (see figure 6.11). We have very less evidence for the whole categories of Saver and upwards. These could also have been separated out because of the bounds we have decided on age (more than 25 years) and education levels (less than or equal to class 12).

In this chapter, we have detailed out the User-Usage model in terms of the usage patterns and interaction-behaviours. We have supported the design of the model in terms of theory(chapter 4)) and user studies (chapter 5). In the next two chapters, we test the strength of the User-Usage model. In chapter 7, we report the result of another study, a quantitative one of 89 emergent users from different parts of India, and statistically test the prediction ability of the model. In chapter 8, we use a case study approach to understand, on the basis of the User-Usage model, how WhatsApp, an Account Based application, was successfully adopted by a large number of emergent users in India.

6.6 Summary

The User-Usage model maps a user's broad usage patterns in terms of tasks he could perform with ICT artefacts. Termed as User Types, these patterns inform whether a user does only absolutely simple tasks or is able to do navigational task, or more complex tasks such as those involving text input, saving in folders, account operation or transaction over the Internet. Further, for every broad pattern, it also tells what kind of barrier—complexity avoidance, low frequency of usage, or lack of proper mental models—he has been able to conquer. The space between two adjacent barriers is termed as Stage of Usage, and depicts typical interaction-behaviours. Both user types and stages of usage, comprehensively inform about the level of technology adoption.

Chapter 7

Quantifying the User-Usage Model

7.1 Introduction

We have presented the User-Usage Model of Technology Adoption by the EUs in Chapter 6. It describes the User types and Stages of Usage and discusses their relationships with the various user-related constructs (Age, Education etc.). In this chapter, we describe (a topic touched upon in Section 6.1) *How could we decide a user's placement on the User-Usage model.* In other words, if a user's Age, Gender and Education-level et cetera are stated, what is his *likely* User Type and Stage of Usage? A way to answer is to quantify the model. That means, the relationship between the user-related constructs and the User Types/Stages of Usage are defined mathematically so that the former could be used to predict the latter,

Based on the above, the following hypotheses could be stated:

- H1a: A particular user-related construct is significant in deciding a given User Type.

- H1b: A particular user-related construct is significant in deciding a given Stage of Usage.

- H2a: A particular user-related construct is significant in discriminating between two User Types.

- H2b: A particular user-related construct is significant in discriminating between two Stages of Usage.

In this chapter, we have operationalised 13 user-related constructs (henceforth called variables) related to users. We have also devised a way to identify each user's User Type and Stage of Usage on the basis of the descriptions provided by the model. The former set acts as the input or independent variables, the latter as the output or dependent. The relationship between the two has been ascertained by collecting the data from 85 EUs across India, and then *training* the model statistically. For this purpose, a questionnaire was prepared (it is provided in Appendix A). The interviews also yielded qualitative data which is used to support the quantitative analysis. We have also applied the operationalised model for estimating (it is reported in chapter 8), using available population demographics of India, the number of different User Types and Stages of Usage.

In the following section, we describe various variables, both independent and dependent, and how we have operationalised them. Next, we detail out the method employed for the data collection. Finally, we inform how the data was interpreted and the results of interpretation.

7.2 The Users

As mentioned, a total of 85 users were interviewed. The locations selected were villages and semi-rural settlements in seven districts of India (see Figure 7.1 and Appendix B). Consecutive sampling was used with age range decided to be between 25 to 55 years and education between 0 to 12 years of education.

Screening was done on the basis of following rules:

- A user had her/his own phone with her/him at the time of the interview.
- She/he had been using it for at least 6 months.

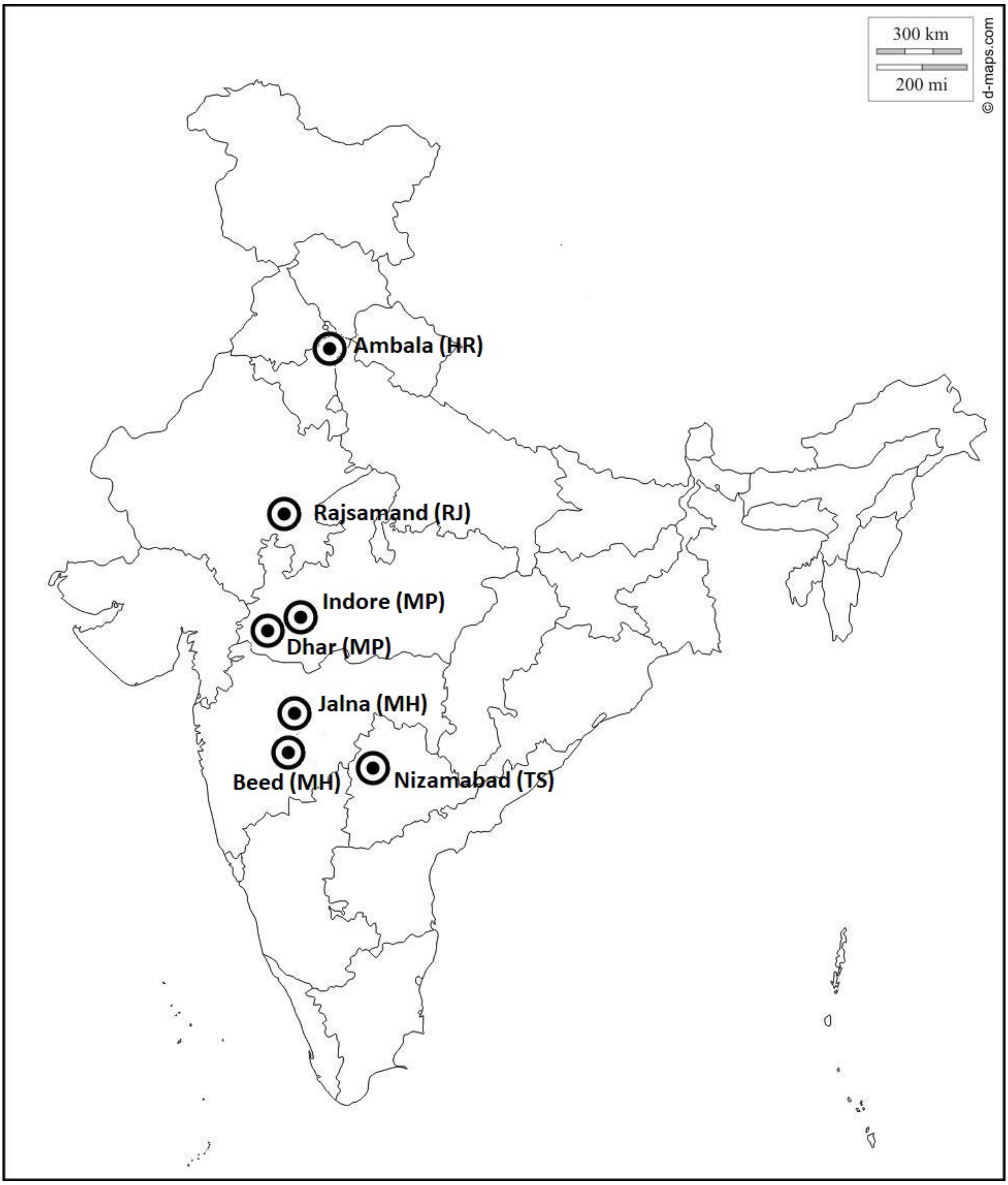


Figure 7.1: Districts in which data collection was done.

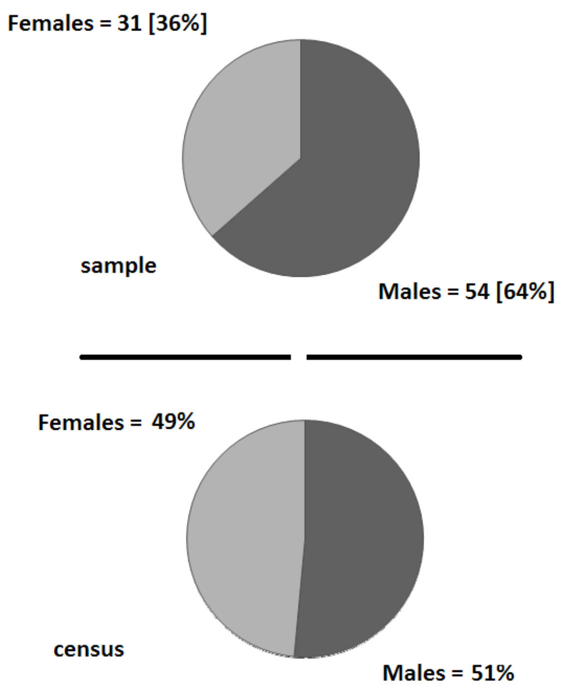


Figure 7.2: Gender Distribution of the Sample. The bottom figure is Gender distribution according to the 2010 Indian census.

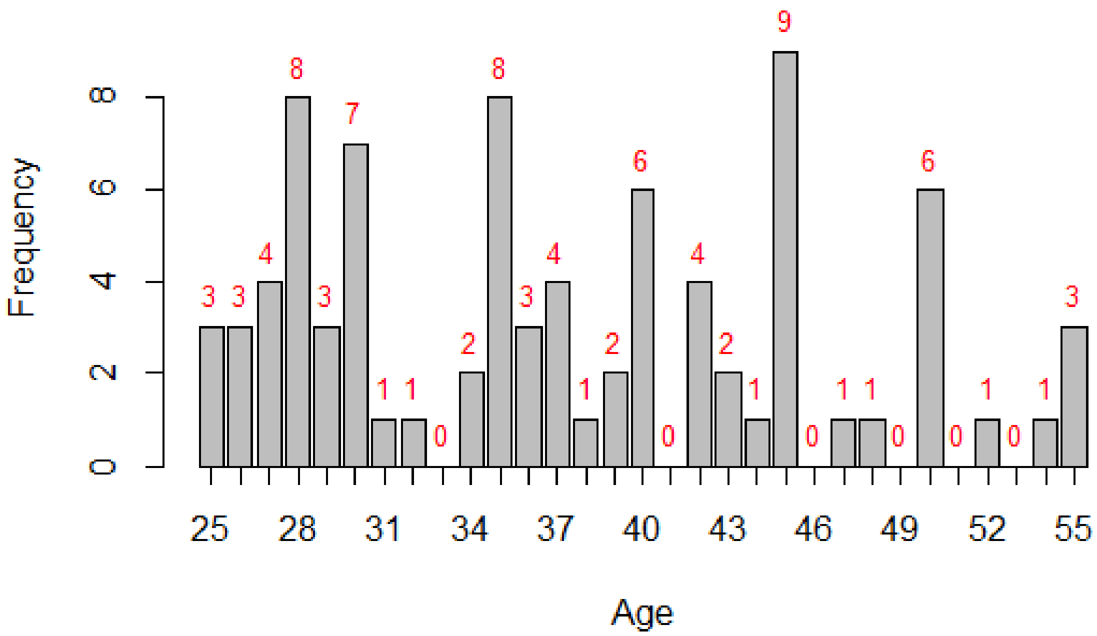


Figure 7.3: Ages in the Sample.

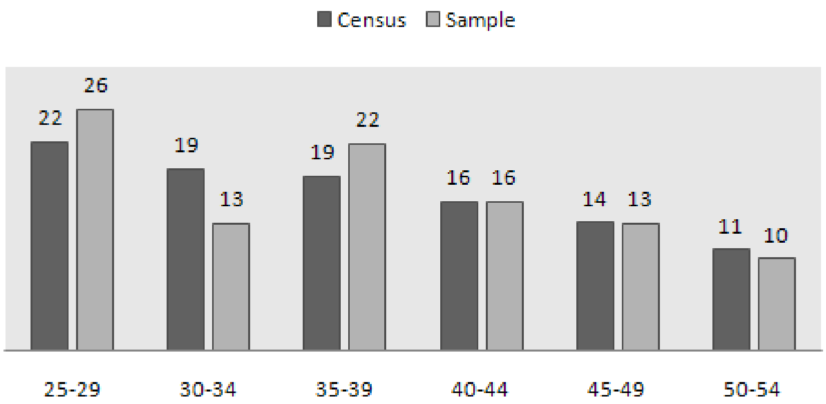


Figure 7.4: Age distribution (in percent) in the sample compared with that according to the 2010 Indian census.

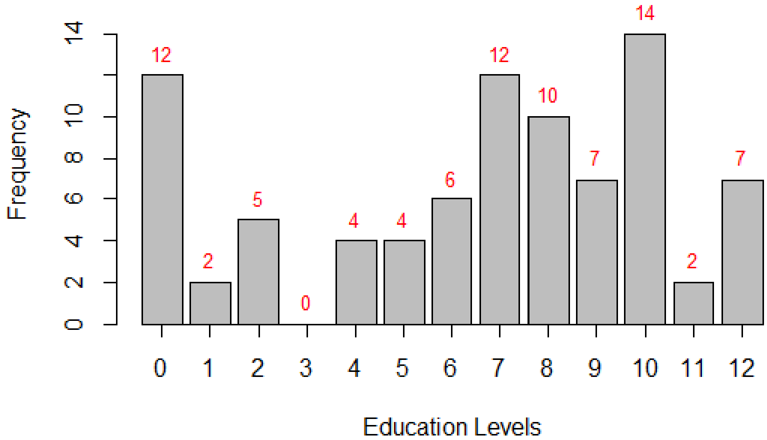


Figure 7.5: Educational Levels in the Sample.

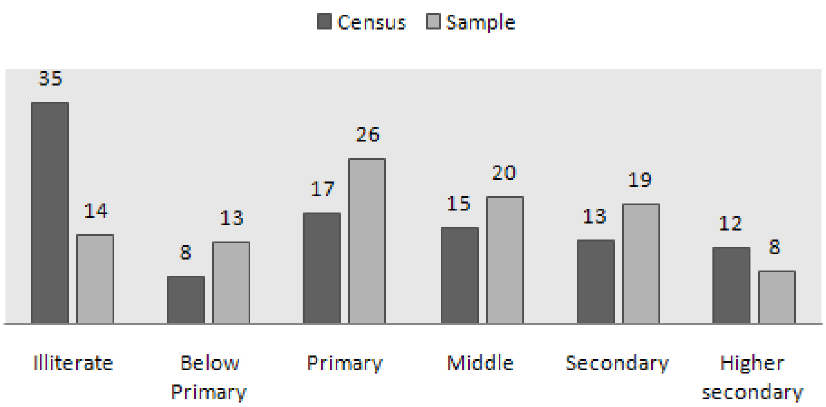


Figure 7.6: Educational Level distribution (in percent) in the sample compared with that according to the 2010 Indian census.

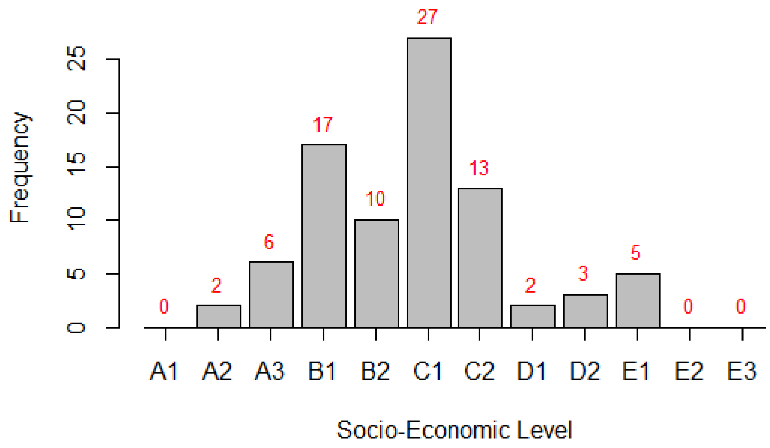


Figure 7.7: Socio-Economic Levels in the Sample.

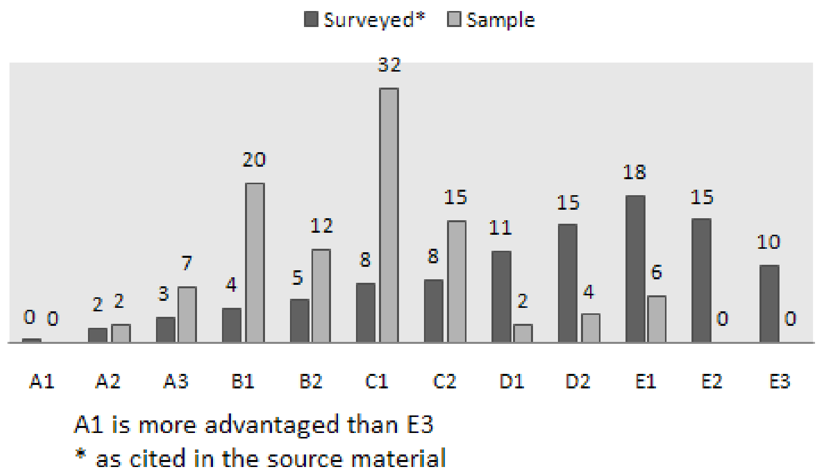


Figure 7.8: Educational Level Distribution distribution (in percent) in the sample compared with that accordingIMRB [2011].

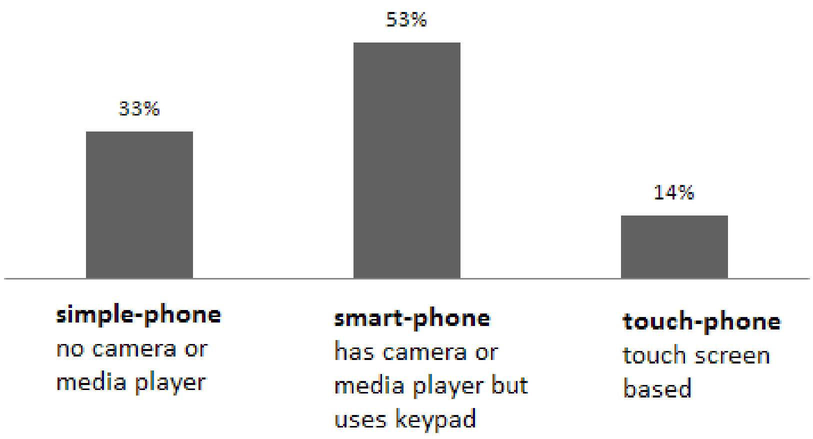


Figure 7.9: Phone type distribution (in percent) in the sample.

- She/he had not discontinued it more than 15 days earlier.

7.3 The Variables and their Operationalisation

The various variables used to train the model are shown in Table 7.1. They are further elaborated upon in the the following sub-sections.

Variable Name	**Range**	**Description**	**Reference to earlier Chapters (Name of the referred topic)**
Independent Variables: Basic Demographics			
AGE	[25-55]	Age (in number of years)	Section 5.3.1 (Age)
GEN	[1, 2]	Gender: 1 for a Female, 2 for male	Section 5.3.1 (Gender)
EDU	[0-12]	Education-Level: highest class or grade successfully completed	Section 5.3.1 (Education)
Independent Variables: Social Characteristics			
SEC	[1-12]	Socio-Economic Class (determined according to method by IMRB [2011])	Section 5.3.1 (Low Income)
RUR	[0-]	Rurality-Index: Measured as distance from the nearest private bank.	Section 5.3.1 (Infrastructure)
POP	[0-]	Rurality-Index: Measured as population of the census unit (according to Indian census 2011) to which the location of user belongs to.	Section 5.3.1 (Infrastructure)
PVL	[0-100]	Prevalence of ICT	Section 5.3.3 (Socialisation)

Independent Variables: Usage Related Characteristics			
UTL	[-1,0,1]	Utility: The three levels signify non-utility, neutral stance and positive utility respectively	Section 5.3.2 (Extrinsic Motivation)
PRO	[0-]	Proactiveness: count, integer	Section 5.3.2 (Intrinsic Motivation)
SEF	[-1,0,1]	Self-Efficacy: The three levels signify negative self-efficacy, neutral stance and positive self-efficacy respectively	Section 5.3.2 (Self-Efficacy)
ANX	[-1,0,1]	Computer-Anxiety: The three levels signify non-anxiety, neutral stance and presence of anxiety respectively	Section 5.3.2 (Computer anxiety)
PRD	[-1,0,1]	Social status: The three levels signify non-influence of mobile phones on the social status, neutral stance and influence of mobile phones on the social status. integer	Section 5.3.2 (Self-Identity)
TIM	[0-]	Time since first use (in number of years)	Section 5.3.1 (Total Time of Interaction)
Dependent (Response) Variables			

TYPE	[BAS,NAV,TXT,SAV]	User Type: Basic-User, Navigator, Text-Inputter, Saver	Section 6.3 (User Type)
STAGE	[NOV,RTL,FLT,COM]	Stage of Usage: Novice, Rote-Learner, Fluent, Competent	Section 6.2 (Stage of Usage)
Individual Task Related (Supplementary) Variables			
FRQ	[1-5]	Frequency of performing the task: 5-many times per day; 4-few times per week; 3-few times per month; 2-fewtimes per year; 1-sometimes in many years; 0-Never	
SNC	[0-]	Time in (rounded off) years since initiation of the task (as in 2016-17).	
LRN	[1-5]	Time taken to learn the task: 5-hours; 4-days; 3-weeks; 2-months; 1- more than few months; 0-never	

Table 7.1: Summary of the Variables.

7.3.1 Basic Demographics

The basic demographics are the most basic variables describing a person. They consist of Age, Gender and Level of Education. The importance of these variables lie in the fact that they are part of the census data and can be used for population level analysis (as we have demonstrated later in this chapter in section 8.3)

7.3.2 Social and Economic Characteristics

Variables of this type measure the characteristics of the social and economic contexts of the user.

Socio-Economic Class

As discussed in section 5.3.1, better socio-economic status implies an improvement in total time of interaction. This may have an effect on the formation of adequate mental models leading to better levels of Technology Adoption.

We have used an established instrument (IMRB [2011], item 16 in Appendix A). It is used for Socio-Economic Classification (SEC) for the purpose of marketing in India. It is done through following steps:

- **Q1a: Record a total of the different type of household items, enlisted below, owned by the family.**
  - Electricity Connection
  - Ceiling Fan
  - LPG Stove
  - Two Wheeler
  - Colour TV

- Refrigerator
- Washing Machine
- Personal Computer/Laptop
- car/Jeep/van
- Air Conditioner
- Agricultural Land

- **Q1b: Agricultural land, if owned, is added to the number.**
- **Q2: Record the education level of the member earning most.**
- **Find the intersection of Q1 and Q2 on the SEC grid (see figure 7.10). It yields one of the 12 values ranging from A1 to E3.**

No of items in household (inc. land)	Illiterate	Literate but no formal schooling/ School Upto 4 years	School- 5 to 9 years	SSC/ HSC	Some College (incl a Diploma) but not Grad	Graduate/ Post Graduate: General	Graduate/ Post Graduate: Profession al
0	E3	E2	E2	E2	E2	E1	D2
1	E2	E1	E1	E1	D2	D2	D2
2	E1	E1	D2	D2	D1	D1	D1
3	D2	D2	D1	D1	C2	C2	C2
4	D1	C2	C2	C1	C1	B2	B2
5	C2	C1	C1	B2	B1	B1	B1
6	C1	B2	B2	B1	A3	A3	A3
7	C1	B1	B1	A3	A3	A2	A2
8	B1	A3	A3	A3	A2	A2	A2
9	B1	A3	A3	A2	A2	A1	A1

Figure 7.10: SEC Mapping

The use of the instrument is exemplified as follows. Suppose, a household has an electricity connection, ceiling fan and a two wheeler. This would yield 3 items (from question Q1 (including Q1a and Q1b) which map to the 4th row of the table 7.10). If the person earning the maximum within the household is educated till class 8th (answer to question Q2 maps to the third column of the table 7.10), then intersection of Q1 and Q2 indicate the SEC to be D1.

Rurality Indices

One of the aspects that defines the EU is their distance from the urban centres (see the discussion in section 2.1). Therefore, it is worthwhile to measure the level of rurality. The description of the locations of the interviews (provided in Appendix B) informs that the levels of rurality differ in myriad ways. Some of them are small clusters of population below 1000, while some have merged with edges of fast growing semi-urban settlements.

Presence of banks are likely to be good indicators of level of rurality, because banks, especially from the private sector, are likely to open branches only in the areas where there is a considerable economic activity and which are easily approachable. We have, therefore, considered the distance (in kilometres) from the nearest branch of a private sector bank (as contrasted with nationalised banks which are also governed by social obligation) as a measure of rurality.

The other measure used is the population of the census unit to which a user location belongs to according to the Indian census of 2011.

Prevalence of ICT

In section 5.3.3, we have discussed how community plays an important role in the adoption of ICT artefacts. We have decided to include a measure of Prevalence of ICT in community. While operationalising, we have kept a view of two issues. The first is approachability to a given teacher. In cases where a student and a potential teacher, in spite of belonging to a community, have a social barrier, the skills of the teacher would be of no use. The second is skill differential. A potential teachers' skill has to be better than the student's in order to be useful.

For each type of community (home, neighbourhood, workplace), the following was asked:

- N (items 17.1.1, 17.2.1 & 17.3.1 in Appendix A):How many persons are there (within the social circle or unit)?
- X (items 17.1.2, 17.2.2 & 17.3.2 in Appendix A):How many of them know the use of mobile phones better than you?

The overall percentage $100(\Sigma X/\Sigma N)$, summed up for the three communities, will tell the density of *potential* instructors.

For example, a user has 4 people consisting of husband, parents-in-law and children, at home. She has around 10 persons comprising of neighbourhood friends. She has 4 persons at workplace, which includes a male supervisor, a male worker and two other female workers. The user reports that husband has taught her many times at home. Parents-in-law do not use phones, neither the children. In the neighbourhood, none of her friends know better than her. At work, she cannot approach the men. Among women, one knows better than her and teaches her sometimes. The effective prevalence for the user is as follows. The total numbers of persons who have taught her are 1 at home, 0 in the neighbourhood and 1 at work. The total numbers of persons around her are 5 at home, 10 in the neighbourhood and 6 at work. From that, her prevalence is (1 +0 +1)/(5+10+6) =2/16=12.50%

7.3.3 Usage Related Characteristics

These variables pertain to the characteristics related to phone usage by a user. We had referred to TAM3 (Venkatesh and Bala [2008b]) for identifying these variables. These variables have been traditionally used as predictors of Technology Adoption. We have not employed all of the variables mentioned there, and have selected only the ones suitable for an EU's context. Job Relevance (perception regarding ICTs relevance to jobs), Output quality (belief regarding quality of the job), Result Demonstrability (tangibility of results) and Voluntariness (perception of a job to be non-mandatory) have not been used by us as they are specific to 'job' as understood in the organisational contexts which are very different from the ones of the EU's (see Section 3.5). We have measured the other measures, but in ways different than that proposed in the literature (the reasons are cited in their descriptions below). Computer Anxiety has been measured as Anxiety, and Computer Sef-Efficacy as Efficacy. We use the term Social Status instead of Image. Computer Playfulness (cognitive spontaneity in computer use) is treated as Proactiveness. Perceived Usefulness could also be treated as an independent variable and is measured as Utility. Experience is measured in terms of years of phone usage. Perceived ease of use is not measured, as we are interested in measuring the levels of Technology Adoption in terms of actual usage patterns and interaction behaviour.

The original instruments to measure the above variables were very detailed as they measured only a single trait. Incorporating them as they were would have been counter productive. We, therefore, selected one representative question for each of them. These are described below.

Utility

It is the perceived utility of mobile phones. It is based on perceived usefulness by Davis [1989]. We used the following question (item 21 in Appendix A). It yielded a three levelled scores shown in the barackets:

"A mobile phone is—

1. *Is a very useful thing/ it helps me in my work. (-1)*
2. *Does not matter if I have one (a mobile phone) or not.(0)*
3. *Is a useless thing/ It does not serve a purpose/It should be banned. (+1)*

Proactiveness

Proactiveness measures the users' *internal motivation* to use an artefact. During our qualitative studies, we observed that many users would explore their devices, while others would be satisfied with immediate objectives. This could make a difference, as a motivated person would get more interaction time which, in turn, would help him learn routines/recipes better, and acquire good models.

We measured this variable in an indirect way by asking how many persons a user had helped learn usage of mobile phones in any manner. The exact question was:

Who all, in your family/neighbourhood/workplace(for each of the the three sub-groups of *a users' community*[1]*), you have helped to learn mobile phone?*

For the question, we found support from the field observations where highly motivated users were found to be inclined to teach others as well (as was the case with user UJN12 [22, M, XIII, College Student]).

In the process of arriving at the question, we had also considered a few potential measures. Computer Playfulness (CP) was proposed by Webster and Martocchio [1992]. It denotes a users' trait of interacting *'spontaneously, inventively and imaginatively'* with their devices. It had five measures- cognitive spontaneity, social spontaneity, physical spontaneity, manifest joy, and sense of humour. The other potential measure to access Proactiveness was intrinsic motivation inventory (IMI) by Ryan and Deci [2000b]. Intrinsic motivation pertained to a users' sense of pleasure arising from control over an activity, that is, an appropriate balance between ease and challenge of doing tasks involved in that activity. Intrinsic motivation helped in increased usage and thus added to the skill acquisition. IMI constituted measures of enjoyment, perceived competence, perception of effort invested, usefulness, felt tension, and perceived choice. However, we had avoided questions directly referring to sense of enjoyment, and used the above mentioned question instead, because we had found in the field studies that conveying the idea of intrinsic enjoyment was difficult the questions regarding enjoyment were very commonly answered affirmatively.

Computer Self-Efficacy

We had focused on the perceived ability to gain 'mastery' and 'completeness' in phone usage and thus framed our question as (item 18 in Appendix A):

[1] *Family* means the immediate family. In this case, on one hand the family ties extend over many neighbouring houses, and often the extended family is considered as a whole. On the hand, extended family could be living under the same roof. We have bounded the definition in the following way: *'people living under the same roof'*. In this way we have included only the social group that was more intimate in terms of shared physical space. *Neighbourhood* represents the group of friends in neighbourhood. Often the power parity is low in case of peers. Also, persons learns more outside the house than they do with in the house. *Workplace* comprises the third sub-group. Given the fact that a large part of the day is at the work place, which has a separate peer group, workplace is a valid site for technology learning.

Imagine that you buy a new phone, which is completely different from your current phone. How long will it take to completely, that is 100 per cent, master it?

The Computer Self-Efficacy score by Compeau and Higgins [1995] is a frequently used measure. It is discussed in detail in section 5.3.2. It is described as 'a judgement of one's capability to use a computer'. It is a special redefinition, with respect to computer usage, of Bandura's definition (Bandura [1977]) of general self-efficacy. This instrument measures self-efficacy by asking (*'I will be able to do the job, using...'*) for a variety of situations, for example, 'if there was no one around to help' or 'if I had lot of time' We have not used the above measure because, as we have discussed in section 3.5, the emergent users employ their artefact in many situations that depart from the notion of well define 'job'. For example, mobile phones are used for general talking and listening to songs.

Computer-Anxiety

We decided to measure the emotion of anxiety by using the following question (item 19 in Appendix A):

Imagine that you buy a new phone, which is completely different from your current phone. Imagine that you pick it up in your hand, how would you feel?

This measure is not much different to Anxiety rating scale by (Heinssen et al. [1987]). It measures Computer Anxiety which is the fear or apprehension of using a computer. This stops users from initiating the usage. Though, we found meagre evidence of computer anxiety during in the qualitative studies reported in chapter 5, we had included it as it was treated as an important measure in TAM3. The computer Anxiety Rating Scale discussed in the same article measures aspects of anxiety like insecurity, challenge, fear, apprehension, dislike, difficulty, hesitation, avoidance etc.

Social Status

Many users like UJN04 [40, M, X^{th}, Sales Agent] projected self-identity through owning and using artefacts, For others like user UJN02 [45, M, XII^{th}, Tuition Teacher] phone did not play a role. We measure this phenomenon as social-status.We have used the following question (item 20 in Appendix A):

"Do you think that having or not having a mobile phone has anything to do with your social status?"

In case of respondents' indecision, it was augmented with the following (considering weddings are important social gatherings):

"Can you take a broken phone (showing a damaged phone) with you to a wedding?"

Time

This variable measured the time elapsed in years since the user has owned and started using a mobile phone.

7.3.4 Output Classes

Deciding the User Type

Task	**Task Type**	**Remarks**
Making a call	Basic Usage / Text Inputting	Basic Usage, if the user knows only to pick up and disconnect the phone. Basic Usage if she searches in the list one after one. Text Inputting if she could type numbers Text Inputting if she searches by typing a name.
Playing song	Navigation / Basic Usage	Navigation, if song list could be reached through menu. Basic usage if player started from the screen.

Task	**Task Type**	**Remarks**
Finding a missed call	Navigation / Basic Usage	Navigation, if done through menu. Basic Usage, if done through onscreen notification.
Taking a photograph	Navigation / Basic Usage	Navigation, if done through menu. Basic Usage, if done through hardware button or from the home screen icon).
Deleting SMS	Navigation	
Transferring a song using Bluetooth	Navigation	
Saving contact	Text Inputting	
Sending SMS	Text Inputting	
Searching something over Internet	Text Inputting	
Copying a video or song	Saving	
Posting something over Facebook	Account Holding	
Sending an E-Mail	Account Holding	
Buying something over Internet	Transaction	
Booking a train ticket	Transaction	

Table 7.2: The list of task covered, in order of decreasing complexity.

A user was asked, from the list given in table 7.2 which of the tasks (s)he could perform. (S)he was then requested to perform, on her/his phone, each of the tasks we (s)he had reported (s)he could. Some tasks could be completed in multiple manners where each manner might map to a different User Type. The User Type was decided upon *the* *most complex manner in which any of the tasks was accomplished* successfully without breakdown.

Task	**Manner**	**Observation**	**Implication**
(A)	**(B)**	**(C)**	**(D)**
Making Calls	Simply accepting a call by pressing button.	Accomplished without difficulty.	Basic User
	Sequentially go through the contact list.	Reported not a preferred method.	
	Searching a contact by typing.	Accomplished without difficulty.	Text Inputter
Playing songs	From the shortcut on home screen, or through hardware button.	Accomplished without difficulty.	Basic User
	Reaching the application through menu.	Accomplished without difficulty.	Navigator
Finding missed calls	From the screen notification.	Accomplished without difficulty.	Basic User
	Reaching the list through menu.	Accomplished with slight difficulty.	Navigator
Saving Contacts		Accomplished without difficulty.	Text Inputter

Table 7.3: Deciding the User Type (Example).

The process is illustrated through the following example. A user (P) had reported that she could do the following tasks – making calls, playing songs, finding the missed calls and saving contacts. As shown in Table 7.3, we requested her to do all the tasks in all the manners (column C) possible. The most complex manner in which a task was completed was Saving contact (there was only a single manner to do this task). This manner of doing the task mapped to Text Inputter (Column D), therefore the user was a Text Inputter.

Deciding the Stage of Usage

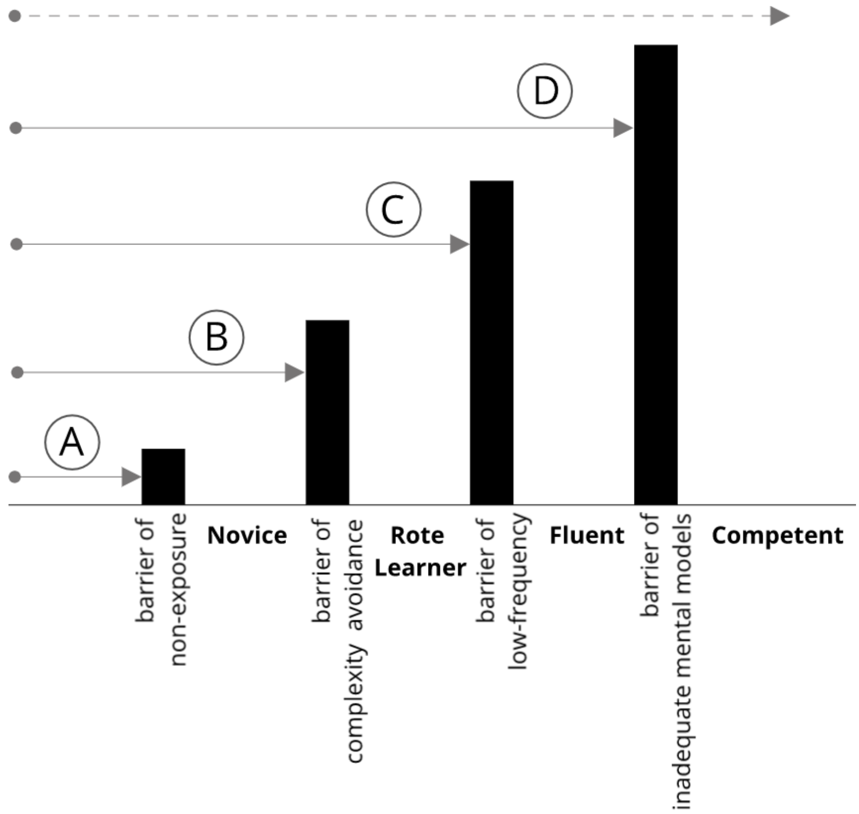


Figure 7.11: Tests for Detection of Various Barriers.

The Stage of Usage was decided by identifying the barriers (as shown in figure 7.11) while a user performed the tasks. It was done for the task(s) representing the User Type. If the user performed two or more tasks representing the given User Type, then the case of the one stopping at the highest barrier (or transcending all the barriers) was selected. We will illustrate that now through the example of the user (P), the same one used for exemplifying the identification of the User Type).

- **Detecting the barrier of non-exposure (test A in figure 7.11)**: If the task was reported as ”Not done/I cannot do.” by the user then certainly this barrier had not been crossed. In case the user reported that (s)he did the task, but was unable to initiate the task or experienced a breakdown while doing the task, it was also considered to be an indication of non-exposure.

- **Detecting the barrier of complexity avoidance (test B in figure 7.11)**: The presence of this barrier was tested by examining the speed, errors and interruptions in the task. A slow and error prone execution implied that the person had neither an appropriate mental model nor had (s)he had memorised the task. Such a person would not have crossed the barrier of task complexity, and thus would be a Novice.

- **Detecting the barrier of low frequency of usage (test C in figure 7.11)**: This was done by requesting to explain the task while executing the task. As this capability resulted from good mental models as well as high frequency of usage, a person not able to do so would have been neither a Fluent nor a Competent user, and therefore would not have crossed the barrier of task complexity.

- **Detecting the barrier of inadequate mental models (test D in figure 7.11)**: This was done by requesting the user to attempt the task on a device different than hers/his[2]. A user with out an adequate mental model would be clueless or would give up. On the other hand, a user with a mental model was likely to be able to either figure out to initiate the task by himself, or ask an appropriate question (for example, seeking a menu or equivalent on the foreign device). A user without an adequate mental model would not have crossed this barrier, and would not be a Competent user.

- **Absence of any barrier (dotted arrow in figure 7.11)**Any user who had crossed over all the four barriers would be a Competent user.

We continue with the example of the user (P) used for identifying the User Type. Only the task(s) associated with the User Type[3] were considered. The four barriers were ascertained

[2]We had observed that hardly any user could do the task on an alternative phone without some amount of effort.

[3]User Type itself represents the most complex task done by the user.

Barrier	Observation	Implication
Task: Searching contacts by typing		
Unexposure	Crossed: Done without breakdown.	Novice or better
Task Complexity	Crossed: Done smoothly without interruptions or errors.	Rote Learner or better
Frequency	Crossed: Could explain while doing.	Fluent or better
Mental models	Crossed: Contact list opened for her on an alternative phone. Could search a requested name through keypad.	**Competent**
Task: Saving Contact		
Unexposure	Crossed: Done without breakdown.	Novice or better
Task Complexity	Crossed: Done smoothly without interruptions or errors.	Rote Learner or better
Frequency	Crossed: Could explain while doing.	Fluent or better
Mental models	Crossed: Contact list opened for her on an alternative phone. Could not initiate a task and proceed. Did not ask any questions. Competent	**Fluent** (not Competent)

Table 7.4: Deciding the Stage of Usage.

for the task(s) associated with *Text Inputter*, her User Type. Saving contacts, using the dialpad and searching contacts by typing (see Table 7.3) were the two Text Input tasks that the user did. The observations for the two tasks are tabulated in Table 7.4. The Stage of Usage was decided as Competent for one task and Fluent for the other. Out of the two, the more advanced one, that is, *Competent* was chosen to be the final Stage of Usage.

7.3.5 Task Related (Supplementary) Variables

These measures are related to the individual tasks done by a user. These are not used as independent variables because, it is difficult to arrive at a representative or central values of these measures for a user as (s)he, depending upon her/his motivation and need, may perform different mix of multiple tasks of different types and complexity levels .

Frequency of Performing the Task

It was recorded by requesting the user (for example, see item 24.3.1.4 in Appendix A) to elicit retrospective account:

"When did you last do <the task> (How frequently do you do the <task>?)" It had five levels;

- 5-many times per day
- 4-few times per week
- 3-few times per month
- 2-fewtimes per year
- 1-sometimes in many years

Time Since Initiation of the Task

It was recorded by asking the user (for example, see item 24.3.1.5 in Appendix A.

"When was the first time you did <the task> using a mobile phone?"

Time Taken to Learn the Task

"How much time did it take you to learn to do <the task> over the Internet using a mobile phone?" It had five levels;

- 5-hours
- 4-days

- 3-weeks
- 2-months
- 1- more than few months

7.4 Method

The questionnaire, once finalised, was translated into various regional languages. Each version was back translated by a native speaker to make sure that the intent of the questions was maintained. Any discrepancy that was found was rectified.

The questionnaire was administered through an Android Tablet using an application called ODK (Anokwa et al. [2009]). The questionnaire was typed in Microsoft Excel in a manner prescribed for ODK. A utility on the application's website was used to convert it into an XML based format required by the application.

As Table B.2 shows, the interviews in Hindi were conducted by me. In some cases, I had the support of another person (a mediator). Interviews in Marathi and Telugu, languages not spoken by me, were delegated to other interviewers who spoke these languages. In most of the cases of the delegated sessions, I was present. However, in a few cases, the interviewers conducted the interviews completely on their own.

The mediator and the (delegatee) interviewers played important roles. Firstly, they had recruited the users. They belonged to the contexts of the users, so it was easier for them to do so. Secondly, they helped establish communication with the users. They explained the purpose of the interview in the language and manner appreciated by the users. Thirdly, they helped build trust, and resolve conflicts that sometimes arose because of the social distance between the interviewees and the interviewers, the intrusive nature of the questionnaire, and the fact that mobile phones are personal artefacts.

These delegatee interviewers were well-educated native speakers of the languages. They could also communicate well with me in Hindi or English. The ODK questionnaire was loaded onto their Android phones and its usage was taught. Mock interviews were conducted to acquaint these interviewers with the tool as well as the questionnaire.

At the time of briefing, the mediators and the delegatee interviewers were informed about the nature and the purpose of the study. They were explained that the interviews pertained to the usage of mobile phones in daily life of the potential interviewees. They were part of research to understand how mobile phones could be better designed to facilitate usage. They were not conducted to test the abilities of the potential interviewees to use digital technology. We also made it clear that no personal information like name, address, pictures or phone number would be collected as they were not needed for the objective. We ran through the questionnaire with every mediator/interviewer. For every question we had asked the mediator/interviewer to explain back the intent. This had helped because any times the mediators/interviewers interpreted the intent wrongly or could not understand the question. We re-explained the question in those cases. The mediators and the interviewers were also informed of the requirement that the potential interviewees needed to be from the rural or semi-urban areas.

Before the start of an interview, the users were explained about the integrity of their privacy, trust and safety by explaining that the interview did not involve commercial interest and was done under academic research. There was no direct benefit involved for them or anyone else. It intended to generate knowledge in general for the betterment of technology. We were not directly responsible for making better artefacts for the Emergent Users like them in the future. However, the knowledge generated from the research might be used by others to do so. They were emphatically informed that no private data including there names, phone numbers, address, photographs, voice-recordings or any other identity would be captured. As the captured data did not have any personal details, their privacy and safety was not affected.

The questionnaire starts with a briefing. We had made sure that we read it out loudly every time. The important aspects of the briefing (see item 8 in Appendix A) were as follows:

- The interview is centred around the usage of digital technology.

- The interviewer represents a Indian central government academic institution and not a commercial concern.
- This pertains to research work, whose results would be accessible to all and beneficial to the society in general.
- User's privacy will be strictly maintained. No personal data is needed.
- It is an examination of technology. The user would not be judged regarding her/his ability to use ICT artefacts.
- The user would not benefit directly.
- Questions regarding technology usage and demonstration of the related tasks would be required.

As we desired to actually observe the tasks (item 24 in Appendix A) done by the users, on mobile phones normally used by them, we ensured that the users carried their phones in working condition during interview. We also carried another phone, a Nokia C5.00 feature phone, which was used to assess the mental model of the users. This model was not found with any user. In cases, where a user was able to a large number of tasks, only some tasks under each User Type were requested for demonstration . This was done to reduce fatigue [4].

We ensured that we did not interrupt a user's routine in any manner. We also made it explicit to the users that we did not intend to interrupt them while they did their chores.

The questions were asked in the users' language. In case of the locations in Rajasthan and Madhya Pradesh, though the users often spoke in the local dialects, like Mewari or Malwi at home and with friends and colleagues, they were well versed in standard Hindi as it was used in formal situations and with the outsiders. Therefore, in these cases, the interviews were conducted in standard Hindi and not in the local dialects.

I, whenever, assisted another interviewer, in cases where I did not speak the language of the interviewee, always maintained a firm control over the nature of the information

[4]Depending on the tasks done, an interview ran upto one and a half hours.

collected. I made it sure that the intent and the purpose was read out and explained at the start of the interview. I would reconfirm the user's response with the mediator in order to be assured that the response was in accordance with the intent of the question. In case a response did not meet the intent, the mediator was asked to re-frame the question in different ways. I also monitored users expressions to examine if there was any ambiguity in understanding. In that case, the mediator was inquired about the reason and briefed to address the doubts.

The users were interviewed in their workplaces, homes or meeting places (for example, in a *chaupal*[5]). Many times homes and workplaces were the same as many users were involved in home based occupations.

It was never possible to interview a person in isolation. In the social settings, often the respondents worked (for example making *bidis*) and were surrounded by other people. However, we ensured that a user was not helped or supported by another during the interview. The problem of bias from a previous interviewee was negligible, as we had relied upon the actual usage behaviour and had asked questions related to the usage (such as frequency and time elapsed since initiation).

I, on account of belonging to a semi-urban location in India, was well conversed with the social conventions. Therefore, regardless of gender, I and the mediators were able to make respondents comfortable and communicate well. In an interview setting, this required to follow the rules pertaining to the sitting configuration, eye contact, tone and mood of the conversation and posture.

We faced difficulty in recruiting female users, who were many a times uncomfortable for an interview to the extent of refusal. This happened in spite of the fact that we always had a female mediator from the region of the interview. At other times, women were reserved, and we had to make sure that the responses were not affected. Our protocol and conduct of the interviews ensured that this did not affect the elicitation. Firstly, female mediators were used to recruit and interview women. Secondly, I allowed the mediator to conduct interview and acted in a secondary role. At the same time, I observed the social rules regarding eye contact, physical proximity and presence of the other members of the family.

[5]village meeting place

7.5 Results

The data from the 85 users was analysed from various perspectives. The immediate section provides descriptive statistics pertaining to the different variables. The next one uses Ordinal Logistic Regression (OLR) to find the relationships between the independent and the dependent variables. It also examines the significance of variables and goodness of fit. The next section examines in what manner the value a given variable distributes a population into various User Types and Stages. The last section employs OLR, using the most significant variables simultaneously, to examine various patterns of probabilities of belonging to different User Types and Stages of Usage. (The data was checked for sanity as reported in Appendix D)

7.5.1 Descriptive Statistics

Figures 7.12 through 7.16 show the means, standard deviations, confidence intervals for the variables with respect to the User Types, Stages of Usage and combinations thereof. The largest text in each cell shows the mean value. Just below the mean, within parentheses, is the standard deviation. Below it, in square brackets, is the 95% confidence interval. The figures between two adjacent cells are the p-values of difference of means (calculated considering different sample sizes and different variances).

General Trends

For all the user-related variables, the means increase with respect to the User Types (Age behaves in the opposite way, so they decrease for Age). The highest means are found for the Savers, the lowest for the Basic Users. For example, in Figure 7.12, the Savers had an average of 9.00 years of schooling while Basic Users, 4.16. The pattern for Stages of Usage are inconsistent.

Education Level (class completed)	Novice		Rote Learner		Fluent		Competent		Type (Overall)
Saver							9.00 (3.00) [3.12, 14.88]		**9.00 (3.00) [3.12, 14.88]**
							p=0.94		***p=0.98***
Text Inputter			9.00 (1.76) [5.55, 12.45]	*p=0.86*	8.80 (2.17) [4.55, 13.05]	*p=0.79*	9.11 (2.32) [4.56, 13.66]		**9.03 (2.08) [4.95, 13.11]**
			p=0.04		*p=0.01*				***p=0.00***
Navigator			5.00 (3.08) [-1.04, 11.04]	*p=0.89*	4.78 (3.79) [-2.65, 12.21]				**4.82 (3.62) [-2.28, 11.92]**
									p=0.55
Basic User	4.16 (3.67) [-3.03, 11.35]								**4.16 (3.67) [-3.03 - 11.35]**
Stage (Overall)	**4.16 (3.67) [-3.03, 11.35]**	***p=0.00***	**7.67 (2.92) [1.95, 13.39]**	***p=0.05***	**5.50 (3.85) [-2.05, 13.05]**	***p=0.00***	**9.09 (2.41) [4.37, 13.81]**		**6.55 (3.77) [-0.84, 13.94]**

Figure 7.12: Means, Standard Deviation and Confidence Intervals of Education levels, in years, across the User Usage Model.

Age (in years)	Novice		Rote Learner		Fluent		Competent		Type (Overall)
Saver							33.00 (6.96) [19.36, 46.64]		**33.00 (6.96) [19.36, 46.64]**
							p=0.46		***p=0.97***
Text Inputter			35.10 (4.95) [25.40, 44.80]	*p=0.28*	39.20 (6.94) [25.60, 52.80]	*p=0.05*	30.33 (4.33) [21.84, 38.82]		**33.12 (5.85) [21.65, 44.59]**
			p=0.20		*p=0.70*				***p=0.01***
Navigator			43.20 (11.34) [20.97, 65.43]	*p=0.36*	37.74 (8.86) [20.37, 55.11]				**38.71 (9.36) [20.36, 57.06]**
									p=0.04
Basic User	43.79 (7.00) [30.07, 57.51]								**43.79 (7.00) [30.07 - 57.51]**
Stage (Overall)	**43.79 (7.00) [30.07, 57.51]**	***p=0.03***	**37.80 (8.26) [21.61, 53.99]**	***p=0.94***	**38.00 (8.45) [21.44, 54.56]**	***p=0.00***	**30.91 (4.95) [21.21, 40.61]**		**37.34 (8.50) [20.68, 54.00]**

Figure 7.13: Means, Standard Deviation and Confidence Intervals of Age, in years, across the User Usage Model.

Gender (probability of being male)

	Novice		Rote Learner		Fluent		Competent		Type (Overall)
Saver							1.00 (0.00) [1.00, 1.00]		**1.00** **(0.00)** **[1.00, 1.00]**
							p=0.04		***p=0.00***
Text Inputter			0.70 (0.48) [-0.24, 1.64]	*p=0.33*	0.40 (0.55) [-0.68, 1.48]	*p=0.21*	0.78 (0.43) [-0.06, 1.62]		**0.70** **(0.47)** **[-0.22, 1.62]**
			p=0.74		*p=0.39*				***p=0.63***
Navigator			0.60 (0.55) [-0.48, 1.68]	*p=0.86*	0.65 (0.49) [-0.31, 1.61]				**0.64** **(0.49)** **[-0.32, 1.60]**
									p=0.15
Basic User	0.42 (0.51) [-0.58, 1.42]								**0.42** **(0.51)** **[-0.58, 1.42]**
Stage (Overall)	**1.42** **(0.51)** **[0.42, 2.42]**	***p=0.16***	**1.67** **(0.49)** **[0.71, 2.63]**	***p=0.71***	**1.61** **(0.50)** **[0.63, 2.59]**	***p=0.08***	**1.83** **(0.39)** **[1.07, 2.59]**		**1.64** **(0.48)** **[0.70, 2.58]**

Figure 7.14: Means, Standard Deviation and Confidence Intervals of the Probability of being a Male across the User Usage Model.

Proactiveness (number of persons assisted in learning)

	Novice		Rote Learner		Fluent		Competent		Type (Overall)
Saver							6.20 (4.49) [-2.60, 15.00]		**6.20** **(4.49)** **[-2.60, 15.00]**
							p=0.39		***p=0.19***
Text Inputter			2.30 (3.27) [-4.11, 8.71]	*p=0.05*	0.00 (0.00) [0.00, 0.00]	*p=0.02*	3.94 (6.41) [-8.62, 16.50]		**2.85** **(5.18)** **[-7.30, 13.00]**
			p=0.05		*p=0.05*				***p=0.01***
Navigator			0.00 (0.00) [0.00, 0.00]	*p=0.05*	0.22 (0.52) [-0.80, 1.24]				**0.18** **(0.48)** **[-0.76, 1.12]**
									p=0.32
Basic User	0.47 (1.17) [-1.82, 2.76]								**0.47** **(1.17)** **[-1.82 - 2.76]**
Stage (Overall)	**0.47** **(1.17)** **[-1.82, 2.76]**	***p=0.19***	**1.53** **(2.85)** **[-4.06, 7.12]**	***p=0.09***	**0.18** **(0.48)** **[-0.76, 1.12]**	***p=0.00***	**4.43** **(6.03)** **[-7.39, 16.25]**		**1.64** **(3.79)** **[-5.79, 9.07]**

Figure 7.15: Means, Standard Deviation and Confidence Intervals of Proactiveness, in terms of number of users assisted, across the User Usage Model.

Time	Novice		Rote Learner		Fluent		Competent		Type (Overall)
Saver							9.00 (4.00) [1.16, 16.84]		**9.00** **(4.00)** **[1.16, 16.84]**
							p=0.85		***p=0.79***
Text Inputter			7.30 (4.76) [-2.03, 16.63]	*p=0.26*	10.20 (4.21) [1.95, 18.45]	*p=0.47*	8.61 (3.38) [1.99, 15.23]		**8.45** **(3.95)** **[0.71, 16.19]**
			p=0.63		*p=0.15*				***p=0.07***
Navigator			6.20 (3.56) [-0.78, 13.18]	*p=0.81*	6.65 (4.11) [-1.41, 14.71]				**6.57** **(3.96)** **[-1.19, 14.33]**
									p=0.99
Basic User	6.58 (4.54) [-2.32, 15.48]								**6.58** **(4.54)** **[-2.32 - 15.48]**
Stage (Overall)	**6.58** **(4.54)** **[-2.32, 15.48]**	***p=0.82***	**6.93** **(4.30)** **[-1.50, 15.36]**	***p=0.80***	**7.29** **(4.28)** **[-1.10, 15.68]**	***p=0.20***	**8.70** **(3.43)** **[1.98, 15.42]**		**7.45** **(4.14)** **[-0.66, 15.56]**

Figure 7.16: Means, Standard Deviation and Confidence Intervals of Proactiveness, in terms of number of users assisted, across the User Usage Model.

Social Status (-1=low, 0=neutral, +1=high)	Novice		Rote Learner		Fluent		Competent		Type (Overall)
Saver							0.60 (0.89) [-1.14, 2.34]		**0.60** **(0.89)** **[-1.14, 2.34]**
							p=0.28		***p=0.56***
Text Inputter			0.70 (0.67) [-0.61, 2.01]	*p=0.83*	0.60 (0.89) [-1.14, 2.34]	*p=0.28*	0.06 (1.00) [-1.90, 2.02]		**0.33** **(0.92)** **[-1.47, 2.13]**
			p=0.22		*p=0.23*				***p=0.17***
Navigator			0.00 (1.00) [-1.96, 1.96]	*p=1.00*	0.00 (0.95) [-1.86, 1.86]				**0.00** **(0.94)** **[-1.84, 1.84]**
									p=0.71
Basic User	0.11 (0.99) [-1.83, 2.05]								**0.11** **(0.99)** **[-1.83 - 2.05]**
Stage (Overall)	**0.11** **(0.99)** **[-1.83, 2.05]**	***p=0.26***	**0.47** **(0.83)** **[-1.16, 2.10]**	***p=0.21***	**0.11** **(0.96)** **[-1.77, 1.99]**	***p=0.83***	**0.17** **(0.98)** **[-1.75, 2.09]**		**0.19** **(0.94)** **[-1.65, 2.03]**

Figure 7.17: Means, Standard Deviation and Confidence Intervals of Pride across the User Usage Model.

Anxiety (-1=high, 0=neutral, +1=low)	Novice		Rote Learner		Fluent		Competent		Type (Overall)
Saver							0.00 (1.00) [-1.96, 1.96]		**0.00 (1.00) [-1.96, 1.96]**
							p=0.22		***p=0.42***
Text Inputter			0.20 (0.92) [-1.60, 2.00]	*p=0.72*	0.00 (1.00) [-1.96, 1.96]	*p=0.22*	0.67 (0.69) [-0.68, 2.02]		**0.42 (0.83) [-1.21, 2.05]**
			p=0.70		*p=1.00*				***p=0.11***
Navigator			0.40 (0.89) [-1.34, 2.14]	*p=0.40*	0.00 (0.85) [-1.67, 1.67]				**0.07 (0.86) [-1.62, 1.76]**
									p=0.93
Basic User	0.05 (0.78) [-1.48, 1.58]								**0.05 (0.78) [-1.48 - 1.58]**
Stage (Overall)	**0.05 (0.78) [-1.48, 1.58]**	***p=0.45***	**0.27 (0.88) [-1.45, 1.99]**	***p=0.34***	**0.00 (0.86) [-1.69, 1.69]**	***p=0.03***	**0.52 (0.79) [-1.03, 2.07]**		**0.20 (0.84) [-1.45, 1.85]**

Figure 7.18: Means, Standard Deviation and Confidence Intervals of Anxiety across the User Usage Model.

Self-Efficacy (-1=low, 0=neutral, +1=high)	Novice		Rote Learner		Fluent		Competent		Type (Overall)
Saver							3.00 (0.71) [1.61, 4.39]		**3.00 (0.71) [1.61, 4.39]**
							p=0.89		***p=0.88***
Text Inputter			3.10 (1.20) [0.75, 5.45]	*p=0.75*	3.40 (1.82) [-0.17, 6.97]	*p=0.62*	2.94 (1.30) [0.39, 5.49]		**3.06 (1.32) [0.47, 5.65]**
			p=0.54		*p=0.73*				***p=0.71***
Navigator			3.60 (1.52) [0.62, 6.58]	*p=0.52*	3.09 (1.12) [0.89, 5.29]				**3.18 (1.19) [0.85, 5.51]**
									p=0.13
Basic User	2.53 (1.54) [-0.49, 5.55]								**2.53 (1.54) [-0.49 - 5.55]**
Stage (Overall)	**2.53 (1.54) [-0.49, 5.55]**	***p=0.14***	**3.27 (1.28) [0.76, 5.78]**	***p=0.75***	**3.14 (1.24) [0.71, 5.57]**	***p=0.60***	**2.96 (1.19) [0.63, 5.29]**		**2.98 (1.31) [0.41, 5.55]**

Figure 7.19: Means, Standard Deviation and Confidence Intervals of Self-Efficacy across the User Usage Model.

Socio-Economic Level (1-owest to 12-highest)

	Novice		Rote Learner		Fluent		Competent		Type (Overall)
Saver							7.80 (1.79) [4.29, 11.31]		**7.80 (1.79) [4.29, 11.31]**
							p=0.59		***p=0.68***
Text Inputter			7.20 (1.48) [4.30, 10.10]	*p=0.07*	8.40 (0.89) [6.66, 10.14]	*p=0.09*	7.28 (1.99) [3.38, 11.18]		**7.42 (1.73) [4.03, 10.81]**
			p=0.82		*p=0.05*				***p=0.65***
Navigator			7.40 (1.52) [4.42, 10.38]	*p=0.78*	7.17 (1.99) [3.27, 11.07]				**7.21 (1.89) [3.51, 10.91]**
									p=0.72
Basic User	7.00 (2.05) [2.98, 11.02]								**7.00 (2.05) [2.98 - 11.02]**
Stage (Overall)	**7.00 (2.05) [2.98, 11.02]**	***p=0.66***	**7.27 (1.44) [4.45, 10.09]**	***p=0.82***	**7.39 (1.89) [3.69, 11.09]**	***p=1.00***	**7.39 (1.92) [3.63, 11.15]**		**7.28 (1.84) [3.67, 10.89]**

Figure 7.20: Means, Standard Deviation and Confidence Intervals of Socio-Economic Group, in terms of levels (12 being highest), across the User Usage Model.

Distance from Pvt. Bank (in km)

	Novice		Rote Learner		Fluent		Competent		Type (Overall)
Saver							17.80 (20.30) [-21.99, 57.59]		**17.80 (20.30) [-21.99, 57.59]**
							p=0.58		***p=0.66***
Text Inputter			14.20 (18.20) [-21.47, 49.87]	*p=0.88*	16.00 (23.08) [-29.24, 61.24]	*p=0.73*	11.94 (16.56) [-20.52, 44.40]		**13.24 (17.54) [-21.14, 47.62]**
			p=0.83		*p=0.82*				***p=0.98***
Navigator			12.00 (17.87) [-23.03, 47.03]	*p=0.88*	13.35 (17.69) [-21.32, 48.02]				**13.11 (17.40) [-20.99, 47.21]**
									p=0.59
Basic User	10.53 (14.92) [-18.71, 39.77]								**10.53 (14.92) [-18.71 - 39.77]**
Stage (Overall)	**10.53 (14.92) [-18.71, 39.77]**	***p=0.61***	**13.47 (17.47) [-20.77, 47.71]**	***p=0.95***	**13.82 (18.30) [-22.05, 49.69]**	***p=0.90***	**13.22 (17.12) [-20.34, 46.78]**		**12.86 (16.87) [-20.21, 45.93]**

Figure 7.21: Means, Standard Deviation and Confidence Intervals of Distance of location from the nearest Private Sector Bank (in 1000 km) across the User Usage Model.

Settlement Size (in thousands)

	Novice		Rote Learner		Fluent		Competent		Type (Overall)
Saver							64.52 (123.82) [-178.16, 307.19]		**64.52 (123.82) [-178.16, 307.19]**
							p=0.57		***p=0.59***
Text Inputter			46.95 (91.93) [-133.23, 227.13]	*p=0.21*	7.52 (11.09) [-14.21, 29.25]	*p=0.24*	28610.22 (70217.82) 109016.71, 166237.15]		**30.97 (71.98) [-110.10, 172.04]**
			p=0.19		*p=0.05*				***p=0.73***
Navigator			5.95 (5.27) [-4.37, 16.27]	*p=0.04*	44.56 (84.67) [-121.40, 210.51]				**37.66 (77.93) [-115.07, 190.40]**
									p=0.64
Basic User	50.94 (104.55) [-153.99, 255.87]								**50.94 (104.55) [-153.99, 255.87]**
Stage (Overall)	**50.94 (104.55) [-153.99, 255.87]**	***p=0.57***	**33.28 (76.43) [-116.51, 183.08]**	***p=0.85***	**37.94 (77.90) [-114.74, 190.63]**	***p=0.95***	**36.42 (82.62) [-125.53, 198.36]**		**39.61 (84.23) [-125.47, 204.70]**

Figure 7.22: Means, Standard Deviation and Confidence Intervals of Population of the Census Unit (in 1000) a location belongs to across the User Usage Model.

Prevalence (in percent)

	Novice		Rote Learner		Fluent		Competent		Type (Overall)
Saver							39.72 (21.83) [-3.07, 82.51]		**39.72 (21.83) [-3.07, 82.51]**
							p=0.81		***p=0.72***
Text Inputter			36.21 (23.06) [-8.99, 81.41]	*p=0.71*	30.21 (30.06) [-28.71, 89.13]	*p=0.68*	36.74 (27.58) [-17.32, 90.80]		**35.59 (25.92) [-15.21, 86.39]**
			p=0.26		*p=0.68*				***p=0.84***
Navigator			22.49 (19.41) [-15.55, 60.53]	*p=0.23*	36.64 (31.77) [-25.63, 98.91]				**34.11 (30.14) [-24.96, 93.18]**
									p=0.86
Basic User	35.53 (25.19) [-13.84, 84.90]								**35.53 (25.19) [-13.84 - 84.90]**
Stage (Overall)	**35.53 (25.19) [-13.84, 84.90]**	***p=0.64***	**31.64 (22.23) [-11.93, 75.21]**	***p=0.64***	**35.49 (31.02) [-25.31, 96.29]**	***p=0.81***	**37.39 (26.00) [-13.57, 88.35]**		**35.33 (26.61) [-16.83, 87.49]**

Figure 7.23: Means, Standard Deviation and Confidence Intervals of Prevalence (as percentage) across the User Usage Model.

Utilty (-1=low, 0=neutral, +1=high)	Novice		Rote Learner		Fluent		Competent		Type (Overall)
Saver							1.00 (0.00) [1.00, 1.00]		**1.00 (0.00) [1.00, 1.00]**
							p=0.16		***p=0.08***
Text Inputter			0.90 (0.32) [0.27, 1.53]	*p=0.35*	1.00 (0.00) [1.00, 1.00]	*p=0.16*	0.89 (0.32) [0.26, 1.52]		**0.91 (0.29) [0.34, 1.48]**
			p=0.35		*p=1.00*				***p=0.08***
Navigator			1.00 (0.00) [1.00, 1.00]	*p=1.00*	1.00 (0.00) [1.00, 1.00]				**1.00 (0.00) [1.00, 1.00]**
									p=0.15
Basic User	0.89 (0.32) [0.26, 1.52]								**0.89 (0.32) [0.26 - 1.52]**
Stage (Overall)	**0.89 (0.32) [0.26, 1.52]**	***p=0.69***	**0.93 (0.26) [0.42, 1.44]**	***p=0.31***	**1.00 (0.00) [1.00, 1.00]**	***p=0.15***	**0.91 (0.29) [0.34, 1.48]**		**0.94 (0.24) [0.47, 1.41]**

Figure 7.24: Means, Standard Deviation and Confidence Intervals of Utility across the User Usage Model.

Statistical Separation between the Sub-populations

Between two adjacent cells, how well separated are the means? For example, in Figure 7.12, are the means for Text Inputter-Rote Learners (9.00) and for Text Inputter-Fluent users (8.80) statistically distinct from each other? The statistical separation between the two populations can be assessed by examining the p-values along with the confidence intervals. In order that the two representative means be significantly apart the p-values should be lower than or equal to 0.05 (for 95% confidence). In addition to that: One of the two normal distribution curves should not contain the other. The intersection of the normal distribution curves should lie between the two means.

From this perspective, Age (Figure 7.13) nicely separates two of the Stages–Fluent and Competent. The intersection point of the normal curves for the means of Fluent and Competent happens at 36.14 years of age. Not just globally, Age also separates these two Stages for the Text Inputters. The intersection point for the normal curves of means of Text Inputter-Fluent and Text Inputter-Competent users happens at 35.21 years.

Education (Figure 7.12) also separates the Fluent and the Competent users well. The intersection point of the normal curves for the means of Fluent and Competent is 6.64 years of Education. Age also segregates the Navigators and the Text Inputters. The intersection of the Navigators and the Text Inputters happens at 6.61 years. The segregation between these two User Types is good even when only Fluent or Competent Stages are considered. That intersection between Navigator-Fluent and Text-Inputter-Fluent happens at 6.34 years, and between Navigator-Competent and Text-Inputter-Competent at 6.86 years.

Proactiveness (Figure 7.15) segregates the the Navigators and the Text Inputters among User Types. It also separates the Fluent and the Competent among Stages of Usage. The intersection of the curves of means for the former is 1.24, while for the latter is 1.29.

Task Frequency, Time Since Initiation & Learning-time

Regarding the individual tasks, across the sample, a task belonging to a task-family representing the lower User Types is done more frequently (Figure 7.25) and takes lesser time to learn. On an average, Basic tasks (such as making calls) are performed many times a day. Saving a video or a song in a folder is done (by those who do) only few times a month. With in a task family, there is a difference in the frequencies. Using a camera is done much sparingly than finding a missed call.

Basic tasks (such as making calls) were reported to be the easiest to learn taking only hours, while using Bluetooth and saving a video or a song in a folder were the most difficult and had taken days to months to learn.

In case of the time elapsed since initiation of a task, in 2016-17 when these measures were recorded, users in the sample had started searching the Internet for around 1 year. On the other hand the first phone call was almost 9 years ago (this needs to be compared with 7.45 years, the average value of total time of mobile phone usage as depicted in Figure 7.16)

Task-Family	Task	Frequency Level: 5-many times per_day 4-few times per week 3-few times per month 2-fewtimes per year 1-sometimes in many years 0-Never		Time (years) since Initiation (as recorded in 2016-17)		Time (as levels) taken to learn: 5-hours 4-days 3-weeks 2-months 1- more than few months 0-never	
		for the Task	for the Task-Family	for the Task	for the Task-Family	for the Task	for the Task-Family
Basic Usage	Making Calls (simple pickup/sequential search)	4.9 (0.3)	**4.8 (0.6)**	7.5 (4.1)	**6.5 (4.2)**	4.7 (0.9)	**4.4 (1.2)**
	Playing song (directly from hardware button.short cut)	4.5 (0.9)		4.1 (3.1)		3.8 (1.6)	
	Finding a missed call (through on-screen notification)	4.8 (0.6)		4.5 (3.3)		4.4 (1.3)	
	Taking a photograph ((directly from hardware button.short cut))	3.6 (1.3)		3.7 (2.5)		4.5 (0.6)	
Navigational	Playing song through menu)	4.7 (0.8)	**4.2 (1.0)**	6.5 (4.1)	**5.5 (3.5)**	4.7 (0.6)	**4.1 (1.2)**
	Finding a missed call (through menu)	4.8 (0.4)		6.4 (4.0)		4.3 (1.0)	
	Taking a photograph (through menu)	3.1 (0.9)		4.0 (2.5)		4.1 (1.5)	
	Deleting SMS	4.1 (1.0)		5.7 (3.4)		4.1 (1.3)	
	Transferring a song using Bluetooth	4.3 (0.8)		3.9 (2.3)		3.7 (1.3)	
Text-Input	Making Calls (type numbers, search by typing)	5.0 (0.0)	**3.2 (1.1)**	8.7 (4.2)	**6.2 (3.8)**	5.0 (0.0)	**3.8 (1.3)**
	Saving contact	3.3 (0.9)		6.3 (4.1)		3.8 (1.3)	
	Sending SMS	2.5 (1.2)		5.5 (2.8)		3.9 (1.5)	
	Searching something over Internet	3.5 (1.0)		0.0 (0.0)		3.7 (1.2)	
Saver	Copying Video or Song	2.8 (1.3)	**2.8 (1.3)**	4.8 (1.8)	**4.8 (1.8)**	3.7 (1.2)	**3.7 (1.2)**

Figure 7.25: Frequency, Time Elapsed since Initiation and Time Taken to learn for Individual tasks. Compare with Table 7.2

7.5.2 Significance of the Variables and the Goodness of Fit

To examine the role of the independent variables in determining the User Types and Stages of Usage, we have used ordinal logistic regression (OLR)[6]. The results are recorded as Tables 7.5 and 7.6. The former is for User Types and the latter for Stages of Usage. In both the tables, columns A, B and C are the intercepts (constant terms) for the class boundaries (there are three in both the cases). The rest of the columns depict the other metrics including the coefficient values.

Tables 7.7 and 7.8 show additional metrics. These are the following:

* Standardised coeefiicients (column B), which have been calculated as suggested by Agresti [2013]. Standardising makes it easy to compare the coefficients with each other.

- McFadden's pseudo-R^2 (C), which is calculated for a measure of model fit. It compares the ratio between the likelihoods of a model fitted using a variable (full model) and one fitted without any (null model). If the full model does not explain the outcome well, its likelihood is supposed to be near to the null model. The score McFadden's pseudo-R^2 for is given by $1 - \frac{LogLik(Full)}{LogLik(Null)}$ where numerator and denominator are the log-likelihoods of the full model and the null model.

- Two commonly used goodness of fit statistics, Pearson and Deviance, are used. Both are based on the expected and the observed values and follow chi square distribution. These are given, respectively, by $2\sum_j O_j log\left(\frac{O_j}{E_j}\right)$ and $\sum_j \frac{(O_j - E_j)^2}{E_j}$, where E_j and O_j are the expected and observed values for the j_{th} record.

[6]OLR is used because both the dependent variables, the User Type and Stage of Usage are ordinal in nature. Consider the User Types first. A User Type at a 'higher' level is inclusive of the 'lower' ones. For example, a Navigator is able to do thw Basic tasks while a Saver is also able to do all the Basic, Navigational and Text Input tasks. In case of the Stages ogf usage, the reasoning is more straightforward– Stages of Usage are inherently in the order of increasing level of skill. For example a Competent user is placed at a higher level than a Novice user because he is, definitionally more adept than a Novice user. The theoretical basis of OLR is described in section C.1 in Appendix C We have used `VGAM` library in R, and `LOGISTIC` function in SAS for the purpose.

- Column D and E contain Pearson and Deviance scores, respectively.

- Columns F and G contain with their chi-square scores of significance for Pearson and Deviance statistics, respectively.

From Table 7.7 we observe that, for User Types, the most significant variables are Education Levels, Age, Proactiveness, Gender and Time. They take the top five positions in the table where the results are tabulated in the ascending order of absolute values of the Standardised Coefficients (column B). The McFadden's R^2 (C) values for these variables vary (though in descending order) in the same manner. Table 7.5, too, affirms the significance of these variables by showing low p-values for them. The chi-square scores (E, G) for the Pearson and Deviance statistics have values higher than 0.05 for these variables suggesting a good fit.

Variable	Intercepts			Coeff.			
	BAS | NAV	**NAV | TXT**	**TXT | SAV**	**Estimate**	**Std. Err.**	**z-value**	**Pr(>|z|)**
	(A)	**(B)**	**(C)**	**(D)**	**(E)**	**(F)**	**(G)**
Age	-5.86	-4.05	-1.21	0.12	0.03	4.28	0.00*
Gender	0.36	1.89	4.52	-1.02	0.43	-2.39	0.02*
Education Level	0.39	2.35	5.38	-0.32	0.06	-4.89	0.00*
Proactiveness	-1.04	0.53	3.66	-0.24	0.07	-3.24	0.00*
Self-Efficacy	-0.76	0.72	3.29	-0.17	0.15	-1.07	0.28
Anxiety'	-1.20	0.29	2.88	-0.32	0.24	-1.34	0.18
Social Status	-1.22	0.26	2.86	-0.30	0.21	-1.42	0.16
Utilty	-1.19	0.27	2.83	-0.06	0.84	-0.07	0.94
Socio-Economic Level	-0.45	1.02	3.60	-0.11	0.11	-1.02	0.31
Distance from Bank	-1.14	0.32	2.89	-0.01	0.01	-0.73	0.47
Prevalence	-1.19	0.27	2.83	0.00	0.01	-0.21	0.83
Time	-0.54	0.98	3.62	-0.10	0.05	-2.07	0.04*
Population	-1.29	0.17	2.73	0.00	0.00	0.47	0.64

*Table 7.5: Ordinal Logistic Regression (**Univariate**) for **User Types**. Every individual parameter is regressed separately. (* denotes significance at a level of 0.05.)*

Variable	Intercepts			Coeff.			
	BAS | NAV	**NAV | TXT**	**TXT | SAV**	**Estimate**	**Std. Err.**	**z-value**	**Pr(>|z|)**
	(A)	**(B)**	**(C)**	**(D)**	**(E)**	**(F)**	**(G)**
Age	-5.97	-4.98	-3.29	0.12	0.03	4.48	0.00*
Gender	0.36	1.24	2.70	-1.02	0.42	-2.44	0.01*
Education Level	-0.07	0.82	2.35	-0.20	0.06	-3.48	0.00*
Proactiveness	-0.98	-0.12	1.44	-0.30	0.10	-3.00	0.00*
Self-Efficacy	-0.87	-0.03	1.37	-0.12	0.15	-0.82	0.41
Anxiety	-1.20	-0.36	1.06	-0.35	0.24	-1.47	0.14
Social Status	-1.25	-0.41	0.98	0.04	0.21	0.19	0.85
Utilty	-0.85	0.00	1.39	-0.42	0.83	-0.51	0.61
Socio-Economic Level	-0.68	0.16	1.57	-0.08	0.11	-0.73	0.47
Distance from Bank	-1.18	-0.34	1.06	-0.01	0.01	-0.45	0.65
Prevalence	-1.15	-0.31	1.09	0.00	0.01	-0.37	0.71
Time	-0.68	0.18	1.61	-0.08	0.05	-1.68	0.09
Population	-1.29	-0.45	0.95	0.00	0.00	0.48	0.63

*Table 7.6: Ordinal Logistic Regression (**Univariate**) for **Stages of Usage**. Every individual parameter is regressed separately. (* denotes significance at a level of 0.05.)*

Field	**St. Coeff.**	**McFadden's**	**Pearson GOF**	**Pearson χ^2**	**Deviance GOF**	**Deviance χ^2**
(A)	**(B)**	**(C)**	**(D)**	**(E)**	**(F)**	**(G)**
Education Level	-1.20	0.14	30.72	0.53	41.73	0.12
Age	0.99	0.10	75.05	0.35	84.10	0.14
Proactiveness	-0.91	0.07	29.29	0.45	33.34	0.26
Gender	-0.49	0.03	2.79	0.25	1.92	0.38
Time	-0.43	0.02	41.86	0.69	38.41	0.81
Social Status	-0.29	0.01	3.27	0.66	3.03	0.69
Anxiety'	-0.27	0.01	5.92	0.31	6.25	0.28
Self-Efficacy	-0.22	0.01	13.87	0.24	12.14	0.35
Socio-Economic Level	-0.20	0.00	22.48	0.49	20.98	0.58
Distance from Bank	-0.15	0.00	41.22	0.46	36.27	0.68
Population	0.09	0.00	56.85	0.56	50.36	0.78
Prevalence	-0.04	0.00	155.11	0.83	174.61	0.45
Utilty	-0.01	0.00	5.14	0.08	3.40	0.18

Table 7.7: Various statistics for User Types calculated for each independent variable separately.

Field	**St. Coeff.**	**McFadden's**	**Pearson GOF**	**Pearson χ^2**	**Deviance GOF**	**Deviance χ^2**
(A)	**(B)**	**(C)**	**(D)**	**(E)**	**(F)**	**(G)**
Proactiveness	-1.14	0.06	27.74	0.53	38.21	0.12
Age	1.02	0.10	90.75	0.06	83.40	0.15
Education Level	-0.74	0.06	41.76	0.12	37.60	0.23
Gender	-0.49	0.03	1.65	0.44	1.65	0.44
Time	-0.34	0.01	38.26	0.81	32.33	0.95
Anxiety'	-0.29	0.01	7.31	1.46	7.34	1.47
Self-Efficacy	-0.16	0.00	14.69	0.20	14.74	0.19
Socio-Economic Level	-0.14	0.00	31.97	0.10	28.35	0.20
Utilty	-0.10	0.00	4.11	0.13	2.85	0.24
Population	0.09	0.00	69.68	0.16	60.58	0.42
Distance from Bank	-0.09	0.00	49.70	0.17	40.44	0.50
Prevalence	-0.07	0.00	164.94	0.66	171.59	0.52
Social Status	0.04	0.00	3.40	0.64	3.21	0.67

Table 7.8: Various statistics for Stages of Usage calculated for each independent variable separately.

The results in Table 7.8 for Stage of Usage, too, are tabulated in the ascending order of absolute Standardised Coefficients (column B). The top five positions, again, are taken by Education Levels, Age, Proactiveness, Gender and Time. The McFadden's R^2 values (C) also varies (in descending order) in the same manner as the Standardised Coefficients except for Age, where it is lower than for Proactiveness. The p-values (in Table 7.6) for these variables (except Time) are highly significant. The chi-square scores (E, G) for the goodness of fit statistics also have values higher than 0.05 showing good fit.

7.5.3 Predictive Power of the Significant Variables

We have also calculated how would the significant variables *individually* determine the distribution of a population across the User-Usage matrix (such as the one shown in Figure 7.27). (We are treating the variables individually for the ease of visualisation.) This is done by first determining the distribution of probabilities among various classes of User Type. Subsequently, the probabilities of different Stages of Usage *for each individual* User Type are calculated.

OLR is used for deciding the probability of a user of belonging to a given class *or below* based on the given value of the variables. As equation C.5 shows, OLR is used with multiple variables. However, as we are using single variable at a time, the same could be represented as:

$$\log \frac{P(Y \leqslant \mathbf{C}_k)}{P(Y > \mathbf{C}_k)} = \beta_0 + \beta x \tag{7.1}$$

where β_0 is the constant term (also known as the intercept), and β is the coefficient for the variable x. $P(Y \leqslant \mathbf{C}_k)$ is the probability of a user of belonging to class C_k and below, whereas $Y \leqslant \mathbf{C}_k$ that of belonging to a class above C_k.

The above equation leads to

$$P(Y \leqslant \mathbf{C}_k) = \frac{\exp(\beta_0 + \beta x)}{1 + \exp(\beta_0 + \beta x)} \tag{7.2}$$

Table 7.5, shows the coefficients and intercepts for OLR done *independently* for each variable for User Types. We can put them in Equation 7.2 to calculate probabilities, for a user, of belonging to different User Types.

For each regression, there are three probability functions corresponding to the three class boundaries (BAS|NAV, NAV|TXT, and TXT|SAV). Each of them defines how probabilities of belonging to a class *or below* varies with respect to a variable. The first function is of the probabilities of belonging to Basic Users. The second of Navigators and below (that is, Basic Users *as well as* Navigators). The third one is of Text-Inputters and below. The probability of a user being Saver and below (that is, either of the four classes) is 100%, and therefore, is not required to be calculated.

Let us take example of education level as variable. The probability function with respect to education level, of belonging to Basic Users, for User Types (see column A for the intercept for BAS|NOV, and column D for the coefficient for education in the Table 7.5) is given by:

$$P(Y \leqslant \mathbf{C}_{BAS}) = \frac{\exp((0.39) + (-0.32)EDU)}{1 + \exp((0.39) + (-0.32)EDU)} \tag{7.3}$$

The probability function of belonging to Navigators or below (see column B for the respective intercept) is given by:

$$P(Y \leqslant \mathbf{C}_{NAV}) = \frac{\exp((2.35) + (-0.32)EDU)}{1 + \exp((2.35) + (-0.32)EDU)} \tag{7.4}$$

The probability function of belonging to Text-Inputters or below (see column C) is given by:

$$P(Y \leqslant \mathbf{C}_{TXT}) = \frac{\exp((5.38) + (-0.32)EDU)}{1 + \exp((5.38) + (-0.32)EDU)} \tag{7.5}$$

The probability functions for the three classes for User Types (depicted above) are shown graphically in Figure 7.26. As the functions calculate probability of a user of belonging to a class *and below*, they are cumulative over classes. Absolute probability can thus be calculated by subtracting the probability of the lower class from cumulative probability as shown in example for an 8th class educated user in Table 7.9.

Once the probabilities for the User Types have been calculated, those for Stages of Usage are calculated separately for every User Type . In other words, the probabilities of Stages of Usage are determined for users belonging to each User Type individually, and not

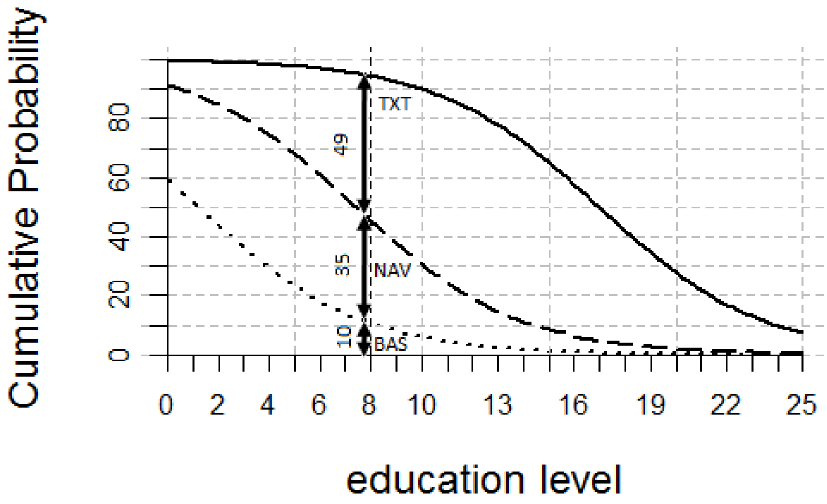


Figure 7.26: Probabilities (in percent) of being Basic Users (dotted), Navigators (dashes) and Text-inputters (solid) plotted against education levels. Probabilities for the three classes are shown for class 8th.

	Probabilities in percentage	
	Cumulative	**Individual**
SAV	100	10
TXT	94	35
NAV	45	49
BAS	10	6

Table 7.9: Cumulative and individual probabilities for various classes of User Types for 8 years of education. Compare with figure 7.26

globally. This is done by sub-setting the data according to the User Types, and then using each subset separately for doing regression against the different Stages of Usage[7]. As a result, the probability-distributions across the User Usage model can be observed as a User-Usage matrix (for example, see figure 7.27).

Table 7.10 shows, for education levels, the coefficients and intercepts of Stages of Usage with respect to *individual User Types*. These values can be put in Equation 7.2 for calculating the probabilities. For (8th class educated) Navigators, the probabilities for being a Rote Learner is 19% (RTL) and for being Fluent is 81%(FLT) adding up to 100%. However, as has been shown in Table 7.9, the overall probability of being a Navigator is itself 35%. Therefore, the probabilities of being a Rote Learner and being a Fluent have to be scaled down from 100% to 35%. This results in values of 07%(RTL) and 28%(FLT) respectively which total up to 35%. The complete User-Usage probability-matrix for an 8th class educated person is shown as Table 7.12.

User Type	**Intercepts**			**Coeff.**
	NOV | RTL	**RTL | FLT**	**FLT | COM**	**Estimate**
SAV	N/A: Only single Stage for this User Type			
TXT	N/A	-0.56	0.09	-0.03
NAV	N/A	N/A	-1.61	0.02
BAS	N/A: Only single Stage for this User Type			

Table 7.10: Ordinal Logistic Regression for Stages of Usage with respect to individual User Types (for education level). Not applicable for Basic Users and Savers (as they contain single Stage).

The probabilities calculated thus, in the form of User-Usage probability-matrices are shown for all the significant variables treated independently in Figures 7.27, 7.28, 7.30, 7.29 and 7.31[8]. There are five sets of such matrices, one each for Age, Education level, Gender, Proactiveness and total Time of using mobile phones. Each of these sets would have individual matrices that depict, for a given *range* of an independent variable, a distribution of 100 users from population represented by the sample. Each of them also shows, in brackets, the probability-distribution within a range. For example, Figures 7.27,

[7]As Basic Users and Savers both have only one stage (see Table 7.13), this is required for only Navigators and Text-Inputters. Also, there are two classes for Navigators and three for Text-Inputters

[8]These matrices should be compared with the overall distribution for the sample depicted in Table 7.13.

	NOV	**RTL**	**FLT**	**COM**	**Total**
SAV	N/A	N/A	N/A	100	100
TXT	N/A	31	15	54	100
NAV	N/A	19	40	N/A	100
BAS	100	N/A	N/A	N/A	100

Table 7.11: Probabilities (in percent) for various Stages of Usage with respect to individual User Types, with every User Type independent of each other, calculated for 8 years of education.

	NOV	**RTL**	**FLT**	**COM**	**Total Probability for User Type**
SAV	0	0	0	10	10
TXT	0	11	5	19	35
NAV	0	9	28	0	49
BAS	6	0	0	0	6

Table 7.12: Probabilities (in percent) for various Stages of Usage ***redistributed*** *according to probabilities for individual User Types (see right column of Table 7.9 for exact probabilities), calculated for 8 years of education.*

depicts the five matrices distributed across 0 years of education (illiterate), 1-5 years (primary school), 6-8 (middle school), 9-10 (secondary) and 11-12 (higher secondary). The matrix for the primary school group users shows the proportion of the users, for all the users in the five categories, for various User Types and Stages of Usage (and also their combination). The numbers in brackets show percent distribution only for the given category, that is, primary school group.

	NOV	**RTL**	**FLT**	**COM**	**Type**
SAV				05 (06%)	**05 (06%)**
TXT		10 (12%)	05 (06%)	18 (21%)	**33 (39%)**
NAV		05 (06%)	23 (27%)		**28 (33%)**
BAS	19 (22%)				**19 (22%)**
Stage	**19 (22%)**	**15 (18%)**	**28 (33%)**	**23 (27%)**	**85 (100%)**

Table 7.13: Total Number of Users (proportions in percentage in brackets) in the Sample belonging to different User Types and Stages.

It is important to use the notion of *advantage* in order to read the probabilities in the tables. An advantage would occur whenever the probability of adopting an ICT artefact improves due to a change in the value of a variable. As would be evident from discussion in chapter 5, advantage decreases with Age and increases with Education, Praoctiveness and total Time of usage. Also, with respect to Gender, being a male is advantageous. We would also use a related notion— *disadvantage-offset*. It means that disadvantage happening due to one variable could be offset by advantage due to another. For example, the disadvantage of Gender could be offset by a high level of Proactiveness.

Within the probability-matrices, the most advantaged group with respect to Education levels (Figure 7.27) are of the users who are educated between class 11th to 12th. With respect to Age (Figure 7.28), the most advantaged users are aged between 25-34 years. From the perspective of Gender (Figure 7.29), males are more advantaged than females. Similarly, from that of Proactiveness (Figure 7.30), the users who have assisted more than 10 people in learning mobile phones are more advantaged, and from that of usage Time (Figure 7.31) they would have been using mobile phones for more than 10 years. In contrast, the least advantaged groups with respect to Age comprise of users aged between

EDU=0					
	NOV	**RTL**	**FLT**	**COM**	**Total**
SAV				00 (00)	**00 (00)**
TXT		00 (03)	00 (01)	01 (04)	**01 (08)**
NAV		01 (05)	04 (27)		**05 (32)**
BAS	08 (60)				**08 (60)**
Total	**08 (60)**	**01 (08)**	**04 (28)**	**01 (04)**	***14 (100)***
EDU=1 TO 5					
	NOV	**RTL**	**FLT**	**COM**	**Total**
SAV				00 (01)	**00 (01)**
TXT		01 (07)	01 (03)	02 (10)	**04 (20)**
NAV		01 (07)	06 (35)		**07 (42)**
BAS	07 (37)				**07 (37)**
Total	**07 (37)**	**02 (14)**	**07 (38)**	**02 (11)**	***18 (100)***
EDU=6 TO 8					
	NOV	**RTL**	**FLT**	**COM**	**Total**
SAV				01 (04)	**01 (04)**
TXT		05 (13)	02 (07)	07 (23)	**14 (43)**
NAV		02 (07)	11 (32)		**13 (39)**
BAS	05 (14)				**05 (14)**
Total	**05 (14)**	**07 (20)**	**13 (39)**	**08 (27)**	***33 (100)***
EDU=9 TO 10					
	NOV	**RTL**	**FLT**	**COM**	**Total**
SAV				02 (09)	**02 (09)**
TXT		04 (17)	02 (09)	08 (31)	**14 (57)**
NAV		01 (05)	05 (22)		**06 (27)**
BAS	02 (07)				**02 (07)**
Total	**02 (07)**	**05 (22)**	**07 (31)**	**10 (40)**	***24 (100)***
EDU=11 TO 12					
	NOV	**RTL**	**FLT**	**COM**	**Total**
SAV				02 (15)	**02 (15)**
TXT		02 (18)	01 (09)	04 (36)	**07 (63)**
NAV		00 (04)	02 (14)		**02 (18)**
BAS	00 (04)				**00 (04)**
Total	**00 (04)**	**02 (22)**	**03 (23)**	**06 (51)**	***11 (100)***
				TOTAL	***100***

Figure 7.27: Probabilities (in percent) for Education levels, subdivided into ranges*, across the User Usage Model. The main numbers denote the proportion with respect to the total sample, the numbers in brackets denote the proportion with respect to the range.*

AGE=25-34					
	NOV	RTL	FLT	COM	Total
SAV				04 (10)	**04 (10)**
TXT		04 (10)	03 (07)	14 (37)	**21 (54)**
NAV		01 (03)	09 (25)		**10 (27)**
BAS	03 (08)				**03 (08)**
Total	**03 (08)**	**05 (13)**	**12 (32)**	**18 (47)**	***38 (100)***
AGE=35-44					
	NOV	RTL	FLT	COM	Total
SAV				01 (03)	**01 (03)**
TXT		05 (15)	02 (06)	05 (13)	**12 (34)**
NAV		03 (07)	12 (33)		**15 (40)**
BAS	08 (23)				**08 (23)**
Total	**08 (23)**	**08 (22)**	**14 (39)**	**06 (16)**	***36 (100)***
AGE=44-55					
	NOV	RTL	FLT	COM	Total
SAV				00 (01)	**00 (01)**
TXT		03 (11)	00 (02)	00 (01)	**03 (14)**
NAV		03 (10)	07 (26)		**10 (36)**
BAS	13 (49)				**13 (49)**
Total	**13 (49)**	**06 (21)**	**07 (27)**	**00 (03)**	***26 (100)***
				TOTAL	***100***

Figure 7.28: Probabilities (in percent) for Age (in years), subdivided into ranges, *across the User Usage Model. The main numbers denote the proportion with respect to the total sample, the numbers in brackets denote the proportion with respect to the range.*

GEN=Female					
	NOV	RTL	FLT	COM	Total
SAV				02 (03)	**02 (03)**
TXT		06 (10)	03 (04)	08 (12)	**17 (26)**
NAV		05 (07)	18 (30)		**23 (37)**
BAS	22 (34)				**22 (34)**
Total	**22 (34)**	**11 (17)**	**21 (34)**	**10 (15)**	***64 (100)***
GEN=Male					
	NOV	RTL	FLT	COM	Total
SAV				03 (08)	**03 (08)**
TXT		04 (12)	02 (07)	10 (27)	**16 (46)**
NAV		02 (05)	09 (25)		**11 (30)**
BAS	06 (16)				**06 (16)**
Total	**06 (16)**	**06 (17)**	**11 (32)**	**13 (35)**	***36 (100)***
				TOTAL	***100***

Figure 7.29: Probabilities (in percent) for the two Genders across the User Usage Model. The main numbers denote the proportion with respect to the total sample, the numbers in brackets denote the proportion with respect to the range.

PRO=0 TO 5					
	NOV	**RTL**	**FLT**	**COM**	**Total**
SAV				04 (05)	**04 (05)**
TXT		12 (14)	07 (07)	24 (26)	**43 (47)**
NAV		01 (01)	28 (30)		**29 (31)**
BAS	16 (17)				**16 (17)**
Total	**16 (17)**	**13 (15)**	**35 (37)**	**28 (31)**	***92 (100)***
PRO=6 TO 10					
	NOV	**RTL**	**FLT**	**COM**	**Total**
SAV				01 (16)	**01 (16)**
TXT		01 (13)	00 (08)	02 (43)	**03 (64)**
NAV		00 (00)	01 (15)		**01 (15)**
BAS	00 (05)				**00 (05)**
Total	**00 (05)**	**01 (13)**	**01 (23)**	**03 (59)**	***05 (100)***
PRO>10					
	NOV	**RTL**	**FLT**	**COM**	**Total**
SAV				02 (63)	**02 (63)**
TXT		00 (04)	00 (02)	01 (27)	**01 (33)**
NAV		00 (00)	00 (03)		**00 (03)**
BAS	00 (01)				**00 (01)**
Total	**00 (01)**	**00 (04)**	**00 (05)**	**03 (90)**	***03 (100)***
				TOTAL	***100***

Figure 7.30: Probabilities (in percent) for levels of Proactiveness, subdivided into ranges*, across the User Usage Model. The main numbers denote the proportion with respect to the total sample, the numbers in brackets denote the proportion with respect to the range.*

TIM=0 TO 2					
	NOV	**RTL**	**FLT**	**COM**	**Total**
SAV				00 (03)	**00 (03)**
TXT		01 (11)	01 (04)	02 (12)	**04 (27)**
NAV		01 (07)	04 (29)		**05 (36)**
BAS	05 (34)				**05 (34)**
Total	**05 (34)**	**02 (18)**	**05 (33)**	**02 (15)**	***14 (100)***
TIM=3 TO 5					
	NOV	**RTL**	**FLT**	**COM**	**Total**
SAV				01 (04)	**01 (04)**
TXT		02 (11)	01 (05)	03 (16)	**06 (32)**
NAV		01 (07)	06 (29)		**07 (36)**
BAS	06 (28)				**06 (28)**
Total	**06 (28)**	**03 (18)**	**07 (34)**	**04 (20)**	***20 (100)***
TIM=6 TO 10					
	NOV	**RTL**	**FLT**	**COM**	**Total**
SAV				03 (06)	**03 (06)**
TXT		06 (12)	03 (06)	10 (22)	**19 (40)**
NAV		03 (06)	14 (28)		**17 (34)**
BAS	09 (20)				**09 (20)**
Total	**09 (20)**	**09 (18)**	**17 (34)**	**13 (28)**	***48 (100)***
TIM>10					
	NOV	**RTL**	**FLT**	**COM**	**Total**
SAV				02 (10)	**02 (10)**
TXT		02 (12)	01 (07)	06 (32)	**09 (51)**
NAV		01 (04)	04 (23)		**05 (27)**
BAS	02 (12)				**02 (12)**
Total	**02 (12)**	**03 (16)**	**05 (30)**	**08 (42)**	***18 (100)***
				TOTAL	***100***

Figure 7.31: Probabilities (in percent) for Total Usage Time (in years), subdivided into ranges, *across the User Usage Model. The main numbers denote the proportion with respect to the total sample, the numbers in brackets denote the proportion with respect to the range.*

45-55, with respect to Education levels, the illiterate ones (0 education), and Females according to Gender. With respect to Proactiveness they would have taught between 0 to 5 users and according to Time, they would have been using mobile phones between 0 to 2 years.

In each of the probability-matrices, the probability of being a Basic User decreases with an increase in advantage, while that of being a Text Inputter increases. In other words, the most advantaged users are very less likely to be Basic Users and highly likely to be Text Inputters. In contrast, the least advantaged users are highly likely to be Basic Users and very less likely to be Text Inputters. There are hardly any Savers in the sample, therefore regardless of advantage, across all the probability-matrices, very few users are likely to be Savers. If one refers to Figure 7.28, among the users belonging to the range between 11 to 12 years of education, the most advantaged group, only 4% are Basic Users (BAS), but a large proportion, that is 63%, are Text-Inputters. The opposite is the case of the least advantaged group, which is made up of illiterate users. 60% of the users within this group are Basic Users, while merely 08% make up Text-Inputters.

The same pattern is evident across the Stages as well. The probability of being Competent increases and being Novice decreases as advantage increases. Therefore, the most advantaged users are highly likely to be Competent and very less likely to be Novice. On the other hand, the least advantaged users are highly likely to be Novice and very less likely to be Competent.

Among various Stages of Usage for the individual User-Types (*the intra-Type Stages*), there are evident patterns regarding distribution of users . Every User-Type has different number of Stages of Usage under it. For Basic Users and Savers there is one each, and therefore does not need discussion. Navigators has two (Rote Learner and Fluent) Stages of Usage, while Text-Inputters three (Rote Learner, Fluent and Competent). For Navigators, across all the probability-matrices, the probability of being in Fluent stage is more than that of being in Rote Learner. For example, in Figure 7.27, in the probability-matrix for users educated between 11th to 12th class, the probability of being a Navigator-Rote Learner (NAV-RTL) is 04% (shown in brackets, it is for the group only, not for the total), while of being a Navigator-Fluent (NAV-FLT) is 14%. Across all the probability-matrices, the probability of being in Text Inputter-Fluent (TXT-FLT) stage becomes lesser than that for Text Inputter-Rote Learner (TXT-RTL). It increases again for Text Inputter-Competent (TXT-COM) to become the highest among the three Stages of Text Inputters. For the same group as discussed above, the probability of being Text Inputter-Rote Learner (TXT-RTL) is 18%. It drops to 09% for Text-Inputter-Fluent (TXT-FLT). It rises again and becomes 34% for Text Inputter-Competent (TXT-COM) , which is maximum of the three.

	Intercepts/Coeff.	**St. Coeff. (desc. by abs. value)**
User Type		
BAS | NAV	-1.97	(Intercept)
NAV | TXT	-0.68	(Intercept)
TXT | SAV	4.56	(Intercept)
Age	0.13	1.13
Education	-0.27	-1.04
Gender	-1.38	-0.67
Time	-0.13	-0.56
Proactiveness	-0.09	-0.34
Stage of Usage		
NOV | RTL	-3.13	(Intercept)
RTL | FLT	-1.99	(Intercept)
FLT | COM	0.09	(Intercept)
Age	0.14	1.21
Gender	-1.34	-0.65
Time	-0.12	-0.49
Education	-0.11	-0.43
Proactiveness	-0.11	-0.41

Table 7.14: Coefficients, Intercepts and Standardised Coefficients when the most significant variables are regressed together on User Type and Stage of Usage

7.5.4 Significant Variables versus User Types/Stages of Usage: Pentadimensional Plots

After examining how the variables individually decide a user's Type and Stage, we examine how the five most significant variables *together* decide a user's probability of a user of belonging to various User Types and Stages of Usage. To know that, we have regressed, employing OLR, the User Types and the Stages of Usage on these variables *simultaneously*. The coefficients & the intercepts, and the resulting standardised coefficients for the OLR are shown in 7.14. These coefficients and intercepts are used to calculate the probabilities to various classes of User Types and Stages of Usage with respect to various combinations of the five variables. The equation used is similar to Equation 7.2, but uses multiple variables:

$$P(Y \leqslant \mathbf{C}_k) = \frac{\exp(\beta_0 + \beta_{edu} + \beta_{age} + \beta_{gen} + \beta_{pro} + \beta_{tim})}{1 + \exp(\beta_0 + \beta_{edu} + \beta_{age} + \beta_{gen} + \beta_{pro} + \beta_{tim})} \tag{7.6}$$

where β_0 is the constant term (also known as the intercept), and β_{edu}, β_{age}, β_{gen}, β_{pro} and β_{tim} are the coefficient for the Education, Age, Gender, Proactiveness and Time respectively . $P(Y \leqslant \mathbf{C}_k)$ is the probability of a user of belonging to class C_k and below, whereas $Y \leqslant \mathbf{C}_k$ that of belonging to a class above C_k.

The probabilities are provided as a sequence of visualisations (as heat maps, in Appendix F—use book view/two-page view if reading on a computer) from Figure F.2 through Figure F.17. (The arrangement of the visualisations has been explained in Figure F.1 in Appendix F). Between page 362 and 377 (in Appendix F) , there are eight pairs of even and odd pages. The first four pairs are for User Types, the last four for Stages of Usage. Each pair, spread across odd and even page, contains eight panels (2 types of Gender x 2 levels of Proactiveness x 2 values of Time). They have been marked from A to H for easy reference. Each individual panel is a 13 x 64 matrix of probabilities for the 13 levels of education (0-12) and 7 equidistant instances of age (25-55). The five-level heat maps overlayed on each panel depict the highest probabilities with black, and the lowest ones with white.

The panels are further supplemented by class boundary curves through Figures F.18 and F.20 (in Appendix F). These are calculated by finding the loci of the points where probabilities become equal for adjacent two classes. For the sake of comparison, the three boundaries are depicted using three different line types. The eight panel configuration (per pair of pages) of the heatmaps is followed in this case too.

For Basic Users (pages 362 & 363), the regions near the bottom-right corners of the heatmaps are dark in colour. For the next three User Types (Navigators, Text-Inputters and Savers, from page 364 to 369), the regions near the same corners are consistently white. It means that people who are *older and less educated <u>at the same time</u> are highly likely to be Basic Users* and highly unlikely to be anything else. In other words, when the combined advantage of Age and Education are low, then a user is likely to be a Basic User. This supports the conclusion drawn in section 7.5.3.

For Text-Inputters (pages 366 & 367), the case is opposite. Here, the regions near top-left corners are dark in colour. The same areas are largely white for the other User Types. This indicates that the *users who are advantaged <u>in terms of both</u> Age and Education are most likely to be Text-Inputters.* There are extremely less number of Savers as seen by mostly white panels. (pages 366 & 367).

The above discussion is supported by the boundary curves for the User Types (pages 380 & 381). The Basic Users lie towards the lower-right corner, while Text-Inputters towards the upper-left. The Savers are largely absent except amongst the users who are highly advantaged (see panels F on the right page in every set) in terms of gender (Male), Proactiveness (10) and Usage Time (10 years). Even there, they occupy a very tiny portion of the sample.

What happens when the total advantage is moderate? What if high Age offsets high Education, or vice-versa? In those cases, the user is likely to be a Navigator. The diagonal distribution of Navigator stretching across from the low age-low education to the high age-high education corners suggests the presence of offset of disadvantage of Age by the advantage of Education, and vice-versa.

The case of Navigators (pages 364 & 365) is interesting. The diagonal bands representing Navigators are dominated by grey colour. The probability of Navigators, as depicted by the panels, hover between a moderate range of 20% to 60%. The remainder could be found distributed amongst the Text Inputters or Basic Users. For example, in panel A for Navigators, the probability of a 40 years old 5th class educated user is 51%. The probability for the same user in panel A for Basic Users is 39% and that for Text Inputters is 10% (adding to 49%). We see that probability of a user of belonging to Basic Users (39%) is four times *more* than that of Text Inputters (10%). This proportion is reversed when a user becomes better advantaged. For a 30 years old 7th class educated user, being a Navigator is 49% (panel A). Now, the larger portion of the remainder (51%) belongs to Text-Inputters (41%), while the smaller to Basic Users (10%).

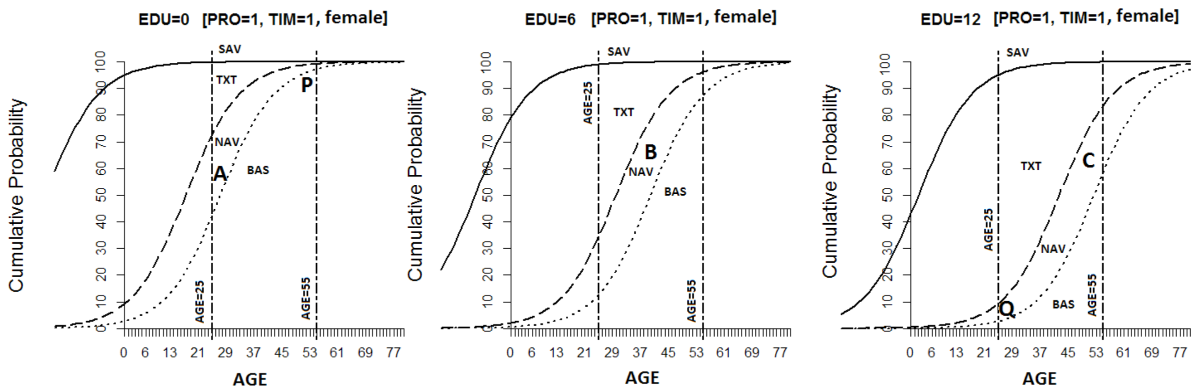


Figure 7.32: OLR plots for Age with respect to three Education regressed on User Type. Compare with panel C on pages 362, 364, 366, and 368. Note that each curve depicts a Cumulative Probabilities, while the heatmaps depict Absolute Probabilities.

The above discussion regarding Navigators could be understood more clearly with the help of actual plots of OLR (Figure 7.32). At 'A' in the leftmost plot, see the height (or thickness) of the Navigators. It shows a probability (48 %) of being a Navigator at EDU=0, AGE=25. Now, see B in the middle plot. At AGE=40, EDU=6 the probability becomes 42%. In the third panel at 'C', at AGE=55, EDU=12, the probability of being a Navigator is 35%. The three 'heights' are neither too small, nor too large—they are moderate. (These three values for probability of being a Navigator could be also be read off from panel 'C' on 364.) Now, in the above figure, see 'P' in the left most plot . At AGE=55, EDU=0, the total advantage is low. The height of Navigator shrinks to 2%, but that of Basic User is a large 98% (again, compare with panel 'C' on 362). Subsequently, see 'Q' in the rightmost plot. At AGE=25, EDU-12, the total advantage is high. Here, the height of Navigator is 26 %. However, the proportion of Text Inputter is very large (66

%) (compare with panel ‘C’ on 366). The discussion shows that, for moderate advantage, the probability of Navigator remains moderate (between 30% to 60%). With high or low advantage it goes lower than 30 %. It never goes higher than 60 %. This is the reason for the grey color diagonal and medial band in the heatmaps for Navigators. The diagonality signifies the mutual disadvantage-offset between Age and Education. The mediality signifies that the total advantage remains moderate. The grey color signifies that the probability of belonging to Navigators is also moderate.

The role of Gender, Proactiveness and Time, which has been discussed in section 7.5.3 as well, is also discernible from the panels and class boundaries. The support for their high significance (as depicted in section 7.5.2) should be evidenced in the shifts that happen across the panels. If one compares, for a given User Type, the panels vertically, one finds that a change in Proactiveness, from lower to higher, shifts the probability-distribution patterns (also compare with boundary curves on pages 378 & pages 381). By ‘shifting of the patterns’, we mean an increase or decrease in areas of the dark and light colours. A larger proportion of the dark (that is, high probability) areas would mean a larger number of users belonging to a given panel. In similar manner, the role of Gender is evident when ‘Male’ and ‘Female’ panels are compared. In the same manner, the role of Time could be ascertained by comparing the corresponding panels between the even and the odd pages (for example, A $\longrightarrow$ E[9]).

The advantages could be inferred by comparing different panels (and the boundary curves on pages 378 & 381) for a given User Type (or Stage of Usage). In all the heat maps, when the left and the right panels, corresponding to Female and Male, are compared, one discerns a significant advantage for males. As one moves rightwards from Female to Males (for instance, C $\longrightarrow$ D), the white (low-probability) regions expand for Basic Users, while dark (high-probability) ones expand for Text-Inputters. This means that males are less likely to be Basic Users and more to be Text-Inputters for the same Age, Education and Proactiveness levels.

In a similar manner, the advantage of Proactiveness can be assessed by comparing bottom panel with the corresponding top panels (for example, C $\longrightarrow$ A). It suggests that the users

[9] This notation means: Compare the shift in the probability pattern by moving the gaze from A to E. (We would use this notation through out the Chapter)

with more Proactiveness decrease their chance of being Basic Users and increase that of being a Text-Inputter. Likewise, the effect of Time can be judged by comparing a panel on even page with a corresponding one on the odd page (for example, C $\longrightarrow$ G).

The *disadvantage-offset* can be assessed in the following manner. Take the case of Basic Users (Figure F.2 and F.3). The disadvantage-offset offered by Time and Proactiveness against Age, Education and Gender is discernible. A female who has expended more Time in using mobile phones gets an advantage comparable to a male with less experience. To understand that, we need to compare C $\longrightarrow$ D & C $\longrightarrow$ G. We find that the shifts in the pattern, signifying lesser number of Basic Users, are similar in the two cases—when we do C $\longrightarrow$ D, and when we do C $\longrightarrow$ G. That means, the advantage gained by expending more time is the same as that if the person were, hypothetically, a male. Similarly, by doing C $\longrightarrow$ D & C $\longrightarrow$ A, we can assess how a female can offset the disadvantage of gender through higher level of Proactiveness.

To appreciate the disadvantage-offset for Age and Education we would have to compare a particular cell across the panels. For example, among Basic Users (page 362), the cell for 40 years old-class 6th educated user in panel C shows a probability of 52%. Going C $\longrightarrow$ A, we find that, as Proactiveness increases, it reduces to 32% in the equivalent cell in panel A, signifying lesser probability of being a Basic User (and higher of being in the higher User Types). It means that a higher level of Proactiveness has offset the disadvantage of both Age and Education. This method could be used to examine the disadvantage-offset due to Time. For example, for the same user (Age=40, Edu=6), as Time increases, the probability reduces to 24% in panel G. It means that an increase in the value of Time (C $\longrightarrow$ G), decreases the probability of being a Basic User. This demonstrates the disadvantage-offset provided by Time against those presented by Education and Age.

The boundary curves reveal the relative gaps between the different classes of User Types. Figures F.18 and (F.19) suggest that becoming a Saver is highly improbable as compared to the other categories.

Coming to Stages of Usage, the least advantaged users are most likely to be Novices (dark areas in panel C in Figure F.16). The opposite is true too. Persons having the advantage of all the four parameters (see panel F in Figure F.17) are highly likely to be Competent users. This same has been concluded in section 7.5.3.

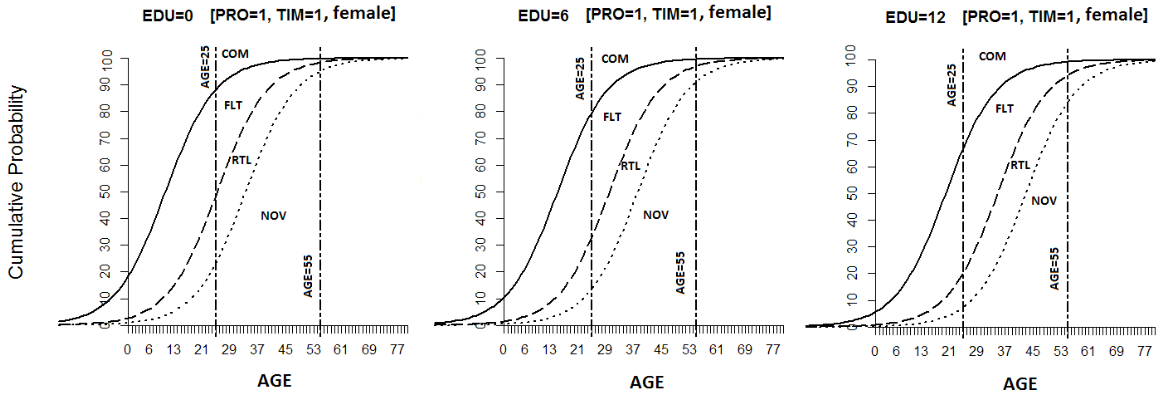


Figure 7.33: OLR plots for Age with respect to three Education regressed on Stage of usage. Compare with panel C on pages 370, 372, 374, and 376. Note that each curve depicts a Cumulative Probabilities, while the heatmaps depict Absolute Probabilities.

The Rote Learners ((pages 372 & 373)) are represented by a diagonal and medial band of low probabilities (20%-30%). The remainder of probabilities is distributed amongst the lower Stage (Novice) and the higher (Fluent). The proportion of the distribution depends on the total advantage. If a user is more advantaged in terms of Age and Education, the share of Fluent users increases, otherwise that of Novice users does. It is similar to the case of Navigators. If we examine Figure 7.33 (and compare with panels 'C' on Pages 370, 373 and 374), we find that probabilities for the Fluent users remains small across the three plots shown above. The proportion of the Novice and Fluent depends on the total advantage available with the user.

As has been discussed in section 7.5.3, Gender, Proactiveness and Time have important role to play. The shift in the probability patterns signify a change in the number of users belonging to a Stage of Usage. The pattern-shifts are recognisable when, for a given Stage of Usage, one compares males with females (for example, C $\longrightarrow$ D). The same shifts are discernible when low levels of Proactiveness are compared with high levels (for example, C $\longrightarrow$ A) or less Time is compared with more (for example, C $\longrightarrow$ G).

The disadvantage-offset is visible for Stages of Usage also. In panels for Novice (Figure F.10 and F.11), a female (panel C) has disadvantage as compared to a male (panel

D). By being more proactive (moving to panel A), or by expending more Time (moving to panel G) she could offset this disadvantage. The disadvantage-offset with respect to Age and Education can be assessed by comparing individual cells in the panels. The probability of being a Novice for a 40 years old, class 6th educated user in panel C is 57%. As Proactiveness increases (C $\longrightarrow$ A), it reduces to 33%. As Time increases (C $\longrightarrow$ G), it becomes 32%.

The boundary curves reveal the relative gaps between the different classes of Stages of Usage. Figures F.20 and F.21 suggest that becoming Competent is more difficult as compared to the other classes. This should be compared with heatmaps for Competent users (pages 376, 377), where Competent Stage is possible only for the users who are advantaged in terms of Proactiveness or Time in addition to Age, Education and Gender. Also, in general, the probability of being a Rote-Learner is lesser than that of being a Novice and Fluent. Both the facts are in harmony with the discussion in section 7.5.3, where Fluent stage has been shown to be the least probable amongst Stages.

7.5.5 Predictive Ability of the Model

How good is model at predicting User Type and Stage of Usage if the parameters for a user are provided? Cross validation provides a way by dividing the orginal data set into two parts–one for calculating the estimates, termed as *training* set, and the other for testing, called the *test* set to find out the accuracy of prediction.

A particular form of cross-validation is leave one out validation (LOOCV). It uses a training set of size N-1 (where the total number of records in dataset is N), and only a single record for testing. The process is repeated over all the records. The deviation between the predicted and the actually observed value is summated over every step and used to find the average deviation or mean error. We have taken the advantage of the fact that we are calculating the probabilities of an observation belonging to each of the classes. Therefore, we have calculated the deviation of the probability score of the actual class (that was observed in the field) from 1. In other words, if the prediction was perfect the probability of the observed class would be a perfect 1, while others would be 0. However, this is unlikely and the probabilities are distributed across the classes. Therefore, the probability of the observed class would be lesser than 1. This difference would contribute towards the error in prediction. The method is described in detail in in the form of Algorithm 1 and the results are in Table 7.15.

Algorithm 1 Leave Out One Cross-Validation.

.... Dataset $\mathbf{D}$ contains N observations: $\mathbf{D} = \{\mathbf{X}_1, \mathbf{X}_2, ...\mathbf{X}_N\}$

.... Each observation contains M parameters.

.... Therefore, pth observation $\mathbf{X}_p = \{x_{p,1}, x_{p,2}....x_{p,M}\}$

Require: $\mathbf{D}$

1: $Total\_Error = 0$;

.... Initialise Total_Error = 0

2: **for** i = 1 to N **do**

.... Loop for all the observations in the dataset

3: $E_i = Train(\mathbf{D}_{\sim i})$

.... Train using subset $\mathbf{D}_{\sim i}$.

.... $\mathbf{D}_{\sim i}$ contains all the observations from $\mathbf{D}$ except the ith observation.

.... This results in $\mathbf{B}_i = \{\beta_{i,0}, \beta_{i,1}, \beta_{i,2}, ...\beta_{i,M}\}$.

.... $\mathbf{B}_i$ is the vector of coefficients calculated for the ith iteration

4: $y_{i,k} = \mathbf{X}_i \mathbf{B}_{i,k} = \beta_{i,0,k} + x_{i,1}\beta_{i,1,k} + x_{i,2,k}\beta_{i,2,k}.....x_{i,M}\beta_{i,M,k}$; $k = 1, 2.......K$

.... Test the coefficient $\mathbf{B}_{i,k}$ on the ith set of observations $\mathbf{X}_{i,k}$,

.... where K is the total number of classes.

.... This is done by doing a vector multiplication of $\mathbf{X}_i$ and $\mathbf{B}_{i,k}$.

.... $y_{i,k}$ is the probability of observation $\mathbf{X}_{i,k}$ belonging to the class, $\mathbf{C}_k$.

.... Or, $y_{i,k} = P(\mathbf{X}_i|\mathbf{C}_k)$

5: $\epsilon_i = 1 - P(\mathbf{X}_i|\mathbf{C}_{observed,i})$

.... Calculate local error, ϵ_i

.... $P(\mathbf{X}_i|\mathbf{C}_{observed,i})$ is the fitted probability -

.... of the class that was actually observed for the i_{th} record

6: $Total\_Error = Total\_Error + \epsilon_i$

7: **end for**

8: $Mean\_Error = Total\_Error/N$;

9: Calculate $Standard\_Error$ from $Mean\_Error$ and ϵ_i

User Types	Stages of Usage
Mean Error (Standard Error)	**Mean Error (Standard Error)**
All Variables	
Age + Gender + Socio-Economic Clasification + Education Levels + Prevalence + Proactiveness + Self-Efficacy + Anxiety + Population + Social-Status + Utility + Distance from Bank + Time	
0.56 (0.24)	0.63 (0.24)
Significant Variables	
Age + Gender + Education-Levels + Proactiveness	
0.54 (0.23)	0.61 (0.23)
Demographics	
Age + Gender + Education-Level	
0.56 (0.21)	0.63 (0.20)

Table 7.15: Prediction (Deviation of predicted values from the observed) after Cross Validation.

The prediction algorithm is run thrice. The first instance includes all the variables. The second one includes all the variables that have been found significant during the Ordinal regression. The third instance is done to test the efficacy of using only the demographics as it will help prediction using the census data alone.

The prediction is best for the second case. However, it still is in the range of 50 to 60 %. This could be attributed to human error in labelling of the classes while collecting the data.

7.5.6 Confidence of Classification

We now attempt to find out with what confidence the OLR classifies a given user. It is difficult to arrive at confidence intervals for an individual probability using this method. This is because OLR deals with cumulative probabilities, which have an upper bound of 1. The maximum limit of one class squeezes the other classes resulting in absurd intervals (for example, a larger number representing the lower limit of the confidence interval and vice-versa). As an alternative, we have plotted the 95% confidence intervals (Figures F.22 through F.25) for the three class boundaries (compare with Figures F.18 through F.21), both for User Types and Stages of Usage. (The presentation of the confidence interval plots follow the same presentation pattern as for class boundary curves.) Though the sample's range lies between Age=25-55 years and Education=0-13 years, the confidence intervals have been plotted for an extended range (including the non-plausible negative values) to show a larger view.

For a given class-boundary, there are two interval-limits. In other words, there are two interval-limits—an upper and a lower—each for BAS|NAV, NAV|TXT & TXT|SAV in case of User Types, and NOV|RTL, RTL|FLT & FLT|COM for Stages of Usage. That means, the possible range (or spread) of a given class-boundary exists between its upper limit and lower limit (with 95% confidence). It means that a particular class boundary (for example, TXT|SAV) is highly unlikely to exist beyond its range—(see Figure F.22) either in a region above and left of the upper limit, or in a region below and right of the lower limit. The line in the middle shows the mean value of the range. The small rectangle within a plot depicts the *sample's range* (AGE=25-55, EDU=0-13].

In plot C (page 382, Females, low Proactiveness, less Time), the lower-limit of SAV|TXT class-boundary's range (horizontal hatch pattern) intercepts the left limit (at EDU=3.45 years) and right limits (at EDU=9.42 years) of the sample's rectangle. If a less-proactive and less-experienced female user, for example a certain user Y with 2 years of education, falls below this line, she would most likely find herself below the possible range of SAV|TXT class-boundary. In other words, the SAV|TXT class-boundary would be highly unlikely to come down enough to 'cover' the user Y. Statistically speaking, there is more than 95% chance that the probability of the user Y of being a Saver would be below 50% (Given the fact that on the class-boundaries, the probabilities are shared equally between two classes (50%-50%), and the fact that the class-boundary's ranges are identified at 95% confidence). Stated simply, there is a very negligible chance that the user Y will be classified as a Saver.

Also, in plot C (page 382, Females, low Proactiveness, less Time), the other limit, which barely touches the sample's rectangle, is for TXT|NAV (vertical hatch pattern). It intercepts at EDU=0.04 and AGE=54.0. This implies that a user who is situated below this line, for instance one with 0 years of Education and is 55 years old, one can say with a high confidence that she is unlikely to be a Text-Inputter or a Saver.

If for the user Y, Gender were male (plot D, page 382), the SAV|TXT lower limit intercepts would shift further down and rightwards (EDU=3.71, AGE=36.35) . In that case, the lower limit of TXT|NAV class-boundary's range would be out of the sample's rectangle. Now there would be more users for whom there is little ambiguity of being not a Saver (it is same as being a Text-Inputter, a Navigator or a Basic User).

For the user Y, a higher value of Time (plot G) also makes the SAV|TXT intercepts shift down and rightwards (EDU=3.98, AGE=35.01) . In this case too, the lower limit of TXT|NAV boundary's range is out of the sample's range. If the user Y becomes more Proactive (plot A), the SAV|TXT intercepts shift further down and rightwards (EDU=4.65, AGE=31.61). For all the other combinations of Time, Proactiveness and Gender, which actually encompass high total advantage, all the boundary-range limits lie outside the sample's rectangle.

For Stages of Usage, the boundary's range limits, in general lie outside the sample's rectangle. The only trivial exception is seen in plot C where the lower limit of COM|FLT boundary range barely touches the sample's range at Age=52.07 and Edu=1.21.

Over all, the classification of a user (from our sample) as one of the User Types can be done with high confidence only in case of Savers of the following profile: less experience *or* less proactive females, less-experienced *and* less-proactive males. The classification of a user (from our sample) with respect to Stages of Usage cannot be done with a high confidence.

7.6 Discussion and Conclusions

Following is the statement of the result of testing of the hypotheses defined at the start of this chapter. We will follow it with a wider critique of the results.

- H1a: Age, Gender, Education levels, Proactiveness and Time were found to be significant in deciding the User Types (Section 7.5.2). Socio-Economic class, Distance from private bank, Prevalence, Utility, Self-efficacy, Anxiety, Social status, Population of the census unit were not found to be significant. The former five variables, when carry the advantage, significantly decide the probability of a User belonging to a higher User Type, and vice-versa. Prevalence was expected to be significant but did not turn to be. Many variables such as Anxiety and Self-Efficacy pertain to a user's internal state and are difficult to measure, particularly in case of the EUs, using single-item questionnaires

- H1b: Age, Gender, Education levels and Proactiveness were found to be significant in deciding the Stages of Usage (Section 7.5.2). Time, Socio-Economic class, Distance from private bank, Prevalence, Utility, Self-efficacy, Anxiety, Social status, Population of the census unit were not found to be significant.

- H2a: From the perspective of the whole sample, around 35 years of Age discriminates between Fluent and Competent Stages of Usage (Section 7.5.1). Proactiveness, at around 1 assisted person, also discriminates between the two Types. None of the other significant variables differentiates between two User Types.

  From the perspective of probabilities as function of the five significant variables (Section 7.5.6), only Savers and Text-Inputters could be discriminated from each other, that too, only for the users from the sample with the following profiles: less experience *or* less proactive females, less-experienced *and* less-proactive males (Ref. plots in pages 382 & 383).

- H2b: From the perspective of whole sample, around 35 years of Age separates Text Inputter and Navigation User Types (Section 7.5.1). Class 7th, from the perspective of Education level, also separates Fluent and Competent Stages. Same is the case with Proactiveness, at around 1 assisted person, which separates the two Stages. None of the other significant variables differentiate between any pair of adjacent Stages.

  From the perspective of probabilities as function of the five significant variables (Section 7.5.6), no two Stages could discriminated from each other for the sample.

We have introduced two concepts—*advantage* and *disadvantage-offset*. Advantage is the increase in the chance of adoption of technology by an Emergent User that occurs due to an increase in the value of a variable (decrease in case of Age). Disadvantage-offset happens when the disadvantage due to low value of a variable (high, in case of age) is offset by high value of another (low for age) .

We have found that Age, Education level and Gender are significant in deciding the User Type and Stages of Usage of a user. This supports the finding, from chapter 5, that the three are likely to have a significant effect on Technology Adoption. The finding is important because of its applicability which is enhanced because of the following reason.These three variables could be availed directly in the form of census data. They need not be collected 'in field', which makes it easy to predict the patterns of Technology Adoption for a given population. Given that these three variables are found to be significant as well, they provide a level of sufficiency for such an exercise. (We have demonstrated the same as a prediction exercise in Section 8.3.) The other advantage is that the census provides the data for the whole population rather than a sample which should improve the accuracy of a prediction. It is worthwhile to add that the robustness of the prediction would depend upon how rigorously the studies are conducted to establish the relationships between these three independent variables and the dependent variables.

Time and Proactiveness have also been found to be important factors. It has to be appreciated that Time and Proactiveness work in similar ways. They both increase total time of interaction (we have introduced the idea in section 5.3.1 in chapter 5). Now that we have seen that Time and Proactiveness could offset the disadvantage of Age, Education and Gender, it implies that *the total time of interaction can offset the disadvantages* occurring due to these three traits which are very less amenable to be in control of a user. That points towards design opportunities to enhance total time of interaction, through motivation or otherwise, in order to help a user towards Technology Adoption in spite of the disadvantages accruing due to Age, Gender or Education.

Though Proactiveness, has been found to be an important factor, we would raise caution at this point and re-examine the validity of the question used to measure Proactiveness. It has been measured in terms of the number of persons assisted in learning by a user. This was based on observations (as discussed in chapter 5) where the users who exerted effort in teaching others, often going out of their way, were also found to be keen on learning about ICT artefacts, both on their own and from others. However, the doubt arises from the fact that an inclination to teach others could also be dependent on the level of skill, and not just on motivation. In that case, the scores for Proactiveness may reflect the outcome themselves. In this regard, we would also like to point out that Proactiveness has less effect in deciding User Types than it has in Stages of Usage. This fact may have some implication in support of the validity of the measure due to the following reasons. The barriers of task complexity, frequency of usage and acquisition of mental models, which give rise to the Stages of Usage, are likely to be offset by individual efforts resulting from Proactiveness. On the other hand, the factors responsible for User Types, ability to abstract, read and write, develop online trust are more dispositional and may have less dependence on Proactiveness.

Self-Efficacy, Utility, Anxiety and Social-status were not found to be important variables. At this juncture, it is worthwhile to discuss validity, also, of the questions used to measure these four. In this regard, we found that it was a challenge to measure complex psychological traits, using single item instruments (as part of larger questionnaire), of users whose contexts and world-views are different than of the users for whom these instruments were originally designed. With these constraints, we would argue that the non-importance of these variables may have some validity. We discuss them as follows:

Self-Efficacy: Self-Efficacy is normally measured as a perceived ability to do an action. A mobile phone consists of multiple tasks with varied level of complexity. Therefore, we made the question encompass the whole of a device (and also more concrete). We had asked (see Q18 in Appendix A): *"....How much time you will take to learn it completely, in other words, 100 per cent?"* The measure depended on a user's ability to project, which required some cognitive effort. This may have added to the non-significance. We would also argue, in line with our critique of TAM in Chapter 3, that it is difficult to convey concepts like Self-Efficacy to the Emergent Users in a non-organisational and informal context where the goals are not concrete but in the form of continuous engagement. An example is listening to songs on a mobile phone in the fields.

Utility: Utility was found to be a non-significant variable because a large number of users (94 %) reported mobile phones to be useful. For a majority of them ability to communicate, in light of its portability, was a very important utility.

Computer anxiety: Computer anxiety has been traditionally framed in terms of non-mobile systems. The question was framed in terms of an unfamiliar (that is newly encountered) artefact. Still, the fact that an Emergent User frequently finds mobile phones of various types in her social context (such as a smartphone used by one's child) may have contributed to insignificance of anxiety.

Social Status: Social status was also found to be an insignificant variable. Many user's used mobile phones simply as a tool for communicating and did not attach any material value to it.

Income has not been found to be a significant factor. A likely reason is that most of the users in the sample do the tasks that would require expensive phones. There are very few Savers and none beyond them. As cheap phones could be bought as used ones or received as gifts from other users, income's role seems to be limited. A closely related measure, the level of rurality, was also not found to be significant. It was measured in two ways—by finding the distance from the nearest private bank and from the population of the census unit to which the location of a user belonged to. The reason could be attributed to the fact that penetration of mobile phones in rural India has reached significant levels (56.25 phones per 100 users according to Telecom Regulatory Authority of India [2018]), and therefore phones could be acquired easily in rural areas too.

Based on our understanding in chapter 5, we had expected Prevalence (of mobile phones in a user's community) to be a significant factor. However, the quantitative analysis has not supported it. We had expected it to be a strong predictor and it needs to investigated why it has not been one.

It is also evident that the higher is the User Type represented by a task, the less is the task Frequency and more is the time to learn. Frequency could represent many things—the ease of doing the task, its utility and the motivation to do the task. The task done with highest frequency is making calls. It is explainable because making phone calls is the *raison d'etre* of a mobile phone. At the same time being a Basic task, it is among the least complex. The least done task was sending SMS. From the qualitative data collected during the data collection it was found that many Text-Inputters have migrated to Whatsapp preferring it over Facebook and SMS (The reasons for it have been investigated in a study reported in Chapter 8). The next least frequent tasks was Saving files in folders. Doing this task is difficult (it is a Saving task). From the qualitative data it was found that often songs were saved by someone other (like a mobile shop owner) without any regard to directory structure. The user, too listened to songs in a sequential manner and did not need a structure. Many a times, the user did not have an awareness of the directory structure. Images were never stored in a folder structure. A user only captured an image, leaving the operating system to store it in Gallery or equivalent. Similarly, while retrieving images, a user accessed the gallery or equivalent, and bypassed the folder structure. Deleting SMS was done with a high frequency. The users reported that they were often annoyed by the promotional SMS, as they were considered to be of nuisance value (One person terms them as crowd). Many users reported that they were concerned with SMS filling up the memory.

The 'oldest' task the users did was making a phone call. Given that it is the most primary of tasks for which a mobile phone is bought, it is explainable. The most recent task (around a year ago) learnt by users was searching something over the Internet. It is the only task requiring the Internet. An explanation could be sought from qualitative data. Users were conscious of the data charges in 2016-17 and would often raise the issue of charges or cite the non-availability of balance when asked to perform Internet based tasks.

The least difficult task to learn is making a phone call. Among the most difficult are copying a video or song in a folder structure. Being a Saving task, it is difficult. The other difficult task was searching on the Internet. Another difficult task, though a navigational task was using Blutooth. The reason could be attributed to the fact that, though it could be memorised as a recipe/routine based task, it is done infrequently. At the same time, number of steps and involved are large. It also involves rules such as checking if the other device is visible. In all, it is cognitively more complex than other navigational tasks.

Various plots have suggested that the probability of a user of belonging to a category increases with advantage. If the total advantage, considering all the variables, of a user is low, he is likely to be in the lowest category, which is Basic User and Novice respectively for User Type or Stage of Usage. Now, regarding the opposite of that, if the total advantage is high, a user is most likely to be a Competent, the highest Stage. However, a highly advantaged EU is not likely to be among the highest Type, that is Saver. Rather, he is likely to be among the next lower, Text-Inputter. The reason for this anomaly is that, overall, the sample has very few Savers, which gets translated to low global probability. It is likely that this low proportion reflects the portion of the population within the range that was decided for the sample (Age=25-55 years, Education=0-12 years). This is an assumption which needs to be investigated.

When Age and Education both are moderately valued, or when they offer disadvantage-offset against each other (either low age offsetting low education or vice-versa), a user is likely to be a Navigator. As the total advantage shifts either towards better or worse, the probability changes in favour of Text Inputter or Basic User respectively. Similar is the case for Rote Learners. As long as total advantage is moderate, a user is likely to be a Rote-Learner. A shift in advantage shifts the probability in favour of either Novice or Fluent stage depending on its direction.

Becoming Competent is difficult unless there is an advantage of Age, Education and Gender which is also aided with total time of interaction (as Proactiveness or Time). This is plausible because being Competent requires formation of mental models, which os difficult as compared to learning a task as recipe or routine. Formation of mental models (more specifically, Device's Experienced Model as discussed in section 4.2.4) would require that the user engages with the artefact enough to develop a schematic understanding.

For individual values of the variables, the segregation could be done only between Savers and non-Savers. For all other User Types and Stages of Usage, considering 95% confidence intervals for the class boundaries, it is difficult to segregate. However, at the level of whole sample, Fluent and Competent Stages are well separated with respect to Age (at approximately 35 years), Education levels (at approximately class 7th) and Proactiveness (at around 1 assisted person). Text-Inputter and Navigator User Types are well separated by Education (at approximately 35 years) and Proactiveness (at around 1 assisted person). It implies that the capabilities leading towards Technology Adoption are more likely to be acquired before 35 years of Age. Class 6th seems to be important with respect to Education. It implies thae these capabilities are likely to be gained after 6 years of schooling. There is also an implication that a user guiding at least 1 user as compared to none, signifies a substantial difference in Proactiveness levels.

Among Text Inputters, the number of Fluent users tend to be lesser than the other two Stages. It suggests that users remain mostly on either side of this Stage. Persons who are better skilled, are likely to to jump it over and become Competent. The barrier of low frequency is of not much consequence to Text Inputters. A plausible reason could be that memorising of a routine/recipe is not effective in case of Text-Input tasks and adequate mental models are needed for a good level of proficiency.

7.7 Summary

We have operationalised the User-Usage model by identifying various dependent variables. The dependent variables were User Types and Stages of Usage. Through Ordinal Logistic Regression we found that Age., Gender, Educational Levels, Proactiveness and Time (the motivation to learn on one's own) were the most highly significant predictors of technology usage for the emergent users. This is valuable because these are demographic variables and predictions/explanations of technology use based on these variables will be easy to implement.

Chapter 8

Application of the User Usage Model

8.1 Introduction

In this chapter we demonstrate the applicability the User-Usage model. It has three sections. The first, is a methodology to describe a user's usage patterns and interaction behaviour with respect to ICT. The second section, based on the census data, divides a user population into various User Types and Stages of Usage. The second uses the User-Usage model to understand the recent widespread Adoption of WhatsApp in India.

8.2 Describing a User's Usage Patterns and Interaction Behaviour

In Chapter 7, based on a users characteristics (Age, Education etc.), we have been able to 'place' a user on the User-Usage model. Using the descriptions from Chapter 6, this placement could be used to describe a user's potential to attempt tasks of certain types (User Type, see Table 7.2) and the typical usage-patterns (Stages of Usage). Chapter 5 would, on the other hand, give us in-depth understanding of the causal connections between the users' characteristics, User Type and Stages of Usage.

To bring forth these connections, we use the example of a 40 years old, 10^{th} educated, male user who has been using his phone for the last 10 years (as of in 2018) and reports that he is highly motivated in using his phone. We follow the following steps:

8.2.1 Identifying the User Type and Stage of Usage

In the heat maps for User Type (Figures F.2 to F.17, pages pages 362 to 377), this user maps to panel F at the position signifying AGE=40, EDU=10. This probabilities at this position for Basic Users (page 363), Navigators (page 365), Text Inputters (page 367) and Savers (page 369), respectively, are 1%, 13%, 75 % and 11%. With the highest probability of being a Text-Inputter, the user could be classified as such.

In the heat maps for Stages of Usage (Tables F.2 to F.9, AGE=40, EDU=10; pages pages 342 to 349), the probabilities in panel F for Novice, Rote Learner, Fluent and Competent are, respectively, 3%, 5%, 34% and 58%. Therefore, this user is likely to be a Competent user.

8.2.2 Describing the User-Type

The descriptions of a Text-Inputter are provided in Section 6.3.3. The user is likely to have adequate mental models to deal with the tasks involving typing. However, he may not be able to deal with the tasks that require more complex mental models such as designing folder hierarchy or using account based applications. He is likely to able to write messages of adequate length and send them using (seemingly) account-less (see Section 8.4) applications such as WhatsApp. He is likely to able to navigate menu hierarchies as well. He is also likely to be able to search for information by typing.

8.2.3 Describing the Stage of Usage

The descriptions of a Competent user are provided in Section 6.2. With adequate mental model, the user is likely to deal with the tasks he does (the most complex being typing) with confidence. He is likely to focus on the goals rather than the task itself. If he commits an error, by chance, he is likely to be able to recover quickly. He is likely to be creative with his tasks and can use it for achieving goals in new situations. He is also likely to teach others regarding the task.

8.2.4 Explaining the Underlying Causes

The user is advantaged (see Section 7.5.3) with respect to all the parameters except Age. This user would have started late regarding the usage of mobile phones (at the age of 30). We have seen that Age (see Section 5.3.1) brings in decline in learning abilities.

The disadvantages of age are offset through the other variables. For example, he is educated till class 10th. We have seen that literacy (see Section 5.3.1) helps in following the instructions, mental spatial orientation and abstraction. It helps that he can read and write which has a bearing upon his ability to type.

In addition, being a Male (see Section 5.3.1) means that he has an adequate opportunity to buy his own device and have a circle of adept friends to learn from. He is also likely to have exposed to many devices (for example, in his social groupings) which might have contributed to his collection of mental models. He was also motivated (see Section 5.3.2) enough to try on his own which results in a high frequency of usage and helps in the formation of good mental models.

8.2.5 Design Guidelines for the User

The user can type and send messages from a non-account based application. The access to (the list of) the messages should be by default because the user would not be able to design a folder structure by himself. However, he would be able to search for a message or file by typing. In addition, he would use navigating through a menu structure quite easily. As he is a highly motivated user, gamification could be used to progress him further.

8.3 Predicting the Number of Persons in Various User Types and Stages of Usage

As we have discussed in Section 7.6 Age, Gender and Education levels have been found to be significant variables. Given that these are readily available for population in the form of census, data helps to make prediction about the number/proportion of the users belonging to the different User Types and Stages of Usage. We have done such a prediction based on the census data from year 2011. The census data is sourced from the census digital library at `censusindia.gov.in/DigitalLibrary/Archive_home.aspx`. The relevant data is classified (among the census tables as) as C-8: Educational Level by Age and Sex for Population Age 7 and Above.

Name	**Interval (Years of Education)**	**Remarks**
Illiterate	[0]	No education
below Primary	[1,4]	Dropped out before class 5th.
Primary	[5,7]	Dropped out before class 8th but completed class 5th.
Middle	[8,9]	Dropped out before class 10th but completed class 8th.
Secondary	[10,11]	Dropped out before class 12th but completed class 10th.
Higher Secondary	[12]	Dropped out before class 8th but completed graduation. Assuming 3 years of graduation. Not considering users with 13 and 14 years of education for analysis.

Table 8.1: Ranges of the classes of education level used in the census data.

The data in C-8, for Age, Gender and Education level, has been tabulated as intervals. The age is divided into intervals of 5 (beyond the age of 20 years). We have considered the following 6 intervals: 25-29, 30-34, 35-39, 40-44, 45-49, 50-54. The ranges of education levels according to the census considered by us is as shown in Table 8.1. The upper bound and lower bound of Age and Education levels are same as the ones set for our sample data in Chapter 7 except that the upper bound for Age was 55 years there (see Table 7.1).

Population distribution (in millions) of the interval range. [Total population of India = 1210.85 millions)

Age	Illiterate	below-Primary	Primary	Middle	Matric/ Secondary	Higher secondary/ Intermediate/ Pre-University/ Senior secondary	Total	Total (Male + Female)
Males								
25-29	8	3	8	9	7	6	40	
30-34	8	3	7	7	6	5	36	
35-39	9	3	6	6	6	5	35	
40-44	10	3	6	5	5	3	31	
45-49	9	3	5	4	4	3	27	
50-54	8	2	4	3	3	2	22	
Total	**44**	**14**	**31**	**31**	**28**	**21**	**191**	
Females								
25-29	15	3	7	6	5	4	41	81
30-34	16	3	6	5	4	3	38	73
35-39	19	3	6	4	3	3	37	72
40-44	17	2	5	3	2	2	31	62
45-49	16	2	4	2	2	1	27	54
50-54	13	2	3	1	1	1	21	43
Total	**83**	**13**	**28**	**20**	**17**	**13**	**196**	**387**
Total (Male + Female)	**127**	**27**	**59**	**51**	**45**	**35**	**387**	

Figure 8.1: Distribution of the population range (AGE=25-54 , EDU=0-12) selected for prediction according to the 2011 census of India. (in millions)

Our selection contains 72 intervals (2 x Gender, 6 x Age, 6 x Education levels). The distribution of population (in millions) in various intervals for this range are shown in Table 8.3.

Similar to the exercise done in Section 7.5.3, we have used OLR to calculate the probabilities over different intervals. The only difference is that we are regressing now by using the three variables simultaneously. The equation used is (from Equation C.5):

$$P(Y \leqslant \mathbf{C}_k) = \frac{\exp(\beta_0 + \beta_{edu} + \beta_{age} + \beta_{gen})}{1 + \exp(\beta_0 + \beta_{edu} + \beta_{age} + \beta_{gen})} \tag{8.1}$$

[single interval: AGE=34-39, EDU=5-7,Female]					
Percentage for the Interval Population					
	NOV	**RTL**	**FLT**	**COM**	**Total**
SAV				1	**1**
TXT		8	3	5	**16**
NAV		17	36		**53**
BAS	30				**30**
Total	**30**	**25**	**39**	**6**	**100**
Absolute Numbers (for the interval in millions)					
	NOV	**RTL**	**FLT**	**COM**	**Total**
SAV				0.08	**0.08**
TXT		1.04	0.38	0.68	**2.10**
NAV		2.26	4.64		**6.90**
BAS	3.94				**3.94**
Total	**3.94**	**3.30**	**5.02**	**0.76**	**13.02**

Figure 8.2: Distribution of population interval (Age=34-39, Education level=5-7, Females) with respect to User Types and Stages of Usage. The upper Table shows the distribution as percentage of population. The lower as numbers (in millions)

[range: AGE=25-54 (6 intervals), EDU=0-12 (6 intervals), (Male + Female)]					
Absolute Numbers (for the range, in millions)					
	NOV	RTL	FLT	COM	Total
SAV				16	**16**
TXT		38	17	59	**114**
NAV		28	102		**130**
BAS	127				**127**
Total	**127**	**66**	**119**	**75**	**387**
Percentage of the Range Population					
	NOV	RTL	FLT	COM	Total
SAV				4	**4**
TXT		10	4	15	**29**
NAV		7	26		**33**
BAS	34				**34**
Total	**34**	**17**	**30**	**19**	**100**
Percentage of the Total Population of the Country (1210.85 millions)					
	NOV	RTL	FLT	COM	Total
SAV				1	**1**
TXT		3	1	5	**9**
NAV		2	8		**10**
BAS	10				**10**
Total	**10**	**5**	**9**	**6**	**30**

Figure 8.3: Distribution of population range (Age=25-54, Education level=0-12, Females and Males). The upper Table shows absolute numbers in millions, the middle the distribution as percentage of the interval population, and the lower as percentage of Total population according to 2011 census of India.

Regressing over every interval (for example, Age=35-39, Education=Primary, Gender=Females; Population =5,853,133) would give us a probability distribution as shown in Figure 8.2. Summing for all such intervals over the population range provides us with the distribution for the range as shown in Figure 8.3

The figures indicate that a larger portion of the users would be Basic User and Navigators. It is high not only for the given range (64%) but substantial with respect to the whole population (20%) as well. A large portion of the users have not been able to cross the barrier of inadequate mental model (71% for the range, 24% for the population).

8.4 Explaining the Adoption of WhatsApp in India

The year 2015-16, was perhaps an important landmark in terms of Technology Adoption by the Emergent users, particularly with respect to smartphones. Smartphone sales rapidly increased and achieved between 10-30% penetration in many developing countries GSMA [2015]. There were 220 million smartphone users in India in February, 2016 (according to Statista [2017a]). During that time, WhatsApp had become very popular in India. With around 100 million active users (in 2016 according to Statista [2017b]), India had become its largest market. The smartphone market itself had grown rapidly in India. In 2017, 124 million smartphones were sold which made it the fastest growing market among the top 20 smartphone markets (according to IDC [2018]).

During the same time, while we were collecting the data for quantisation of User-Usage model (as reported in Chapter 7), we experienced the same on the ground. We had noticed a fair number of the Emergent Users using WhatsApp. They had been preferring WhatsApp over other social networking applications (such as Facebook, Twitter, Google+, email, or just plain SMS). They had been able to do 'Account Holding' tasks with a greater ease, which meant that they established social online identities, managed off-line communication, shared and forwarded content, and created and joined groups with less difficulty. We used this opportunity to study the design of WhatsApp using the User-Usage model as a theoretical lens in order to understand its fast adoption amongst the Emergent Users (EUs) in India. We also envisaged that it would inform the design of future products for the EUs.

As we have observed in the last section, a substantial portion of the population of India, according to 2011 census, are likely to be Basic Users and Navigators and have not crossed the barrier of inadequate mental model. Then, what could be the reason of success of WhatsApp, which is essentially an Account Holding application?

The answer lies in the fact that while the factors related to the users, such as Age, Gender and Education levels, are difficult to change, design is not. The barriers against Technology Adoption stem from the disadvantages (many of them are discussed in Chapter 5) occurring due to these factors. However, if design of an ICT artefact is done *as a response to the disadvantages*, a user could be helped to cross the barriers. The disadvantages cannot be addressed without being aware of the causal connections between artefact, user and usage. From this awareness new design solutions are likely to emerge which could creatively circumvent barriers posed by users' characteristics. The list may include designs that let the users do tasks (that would normally need text input) without needing text input, designs that simplify the mental model, or reduce the cognitive complexity.

Our objective is to show how WhatsApp has challenged the User Usage model by helping the EUs accomplish complex tasks (such as operating an 'Account'). At the same time we also show how WhatsApp acts like an exception to the rule, because it is through design innovation only that the barriers posed by complex tasks could be circumvented by the EUs. This exercise helps us understand the specific design features of WhatsApp which facilitate the EUs overcome the barriers of adopting technology. Subsequently, we hope to inform the design of future products and services for the EUs.

The study is based on Contextual InquiriesBeyer and Holtzblatt [1997]. The interviewers were I and the senior post-graduate students studying interaction design. This exercise helped us understand the specific design features of WhatsApp which facilitate the EUs overcome the barriers against Technology Adoption. Subsequently, we hoped to inform the design of future products and services for the EUs.

8.4.1 Method

The Contextual Inquiries were done with 108 users. They were conducted in the following 3 locations in August 2015:

- Mumbai Metroplitan Region
- Wai, a town with a population of 30,000 and 35 kilometers away from the city of Satara in Maharashtra (a major but non-metro city).
- Ralamandala, a rural area with scattered villages, which is 25 kilometers from Indore, the largest city in Madhya Pradesh.

The focus of the study, which was based on Contextual Inquiry method, included the following:

- Users' capabilities and limitations: (a) The capabilities that were required of the user while accomplishing different tasks. (b) The difficulties they faced while accomplishing the tasks.
- User characteristics: age, literacy and income
- Text inputting mechanisms: (a) The languages used to type. (b) The type of text input used.
- Use of WhatsApp as a mode of communication: The purpose and content of the communication. Nature of the recipients (friends, family, business contacts)
- Adoption: Users' adoption process of WhatsApp, and the triggers for starting.
- One time tasks: WhatsApp installation and registration.
- Awareness of features and options: What was possible on WhatsApp?
- Comparison with other similar platforms: The reasons of preferring WhatsApp over SMS/ Facebook.

Demographics		Use Whats-App	Whats-App not used	Total
Settlement Type	Metro (Mumbai)	28	30	58
	Semi-urban (Wai)	31	16	47
	Rural (Ralamadala)	3	0	3
Gender	Male	55	28	83
	Female	7	18	25
Age	Below 25	12	4	16
	26-45	41	23	64
	45+	9	19	28
Education Level'	No Education	2	2	4
	1-5 years	0	0	0
	6-8 years	17	23	40
	9-10 years	41	17	58
	10-15 years	2	4	6
Total		62	46	108

Table 8.2: Demographic distribution of the users

The users were recruited through purposive sampling. The demographics of the users are given in Table 2. In August 2015 (when these studies were done), this represented the leading envelope of smartphone and WhatsApp adoption. The age limit for the users was decided to be between 18-55 years. The ranges used to quantify the User-Usage model validation were extended (chapter 7) a little. We had included very young adults (18-25 years) because they were the primary drivers of WhatsApp. Literacy levels were decided to be between 0 to 15 years of education. The professions of the users were–small business owner/assistant, rickshaw, taxi, bus and truck driver, farmer, guard, hotel worker, tailor, cattle owner, homemaker, peon, mechanic, fruit/vegetable vendor, laborer and delivery personnel. All of the users had smartphones. We included both WhatsApp users and non-users. Data was collected in two ways:

- Semi-structured interviews related to general technology usage.
- Observations of the users' tasks.

The interviewers were divided into small teams of three or four. The interviews and observations were done in the users' natural environments comprising of homes, workplaces and farms. As a rule, the interview was always conducted in the the mother tongue of the user, either Hindi or Marathi.

The data was captured in the form of notes. The User-Usage model was used as a guiding framework during interpretation. With an objective to develop affinity diagrams, the notes and observations were interpreted together by the interviewing team as a whole, where each of the observations was critically discussed.

8.4.2 Analysis and Discussion

As discussed in section 6.3.5, Account Opening in conventional sense requires a set of capabilities which may include ability to read/write, comprehend complex conceptual models, and having a sense of virtual identity. These abilities, in turn, may depend on educational levels, ability to own devices, exposure to technology usage within the community. As the Emergent Users might lack many of these attributes, they might

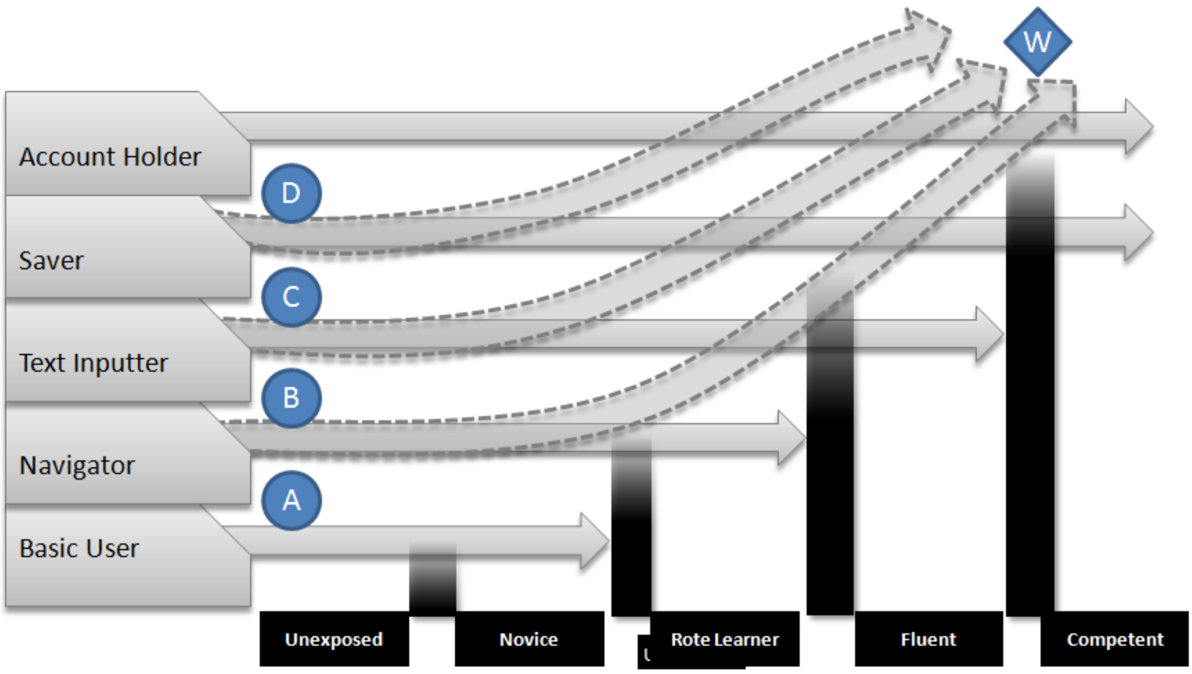


Figure 8.4: From the perspective of the User-Usage Model (shown using solid arrows), the EUs in the positions 'A', 'B' , 'C' and 'D' cannot move vertically be 'Account Holders' (that is, they cannot reach 'W') because the task demands of 'Account Holding' are beyond their capabilities. Only potential 'Account Holders' (at 'W'), with better user caharacteristics, such as high levels of education and lower age, are likely to become actual 'Account Holders'. However, WhatsApp breaks the User Usage model (follow the dashed arrows) by helping the Emergent Users which belong to positions 'B' , 'C' and 'D' to accomplish 'Account Holding' tasks. WhatsApp helps 'Navigators' (at 'B') and above ('C' and 'D') to do the tasks traditionally associated with the users at position 'W'. However, 'Basic Users' (at 'A') will still find it difficult to circumvent the barriers, a fact that re-establishes the model.

be merely 'Navigators'—ones who could only navigate hierarchies. In such a scenario, enabling users to operate accounts can only be done by challenging the design conventions. We find that WhatsApp has been able to do that successfully. It allows the Emergent Users, in the guise of typical 'Navigators', to establish social online identities, manage off-line communication, share and forward content, and create and join groups and thus 'Hold Accounts' (Figure 8.4) without fulfilling the capability requirements posed by conventional 'Account Holding' (position 'W') designs. In this section, we describe the design features particular to WhatsApp which help achieve these objectives.

Account Opening

Account opening is a cognitively intensive and multi-step activity. A typical account requires first name, last name, chosen username, chosen password, re-entry of password, phone number verification, date of birth and gender. The process is exacerbated by the need of unique usernames and complex passwords, which often results in multiple attempts to enter them. Some pieces of the required information may not be available at all. For example, many account opening tasks require the user to already have other accounts such as an e-mail account. Further, adding contacts, an essential procedure, requires writing and saving.

Given that 'Account Opening' in addition to being complex, is a one-time activity, it is likely to be delegated. We have found that many WhatsApp users had delegated 'Account Holding' tasks to their friends or family members who would install the required applications and also impart the initial hand holding.

It should be noted that account opening could be difficult even for a delegatee (who is like to be an Emergent User), and thus can disallow her beneficiary from starting an account. For example, if the delegatee is required to comprehend and enter complex pieces of text (such as selecting a username and password), the probability of account initiation goes down. However, the design of WhatsApp makes account opening easier.

As WhatsApp is associated with a single phone number, it is almost tied to a single device. In this process, though it sacrifices 'any-device' accessibility that the other account based applications allow, it achieves a greater ease of account opening. This is facilitated in multiple ways. Firstly, for account opening, WhatsApp needs just the user's phone number and the name, two highly memorisable pieces of information, which makes it much easier than using logins, passwords and other information. Secondly, WhatsApp makes the phone number verification process easy through a one time password (OTP) sent through SMS.

Single device integration also simplifies the information security. The security of the device ensures the security of the WhatsApp account. Given that the primary and the only device of an Emergent User is likely to be a mobile phone, and that the resulting ease of registration is substantial, that is not much of a drawback.

The integration of WhatsApp also helps utilise information which already exists in the device. This results in automation of certain tasks. For example, there is no need to establish a fresh address book for WhatsApp. Contact names in WhatsApp are nothing but a copy of phone's address book. Being the 'primary key' for users' identities, the phone numbers act as conduits for accessing other WhatsApp accounts. This fact was not unnoticed by users. One of the users interviewed was very much aware that:

> WhatsApp gets contacts from the phonebook automatically, and the friends who have WhatsApp have a green symbol in the contacts.

The ease of registering WhatsApp may help avoid delegation altogether. Users with sufficient self-efficacy are likely to 'try their hand' themselves just as one of the interviewees had done. He told:

> I tried to put WhatsApp on my own phone, installation was almost complete but could not see contacts the way I was told, hence had to go to the phone dealer.

Complexity Reduction

WhatsApp has achieved low complexity through design. It has been done, firstly, by using simpler conceptual models. For instance, the individuals and the groups appear in the single list and thus occupy the same space. Moreover, posting to a group or messaging to an individual entails the same process. Thus, there is a single conceptual model for the two, which means that a user has to learn only one model. In contrast, in Facebook, broadcasting and individual messaging have two distinct conceptual models.

Often, just flattening the navigation hierarchy serves greatly in simplification of interaction. The navigation hierarchy (see figure 8.5) is both shallow (1 level deep) as well as narrow (3 items–"chats","status" and "calls"). It is further facilitated by avoidance of need to recall by making the three panes appear directly under headings titled — "chats","status" and "calls".

Complexity is also decreased by reduction in number of steps needed to accomplish tasks. The more steps there are and the more screens appear, the more cognitive effort is needed to process the information and take decisions. The address box is eliminated, so there is no need to prepare a recipients list by picking names from the address book. Instead, there is exclusively one thread per contact ('D' in Figure 8.5). A single tap on a contact's name is enough to take user to a state where he can simply start typing. This is operationally simpler than other methods (for example, compare with writing SMS on a basic phone as depicted in figure 6.9. However, we must add that the threaded view used by the smartphone SMS applications are similar to WhatsApp), where one may have to reach the typing space and then search for the addressees in the otherwise hidden address book. Reduced complexity is likely to translate into enhanced adoption. We found its evidence in the fact that many users who earlier used SMS, have switched over to WhatsApp.

In WhatsApp, a single container is used for typing a message, attaching a video, attaching a file and inserting a smiley. Operationally, they are similar to each other—a tap on the icon leads to the keyboard, the camera view (with Gallery being shown concurrently), the file manager or the smiley store. This helps in minimal number of mental models needed to insert a variety of 'things'. These tasks also involve a minimal number of steps. This contrasts with Facebook and GMail applications, where each of these are operationally different and involve many steps.

Less number of perceivable states is also a strategy for complexity reduction. The interviewed users had expressed that viewing the videos was more 'direct'. On probing, we

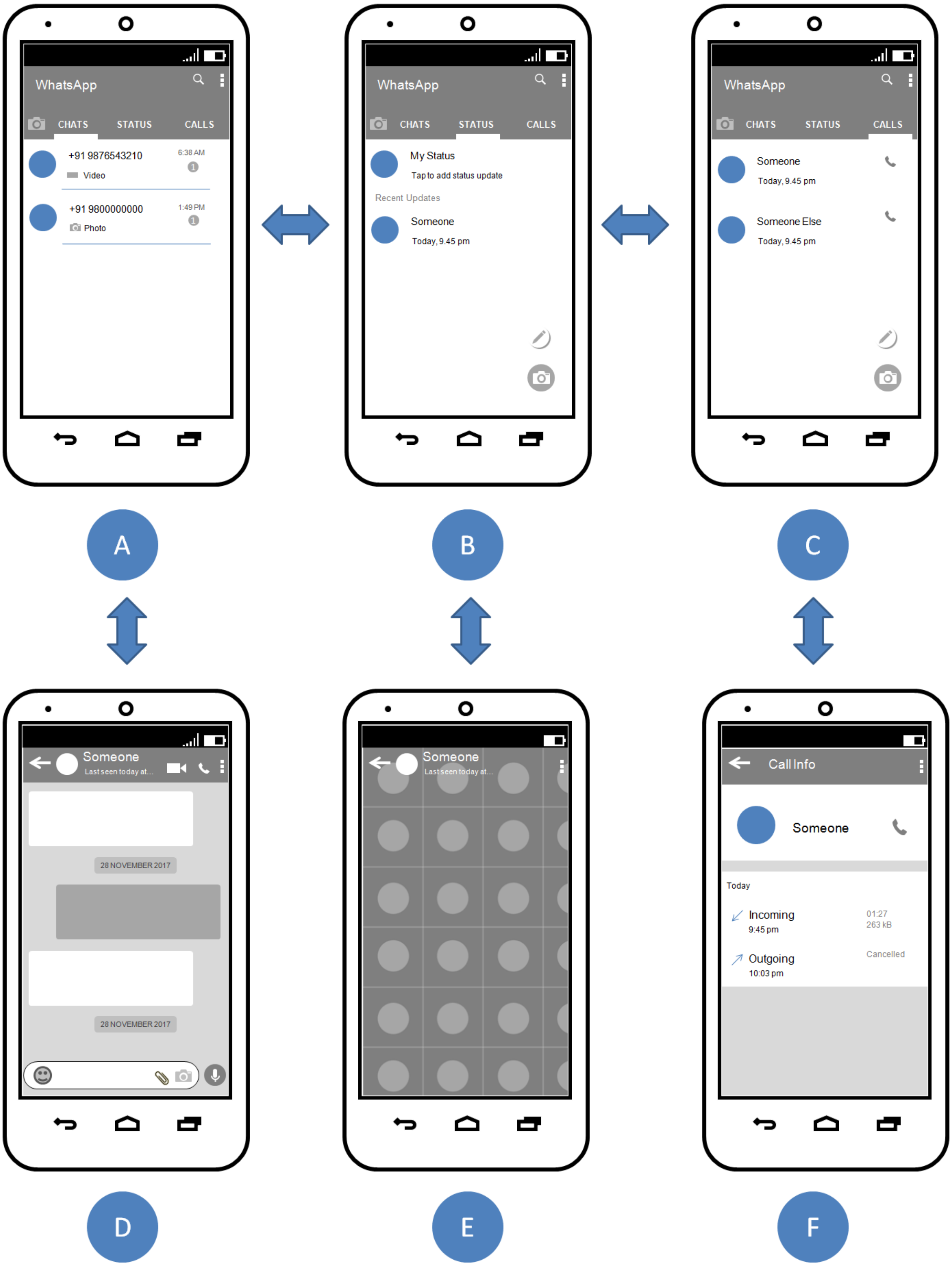
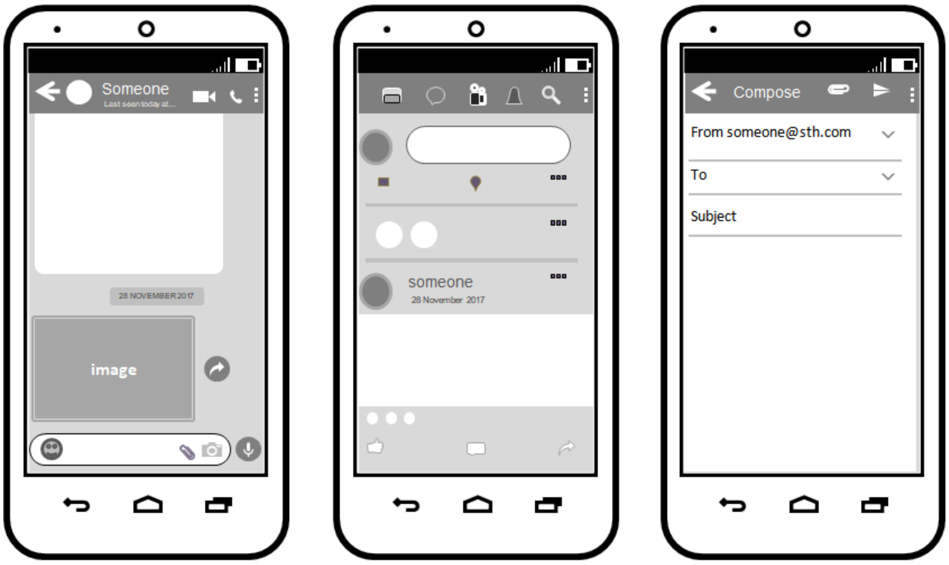


Figure 8.5: Navigation Hierarchy of WhatsApp is both shallow and narrow.



(a) WhatsApp (b) Facebook (c) GMail

Figure 8.6: Inserting/attaching messages, videos, files and smileys in (a) WhatsApp is done from the same 'container'. It also requires minimal number of steps. Compare with (b) Facebook or (c) GMail application.

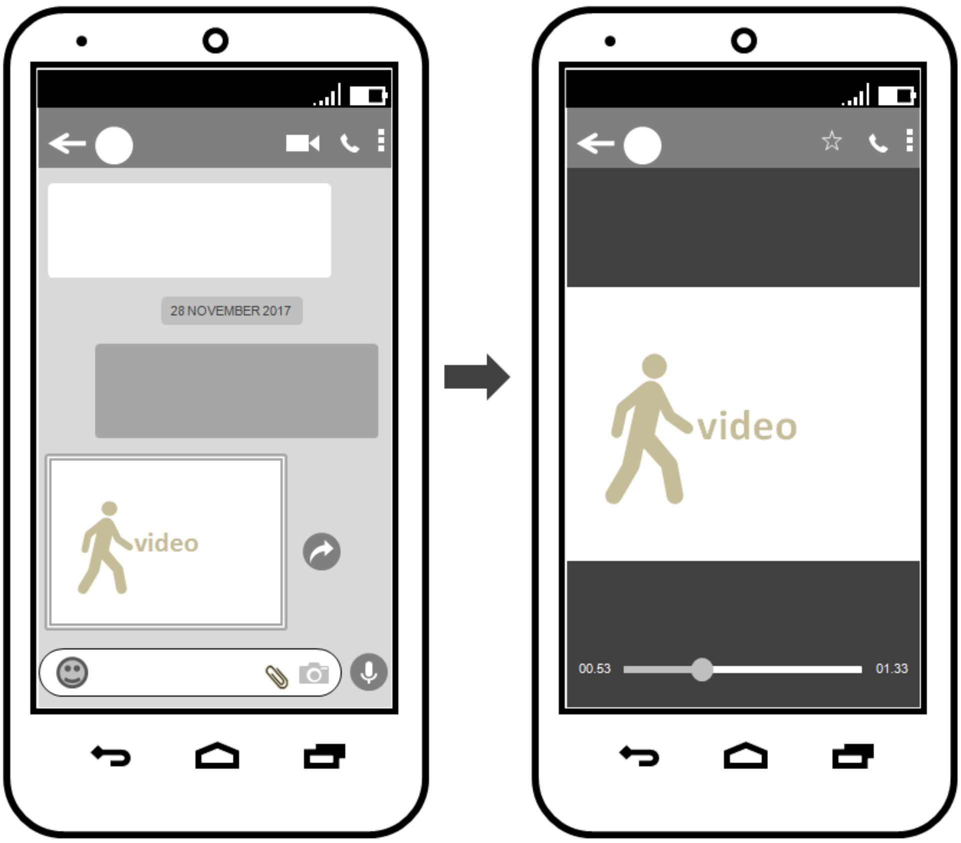


Figure 8.7: Watching video on WhatsApp is a low cognitive load task.

found that watching videos requires a single tap on a video's thumbnail (see figure 8.7).

Complexity is also reduced by ensuring 'visibility'. Visibility encompasses many things. Firstly, it means availability or accessibility. Finding and starting an application needs cognitive effort. WhatsApp, instead, always remains active, even without users' intervention. Actually, users liked the fact that WhatsApp was always hot/active (even when offline). A user put it as follows:

> Just open it and it gets started...Facebook requires logging in....connectivity is also needed.

Visibility also means getting the required information at right time. One example is that of the notification system which helps in keeping the user aware of the new messages It is true for many e-mail applications on mobile phone as well. Still, we are of the opinion that the Emergent User finds it beneficial in the over all context of an application and not as a stand alone feature.. Given that WhatsApp is an application to remain connected, "freshness" of message holds value. A user substantiated:

> Messages are delivered very fast, we get alert as soon as message comes, and as soon as the phone is on, we get messages from WhatsApp.

Visibility could also be envisaged in terms of affordances. If a user knows in unambiguous terms what is possible then it helps in simplification of the tasks. For example, taking and sharing pictures is not made simpler just by reduction in number of steps, but also due to clear visibility and easy accessibility of icons for capturing and sending (see figure 8.8).

The role of touch-screen phones should be highlighted for their contribution to the 'directness' that appears natural to WhatsApp. It would be a worthwhile question to ask whether WhatsApp could have been equally successful with non-touchscreen phones where a user employed navigation buttons instead of tapping directly. This has to be seen particularly from the perspective of Indian language text entry, which has become easier (for example, see Joshi et al. [2011]) on smartphones as compared to featurephones or desktops.

Figure 8.8: The icons for various operations such as sending, recording, attaching a file and photo capturing are visible and accessible.

Passive Engagement

WhatsApp (and Facebook) allows simply observing a conversation by being in a group. (Someone else adds a user to a group, he may leave if he wishes so). A user can feel that he is a part of a group conversation without an insistence on actively generating content.

Passive usage was also evident when the users merely forwarded content from one contact to another instead of generating by themselves. In fact, exclusive forwarding of content in the form of jokes, images and videos was so common that one user had reported to have used blocking in order to avoid unwanted forward messages. This had lead to new social norm where replying to a message was not a necessity, especially when a double tick ('✓✓') informed the sender that the message had been seen by a recipient.

Passive usage indicates a low level of cognitive effort expended to accomplish a goal. In case of photo forwarding, the goal is to remain connected to a community/friend. It should be noted that passive-active is a continuum. Whereas forwarding text-less images is highly passive (as it does not involve reading too), writing thoughtful text is least so.

The effect of passive usage on account holding by the Emergent User is noteworthy. Passive usage reduces or removes the cognitive effort in generating and posting content, and still allows a user to belong to the community of the application users. This could become still more critical when a user cannot type well. A sense of belonging to an online group plays an important role in the initiation and sustained usage of an application. This ensures that the utility of the application is maintained and the user frequently engages with it, which consequently, has a direct effect on latter's ability to use the application.

Overcoming the Hurdle of Low Education

WhatsApp does not place high demands on literacy, and thus helps low-literate persons to communicate. Because of the ease of watching/listening of video/audio contents (see Figure 8.8), and also of posting them, text is not used as a vehicle of communication in many cases. Many users, who cannot read or write in any language, or who find it difficult to type, find it easy to post a voice message, or at the least, communicate through emoticons.

Usable voice messaging is critical in overcoming the hurdles of low education. However usability of keyboards is also important especially in the case where a user can read and write in Indian languages. It is a comforting fact that in the last few years, India has seen a rise in smartphones. This is complemented by the advent of a number of Indian language soft keyboards. This means that a user is not constrained by the conventional keypad, which owing to the issues particular to Indic scripts, used to be unwieldy (see Joshi et al. [2011] both for a survey of keyboards and the challenges of designing them.). The user is also not forced to settle for the Romanized versions of Indian languages.

Discussion

How does WhatsApp Break and Re-establishes the User-Usage Model (or, does it really?) As we have discussed earlier at the start of the chapter, WhatsApp seemingly breaks the User-Usage Model by actually enabling many non-Account Holders to hold Accounts. These people, with conventional designs of the Account-based applications, would never have been able to do so owing to barriers arising due to age and education levels et cetera. WhatsApp breaks this assumption by bringing into the equation the role of design in helping a non-Account Holder to circumvent the barriers and be able to meet objectives, such as being on-line, share content, and manage identities et cetera, which have been hitherto unmet due to barriers in using conventional Account Holding application.

In spite of the above, we also find that there is a limit to what design could do for EUs. We have found that some users were not able to reap much benefit from WhatsApp's design while others were able to extract better. The U2 model is able to explain how that was possible. This is described as the following:

Basic Users do not get benefit WhatsApp allows 'Navigators' to hold accounts, it does not help 'Basic Users'. This is because WhatsApp requires some amount of 'Navigation' (for example, entering into the chat screen.) This could be beyond the capabilities of users who rely on hardware buttons to do single-step tasks such as pressing the red and the green button. Many users who are old and less educated do not own a smartphone.

One of the former says if his phone breaks or becomes useless, he is going to buy a similar phone as it's too much effort to learn the new ways of smartphones and that his life is good without one. A user of the latter type is reluctant to use a smartphone as he claims that it's tedious to learn all the 'new touch system'.

True Account Holders still perform better WhatsApp usage of the 'Navigators' differs vastly from that of true 'Account Holders'. True 'Account Holders' have high income, are better educated and are relatively young. They are known to handle e-mails, which means their conceptual understanding of an 'Account' is more advanced, and thus, they are aware of the strengths and weaknesses of different platforms. For example, a rickshaw driver tells the advantages of WhatsApp vis-à-vis Facebook demonstrating a nuanced understanding of 'Account Holding' platform. Another user, a housekeeper at a university, who had earlier worked at a mobile shop for five years, uses double layers of security, because his friends take his phone to check WhatsApp messages. Still another, user vehemently protects his WhatsApp data by using a third party software. These users do not simply use WhatsApp because it is easier to use, rather, they have a good repertoire of skills and a comprehensive understanding of digital technology into which WhatsApp is integrated well.

Exception to the rule proves the rule The fact that the emergent users can handle 'Account Holding' in form of WhatsApp only, makes it an exception to the following rule—the Basic Users, Navigators and Savers (they are positioned below Savers) cannot accomplish 'Account Holding' tasks. However, the exception does not arise due to any breach of rule because the user-task gap is real and wide, and it is very unlikely that a 'Navigator' or a 'Basic User' could operate typical 'Account Holding' applications. The exception, rather, comes from the fact that WhatsApp has used design innovation to circumvent the rule in such a way that a user can start an account, send and receive content and secure its content in ways unimagined earlier.

8.4.3 Design Directives

We were able to identify design directives for facilitating adoption of applications by the Emergent Users. These design directives are given as follows:

- Re-examining the assumptions about features required: Often many things that are demanded by or considered essential for the non-emergent users are either too complex or non-critical for emergent users. They need to be moved out in order to reduce the number of choices. Too many choices only increase the complexity of the system.

- Automation: Automate the tasks that are complex. One might be required to forfeit flexibility and control in the process.

- Simplify Interaction: This can be done by constructing tasks that are based on simple conceptual models, reducing the navigation hierarchy, and reducing the number of steps to accomplish a task.

- Delegatees are also Emergent Users: Less frequent but critical tasks, like registration are often delegated. However, the delegatees usually themselves are emergent users, though slightly better than the delegators. Therefore simplicity of interaction is important in case of less frequent tasks too.

8.5 Summary

Using the user-usage model as the theoretical lens, we traced the user-task chasm that exists between the emergent users and 'Account Holding' applications. With the support of contextual interviews we were able to demonstrate that the design features of WhatsApp creatively circumvent this chasm and allow emergent users to become 'Account Holders', a goal that would be considered impossible from the user-usage model's perspective. Thus the study seemingly breaks the model. However, from another perspective it re-establishes the model due to the fact that WhatsApp is still difficult for 'Basic Users', and due to the fact that true 'Account Holders' are able to use WhatsApp more efficiently than 'Basic

Users' or 'Navigators'. It also helps in re-establishing the model by showing that the rule–emergent users cannot accomplish 'Account Holding' tasks–has strong reasons but could be circumvented with the help of design.

Chapter 9

Summary and Conclusions

9.1 Contributions

9.1.1 The User-Usage Model

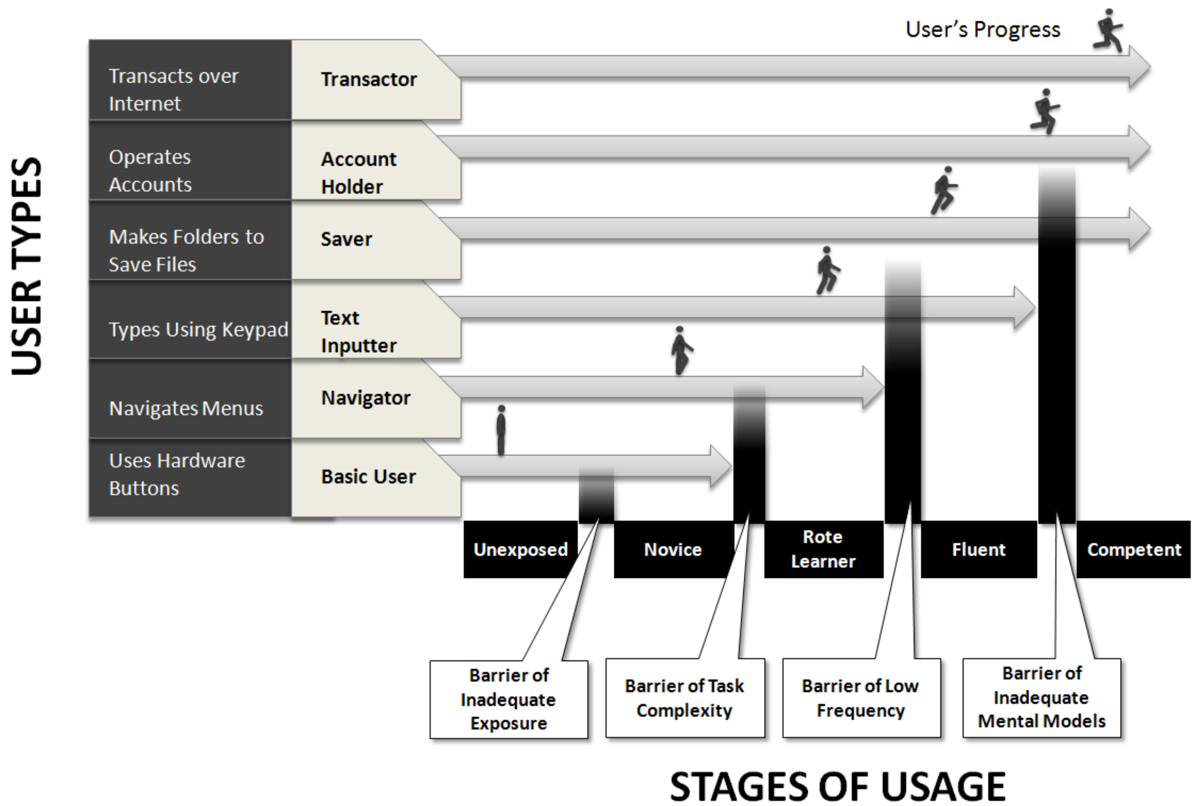


Figure 9.1: The User Usage Model

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The primary contribution of this work is the User-Usage model (Figure 9.1, refer to Chapter 6 for the details).

The model does not merely inform about the success or non-success of Technology Adoption by the Emergent Users, it brings forth its nuances in the form of its various classes. The classes have been described in Chapter 6 and operationalised in Chapter 7. As shown in the figure, each class of Technology Adoption has two dimensions—the User Types (vertical) and the Stages of Usage (horizontal). Both the dimensions are ordinal.

A User Type is an archetypical category of the usage-patterns (See Section 6.3). A Stage of Usage is the level of adeptness, among many, with respect to a given User Type (See Section 6.2). There are five User Types. *Basic Users* only do the tasks that require one or two presses of hardware buttons. *Navigators* can navigate menu hierarchies. *Text-Inputters* can type text. *Savers* can follow, design and manage directory structures to save files. *Account Holders* can manage account based applications, such as e-mail. *Transactors* have enough trust online to commit their money. The User Types are arranged in the order of increasing ability to deal with complexity (for example, Savers deal with more complex tasks than Basic Users).

The Stages are punctuated by the barriers whose difficulty levels vary across the User Types. A Stage is reached by a user, over time (ranging from minutes to years), by crossing the barriers. There are four barriers, those of *inadequate exposure, task complexity, low frequency (of usage)* and *inadequate mental models*. The five Stages resulting from the barriers are *Unexposed*, *Novice* (cannot deal with task-complexity), *Rote-Learner* (memorise tasks in the form of recipes or routines), *Fluent* (same as Rote Learner but have done tasks a large number of times, so exhibit better command) and *Competent* (have adequate mental models, so can put their knowledge to new situations, which others could not.) The Stages are also arranged in the increasing order of difficulty of barriers.

User related constructs such as Age, Education level and Gender could be used to predict a user's 'placement' (that is, identification of the set of classes to which a user has a maximum probability of belonging to) in the model.

The 'placement' has important implications. Firstly, it informs *who is the user* in terms of her/his broad usage patterns. It is about the type of usage, while using ICT artefacts, the user is *predisposed* towards. It informs whether (s)he would do only the tasks that are absolutely basic such as accepting a phone call, or could (s)he do the complex tasks such as buying things online. Secondly, the model informs *what does the user do* in terms of her/his actual behaviour with respect to the ICT artefact. In other words, in which manner (s)he would perform the tasks? Would (s)he merely memorise a task as a recipe or would (s)he develop a comprehensive understanding in the form of mental models which (s)he could use to deal with novel situations.

The placement is decided by the rules that have been derived from the analysis of contextual studies and the literature pertaining to Technology Adoption by the EUs (Chapter 5). The causal relationships between various user-related constructs (Age, Gender et cetera) and the User Types/Stages of Usage have been identified. In addition, constructs from both the sets have been operationalised (in Chapter 7).

The following example illustrates the placement of a user on the model. It shows how (the value of) Age could be used to predict the extent and nature of Technology Adoption. We have known, from the studies and the literature, that old age affects the cognitive abilities negatively. Therefore, a 55 years old person would have more difficulty in dealing with task complexity in comparison to a 25 years old. The (operationalised/quantified) model reflects that by classifying a 55 year old person as a 'Basic User-Novice' (Figure 7.28). As the model also provides the descriptions of the usage (Chapter 6), we are informed that a user classified as 'Basic User-Novice' would perform only the tasks that could be accomplished in one or two steps. These tasks would not require memorising them as recipes/routines or need mental models. The user would have very few goals that (s)he would like to accomplish using an ICT artefact. (S)he would also have a low self-efficacy regarding usage of ICT artefacts in general. In this manner, the model may help predict the usage, if the design of a new ICT artefact is specified.

We have found that Age, Gender and Education levels to be the highly significant factors (Section 7.5.2). Given that these are readily available from the census data, it enhances the applicability of the User-Usage model. A prediction based on the User-Usage model about a population, using census data, would have sufficient validity as wells as ease of operation.

9.1.2 The Methodology

The other contribution is methodological. We have been able integrate a large repertoire of methods. The methodology involves:

1. *Identifying the constructs from the context*: We have identified (1) the constructs affecting, (2) the triggers for initiation of, and (2) the barriers that hinder Technology Adoption. We have identified them through investigations done in the users' contexts (Chapter 5) where they lived and worked while they used their ICT artefacts. The need for contextual studies was motivated by an appreciation that a given EU context is likely to be unique. Many of the issues pertaining to ICT usage might be without precedence (such as the role of community in the learning of ICT usage), might acquire new forms (such as, spatial discrimination leading to non-access to artefact) or might be more significant in comparison to the other contexts (for example, levels of education).

2. *Describing the Technology Adoption in terms of usage patterns and behaviours with respect to a given technology landscape*: We have described the usage patterns and the behaviour in terms of various User Types/Stages of Usage (Chapter 6). Instead of stating that a technology has been adopted/not adopted by a user, we are able to inform *to what extent* and *in what manner* it has been.

3. *Building and quantifying a model, which involves establishing relationships between the constructs and the classes of Technology Adoption*: We have operationalised the user-related constructs and the User Types and Stages of Usage (Chapter 7). We have also established the relationships between the two sets statistically. The data for operationalisation was collected by visiting (another set of) users in their contexts and observing their ICT usage. We have been able to predict, for a proportion of the Indian population, how many persons would belong to the different User Types and Stages of Usage, and by implication, depict different types of usage patterns

and behaviours (Chapter 8).

4. *Validating the model through analysing a design or through the act of designing*: We have applied the model as a lens, and (another) contextual study, to understand the widespread adoption of WhatsApp in India (Chapter 8). In the contextual study, we interviewed about and observed the usage of WhatsApp by the EUs. This also helped us identify the design principles which could be employed to design ICT artefacts for the EUs. We have not used the model to design an ICT artefact.

9.1.3 The Term: Emergent User

Another important contribution is the term 'Emergent User' (Section 2.1) which may be used to inform about the users who are likely to have low incomes, low education, live further from the urban centres, or have less social and political power. This term provides a contrast between the users for whom ICTs have been traditionally designed and the ones who have been neglected in this regard. Highlighting of this contrast is necessary because the approaches employed for designing ICT artefacts for the benefit of the non-EUs are likely to not work in the case of the EUs. This is because, inherently, the latter are disadvantaged on many accounts such as literacy and income, which negatively affects their ability to use and learn the ICT artefacts. The important aspect of this definition is that it plays its role without affecting the dignity and hope, absent in the terms like 'the digital divide' and 'the bottom of the pyramid'. Moreover, the definition is flexible enough to contain a large number of scenarios such as the urban poor, people with disability and women.

9.1.4 Highlighting of the Importance of HCI for ICTD

This research, when placed into the broader domain of ICTD, may help highlight the importance of HCI(4D) approaches. Firstly, it highlights the criticality of the user and the usage, an HCI concern, in ensuring the effectiveness of ICTD interventions. Secondly, it demonstrates that how a contextual understanding derived from the observation of the users' interaction with their artefacts, essentially an HCI approach, could provide strength to the quantitative models

9.2 Theoretical Issues

> In spite of a well-intentioned artefact, without the ultimate beneficiaries initiating and sustaining usage, the benefits would not materialise.

The above statement encompasses the idea behind Technology Adoption by the EUs. A neglect of this issue can negatively affect the efficacy of an ICT intervention for the EUs. It becomes all the more important when it is widely appreciated that Information and Communication Technology (ICT) holds promise for development (Section 2.4). This research is based on the recognition that there is a gap between the EUs and the designers of ICT (Section 1.2), who are likely to be educated and urban and, therefore, are likely to be non-EUs.

We have aimed to develop this research in the form of an applicable model which could be used to describe and predict Technology Adoption by the EUs leading to design of more meaningful artefacts for them. The model is supposed to work in tandem with other methods employed in the practice of ICT design. The strength of the model (and its underlying theory) lies in four types of powers (see Section 1.3)—Rhetoric, Descriptive, Inferential and Application. We will examine how the model fares on these accounts:

- Rhetoric power: The model has provided many terms which have been defined rigorously. They may be used to convey complex ideas without being ambiguous. The terms have very specific meanings and could be used in conversation without a corruption in meaning. Some of the terms—'Emergent User', 'User Types' and 'Stages of Usage'— have been described above. In addition, there are other terms, such as 'Basic Users', 'Navigators' (Chapter 6) 'Advantage' and 'Disadvantage-offset' (Chapter 7).

- Descriptive power: It means the ability to describe the causes of a given effect. The model has been validated quantitatively as well as by using it to explain the case of successful adoption of WhatsApp among the Indian EUs. These two exercises helped define its various components and their relationship in a systematic manner. As a result, it is likely that it could be used to describe another phenomenon regarding Technology Adoption.

- Inferential power: It means the ability to predict the potential effects of a given cause. Inferential power is based on the same factors on which descriptive power is. If the components and their relationships are well defined, then a model can predict outcomes based on the causes that are presented to it.We have done that in a limited way by predicting, using census data, how many people, in a subset of the Indian population, would belong to the different User Types and Stages of Usage (classes of Technology Adoption describing the usage patterns and behaviour).

- Applicative power: It arises from all the above three powers. We have discussed the applicability in Sections **??** and 9.5.

9.3 Validity

The User-Usage model is based on the research done within the actual contexts and environments of the Emergent Users in India while they performed their normal activities at work, leisure and homes. The focus was on observation of the tasks done by the users rather than self-reported measures. This applied to all the studies—the first one for identifying the constructs, barriers and triggers; the second for operationalising the model and the third for applying it for explaining the success of WhatsApp in India. The locations included rural and semi-urban areas, along with a couple of urban areas, in 14 districts from the Northern, Central, Western and Southern India involving (around) 150 users. The interviews were done in the local languages. Mediators were recruited in some cases, particularly when the users did not speak Hindi or English, languages spoken by me.

Though the constructs were identified using contextual studies, the validity of the operationalised constructs, except the demographic constructs such as Age, Gender and

Education levels, may be inadequate. This was due to the challenges in operationalising many of the constructs such as Self-Motivation, Anxiety et cetera. Part of the challenge arose because we have used single item instruments (as part of the larger questionnaire). Secondly, precedents for many of these instruments were found only in their application in the non-EU contexts.

The validity of Stages of Usage may also be inadequate because finding out if a user has an adequate mental model was found to be difficult. On the other hand, User Types' validity may be adequate because they were ascertained on the basis of observation of the tasks performed by the users.

The validity of prediction would depend on the validity of the independent and dependent variables. We were helped by the fact that Age, Gender and Education levels had been found to be highly significant. The fact that these were demographic variables, and available for the whole population in the form of census data, contributed to the validity of prediction.

We have used the model as an analytical framework and have been able to explain the success of WhatsApp in the year 2017 in India and derive design principles. This contributes to the validity of the application of the model for design.

9.4 Relationship with Other Theories

We have paid a tribute to 'Laws of Imitation' by Tarde [1903], one of the earliest work on Technology Adoption. It mentions 'imitation' as a mechanism of adoption. Imitation itself is dependent upon observation (of the others using an artefact) and trialability. We have asserted that usage is inherent in these two facets of imitation. By incorporating the mechanisms of usage, we have added to Tarde's conception of diffusion of innovation. As suggested by him, we have also employed statistical methods to predict the diffusion (of technology) in society.

The User-Usage model owes to two successful models of Technology Adoption—The Technology Acceptance Model (TAM) by Davis [1986] and the Diffusion of Innovation (DoI) by Rogers [1962]. However, the User-Usage model's approach to the problem of Technology Adoption, given that it is particularly oriented towards the EUs, is different from them in some ways. Firstly, it is developed through the observation of actual usage behaviour of the users' with their own ICT artefacts in their actual living and work habitats. Secondly, it takes into account that for the EUs, the tasks may have fluid goals (such as listening to a song). In other words, not all tasks may have concrete and time-bound goals (such as photocopying a document). Thirdly, the unit of analysis for the model is usage which involves (the profile of) the user and (the design specifications of) the artefact. This is different than studying Technology Adoption primarily as a social phenomenon. Fourthly, by making usage as the unit of analysis, we are able to arrive at an important insight—the diffusion of an innovation would change from context to context. The capability of technology-adopters to try out a new technology may be different for two sets of populations, for example, the EU and non-EU. That means, a technology's chance of being adopted, whether by the early adopters or the late, would differ according to the context, which will reflect in the level of adoption with respect to the population as a whole.

We also owe to models such as Skill Acquisition model by Dreyfus and Dreyfus [1980] which have provided us with the basis for the Stages of Usage. Dreyfuss' model is rooted in military aviation and, thus, is more bodily than cognitive. We have utilised an adaptation of it by Hackos and Redish [1998] which is oriented towards ICT artefact.

9.5 Design Guidelines

The primary focus of design should be on Basic Users and Navigators, the categories dominated by the EUs (55% of the sample)(see Table 7.13). These two sets of users have disadvantages in terms of ability to read and write. They also have difficulty in dealing with the cognitive demands of the tasks. Cognitive demands can arise if the task requires good mental models or very complicated set of rules (to be remembered).

Lack of mental models, inability to read and write and task-complexity are critical disadvantages faced by the EUs against Technology Adoption. However, there are also some advantages available to them, which if harnessed, could be helpful. The first advantage occurs due to a user's internal motivation to use an ICT artefact (see Section 7.5). The second due to the fact that learning the usage of ICT from the community is common in the EU contexts (see Section 5.3.3).

Therefore, to design for the EUs (from the perspective of the contexts of the ones interacted with during the studies contributing to this thesis) the following principles could be employed.

9.5.1 Examine the Utility of the ICT Artefact

Users are likely to learn and frequently do those tasks which lead to goals having high utility in an efficient manner. Using the phone for listening to songs is an example. The utility of a goal may change according to the context. We have found, socialising and entertainment to be high utility goals.

9.5.2 Minimise

Minimisation, firstly, means *reducing the number of steps* required to accomplish a task. As we have seen (in Section 6.2.3), many tasks could be rote-learnt. A large number of steps increases the cognitive load and chances of error, which may lead to an abandonment of the task.

Minimisation, secondly, should also be applied to *the length and breadth of a menu*. As the WhatsApp study has shown (Chapter 8), many complex goals (such as Account Holding) could be achieved only through Navigation. As a large number of the EUs are Navigators, this may help them. Therefore, it becomes important to reduce the cognitive load involved with the navigational tasks. An ideal menu would be one with less number of options and levels. As WhtasApp's example shows (see Figure 8.5), a width of three options and depth of one level is an adequate design.

Minimisation, thirdly, also means a *reduced set of functionalities*. Very often the EUs do not have the capability to handle a functionality which does not add value vis-a-vis their needs. In such a case, an extra functionality only adds to the cognitive load. Therefore, it is highly desirable to examine what functionality should be removed from a design.

9.5.3 Reduce Dependence on Text

It could be done through non-textual aids such as icons and sounds and also using only the numbers. Firstly, non-textual aids could be used to help navigation. For example, a 'stem-and-branches' representation of a menu can act as a visual guide for navigation. Secondly, non-textual aids can also help in the identification of names in a list. For example, contacts could be saved as icons or pictures. In addition, non-textual aids can help in communication. For example, a variety of emoticons may be employed to communicate basic messages depicting, for example, affirmation, surprise and query. In this regard, it may be worthwhile to refer to a paper by Medhi et al. [2006], where they have used semi-abstract graphics to design an application for job search for the urban EUs.

The role of voice-based user interface could play a role in enhancing the usage by the EUs. However, the design of a voice-based interface may involve its own set of challenges (as has been discussed in Section 9.6.

9.5.4 Simplify the Conceptual Model

Inadequacy of mental model forms the greatest barrier against Technology Adoption by the EUs (see Section 7.6). Therefore, the complexity of the designed conceptual model(s) should be minimised.

To achieve that one can design an artefact in such a way that only a limited number of conceptual models are needed to perform a wide variety of tasks. In other words, many tasks of different types could be performed in the same manner. For example, (see Figure 8.6 in Section 8.4.2), WhatsApp uses a single conceptual model for all the three—posting a message, posting a video and attaching a file.

The other way mental models could be simplified is by basing them on the analogous tasks present in the physical environment of the user. The user should be able to easily map them from the physical space to the digital space. For example, as described by Medhi et al. [2006] while discussing a design intervention for household workers seeking employment, the users could not understand a two-dimensional matrix resulting from the following two entities—(1)the different types of work required, and (2) the different rooms in the house. The abstract idea of a two-dimensional matrix might have been understood easily by an educated user, the EUs appreciated a representation in the way things happen in the physical space. In this case, the representation that mapped the work explicitly on every room was successful.

9.5.5 Translate the Terms Carefully

We have seen (in Section 5.3.1) that the EUs found it difficult to deal with Indian language interfaces. As a result, the users are forced to use the English language interfaces. As English is not the first language of the users, the interfaces are not likely to be comprehended fully. A proper solution is to arrive at the terms in the native languages that harmonise well with the users' context. Many of the issues of the native language interfaces and their solutions have been highlighted in the work of Ray [2012] (for Bengali) and Welankar et al. [2010] (for Marathi).

9.5.6 Improve the Spontaneity of Usage

The total time of interaction and the motivation to use an ICT artefact improves if the artefact is immediate to the user. This means, firstly, that the artefact remains in proximity to the user as much as possible. The requirement should be viewed along with the fact that a user is expected to be mobile in a wide variety of situations (riding on a motorbike, for example).

Secondly, it means that the time between the intention to do a task and the moment the artefact is 'up and running' to accept the task should be minimal. When the user (in Section 8.4.2) told about WhatsApp, "Just open it and it gets started...", he was referring to this ability. A large gap between intention and the readiness of task would hamper the motivation and, thus, the frequency of tasks.

Thirdly, it means managing the barriers of interruption (see Section 5.3.1 whether those of carrier signals, electric power, talk-time, physical security of the device or the functioning of the device. These are systemic-level problems, but the solutions could be found at the level of the artefact (as demonstrated by Robinson et al. [2018]).

9.5.7 Automate the Tasks.

As discussed in Section 8.4.2), WhatsApp automates many tasks which reduces the cognitive burden on the user. Automation would require that opportunities be sought for beyond the application. WhatsApp, for example, fetches the address list from the phone's address book.

9.5.8 Increase the User's Engagement

Some of the disadvantages of the 'unchangeable' variables such as Age and Gender could be offset by the 'changeable' ones such as Proactiveness (Section 7.6). Therefore, it may help if a user's Proactiveness level could be enhanced through design.

Proactiveness could be enhanced if the tasks are designed to be *emotionally and creatively fulfilling* for the users. We have observed users frequently changing ring-tones and wallpapers. This is indicative of a user's need to engage with their artefact in ways that are not strictly utilitarian. As Rangaswamy and Cutrell [2012] have shown, emotionally fulfilling activities, such as downloading songs for listening, along with the associated activities, such as installing anti-virus programme, can increase the user's engagement with his artefact.

Socialisation is an important contributor to Proactiveness. As we have seen in many examples in Chapters 5 and 8, the need to be in touch with the family or friends is an important goal. Often the usage of ICT is initiated to meet these type of goals. It means, if an ICT artefact enhances the activity of socialisation, it is likely to be engaged with. Better Together Toolkit, a framework for distributing the interaction on many devices for the Emergent Users, by Robinson et al. [2017] depicts many possibilities in this direction. For example, it allows users to collaboratively use their devices for activities like shopping. One can imagine about the level of engagement for a group of young shoppers as it shops together using their devices.

9.5.9 Consider Systemic Interventions

The solutions to many problems may be present beyond the artefact. It could be in the system in which the artefact is used. As we have discussed earlier in this section, the problems and solution regarding common interruptions lie at the systemic level.

The social system forms an important aspect of the EU contexts and it would be important to utilise its strength. We have seen (in Section 5.3.3) how the users learn the usage of ICT artefacts from the other users in their social groupings. Therefore, it is pertinent that the skills and knowledge present in the community are easily shared between the users.

The availability and level of the technology-related skills may not be high, which makes the role of self-motivated technology leaders (see Section 5.3.2) important. The level of skill within a community cannot be more than that of the technology leaders. Therefore, it may be worthwhile for the institutions to engage and mentor them. As discussed in the next section, they can also function as trust-mediators between the users and the institutions.

9.5.10 Build Trust

Building of trust on the artefact, and the institutions responsible for its making and functioning, is important. Distrust results in the abandonment of an artefact (see Section 5.3.2).

Trust, firstly, could be ensured, by helping the *user control* the processes that affect him. For example, controlling the cost is very important for the EU. It would help if a user can know and control the cost of the services he subscribes to. The second critical aspect is of privacy. If an interface is transparent and offers control regarding a user's privacy, it is likely to be adopted well. It must be added that the complexity of an artefact negatively affects the user's ability to control the processes.

From an institutional perspective, trust could be enhanced by reducing the *power asymmetry* between the institution and the user. One way to do is to inform the user about the redressal mechanisms. The other is to employ trained mediators from the user's community (technology leaders could be ideal candidates) who can form a link between the institution and the user.

9.6 Generalisability

- How would the User-Usage model work in times of Chatbots and Voice Assistants?
- Would the User-Usage model work in South Africa or Brazil?
- Would the User-Usage model be utilised in the UK?

These questions challenge the generalisability of the model. From the perspective of the first question, the resurgence of Artificial Intelligence (AI) means that much work of user-ICT interaction could be done by the algorithms. That may have an impact on the Emergent User for whom technology offers a way to interact naturally through voice and using natural language. For example, a farmer may be able to simply voice a query and receive the reply in the form of audio.

The second question is based on the fact that the model has been built on the data from the rural and semi-urban contexts in India (in the second decade of the 21st century). How is it applicable in the other EU contexts?

The third question points towards the potential of applying the model to the non-EU contexts given that it has been emphasised that the model is oriented towards the EU contexts.

While attempting to answer, we would posit that Technology Adoption by the Emergent

Users is difficult to predict. The reason is the complexity and dynamism of the issues of usage, which are specific to their contexts. For example, when the apparent adoption of mobile phone for finding market price by fishermen (in Vota [2016]) was probed into, it was found that many complex social and economic issues had actually hampered the stated use (finding the market prices). The problem is exacerbated with the rise of new technologies. In spite of the above, there are some conjectures we could make.

There still would be emergent users and designing for them would be a challenge We have seen during our research, that many users, even after using their devices for around 10 years, remained Basic Users or Navigators. The reason was that the user-related factors such as (low) education did not change drastically for them. In view of this observation, we expect that 10 years from now (2018) we'll still have several Emergent Users.

On the other hand, we also expect new emergent users to be added to the pool. Given the fact that rural teledensity in India is still 56.25 but increasing (according to Telecom Regulatory Authority of India [2018]), there will be Emergent Users who would buy their first devices. A number of young adults will also join the population. Not all the additional users will be well educated or have a high disposable income and therefore would count as Emergent Users.

The abilities of the future Emergent Users and the technology environment will be quite different though, and, therefore, the model will surely need corresponding adjustments. For example, well-designed speech applications may reduce the importance of Text-Inputter category. However, the aspects pertaining to mental models, trust and cognitive load would still be important. Therefore, the guiding principles (Section 1.7) of the User-Usage model may help a designer to assess the capabilities of different types of users, within a context, with respect to a given design.

In addition to the above, newer issues, such as emotional qualities and privacy, may become more important. Currently emerging work (primarily in the non-EU context) dealing with the new technologies highlights some of these issues. From these studies, it becomes clear that the capabilities of the new technologies are not sufficient. They need to be carefully complemented with an understanding of the interactions between the users and the technology. For example, Thies et al. [2017] have found that the perceived personality of a chatbot plays an important role in the building of the trust between the user and the machine. Cowan et al. [2017] suggest that understanding of mental models of intelligent personal assistants (IPA) and their effect on interaction is little understood. Luger and Sellen [2016] list the types of efforts required on a user's part for interacting with a conversational agent (CA). The list, according to them, includes devising and testing strategies for efficient usage and creating dynamic mental models. Cho [2018] also inform that users form strategies to extract relevant information from Home Virtual Assistants (HVA).

The traditional UI will remain relevant: Many types of information could be used efficiently when arranged as a hierarchy. (Voice-based interaction becomes particularly difficult as the hierarchy needs to be remembered.) Exploring the options with respect to availability, preferred dates and class while buying a train ticket is an example where hierarchical menus are effective. Therefore, the role of traditional interfaces which would remain relevant in the near future along with chatbots and voice assistants.

Grover [2016] while commenting on the limitations of purely conversational apps, states, "purely conversational metaphor makes us surrender the full gamut of choices we'd otherwise have in representing each facet of the task in the UI and how they are arranged spatially and temporally". For example, traditional UIs offer quick recognition and access to information (including its features). On the other hand, in conversational UIs (such as chatbots and voice assistants), one may have to remember or search through the conversation which involves additional cognitive load.

It needs to be carefully examined if and how the barriers faced by the Emergent Users hamper the use of the new technologies. For example, text-based conversational UIs will be affected by the inability to read and write. On the other hand, voice-based conversational agents are prone to the non-retention of information. Conversational agents (behind chatbots and voice assistants) may misconstrue a meaning or intention leading to a break down in the task. This might become an issue when the cultural aspects of an Emergent User's context is ill understood. The fact that the state of Artificial Intelligence has still not advanced (for example, see Simonite [2018]) enough to facilitate an error-free conversation, only adds to the problem.

Conversational agents depend on Artificial Intelligence engines. They need to be tuned for a specific context (such as for a given language) and purpose. A tuning exercise can become extremely difficult, especially due to lack of an institutional effort, for the variety of needs and contexts of the EUs.

Traditional UI constrains interaction by restricting the possibilities and thus lowers the cognitive load. For example, if there is one submit button on an interface, then there is only a single action possible. In contrast, conversations are contextual as well as situational. A produced response or expected input may depend on the context of the whole conversation and may take many forms.

The emerging technologies have potential, but also have inherent limitations of their own Artificial Intelligence based technologies have a dependency on the developers who encode'knowledge' in them. The (Speech and Natural Language Processing) engines have to be tuned for specific groups of users, a time consuming task, in order they work satisfactorily. Given that the world-views, needs and contexts of the Emergent Users are not only distant from the global urban population but also heterogeneous, it may be difficult and expensive to (license and) tune the speech-engines for a substantial portion of the Emergent Users. From that perspective, traditional User Interface has utility. Quite critically, many of these technologies are data-driven. Therefore, the political-cultural bias in the data may affect the performance of the AI engines (as flagged by Gallagher [2018])

The main challenges would arise from the fact that many of these technologies are in their nascent stages (for example intent-recognition is still difficult) and it is not clear how they would fit and disrupt the future (particularly the EU) contexts. For example, it is difficult to say that in 2020 what type of questions a farmer from Orissa, would like to ask a pocket voice-assistant (apart from "tell me the weather five days from now?") and how should be an appropriate response be framed for him.

Contextual studies will remain important A given technology, at any level of advancement, is unlikely to cater to the needs of a user if his needs and contexts are not well understood. A voice assistant is not expected to work properly in an urban settlement like Dharavi where there is noise and dust all around.

The User-Usage model is sensitive to the context. It is envisaged to be transformed and adapted according to the different contexts. The guiding principles (from Section 1.7]) of the User-Usage model are as follows:

- User populations are not homogeneous.
- Different users have different levels of capability to handle ICT.
- A user's ability to achieve a goal depends upon her/his capability to handle ICT artefacts.
- The capability to handle an ICT artefact depends on its design.
- The capability to handle a particular design (of ICT artefacts) by a user probably depends upon the user's characteristics.
- The usage behaviour with respect to a given ICT artefact will depend on the user's capabilities and therefore on her/his characteristics.
- The usage behaviour may evolve over time. However, that too is dependent on the user's capabilities and the given design.
- Design can help the user achieve her/his goals provided it is in done in accordance to her/his capabilities.

The above mentioned principles could be applied to a large variety of contexts, both the EU or non-EU. The difference would be in the user-related constructs that may affect Technology Adoption. The methodology (discussed in an earlier section) requires that the constructs need be identified for each context. For example, in the context of Kenya, device security may become an important construct (see Wyche et al. [2010]). The generalisability of the model also results from the fact that the definition of the

Emergent User is not deterministic in nature. It depends on the effective total of the disadvantages that bar a user from accessing, learning and using the ICT artefacts, the promise of technology in reduction of this gap, and the potential benefit of ICT. From this perspective, the elderly population in the UK may also be considered as Emergent Users. However, their issues related to Technology Adoption would be different from the context of an Indian EU.

An important question would be—can this model be used for designing for the non-EUs? In a sense, it is applicable to the non-EU context as well because the above mentioned principles are true for any context. In a non-EU context, too, the users differ from each other. For example, age, gender and education levels (for example, the difference between the engineers and the non-engineers) would still matter. Moreover, user-related constructs, within a given context, would affect the nature of Technology Adoption. For example, need for entertainment may be important for an elderly lady in Bangalore, while for her software engineer son, it may be productivity.

9.7 Future Work

Many of the variables such as Prevalence, Self-Efficacy and Social status may have an effect on Technology Adoption. However, they have turned out to be non-significant. They need to re-operationalised, preferably in form of a individual studies dedicated to them.

The model has been used for explaining the successful adoption of an application. It is desirable that the model is used for designing and evaluating ICT artefacts.

The model has been developed in the context of rural and semi-urban users who are literate below class XII^{th} and were 25 to 55 years old. It is desired that the model is re-defined for other contexts, including the non-EU. This will include re-investigation of the user-related constructs that may affect Technology Adoption.

The model is oriented towards classical user interfaces, such as those involving visual navigation and text. It is desired that it is re-defined for newer technologies such as chatbots and voice assistants. As these technologies are very new, there is scarcity of their contexts of usage. In that case, these contexts have to be synthesised in form of designed experimental setups to identify the issues that Emergent Users may face in their usage. One of the ways it could be done is by using mock-ups with Wizard of Oz technique.

It is also analyse future public interventions with the help of User-Usage model. Important examples are payment gateways, e-governance and healthcare services.

It is also envisaged to investigate the relation between broader social system and ICT usage. For example, how does it affect the persons who already have power or gain power through usage? How the ICTs become a medium for individual and community-based self-expression? How the ICTs act as a site for the interplay of discourses? and how the flows of power/discourse decide the design of an ICT artefact?

Appendix A

Questionnaire

Item. No.	Item Type	Prompt/Question
1	Session Particulars	Time
2	Session Particulars	Date
3	Session Particulars	Place
4	Screener	Do you have your phone with you?
5	Screener	Has anyone interviewed you in within last 6 months?
6	Screener	When did you first use a mobile phone?
7	Screener	When did you use mobile phone the last time?

8	Opening Instruction	It is needed to make technology, like mobile phones, easy to use, because it is being adopted by common people. We are fom IIT Bombay is a big engineering university of government of India and are doing research on this problem only. The results of this research will be available for everybody. We are not related to any private company. We want to see how a common man uses a mobile phone in his daily life and what kinds of difficulties he faces while doing that. The objective of this interview is to test the technology. It is not about testing the human. For this, we would like to ask you a few questions and also would like to see you do things on your mobile phone. We do not need your personal information like name or address. However, we would need your phone number (which we would not share with anybody) so that if we have a doubt we can call and ask you.
8	**Demographics**	
9	Age	What is your age?
10	Job	What work do you do?
11	Education	Which class did you pass?
12	Screener (for females)	How many years have passed after your marriage?
13	Screener	How many years have passed since you joined your current job?
14	ID	Give an ID
15	Gender	Gender

16	**Income Level**	
16.1	Income Level	Out of the following, what things do you have in your home?
16.2	Income Level	Does your family have farmland or fruit orchards?
16.3	Income Level	Who is the highest earner in your family?
16.4	Income Level	What class $max_earner has passed?
16.5	Income Level	What degree or diploma $max_earner has earned?
17	**Prevalence/ Power/ Proactivity**	
17.1	**Family**	
17.1.1	Community Size	How many people are there in your family?
17.1.2	Prevalence	How many people in your family knows use of mobile phone better than you?
17.1.3	Barriers	Who all, in your family, has helped you learn mobile phone?
17.1.4	Proactiveness	Who all, in your family, you have helped you learn mobile phone?
17.2	**Neighbourhood**	
17.2.1	Community Size	How many people, approximately, are there in your neighbourhood?
17.2.2	Prevalence	How many people in your negihbourhood knows use of mobile phone better than you?
17.2.3	Barriers	Who all, in your neighbourhood, has helped you learn mobile phone?
17.2.4	Proactiveness	Who all, in your neighbourhood, you have helped you learn mobile phone?
17.3	**Workplace**	
17.3.1	Community Size	How many people, approximately, are there at your workplace?

17.3.2	Prevalence	Hpow many people at your workplace knows use of mobile phone better than you?
17.3.3	Barriers	Who all, at your workplace, has helped you learn mobile phone?
17.3.4	Proactiveness	Who all, at your workplace, you have helped you learn mobile phone?
	Individual Characteristics (except proactivity)	
18	Self-Efficacy	Imagine that you buy a new phone, which is completely different from your current phone.How much time you will take to learn it completely, in other words, 100 per cent?
19	Computer Anxiiety	Imagine that you buy a new phone, which is completely different from your current phone. Imagine you pick this phone in your hands. What kind of feeling do you get?[-1]: I will feel anxious. [0]: It would not matter. [-1]: I will enjoy.
20	Pride	Do you think having or not having a mobile phone has any effect on pride (honour in society) of a person? [-1]: No, not at all [0]: It does not matter. [+1]:Yes, a lot
21	Utility	Mobile phone [-1]: Is a useless thing/ It does not serve a purpose/It should be banned. [0]:Does not matter if I have one (a mobile phone) or not . [+1]: Is a very useful thing/ it helps me in my work
22	**Phone Ownership History**	

22.1	**Current Phone**	
22.1.1	Type	What type (or kind) of mobile phone do you have?
22.1.2	History	When did you buy it?
22.1.3	Trigger	Why did you buy it?
22.2	**Last Phone**	
22.2.1	Type	What type (or kind) of phone was your lat phone?
22.2.2	History	When did you buy that?
22.2.3	Trigger	Why did you buy that?
22.3	**First Phone**	
22.3.1	Type	What type (or kind) of phone was your first phone?
22.3.2	History	When did you buy that?
22.3.3	Trigger	Why did you buy that?
24	**Tasks**	
24.1	By Self	What kind of things you are able to do on your phone?
24.2	Through Delegation	What kind of things you ask someone other to do?
24.3	**Task Details (will prompt depending upon values in 24.1 and 24.2)**	
24.3.1	**Buy on Internet [TRX]**	
24.3.1.1	Observe Speed	Using your mobile phone, buy something over the Internet (Observe-Speed)
24.3.1.2	Test Mental Model	Using my mobile phone, try to buy something over the Internet.

24.3.1.3	Test Rote Learning	Using your mobile phone, explain to me (teach me) how to buy something over the Internet.
24.3.1.4	Frequency	When did you last buy something over the Internet using a mobile phone (How frequently do you buy?)
24.3.1.5	First Instance	When was the first time you had bought something over the Internet using a mobile phone?
24.3.1.6	First Instance (through Delegation)	When was the first time you had asked somebody else to buy something over the Internet using a mobile phone?
24.3.1.7	Learning Time	How much time did it take you to learn to buy something over the Internet using a mobile phone?
24.3.1.8	Trigger	What was the need when you had for the first time bought something over the Internet using a mobile phone?
24.3.1.9	Utility	What was the need when you last time bought something over the Internet using a mobile phone?
24.3.1.10	Non-utility (in case of task not done)	Why DON'T you buy anything over the Internet using a mobile phone?
24.3.2	**Book Ticket-[TRX]**	
24.3.2.1	Observe Speed	Using your mobile phone, book a ticket (Observe-Speed)
24.3.2.2	Test Mental Model	Using my mobile phone, try to book a ticket.
24.3.2.3	Test Rote Learning	Using your mobile phone, explain to me (teach me) how to book a ticket.

24.3.2.4	Frequency	When did you last book a ticket using a mobile phone (How frequently do you buy?)
24.3.2.5	First Instance	When was the first time you booked a ticket using a mobile phone?
24.3.2.6	First Instance (through Delegation)	When was the first time you had asked somebody else to book a ticket using a mobile phone?
24.3.2.7	Learning Time	How much time did it take you to learn to book a ticket using a mobile phone?
24.3.2.8	Trigger	What was the need when you had for the first time booked a ticket using a mobile phone?
24.3.2.9	Utility	Why a mobile phone is needed to book ticket?
24.3.2.10	Non-utility (in case of task not done)	Why DON'T you buy anything over the Internet using a mobile phone?
24.3.3	**E Mail-[ACC]**	
24.3.3.1	Observe Speed	Using your mobile phone, send an E-mail (Observe-Speed)
24.3.3.2	Test Mental Model	Using my mobile phone, try to send an E-mail.
24.3.3.3	Test Rote Learning	Using your mobile phone, explain to me (teach me) how to send an E-mail.
24.3.3.4	Frequency	When did you last send an E-mail using a mobile phone (How frequently do you buy?)
24.3.3.5	First Instance	When was the first time you had sent an E-mail using a mobile phone?
24.3.3.6	First Instance (through Delegation)	When was the first time you had asked somebody else to send an E-mail using a mobile phone?

24.3.3.7	Learning Time	How much time did it take you to learn to send an E-mail using a mobile phone?
24.3.3.8	Trigger	What was the need when you had for the first time sent an E-mail using a mobile phone?
24.3.3.9	Utility	Why a mobile phone is needed to send an E-mail?
24.3.3.10	Non-utility (in case of task not done)	Why DON'T you buy anything over the Internet using a mobile phone?
24.3.4	**FaceBook-[ACC]**	
24.3.4.1	Observe Speed	Using your mobile phone, post something on Facebook (Observe-Speed)
24.3.4.2	Test Mental Model	Using my mobile phone, try to post something on Facebook.
24.3.4.3	Test Rote Learning	Using your mobile phone, explain to me (teach me) how to post something on Facebook.
24.3.4.4	Frequency	When did you last post something on Facebook using a mobile phone (How frequently do you buy?)
24.3.4.5	First Instance	When was the first time you had posted something on Facebook using a mobile phone?
24.3.4.6	First Instance (through Delegation)	When was the first time you had asked somebody else to post something on Facebook using a mobile phone?
24.3.4.7	Learning Time	How much time did it take you to learn to post something on Facebook using a mobile phone?

24.3.4.8	Trigger	What was the need when you had for the first time posted something on Facebook using a mobile phone?
24.3.4.9	Utility	Why a mobile phone is needed to post something on Facebook?
24.3.4.10	Non-utility (in case of task not done)	Why DON'T you post something on Facebook using a mobile phone?
24.3.5	**Copy Song/Picture-[SAV]**	
24.3.5.1	Observe Speed	Using your mobile phone, copy a song or a video (Observe-Speed)
24.3.5.2	Test Mental Model	Using my mobile phone, try to copy a song or a video.
24.3.5.3	Test Rote Learning	Using your mobile phone, explain to me (teach me) how to copy a song or a video.
24.3.5.4	Frequency	When did you last copy a song or a video in a mobile phone (How frequently do you buy?)
24.3.5.5	First Instance	When was the first time you had copied a song or a video in a mobile phone?
24.3.5.6	First Instance (through Delegation)	When was the first time you had asked somebody else to copy a song or a video in a mobile phone?
24.3.5.7	Learning Time	How much time did it take you to learn to copy a song or a video in a mobile phone?
24.3.5.8	Trigger	What was the need when you had for the first time copied a song or a video in a mobile phone?
24.3.5.9	Utility	Why a mobile phone is needed to copy a song or a video?

24.3.5.10	Non-utility (in case of task not done)	Why DON'T you copy a song or a video in a mobile phone?
24.3.6	**Search Internet-[TXT]**	
24.3.6.1	Observe Speed	Using your mobile phone, search something over Internet (Observe-Speed)
24.3.6.2	Test Mental Model	Using my mobile phone, try to search something over Internet.
24.3.6.3	Test Rote Learning	Using your mobile phone, explain to me (teach me) how to search something over Internet.
24.3.6.4	Frequency	When did you last search something over Internet using a mobile phone (How frequently do you buy?)
24.3.6.5	First Instance	When was the first time you had searched something over Internet in a mobile phone?
24.3.6.6	First Instance (through Delegation)	When was the first time you had asked somebody else to search something over Internet using a mobile phone?
24.3.6.7	Learning Time	How much time did it take you to learn to search something over Internet using a mobile phone?
24.3.6.8	Trigger	What was the need when you had for the first time searched somrething over Internet using a mobile phone?
24.3.6.9	Utility	Why a mobile phone is needed to search something over Internet?
24.3.6.10	Non-utility (in case of task not done)	Why DON'T you search something over Internet using a mobile phone?
24.3.7	**SMS-[TXT]**	

24.3.7.1	Observe Speed	Using your mobile phone, send an SMS (Observe-Speed)
24.3.7.2	Test Mental Model	Using my mobile phone, try to send an SMS.
24.3.7.3	Test Rote Learning	Using your mobile phone, explain to me (teach me) how to send an SMS.
24.3.7.4	Frequency	When did you last send an SMS using a mobile phone (How frequently do you buy?)
24.3.7.5	First Instance	When was the first time you had sent an SMS using a mobile phone?
24.3.7.6	First Instance (through Delegation)	When was the first time you had asked somebody else to send an SMS using a mobile phone?
24.3.7.7	Learning Time	How much time did it take you to learn to send an SMS using a mobile phone?
24.3.7.8	Trigger	What was the need when you had for the first time sent an SMS using a mobile phone?
24.3.7.9	Utility	Why a mobile phone is needed to send an SMS?
24.3.7.10	Non-utility (in case of task not done)	Why DON'T you send an SMS using a mobile phone?
24.3.8	**Save Contact-[TXT]**	
24.3.8.1	Observe Speed	Using your mobile phone, saved a contact (Observe-Speed)
24.3.8.2	Test Mental Model	Using my mobile phone, try to saved a contact.
24.3.8.3	Test Rote Learning	Using your mobile phone, explain to me (teach me) how to saved a contact.

24.3.8.4	Frequency	When did you last saved a contact in a mobile phone (How frequently do you buy?)
24.3.8.5	First Instance	When was the first time you had saved a contact on a mobile phone?
24.3.8.6	First Instance (through Delegation)	When was the first time you had asked somebody else to saved a contact in a mobile phone?
24.3.8.7	Learning Time	How much time did it take you to learn to saved a contact in a mobile phone?
24.3.8.8	Trigger	What was the need when you had for the first saved a contact in a mobile phone?
24.3.8.9	Utility	Why a mobile phone is needed to saved a contact?
24.3.8.10	Non-utility (in case of task not done)	Why DON'T you saved a contact using a mobile phone?
24.3.9	**Blue Tooth-[NAV]**	
24.3.9.1	Observe Speed	Using your mobile phone, copied a song using Bluetooth (Observe-Speed)
24.3.9.2	Test Mental Model	Using my mobile phone, try to copy a song using Bluetooth.
24.3.9.3	Test Rote Learning	Using your mobile phone, explain to me (teach me) how to copy a song using Bluetooth.
24.3.9.4	Frequency	When did you last copied a song using Bluetooth in a mobile phone (How frequently do you buy?)
24.3.9.5	First Instance	When was the first time you had copied a song using Bluetooth in a mobile phone?
24.3.9.6	First Instance (through Delegation)	When was the first time you had asked somebody else to copied a song using Bluetooth in a mobile phone?

24.3.9.7	Learning Time	How much time did it take you to learn to copied a song using Bluetooth in a mobile phone?
24.3.9.8	Trigger	What was the need when you had for the first copied a song using Bluetooth in a mobile phone?
24.3.9.9	Utility	Why a mobile phone is needed to copied a song using Bluetooth?
24.3.9.10	Non-utility (in case of task not done)	Why DON'T you copied a song using Bluetooth in a mobile phone?
24.3.10	**Delete SMS-[NAV]**	
24.3.10.1	Observe Speed	Using your mobile phone, deleted an SMS (Observe-Speed)
24.3.10.2	Test Mental Model	Using my mobile phone, try to deleted an SMS.
24.3.10.3	Test Rote Learning	Using your mobile phone, explain to me (teach me) how to deleted an SMS.
24.3.10.4	Frequency	When did you last deleted an SMS using a mobile phone (How frequently do you buy?)
24.3.10.5	First Instance	When was the first time you had deleted an SMS in a mobile phone?
24.3.10.6	First Instance (through Delegation)	When was the first time you had asked somebody else to deleted an SMS in a mobile phone?
24.3.10.7	Learning Time	How much time did it take you to learn to deleted an SMS in a mobile phone?
24.3.10.8	Trigger	What was the need when you had for the first deleted an SMS in a mobile phone?
24.3.10.9	Utility	Why a mobile phone is needed to deleted an SMS?

24.3.10.10	Non-utility (in case of task not done)	Why DON'T you deleted an SMS in a mobile phone?
24.3.11	**Camera-[BAS/NAV]**	
24.3.11.1	Observe Speed (also, if uses shortcut or menu)	Using your mobile phone, take pictures (Observe-Speed)
24.3.11.2	Test Mental Model	Using my mobile phone, try to take pictures.
24.3.11.3	Test Rote Learning	Using your mobile phone, explain to me (teach me) how to take pictures.
24.3.11.4	Frequency	When did you last take pictures using a mobile phone (How frequently do you buy?)
24.3.11.5	First Instance	When was the first time you had taken pictures using a mobile phone?
24.3.11.6	First Instance (through Delegation)	When was the first time you had asked somebody else to take pictures using a mobile
24.3.11.7	Learning Time	How much time did it take you to learn to take pictures using a mobile phone?
24.3.11.8	Trigger	What was the need when you had for the first take pictures using a mobile phone?
24.3.11.9	Utility	Why a mobile phone is needed to take pictures?
24.3.11.10	Non-utility (in case of task not done)	Why DON'T you take pictures using a mobile phone?
24.3.12	**Missed calls-[BAS/NAV]**	
24.3.12.1	Observe Speed (also, if uses shortcut or menu)	Using your mobile phone, find a missed call (Observe-Speed)

24.3.12.2	Test Mental Model	Using my mobile phone, try to find a missed call.
24.3.12.3	Test Rote Learning	Using your mobile phone, explain to me (teach me) how to find a missed call.
24.3.12.4	Frequency	When did you last find a missed call in a mobile phone (How frequently do you buy?)
24.3.12.5	First Instance	When was the first time you hadfound a missed call in a mobile phone?
24.3.12.6	First Instance (through Delegation)	When was the first time you had asked somebody else to find a missed call in a mobile phone?
24.3.12.7	Learning Time	How much time did it take you to learn to find a missed call in a mobile phone?
24.3.12.8	Trigger	What was the need when you had for the first find a missed call in a mobile phone?
24.3.12.9	Utility	Why a mobile phone is needed to find a missed call?
24.3.12.10	Non-utility (in case of task not done)	Why DON'T you find a missed call using a mobile phone?
24.3.13	**Media Player -[BAS/NAV]**	
24.3.13.1	Observe Speed (also, if navigates of plays randomly)	Using your mobile phone, play a song (Observe-Speed)
24.3.13.2	Test Mental Model	Using my mobile phone, try to play a song.
24.3.13.3	Test Rote Learning	Using your mobile phone, explain to me (teach me) how to play a song.
24.3.13.4	Frequency	When did you last played a song using a mobile phone (How frequently do you buy?)
24.3.13.5	First Instance	When was the first time you had played a song using a mobile phone?

24.3.13.6	First Instance (through Delegation)	When was the first time you had asked somebody else to play a song using a mobile phone?
24.3.13.7	Learning Time	How much time did it take you to learn to play a song using a mobile phone?
24.3.13.8	Trigger	What was the need when you had for the first time played a song in a mobile phone?
24.3.13.9	Utility	Why a mobile phone is needed to play a song?
24.3.13.10	Non-utility (in case of task not done)	Why DON'T you play a song using a mobile phone?
24.3.14	**Call-[BAS/TXT]**	
24.3.14.1	Observe Speed (also, if uses ladt calls, addressbook or number pad)	Using your mobile phone, make a call (Observe-Speed)
24.3.14.2	Test Mental Model	Using my mobile phone, try to make a call.
24.3.14.3	Test Rote Learning	Using your mobile phone, explain to me (teach me) how to make a call.
24.3.14.4	Frequency	When did you last make a call using a mobile phone (How frequently do you buy?)
24.3.14.5	First Instance	When was the first time you had made a call using a mobile phone?
24.3.14.6	First Instance (through Delegation)	When was the first time you had asked somebody else to make a call using a mobile phone?
24.3.14.7	Learning Time	How much time did it take you to learn to make a call using a mobile phone?
24.3.14.8	Trigger	What was the need when you had for the first make a call in a mobile phone?

24.3.14.9	Utility	Why a mobile phone is needed to make a call?
24.3.14.10	Non-utility (in case of task not done)	Why DON'T you make a call using a mobile phone?
25	ADDITIONAL REMARKS	ADDITIONAL REMARKS
26	Review and Confirmation	Is the survey complete

Table A.1: Questionnaire for Quantitative Study.

Appendix B

Details of the Interviews

Location	Description	Count of Inter-viewees	Constituting Census Unit (as of 2011 census)			Distance from Nearest Bank Branch (km)	
			Name	**Type**	**Pop.**	**National**	**Private**
District: Ambala, Haryana							
Dalipgarh	Semi-Urban Settlement on the edges of Ambala Cantonment. Most of the agricultural land converted to residential plots in unplanned manner.	2	Babiyal	Town	26,412	0	3

District: Beed, Maharashtra							
Amla	Small Village	3	Amla	Village	2,091	23	37
District: Jalna, Maharashtra							
Borkhedi	Small Village	2	Borkhedi	Village	936	10	10
Gokulwadi	Small Village	3	Gokulwadi	Village	999	6	39
Power Loom	Semi-Urban settlment of low income group people. Informal businesses like making beedis at home.	2	Jalna	Municipality	2,85,577	3	4
Sainagar	Edge of Jalna municipality.	2	Jalna	Municipality	2,85,577	2	2
Valmik Nagar	Semi-urban settlment of low income group people. Informal businesses like making beedis at home.	4	Jalna	Municipality	2,85,577	0	0
Ahankar Devlgaon	Small Village	4	Jalna	Village	1,291	7	10
Londhewadi	Village	4	Londhewadi	Village	528	8	57
District: Dhar, Madhya Pradesh							
Dhar Road	Villages on the edges of Pitampura industrial area housing migrant workers. Still asurrounded by agricultural lands.	4	Pithampur	Municipality	1,26,200	3	3
District: Indore, Madhya Pradesh							

Pahad Ghati	One among clusters of village in a soyabean producing region.	3	Bihdiya	Village	1,376	3	7
Kacharod	One among clusters of village in a soyabean producing region.	2	Kacharod	Village	540	3	6
Patthar Mundla	Semi-urban unorganised settlement of migrant workers.	8	Palda	Town	18,697	0	0
Macchli Farm	Fisher community settlement.	3	Ralamandal	Village	2,863	2	3
Ralamandal	The primary one among clusters of village in a soyabean producing region.	8	Ralamandal	Village	2,863	2	0
Tejajinagar	Urbanising edge of the Ralamandal rural cluster.	1	Ralamandal	Village	2,863	0	2
Tillor Khurd	One among clusters of village in a soyabean producing region.	1	Tillor Khurd	Village	6,464	0	3
District: Rajsamand, Rajasthan							
Morra	Village	2	Morra	Village	1,096	3	4
Pachhmata	Village	2	Pachhmata	Village	2,625	9	15
Railmagara	Large Village on state highway.	11	Railmagara	Village	8,611	0	6
District: Nizamabad, Telangana							

Devi Vihar	Edge of town. Separated from Lingapur village and merged with Kamaredy in 2011 census.	1	Kamareddy	Municipality	80,315	3	2
Lingampet	Village and Mandal	3	Lingampet	Village	9,860	0	25
Machareddy	Village and Mandal	2	Machareddy	Village	5,053	0	19
Sadasivanagar	Village and Mandal	1	Sadashivnagar	Village	6,994	0	12
Yellareddy	Village and Mandal	7	Yellareddy	Village	14,923	0	42
	Total	**85**					

Table B.1: The Locations of the Interviews

Primary Interviewer	Supported by	About the Interviewer/Mediator	Language of the Interview	Locations (see Table B.1)	No. of Users Interviewed
Author	None	I speak Hindi well. The location in Ambala (2 interviews) is my own hometown.	Hindi	All places in districts Ambala and Rajsamand.	18
	Mediator	The mediator lived in Ralamandal, one of the locations. He was 50 years old, class 2nd educated, working as taxi driver. He had friends and relatives spread over different rural and semi urban localities. Spoke local dialect and Hindi.	Hindi	All places in district Indore.	29

Interviewer A	Author	The interviewer lived in the district. He was 25 years, class engineering graduate, working as information Technology professional for the municipal corporation. He had friends and relatives spread over different rural and semi urban localities. He was a fluent speaker of Marathi and Hindi, while his mother tongue was Telugu. Some of the contacts spoke Telugu natively, but being settled in Maharashtra were well versed with Marathi. For them, Marathi prompts were also supported by Telugu explanations by the interviwer.	Marathi	Gokulwadi, Power Loom, Sainagar and Valmiknagar in district Jalna.	11

Interviewer B	Author	The interviewer lived in the district. He was 27 years, graduate, unemployed. He had friends and relatives spread over different rural and semi urban localities. He was a fluent speaker of Marathi and Hindi, while his mother tongue was Telugu. I, too, have a rudimentary knowledge of Marathi.	Marathi	Ahankar Devlgaon, Borkhedi, Londhewadi in district Jalna.	10
Interviewer C	None	Beed was hometown of the interviewer. He was 28 years old and worked as a researcher in an Information Technology company in Mumbai. He was a native speaker of Marathi.	Marathi	Amla in district Beed.	3
Interviewer D	Author	Nizamabad was hometown of the interviewer. He was 30 years old and was a post graduate in technology. He ran an NGO and was well connected locally. His native language was Telugu.	Telugu	Devi Vihar in district Nizamabad.	1

Interviewer E	Author	She lived in one of the villages in Nizamabad. She was 23 years old engineering graduate and worked for an NGO. Her native language was Telugu.	Telugu	Yellareddy and Lingampet in district Nizamabad.	9
	None		Telugu	Yellareddy, Machareddy and Sadashivnagar in district Nizamabad.	4
				Total	**85**

Table B.2: The Interviewers

Appendix C

Theoretical Bases of the Statistical Methods

C.1 Ordinal Regression

Ordinal Logistics Regression (OR) is used to predict dependent variables which are ordinal in nature. This is different from simple regression where the response is a continuous variable. Mathematically, the difference arises, both being considered as specific cases of generalized linear models (GLM), because of the different link functions. A link function, g, is used to transforms the predicted value $E(Y)$ of a linear predictor $\mathbf{X}^T\beta$, where $\mathbf{X}$ is a vector of independent variables and β a vector of parameters. In symbols, it means,

$$g(E(Y)) = \mathbf{X}^T\beta \tag{C.1}$$

For ordinal regression many link functions are used. A very common link function is *logit* function. It is the logarithm of odds ratios, that is, the logarithm of the ratio of probability of happening of an event with its not happening.

$$L = \log(\frac{p}{(1-p)}) \tag{C.2}$$

For ordinal regression logit is defined as the odds between belonging to *a given class or lower* and to *a higher class.* Therefore logit $\mathbf{L}_k$ for a given class $\mathbf{C}_k$, is

$$\mathbf{L}_k = \log \frac{P(Y \leqslant \mathbf{C}_k)}{P(Y > \mathbf{C}_k)} \tag{C.3}$$

Finally, equation C.1 can be expressed as

$$\mathbf{L}_k = \mathbf{X}^T \beta \tag{C.4}$$

Or, expansively as,

$$\log \frac{P(Y \leqslant \mathbf{C}_k)}{P(Y > \mathbf{C}_k)} = \beta_0 + \beta_1 x_{i,1} + \beta_2 x_{i,2} ... + \beta_j x_{i,j} ... + \beta_N x_{i,N} + \epsilon \tag{C.5}$$

where β_j is the coefficient of jth parameter when calculated for the ith observation in form of vector ($\mathbf{X}_i = x_{i,1}, x_{1,2} .... x_{i,j} ... x_{i,N}$). ϵ is the error. ϵ is the error.

It should be note that the set of vectors $\beta_0, \beta_1, \beta_2, ... \beta_j .... \beta_N$ are same across all the classes. This is an assumption for ordinal regression and is known as *proportional-odds* or *parallel- regression assumption.*

In all, OLR is based on following assumptions:

- The dependent variables are ordinal.
- The independent variables are continuous, ordinal or categorical.
- There is no multicollinearity.
- The odds are proportional.

In all, OLR is based on following assumptions:

- The dependent variables are ordinal.
- The independent variables are continuous, ordinal or categorical. As table 7.1 depicts, this is true.
- There is no multicollinearity. We have checked for multicollinearity in Section D

- The odds are proportional. We have checked for this assumption, for both User Types and Stages of Usage as responses, using Brant's test using the `brant` library in R. A detailed discussion on Brant's test has been provided by Brant [1990].

Appendix D

Data Checks

D.1 Collinearity

Collinearity check ensures that variables are not highly correlated. Variance Inflation factor (VIF) checks that by measuring the amount of variance caused by collinearity. VIF is calculated from the R^2 when a given independent variable is estimated as a function of all the other independent variables. If variable x_i is estimated as function of all the other variables, or,

$$\hat{x_j} = \alpha_0 + \alpha_1 x_1 + \alpha_2 x_2 + ...\alpha_{j-1} x_{j-1} + \alpha_{j+1} x_{j+1} ... + \alpha_N x_N + \epsilon \tag{D.1}$$

VIF for variable x_j is calculated as

$$\frac{1}{1 - R_j^2} \tag{D.2}$$

where R_j^2 is the R^2 metric for a particular regression.

Table D.1 shows that VIF scores are much below 5, and therefore there is a lack of collinearity.

Variance Inflation factor	
AGE	1.44
GEN	1.22
EDU	1.27
PRO	2.29
SEF	1.24
ANX	1.25
PRD	1.25
UTL	1.06
POP	1.94
SEC	1.31
RUR	1.31
PVL	1.19
TIM	1.40

Table D.1: Variable Inflaction Factors for different variables.

D.2 Influential Points

Influential points when deleted can have large effect on regression analysis. They could be having high residual (large deviation from predicted value) and/or large leverage (large deviation from mean value). The influence of a point is measured through Cook's distance

$$D_i = \frac{\sum_{j=1}^{n}(\hat{y}_j - \hat{y}_{j(i)})}{s^2 p} \tag{D.3}$$

where $\hat{y}_j$ is the predicted value for jth observation when regression coefficients are calculated using the complete data set as compared to $\hat{y}_{j(i)}$ where ith observation is dropped. s^2 is the mean square error and p is the number of coefficients.

Figure D.1 shows the Cook's distance for all the 85 observations when estimated for User Type. Figure D.2 shows the same for Stage of Usage. All of the points, for both the cases, are below 1.0, the cutoff as suggested by Weisberg [2013].

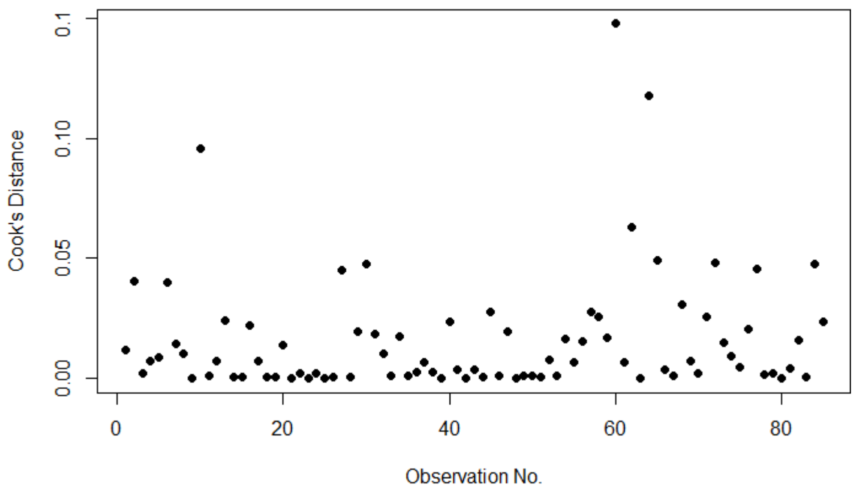

Figure D.1: Cook's distances for all the observations calculated for User Type.

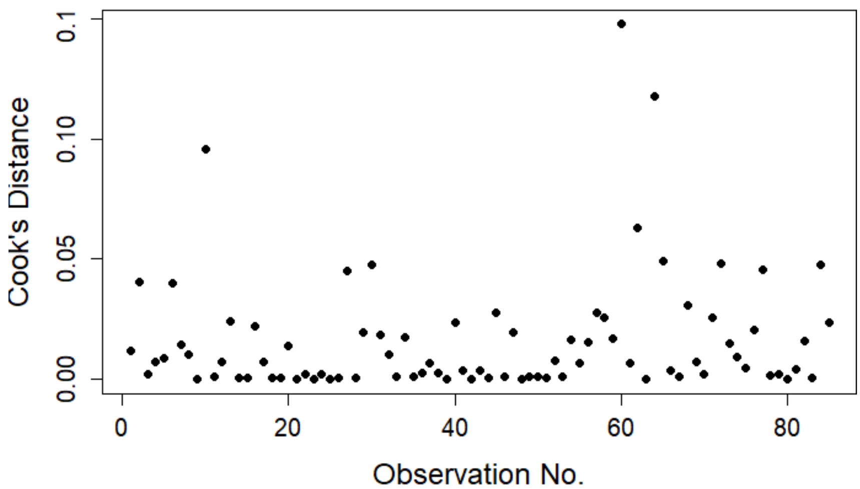

Figure D.2: Cook's distances for all the observations calculated for Stage of Usage.

D.3 Normality

	p-value
AGE	0.00
GEN	0.00
SEC	0.00
EDU	0.00
PVL	0.00
PRO	0.00
POP	0.00
SEF	0.00
ANX	0.00
PRD	0.00
UTL	0.00
RUR	0.00
TIM	0.02

Table D.2: Shapiro-Wilk normality statistic for different variables. Level of significance = 0.05.

Table D.2 shows the Shapiro-Wilk normality statistic for different variables. All of the p-values for te test are below the level of significance, therefore the data is not normally distributed.

Appendix E

Questionnaire for Pilot Studies

1. Age

2. Gender

3. Literacy

— Number of years of schooling

— The type of school (convent/ public/municipality) and college (professional/non • professional) one has attended.

— Whether one has appeared for a competitive exam?

4. Device

— What is your current model?

— What were your earlier models?

— Why did you shift every time you did (Identifying Trigger)?

— Why did you start using the device in the first place (Identifying Trigger)?

5. Exposure/Prevalence

— How many people in your immediate family AND close friends can use the device and with what competency?

5 levels of competencies were defined. In case of mobile phones they were:

1. Cannot use
2. Can receive and make calls only
3. Can do a little
4. Can do a lot
5. Are experts

6. Power Structure

— If you need to buy something for yourself would you and who would you discuss with or inform first?

7. Social Norms

— To what extent your immediate family members/relatives/close friends approve of your using a device?- 1. They have Strong Objections

2. The find it a little inappropriate
3. Does not matter
4. They think it as Good
5. The pressed for using it

8. Task-Tool fitness. We asked this in three parts:

— What are the tasks for which the device is necessary (positive)?

— What are the tasks for which the device is used normally, but it need not be used (neutral)?

— What are the tasks for which the use of device is inappropriate (negative)?

9. Alternatives to Devices

— What is a the best method to accomplish this task*

— When will the particular method fail?

10. Image

— There is no ‘izzat’ (honour, pride) without a mobile/DVD/computer/ATM card. The options were-

1. Quite right
2. Somewhat right
3. Neutral
4. Somewhat wrong
5. Quite Wrong

11. Task Expertise.

The scales for the ease of doing the tasks were:

1. Impossible
2. Do with difficulty
3. Neither easy nor difficult
4. Can do easily
5. Expertise

Frequencies were measured on a non-linear scale

1. Never
2. Once-Twice a year
3. Once-Twice every six months
4. Once-Twice every three months
5. Once-Twice every month
6. Once a week
7. 2-4 times per week
8. Once Daily
9. More than 4 times daily

The tasks for mobile phones were:

— Making calls by Dialing

— Replying to a Call

— Responding to a Missed Call Notification

— Calling using Call History

— Reading SMS

— Radio

— Changing Ringtone

— Sending SMS

— Saving Contact

— Transferring songs through Bluetooth

— Internet

— Taking Photos

— Playing games

The Tasks for ATM were:

— Withdrawing money

— Changing PIN

— Money Transfer

— Paying Bills

The tasks for DVD player were:

— Putting On

— Inserting/Ejecting Disk

— Playing/Stopping

— Forward/Backward

— Selecting a song from menu

— Connecting with a TV

The tasks for computer were:

— Putting On

— Playing Game

— Playing Film

— Typing ABC on MS Word

— Reaching a given Directory

— Copying files

— Finding Date of Creation

— Drawing objects in MS Word

— Using MS Excel to calculate total

The tasks that were used for measuring time taken were:

— Responding to a Missed Call Notifications

— Making calls by Dialing

— Dealing from Phone Book

— Saving Contact from last call

— Calling using Call History

— Reading SMS

— Sending SMS

— Forwarding SMS

Appendix F

Probability Maps

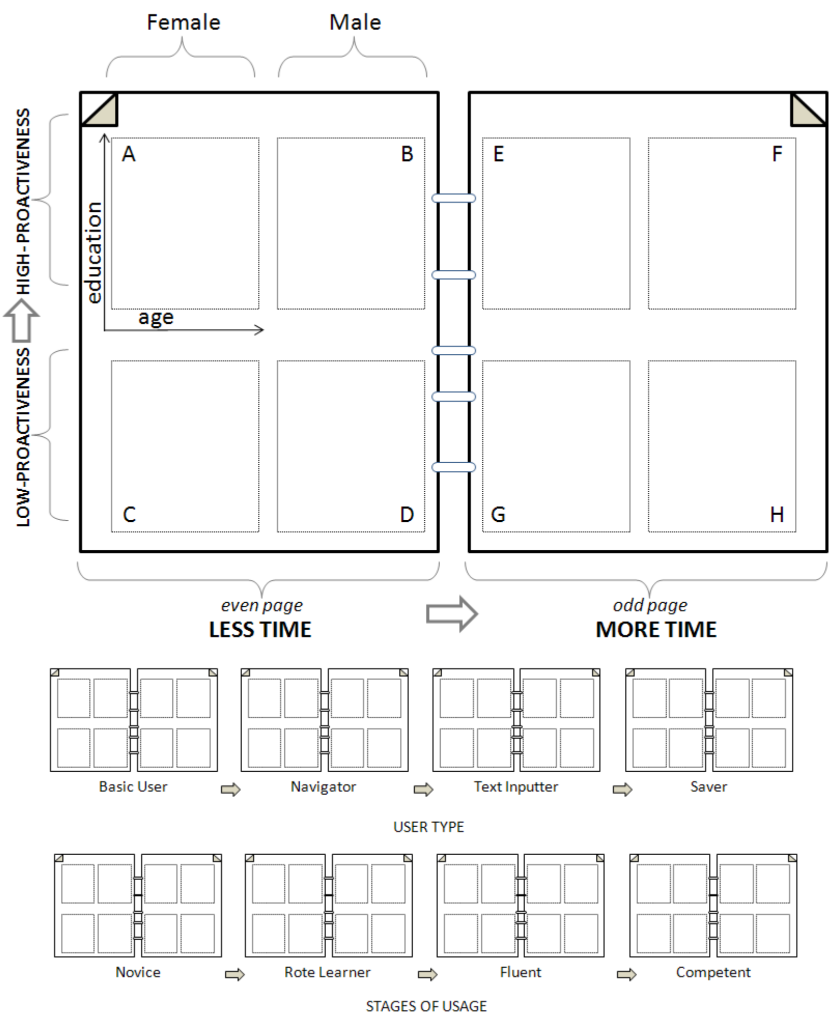

Figure F.1: Schema followed by the heatmaps from pages 362 to 377

A — FEMALE, Proactiveness = 10

Education Levels	25	30	35	40	45	50	55
12	1	2	5	8	15	26	40
11	2	3	6	11	19	31	47
10	2	4	8	14	24	38	54
9	3	5	10	17	29	44	61
8	4	7	13	22	35	51	67
7	5	9	16	27	41	58	73
6	6	11	20	32	48	64	78
5	8	14	25	39	55	70	82
4	10	18	30	45	62	76	86
3	13	23	36	52	68	81	89
2	16	28	43	59	74	84	91
1	21	33	49	65	79	88	93
0	25	40	56	71	83	90	95

Age

FEMALE →

B — MALE, Proactiveness = 10

Education Levels	25	30	35	40	45	50	55
12	0	1	1	2	4	8	15
11	0	1	2	3	6	10	18
10	1	1	2	4	7	13	23
9	1	1	3	5	9	17	28
8	1	2	3	7	12	21	34
7	1	2	4	8	15	26	40
6	2	3	6	11	19	31	47
5	2	4	8	14	24	37	54
4	3	5	10	17	29	44	60
3	4	7	12	22	35	51	67
2	5	9	16	27	41	58	73
1	6	11	20	32	48	64	78
0	8	14	24	38	55	70	82

Age

MALE

Proactiveness = 10

C — FEMALE, Proactiveness = 1

Education Levels	25	30	35	40	45	50	55
12	3	5	10	17	29	44	60
11	4	7	12	22	35	51	67
10	5	9	16	27	41	58	73
9	6	11	20	32	48	64	78
8	8	14	24	38	55	70	82
7	10	18	30	45	62	76	86
6	13	22	36	52	68	80	89
5	16	27	42	59	73	84	91
4	20	33	49	65	78	88	93
3	25	40	56	71	83	90	95
2	31	46	63	76	86	92	96
1	37	53	69	81	89	94	97
0	43	60	74	85	92	96	98

Age

FEMALE →

D — MALE, Proactiveness = 1

Education Levels	25	30	35	40	45	50	55
12	1	1	3	5	9	16	28
11	1	2	3	6	12	21	33
10	1	2	4	8	15	25	40
9	2	3	6	11	19	31	47
8	2	4	7	14	23	37	53
7	3	5	10	17	29	44	60
6	4	7	12	21	35	51	67
5	5	9	16	26	41	57	72
4	6	11	19	32	48	64	77
3	8	14	24	38	55	70	82
2	10	18	30	45	61	75	86
1	13	22	36	52	68	80	89
0	16	27	42	58	73	84	91

Age

MALE

↑ Proactiveness = 1

TIME = 1 YEAR →

User Type: Basic User

Figure F.2: Heat Map (1/2) of Probabilities for TYPE: ***Basic User***

E

Education Levels	25	30	35	40	45	50	55
12	0	1	1	3	5	9	17
11	0	1	2	3	7	12	21
10	1	1	2	5	8	15	26
9	1	2	3	6	11	19	31
8	1	2	4	8	14	24	38
7	1	3	5	10	17	29	44
6	2	4	7	12	22	35	51
5	2	5	9	16	27	41	58
4	3	6	11	20	32	48	64
3	4	8	14	24	39	55	70
2	5	10	18	30	45	62	76
1	7	13	22	36	52	68	80
0	9	16	28	42	59	74	84

Age

FEMALE →

F

Education Levels	25	30	35	40	45	50	55
12	0	0	0	1	1	3	5
11	0	0	0	1	2	3	6
10	0	0	1	1	2	4	8
9	0	0	1	2	3	6	10
8	0	1	1	2	4	7	13
7	0	1	1	3	5	9	17
6	0	1	2	3	6	12	21
5	1	1	2	4	8	15	26
4	1	2	3	6	11	19	31
3	1	2	4	7	14	23	37
2	1	3	5	10	17	29	44
1	2	4	7	12	21	35	51
0	2	5	9	16	26	41	57

Age

MALE

Proactiveness = 10

Education Levels	25	30	35	40	45	50	55
12	1	2	3	6	11	19	31
11	1	2	4	7	14	23	37
10	1	3	5	10	17	29	44
9	2	4	7	12	21	35	51
8	2	5	9	16	26	41	57
7	3	6	11	20	32	48	64
6	4	8	14	24	38	55	70
5	5	10	18	30	45	61	75
4	7	13	22	36	52	68	80
3	9	16	27	42	59	73	84
2	12	20	33	49	65	78	88
1	15	25	39	56	71	83	90
0	18	31	46	62	76	86	92

G

Age

FEMALE →

Education Levels	25	30	35	40	45	50	55
12	0	0	1	2	3	5	10
11	0	1	1	2	4	7	13
10	0	1	1	3	5	9	16
9	0	1	2	3	6	12	20
8	1	1	2	4	8	15	25
7	1	2	3	6	11	19	31
6	1	2	4	7	13	23	37
5	1	3	5	10	17	28	44
4	2	4	7	12	21	34	50
3	2	5	9	15	26	41	57
2	3	6	11	19	32	48	64
1	4	8	14	24	38	54	70
0	5	10	18	29	45	61	75

H

Age

MALE

↑ Proactiveness = 1

TIME = 10 YEARS

User Type: Basic User

Figure F.3: Heat Map (2/2) of Probabilities for TYPE: ***Basic User***

A

Education Levels	25	30	35	40	45	50	55
12	14	23	36	48	57	57	50
11	17	28	41	52	58	55	46
10	21	33	46	56	58	52	40
9	26	39	51	57	56	48	35
8	31	44	54	58	53	43	30
7	37	49	57	57	49	37	25
6	42	53	58	55	45	32	20
5	47	56	58	51	39	27	16
4	51	58	56	47	34	22	13
3	55	58	53	42	29	18	10
2	57	57	49	36	24	14	8
1	58	54	44	31	19	11	6
0	57	51	39	26	16	9	5

Age

FEMALE →

B

Education Levels	25	30	35	40	45	50	55
12	4	7	13	22	35	47	56
11	5	9	17	27	40	52	58
10	7	12	21	32	45	55	58
9	9	15	25	38	50	57	57
8	11	19	30	43	54	58	54
7	14	23	35	48	56	57	50
6	17	28	41	52	58	55	46
5	21	33	46	55	58	52	41
4	26	39	51	57	56	48	35
3	31	44	54	58	54	43	30
2	36	49	57	57	50	37	25
1	42	53	58	55	45	32	20
0	47	56	58	51	40	27	16

Age

MALE

Proactiveness = 10

C

Education Levels	25	30	35	40	45	50	55
12	26	39	51	57	56	48	35
11	31	44	54	58	54	43	30
10	36	49	57	57	50	37	25
9	42	53	58	55	45	32	20
8	47	56	58	51	40	27	16
7	51	58	56	47	34	22	13
6	55	58	53	42	29	18	10
5	57	57	49	37	24	14	8
4	58	54	44	31	20	11	6
3	57	51	39	26	16	9	5
2	56	46	33	21	13	7	4
1	52	41	28	17	10	5	3
0	48	36	23	14	8	4	2

Age

FEMALE →

D

Education Levels	25	30	35	40	45	50	55
12	8	15	25	38	50	57	57
11	11	19	30	43	54	58	54
10	14	23	35	48	56	57	51
9	17	28	41	52	58	55	46
8	21	33	46	55	58	52	41
7	26	38	50	57	56	48	35
6	31	44	54	58	54	43	30
5	36	49	57	57	50	38	25
4	42	53	58	55	45	32	20
3	47	56	58	52	40	27	17
2	51	58	56	47	34	22	13
1	55	58	53	42	29	18	10
0	57	57	49	37	24	15	8

Age

MALE

↑ Proactiveness = 1

TIME = 1 YEAR →

User Type: Navigator

Figure F.4: Heat Map (1/2) of Probabilities for TYPE: ***Navigator***

E

Education Levels	25	30	35	40	45	50	55
12	5	9	15	25	38	50	57
11	6	11	19	30	43	54	58
10	8	14	23	36	48	56	57
9	10	17	28	41	52	58	55
8	13	21	33	46	56	58	52
7	16	26	39	51	57	56	48
6	20	31	44	54	58	53	43
5	24	36	49	57	57	50	37
4	29	42	53	58	55	45	32
3	34	47	56	58	51	40	27
2	40	51	58	56	47	34	22
1	45	55	58	53	42	29	18
0	50	57	57	49	36	24	14

Age

FEMALE →

F

Education Levels	25	30	35	40	45	50	55
12	1	2	4	8	15	24	37
11	2	3	6	10	18	29	42
10	2	4	7	13	22	34	47
9	3	5	9	17	27	40	52
8	4	7	12	20	32	45	55
7	5	8	15	25	38	50	57
6	6	11	19	30	43	54	58
5	8	14	23	35	48	56	57
4	10	17	28	41	52	58	55
3	12	21	33	46	55	58	52
2	16	26	39	51	57	56	48
1	19	31	44	54	58	54	43
0	24	36	49	57	57	50	38

Age

MALE

Proactiveness = 10

G

Education Levels	25	30	35	40	45	50	55
12	10	17	28	41	52	58	55
11	12	21	33	46	55	58	52
10	16	26	38	50	57	56	48
9	19	31	44	54	58	54	43
8	24	36	49	57	57	50	38
7	29	42	53	58	55	45	32
6	34	47	56	58	51	40	27
5	39	51	58	56	47	34	22
4	45	55	58	53	42	29	18
3	49	57	57	49	37	24	14
2	53	58	54	44	31	20	11
1	56	57	51	39	26	16	9
0	58	56	46	34	22	13	7

Age

FEMALE →

H

Education Levels	25	30	35	40	45	50	55
12	3	5	9	16	27	40	51
11	3	7	12	20	32	45	55
10	5	8	15	25	37	50	57
9	6	11	19	30	43	54	58
8	8	14	23	35	48	56	57
7	10	17	28	41	52	58	55
6	12	21	33	46	55	58	52
5	15	26	38	50	57	56	48
4	19	31	44	54	58	54	43
3	24	36	48	57	57	50	38
2	29	41	53	58	55	45	32
1	34	47	56	58	52	40	27
0	39	51	58	56	47	35	22

Age

MALE

↑ Proactiveness = 1

TIME = 10 YEARS

User Type: Navigator

Figure F.5: Heat Map (2/2) of Probabilities for TYPE: ***Navigator***

A

Education Levels	25	30	35	40	45	50	55
12	75	69	57	42	27	16	9
11	73	64	51	36	22	13	7
10	70	59	44	30	18	10	6
9	66	53	38	24	14	8	4
8	61	47	32	20	11	6	3
7	56	41	27	16	9	5	3
6	50	35	22	13	7	4	2
5	43	29	17	10	5	3	1
4	37	24	14	8	4	2	1
3	31	19	11	6	3	2	1
2	26	15	8	5	2	1	1
1	21	12	7	4	2	1	0
0	17	9	5	3	1	1	0

Age

FEMALE →

B

Education Levels	25	30	35	40	45	50	55
12	64	73	75	69	58	43	29
11	69	75	73	65	52	37	23
10	72	75	71	60	46	31	19
9	74	74	67	55	39	25	15
8	75	72	62	48	33	21	12
7	75	69	57	42	28	17	9
6	73	65	51	36	23	13	7
5	70	59	45	30	18	10	6
4	66	54	38	25	14	8	4
3	62	47	32	20	11	6	3
2	56	41	27	16	9	5	3
1	50	35	22	13	7	4	2
0	44	29	18	10	5	3	1

Age

MALE

Proactiveness = 10

Education Levels	25	30	35	40	45	50	55
12	66	54	38	25	15	8	4
11	62	47	32	20	11	6	3
10	56	41	27	16	9	5	3
9	50	35	22	13	7	4	2
8	44	29	18	10	5	3	1
7	37	24	14	8	4	2	1
6	31	19	11	6	3	2	1
5	26	15	9	5	2	1	1
4	21	12	7	4	2	1	1
3	17	10	5	3	1	1	0
2	13	7	4	2	1	1	0
1	11	6	3	2	1	0	0
0	8	4	2	1	1	0	0

C

Age

FEMALE →

Education Levels	25	30	35	40	45	50	55
12	74	74	67	55	40	26	15
11	75	72	63	49	34	21	12
10	75	69	57	42	28	17	9
9	73	65	51	36	23	13	7
8	70	60	45	30	18	10	6
7	67	54	39	25	15	8	4
6	62	48	33	20	12	6	3
5	56	41	27	16	9	5	3
4	50	35	22	13	7	4	2
3	44	29	18	10	5	3	2
2	38	24	14	8	4	2	1
1	32	19	11	6	3	2	1
0	26	16	9	5	2	1	1

Age

D

MALE

↑ Proactiveness = 1

TIME = 1 YEAR →

User Type: Text Inputter

Figure F.6: Heat Map (1/2) of Probabilities for TYPE: ***Text-Inputter***

E — FEMALE →, Proactiveness = 10

Education Levels \ Age	25	30	35	40	45	50	55
12	67	74	74	67	54	39	25
11	71	75	72	62	48	33	21
10	73	75	69	57	42	28	17
9	75	73	64	51	36	23	13
8	75	70	59	45	30	18	10
7	74	66	53	38	25	14	8
6	72	62	47	32	20	11	6
5	68	56	41	27	16	9	5
4	64	50	35	22	13	7	4
3	58	44	29	17	10	5	3
2	52	37	24	14	8	4	2
1	46	31	19	11	6	3	2
0	40	26	15	9	5	2	1

F — MALE, Proactiveness = 10

Education Levels \ Age	25	30	35	40	45	50	55
12	38	53	66	74	74	68	56
11	44	59	70	75	72	63	50
10	50	64	73	75	70	58	43
9	57	68	74	73	65	52	37
8	62	72	75	71	60	46	31
7	67	74	74	67	55	40	26
6	71	75	72	63	49	33	21
5	73	75	69	57	42	28	17
4	75	73	65	51	36	23	13
3	75	70	60	45	30	18	10
2	74	67	54	39	25	15	8
1	72	62	47	32	20	12	6
0	68	56	41	27	16	9	5

Proactiveness = 10

G — FEMALE →, Proactiveness = 1

Education Levels \ Age	25	30	35	40	45	50	55
12	75	73	65	51	36	23	13
11	75	70	60	45	30	18	10
10	74	67	54	39	25	15	8
9	72	62	48	32	20	12	6
8	68	56	41	27	16	9	5
7	64	50	35	22	13	7	4
6	59	44	29	18	10	5	3
5	53	38	24	14	8	4	2
4	46	32	19	11	6	3	2
3	40	26	15	9	5	2	1
2	34	21	12	7	4	2	1
1	28	17	10	5	3	1	1
0	23	14	7	4	2	1	1

H — MALE, Proactiveness = 1

Education Levels \ Age	25	30	35	40	45	50	55
12	56	68	74	73	66	52	37
11	62	72	75	71	61	46	31
10	67	74	74	67	55	40	26
9	70	75	72	63	49	34	21
8	73	75	69	57	42	28	17
7	75	73	65	51	36	23	13
6	75	71	60	45	30	18	11
5	74	67	54	39	25	15	8
4	72	62	48	33	20	12	6
3	68	56	41	27	16	9	5
2	64	50	35	22	13	7	4
1	59	44	29	18	10	5	3
0	53	38	24	14	8	4	2

↑ Proactiveness = 1

TIME = 10 YEARS

User Type: Text Inputter

Figure F.7: Heat Map (2/2) of Probabilities for TYPE: ***Text-Inputter***

A — FEMALE →, Proactiveness = 10

Education Levels \ Age	25	30	35	40	45	50	55
12	10	6	3	2	1	0	0
11	8	4	2	1	1	0	0
10	6	3	2	1	0	0	0
9	5	3	1	1	0	0	0
8	4	2	1	1	0	0	0
7	3	1	1	0	0	0	0
6	2	1	1	0	0	0	0
5	2	1	0	0	0	0	0
4	1	1	0	0	0	0	0
3	1	0	0	0	0	0	0
2	1	0	0	0	0	0	0
1	1	0	0	0	0	0	0
0	0	0	0	0	0	0	0

B — MALE, Proactiveness = 10

Education Levels \ Age	25	30	35	40	45	50	55
12	31	19	11	6	3	2	1
11	26	15	8	5	2	1	1
10	21	12	7	3	2	1	0
9	17	9	5	3	1	1	0
8	13	7	4	2	1	1	0
7	10	6	3	2	1	0	0
6	8	4	2	1	1	0	0
5	6	3	2	1	0	0	0
4	5	3	1	1	0	0	0
3	4	2	1	1	0	0	0
2	3	1	1	0	0	0	0
1	2	1	1	0	0	0	0
0	2	1	0	0	0	0	0

Proactiveness = 10

C — FEMALE →, Proactiveness = 1

Education Levels \ Age	25	30	35	40	45	50	55
12	5	3	1	1	0	0	0
11	4	2	1	1	0	0	0
10	3	1	1	0	0	0	0
9	2	1	1	0	0	0	0
8	2	1	0	0	0	0	0
7	1	1	0	0	0	0	0
6	1	1	0	0	0	0	0
5	1	0	0	0	0	0	0
4	1	0	0	0	0	0	0
3	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

D — MALE, Proactiveness = 1

Education Levels \ Age	25	30	35	40	45	50	55
12	17	10	5	3	1	1	0
11	13	7	4	2	1	1	0
10	11	6	3	2	1	0	0
9	8	4	2	1	1	0	0
8	6	3	2	1	0	0	0
7	5	3	1	1	0	0	0
6	4	2	1	1	0	0	0
5	3	2	1	0	0	0	0
4	2	1	1	0	0	0	0
3	2	1	0	0	0	0	0
2	1	1	0	0	0	0	0
1	1	1	0	0	0	0	0
0	1	0	0	0	0	0	0

↑ Proactiveness = 1

TIME = 1 YEAR →

User Type: Saver

Figure F.8: Heat Map (1/2) of Probabilities for TYPE: ***Saver***

E — Proactiveness = 10, FEMALE →

Education Levels	25	30	35	40	45	50	55
12	28	17	9	5	3	1	1
11	23	13	7	4	2	1	1
10	18	10	6	3	2	1	0
9	15	8	4	2	1	1	0
8	12	6	3	2	1	0	0
7	9	5	3	1	1	0	0
6	7	4	2	1	1	0	0
5	5	3	1	1	0	0	0
4	4	2	1	1	0	0	0
3	3	2	1	0	0	0	0
2	2	1	1	0	0	0	0
1	2	1	1	0	0	0	0
0	1	1	0	0	0	0	0

Age

F — Proactiveness = 10, MALE

Education Levels	25	30	35	40	45	50	55
12	61	44	29	18	10	5	3
11	54	38	24	14	8	4	2
10	47	32	19	11	6	3	2
9	41	26	15	9	5	2	1
8	34	21	12	7	4	2	1
7	28	17	9	5	3	1	1
6	23	13	7	4	2	1	1
5	19	10	6	3	2	1	0
4	15	8	4	2	1	1	0
3	12	6	3	2	1	0	0
2	9	5	3	1	1	0	0
1	7	4	2	1	1	0	0
0	5	3	2	1	0	0	0

Age

Proactiveness = 10

G — Proactiveness = 1, FEMALE →

Education Levels	25	30	35	40	45	50	55
12	15	8	4	2	1	1	0
11	12	6	3	2	1	0	0
10	9	5	3	1	1	0	0
9	7	4	2	1	1	0	0
8	5	3	2	1	0	0	0
7	4	2	1	1	0	0	0
6	3	2	1	0	0	0	0
5	2	1	1	0	0	0	0
4	2	1	1	0	0	0	0
3	1	1	0	0	0	0	0
2	1	1	0	0	0	0	0
1	1	0	0	0	0	0	0
0	1	0	0	0	0	0	0

Age

H — Proactiveness = 1, MALE

Education Levels	25	30	35	40	45	50	55
12	41	26	15	9	5	2	1
11	34	21	12	7	4	2	1
10	29	17	10	5	3	1	1
9	23	14	7	4	2	1	1
8	19	11	6	3	2	1	0
7	15	8	4	2	1	1	0
6	12	6	3	2	1	0	0
5	9	5	3	1	1	0	0
4	7	4	2	1	1	0	0
3	6	3	2	1	0	0	0
2	4	2	1	1	0	0	0
1	3	2	1	0	0	0	0
0	2	1	1	0	0	0	0

Age

↑ Proactiveness = 1

TIME = 10 YEARS

User Type: Saver

Figure F.9: Heat Map (2/2) of Probabilities for TYPE: ***Saver***

A

Education Levels	25	30	35	40	45	50	55
12	3	6	11	20	34	51	68
11	3	6	12	22	36	54	70
10	4	7	13	24	39	57	73
9	4	8	15	26	42	59	75
8	5	9	16	28	45	62	77
7	5	10	18	31	48	65	79
6	6	11	20	33	50	67	81
5	6	12	22	36	53	70	83
4	7	13	24	39	56	72	84
3	8	15	26	41	59	75	86
2	9	16	28	44	62	77	87
1	10	18	30	47	64	79	88
0	11	19	33	50	67	80	89

Age

FEMALE →

B

Education Levels	25	30	35	40	45	50	55
12	1	2	3	6	12	21	36
11	1	2	4	7	13	23	38
10	1	2	4	8	14	26	41
9	1	2	4	9	16	28	44
8	1	2	5	9	18	30	47
7	1	3	5	10	19	33	50
6	2	3	6	12	21	35	52
5	2	3	7	13	23	38	55
4	2	4	8	14	25	41	58
3	2	4	8	16	27	43	61
2	2	5	9	17	30	46	64
1	3	5	10	19	32	49	66
0	3	6	11	21	35	52	69

Age

MALE

Proactiveness = 10

C

Education Levels	25	30	35	40	45	50	55
12	7	14	25	40	58	73	85
11	8	15	27	43	60	76	86
10	9	17	29	46	63	78	88
9	10	19	32	49	66	80	89
8	11	20	34	51	68	81	90
7	12	22	37	54	71	83	91
6	14	24	40	57	73	85	92
5	15	27	42	60	75	86	93
4	17	29	45	63	77	87	93
3	18	31	48	65	79	89	94
2	20	34	51	68	81	90	95
1	22	36	54	70	83	91	95
0	24	39	57	73	84	92	96

Age

FEMALE →

D

Education Levels	25	30	35	40	45	50	55
12	2	4	8	15	26	42	60
11	2	5	9	16	29	45	62
10	3	5	10	18	31	48	65
9	3	6	11	20	33	51	67
8	3	6	12	22	36	53	70
7	4	7	13	24	39	56	72
6	4	8	15	26	41	59	75
5	4	9	16	28	44	62	77
4	5	10	18	30	47	64	79
3	6	11	19	33	50	67	81
2	6	12	21	36	53	70	82
1	7	13	23	38	56	72	84
0	8	14	25	41	59	74	85

Age

MALE

↑ Proactiveness = 1

TIME = 1 YEAR →

Stage of Usage: Novice

Figure F.10: Heat Map (1/2) of Probabilities for STAGE: ***Novice***

E

Education Levels	25	30	35	40	45	50	55
12	1	2	4	8	15	27	42
11	1	2	5	9	17	29	45
10	1	3	5	10	18	31	48
9	1	3	6	11	20	34	51
8	2	3	6	12	22	36	54
7	2	4	7	13	24	39	57
6	2	4	8	15	26	42	59
5	2	5	9	16	28	45	62
4	3	5	10	18	31	47	65
3	3	6	11	20	33	50	67
2	3	6	12	22	36	53	70
1	4	7	13	24	39	56	72
0	4	8	15	26	41	59	74

Age

FEMALE →

F

Education Levels	25	30	35	40	45	50	55
12	0	1	1	2	4	9	16
11	0	1	1	3	5	10	18
10	0	1	1	3	6	11	19
9	0	1	2	3	6	12	21
8	0	1	2	3	7	13	23
7	0	1	2	4	8	14	25
6	1	1	2	4	8	16	28
5	1	1	2	5	9	17	30
4	1	1	3	5	10	19	33
3	1	2	3	6	12	21	35
2	1	2	3	7	13	23	38
1	1	2	4	7	14	25	40
0	1	2	4	8	16	27	43

Age

MALE

Proactiveness = 10

Education Levels	25	30	35	40	45	50	55
12	3	5	10	19	32	49	66
11	3	6	11	21	35	52	69
10	3	7	13	23	37	55	71
9	4	7	14	25	40	57	73
8	4	8	15	27	43	60	76
7	5	9	17	29	46	63	78
6	5	10	19	32	48	66	80
5	6	11	20	34	51	68	81
4	6	12	22	37	54	71	83
3	7	14	24	39	57	73	85
2	8	15	26	42	60	75	86
1	9	17	29	45	63	77	87
0	10	18	31	48	65	79	89

G

Age

FEMALE →

Education Levels	25	30	35	40	45	50	55
12	1	1	3	6	11	20	34
11	1	2	3	6	12	22	36
10	1	2	4	7	13	24	39
9	1	2	4	8	15	26	42
8	1	2	5	9	16	28	45
7	1	3	5	10	18	31	48
6	1	3	6	11	20	33	50
5	2	3	6	12	22	36	53
4	2	4	7	13	24	39	56
3	2	4	8	15	26	41	59
2	2	4	9	16	28	44	62
1	2	5	10	18	30	47	64
0	3	6	11	19	33	50	67

H

Age

MALE

↑ Proactiveness = 1

TIME = 10 YEARS

Stage of Usage: Novice

Figure F.11: Heat Map (2/2) of Probabilities for STAGE: ***Novice***

A

Education Levels							
12	6	10	17	24	28	25	19
11	6	11	18	25	28	25	18
10	7	12	19	26	28	24	17
9	8	13	20	26	27	23	15
8	8	14	22	27	27	22	14
7	9	15	23	27	26	20	13
6	10	17	24	28	26	19	12
5	11	18	25	28	25	18	11
4	12	19	26	28	24	17	10
3	13	20	26	27	23	16	9
2	14	21	27	27	22	14	8
1	15	23	27	26	21	13	8
0	16	24	28	26	19	12	7
Age	25	30	35	40	45	50	55

FEMALE →

B

Education Levels							
12	2	3	6	11	18	25	28
11	2	4	7	12	19	25	28
10	2	4	7	13	20	26	27
9	2	4	8	14	21	27	27
8	3	5	9	15	22	27	27
7	3	5	10	16	23	28	26
6	3	6	11	17	24	28	25
5	3	7	12	19	25	28	24
4	4	7	13	20	26	28	23
3	4	8	14	21	27	27	22
2	5	9	15	22	27	27	21
1	5	10	16	23	28	26	20
0	6	11	17	24	28	25	19
Age	25	30	35	40	45	50	55

MALE

Proactiveness = 10

C

Education Levels							
12	13	20	26	28	23	16	10
11	14	21	27	27	22	15	9
10	15	22	27	27	21	14	8
9	16	23	27	26	20	13	7
8	17	24	28	25	19	12	7
7	18	25	28	24	18	11	6
6	19	26	28	24	16	10	5
5	21	26	27	22	15	9	5
4	22	27	27	21	14	8	4
3	23	27	26	20	13	7	4
2	24	28	26	19	12	7	4
1	25	28	25	18	11	6	3
0	26	28	24	17	10	6	3
Age	25	30	35	40	45	50	55

FEMALE →

D

Education Levels							
12	4	8	13	20	26	27	23
11	5	8	14	22	27	27	21
10	5	9	16	23	27	26	20
9	6	10	17	24	28	26	19
8	6	11	18	25	28	25	18
7	7	12	19	26	28	24	17
6	7	13	20	26	27	23	16
5	8	14	21	27	27	22	14
4	9	15	23	27	26	21	13
3	10	16	24	28	26	19	12
2	11	18	25	28	25	18	11
1	12	19	25	28	24	17	10
0	13	20	26	27	23	16	9
Age	25	30	35	40	45	50	55

MALE

↑ Proactiveness = 1

TIME = 1 YEAR →

Stage of Usage: Rote Learner

Figure F.12: Heat Map (1/2) of Probabilities for STAGE: ***Rote-Learner***

E

Education Levels	25	30	35	40	45	50	55
12	2	4	8	13	21	26	27
11	2	5	8	15	22	27	27
10	3	5	9	16	23	27	26
9	3	6	10	17	24	28	26
8	3	6	11	18	25	28	25
7	4	7	12	19	26	28	24
6	4	8	13	20	26	27	23
5	4	8	14	22	27	27	22
4	5	9	15	23	27	26	20
3	6	10	17	24	28	26	19
2	6	11	18	25	28	25	18
1	7	12	19	26	28	24	17
0	7	13	20	26	27	23	16

Age

FEMALE →

F

Education Levels	25	30	35	40	45	50	55
12	1	1	2	4	8	14	21
11	1	1	3	5	9	15	23
10	1	1	3	5	10	16	24
9	1	2	3	6	11	18	25
8	1	2	4	7	12	19	25
7	1	2	4	7	13	20	26
6	1	2	4	8	14	21	27
5	1	2	5	9	15	22	27
4	1	3	5	10	16	23	28
3	2	3	6	11	17	24	28
2	2	3	7	12	19	25	28
1	2	4	7	13	20	26	28
0	2	4	8	14	21	27	27

Age

MALE

Proactiveness = 10

Education Levels	25	30	35	40	45	50	55
12	5	10	16	23	28	26	20
11	6	11	17	24	28	25	19
10	6	11	18	25	28	24	17
9	7	13	20	26	28	23	16
8	8	14	21	27	27	22	15
7	9	15	22	27	27	21	14
6	9	16	23	27	26	20	13
5	10	17	24	28	25	19	12
4	11	18	25	28	25	18	11
3	12	19	26	28	24	16	10
2	13	21	26	27	22	15	9
1	14	22	27	27	21	14	8
0	16	23	27	26	20	13	7

G

Age

FEMALE →

Education Levels	25	30	35	40	45	50	55
12	1	3	6	10	17	24	28
11	2	3	6	11	18	25	28
10	2	4	7	12	19	26	28
9	2	4	8	13	20	26	27
8	2	5	8	14	22	27	27
7	3	5	9	15	23	27	26
6	3	6	10	17	24	28	26
5	3	6	11	18	25	28	25
4	4	7	12	19	26	28	24
3	4	7	13	20	26	27	23
2	4	8	14	21	27	27	22
1	5	9	15	22	27	26	21
0	5	10	16	24	28	26	19

H

Age

MALE

↑ Proactiveness = 1

TIME = 10 YEARS

Stage of Usage: Rote Learner

Figure F.13: Heat Map (2/2) of Probabilities for STAGE: ***Rote-Learner***

A

Education Levels	25	30	35	40	45	50	55
12	35	45	48	42	31	20	11
11	36	46	48	41	29	18	10
10	38	47	47	39	27	17	9
9	40	47	46	37	26	15	8
8	42	48	45	36	24	14	8
7	43	48	44	34	22	13	7
6	44	48	43	32	20	12	6
5	46	48	41	30	19	10	6
4	46	47	39	28	17	9	5
3	47	46	38	26	16	9	4
2	48	45	36	24	14	8	4
1	48	44	34	22	13	7	4
0	48	43	32	20	12	6	3

Age

FEMALE →

B

Education Levels	25	30	35	40	45	50	55
12	14	24	36	45	48	41	30
11	16	26	38	46	47	40	28
10	17	28	39	47	46	38	26
9	19	30	41	48	46	36	24
8	20	32	43	48	44	34	22
7	22	34	44	48	43	32	21
6	24	35	45	48	42	30	19
5	25	37	46	47	40	28	17
4	27	39	47	47	38	26	16
3	29	41	48	46	36	25	15
2	31	42	48	45	35	23	13
1	33	44	48	43	33	21	12
0	35	45	48	42	31	19	11

Age

MALE

Proactiveness = 10

C

Education Levels	25	30	35	40	45	50	55
12	47	47	39	27	16	9	5
11	47	46	37	25	15	8	4
10	48	45	35	23	14	7	4
9	48	44	33	21	12	7	3
8	48	42	31	20	11	6	3
7	47	41	29	18	10	5	3
6	47	39	27	16	9	5	2
5	46	37	25	15	8	4	2
4	45	35	23	14	7	4	2
3	44	33	22	12	7	3	2
2	42	31	20	11	6	3	2
1	41	29	18	10	5	3	1
0	39	27	17	9	5	2	1

Age

FEMALE →

D

Education Levels	25	30	35	40	45	50	55
12	28	40	47	46	37	25	15
11	30	42	48	45	35	24	14
10	32	43	48	44	34	22	13
9	34	44	48	43	32	20	11
8	36	46	48	41	30	18	10
7	38	46	47	39	28	17	9
6	40	47	46	38	26	15	9
5	41	48	45	36	24	14	8
4	43	48	44	34	22	13	7
3	44	48	43	32	20	12	6
2	45	48	41	30	19	11	6
1	46	47	40	28	17	10	5
0	47	46	38	26	16	9	5

Age

MALE

↑ Proactiveness = 1

TIME = 1 YEAR →

Stage of Usage: Fluent

Figure F.14: Heat Map (1/2) of Probabilities for STAGE: ***Fluent***

E

Education Levels	25	30	35	40	45	50	55
12	18	29	40	47	46	37	25
11	19	31	42	48	45	35	23
10	21	32	43	48	44	33	22
9	23	34	45	48	42	31	20
8	24	36	46	48	41	29	18
7	26	38	47	47	39	27	17
6	28	40	47	46	37	26	15
5	30	42	48	45	36	24	14
4	32	43	48	44	34	22	13
3	34	44	48	43	32	20	12
2	36	45	48	41	30	19	10
1	38	46	47	40	28	17	9
0	40	47	46	38	26	16	9

Age

FEMALE →

F

Education Levels	25	30	35	40	45	50	55
12	6	11	19	30	41	48	45
11	6	12	20	32	43	48	44
10	7	13	22	34	44	48	43
9	8	14	24	36	45	48	41
8	8	15	26	38	46	47	40
7	9	17	28	39	47	47	38
6	10	18	30	41	48	46	36
5	11	20	32	43	48	44	34
4	13	22	33	44	48	43	32
3	14	24	35	45	48	42	30
2	15	25	37	46	47	40	28
1	17	27	39	47	47	38	27
0	18	29	41	48	46	36	25

Age

MALE

Proactiveness = 10

Education Levels	25	30	35	40	45	50	55
12	33	44	48	43	33	21	12
11	35	45	48	42	31	19	11
10	37	46	47	40	29	18	10
9	39	47	47	39	27	16	9
8	40	47	46	37	25	15	8
7	42	48	45	35	23	14	7
6	43	48	44	33	21	12	7
5	45	48	42	31	20	11	6
4	46	47	41	29	18	10	5
3	47	47	39	27	17	9	5
2	47	46	37	25	15	8	4
1	48	45	35	23	14	7	4
0	48	44	33	22	13	7	3

G

Age

FEMALE →

Education Levels	25	30	35	40	45	50	55
12	13	23	34	45	48	42	31
11	15	24	36	46	48	41	29
10	16	26	38	47	47	39	27
9	17	28	40	47	46	37	26
8	19	30	42	48	45	36	24
7	21	32	43	48	44	34	22
6	22	34	44	48	43	32	20
5	24	36	46	48	41	30	19
4	26	38	46	47	39	28	17
3	28	40	47	46	38	26	16
2	30	41	48	45	36	24	14
1	32	43	48	44	34	22	13
0	34	44	48	43	32	20	12

Age

H

MALE

↑ Proactiveness = 1

TIME = 10 YEARS

Stage of Usage: Fluent

Figure F.15: Heat Map (2/2) of Probabilities for STAGE: ***Fluent***

A — FEMALE, Proactiveness = 10

Education Levels	25	30	35	40	45	50	55
12	57	39	24	14	7	4	2
11	54	37	22	12	6	3	2
10	51	34	20	11	6	3	1
9	48	32	18	10	5	3	1
8	46	29	17	9	5	2	1
7	43	27	15	8	4	2	1
6	40	25	14	7	4	2	1
5	37	23	13	7	3	2	1
4	35	21	11	6	3	1	1
3	32	19	10	5	3	1	1
2	30	17	9	5	2	1	1
1	27	16	8	4	2	1	1
0	25	14	7	4	2	1	0

Age

FEMALE →

B — MALE, Proactiveness = 10

Education Levels	25	30	35	40	45	50	55
12	83	71	55	38	23	13	7
11	82	69	52	35	21	11	6
10	80	66	49	32	19	10	5
9	78	64	46	30	17	9	5
8	76	61	44	28	16	8	4
7	74	58	41	25	14	8	4
6	72	55	38	23	13	7	3
5	69	53	35	21	12	6	3
4	67	50	33	19	11	5	3
3	64	47	30	18	10	5	2
2	62	44	28	16	9	4	2
1	59	41	26	15	8	4	2
0	56	38	24	13	7	4	2

Age

MALE

Proactiveness = 10

C — FEMALE, Proactiveness = 1

Education Levels	25	30	35	40	45	50	55
12	33	20	11	6	3	1	1
11	31	18	10	5	3	1	1
10	28	16	9	4	2	1	1
9	26	15	8	4	2	1	0
8	24	13	7	4	2	1	0
7	22	12	6	3	2	1	0
6	20	11	6	3	1	1	0
5	18	10	5	3	1	1	0
4	17	9	5	2	1	1	0
3	15	8	4	2	1	1	0
2	14	7	4	2	1	0	0
1	12	6	3	2	1	0	0
0	11	6	3	1	1	0	0

Age

FEMALE →

D — MALE, Proactiveness = 1

Education Levels	25	30	35	40	45	50	55
12	66	48	32	18	10	5	3
11	63	45	29	17	9	5	2
10	60	43	27	15	8	4	2
9	57	40	25	14	7	4	2
8	55	37	23	13	7	3	2
7	52	34	21	11	6	3	1
6	49	32	19	10	5	3	1
5	46	29	17	9	5	2	1
4	43	27	16	8	4	2	1
3	40	25	14	7	4	2	1
2	38	23	13	7	3	2	1
1	35	21	12	6	3	2	1
0	32	19	10	5	3	1	1

Age

MALE

↑ Proactiveness = 1

TIME = 1 YEAR →

Stage of Usage: Competent

Figure F.16: Heat Map (1/2) of Probabilities for STAGE: ***Competent***

E — FEMALE, Proactiveness = 10

Education Levels	25	30	35	40	45	50	55
12	79	65	48	31	18	10	5
11	77	63	45	29	17	9	5
10	75	60	42	26	15	8	4
9	73	57	40	24	14	7	4
8	71	54	37	22	12	6	3
7	68	51	34	20	11	6	3
6	66	48	32	19	10	5	3
5	63	46	29	17	9	5	2
4	60	43	27	15	8	4	2
3	58	40	25	14	7	4	2
2	55	37	23	13	7	3	2
1	52	35	21	11	6	3	2
0	49	32	19	10	5	3	1

Age

FEMALE →

F — MALE, Proactiveness = 10

Education Levels	25	30	35	40	45	50	55
12	94	88	78	63	46	30	17
11	93	86	76	61	43	27	16
10	92	85	74	58	40	25	14
9	91	84	71	55	38	23	13
8	90	82	69	52	35	21	12
7	89	80	66	49	32	19	10
6	88	78	64	47	30	17	9
5	87	76	61	44	28	16	8
4	85	74	58	41	25	14	8
3	84	72	56	38	23	13	7
2	82	69	53	35	21	12	6
1	80	67	50	33	19	11	6
0	79	64	47	30	18	10	5

Age

MALE

Proactiveness = 10

G — FEMALE, Proactiveness = 1

Education Levels	25	30	35	40	45	50	55
12	59	41	26	15	8	4	2
11	56	39	24	13	7	4	2
10	53	36	22	12	6	3	2
9	50	33	20	11	6	3	1
8	48	31	18	10	5	3	1
7	45	28	16	9	5	2	1
6	42	26	15	8	4	2	1
5	39	24	13	7	4	2	1
4	36	22	12	6	3	2	1
3	34	20	11	6	3	1	1
2	31	18	10	5	3	1	1
1	29	17	9	5	2	1	1
0	27	15	8	4	2	1	1

Age

FEMALE →

H — MALE, Proactiveness = 1

Education Levels	25	30	35	40	45	50	55
12	85	73	57	39	24	14	7
11	83	71	54	37	22	12	6
10	81	68	51	34	20	11	6
9	80	66	48	32	19	10	5
8	78	63	46	29	17	9	5
7	76	60	43	27	15	8	4
6	73	57	40	25	14	7	4
5	71	55	37	23	13	7	3
4	69	52	35	21	11	6	3
3	66	49	32	19	10	5	3
2	63	46	30	17	9	5	2
1	61	43	27	16	8	4	2
0	58	40	25	14	7	4	2

Age

MALE

↑ Proactiveness = 1

TIME = 10 YEARS

Stage of Usage: Competent

Figure F.17: Heat Map (2/2) of Probabilities for STAGE: ***Competent***

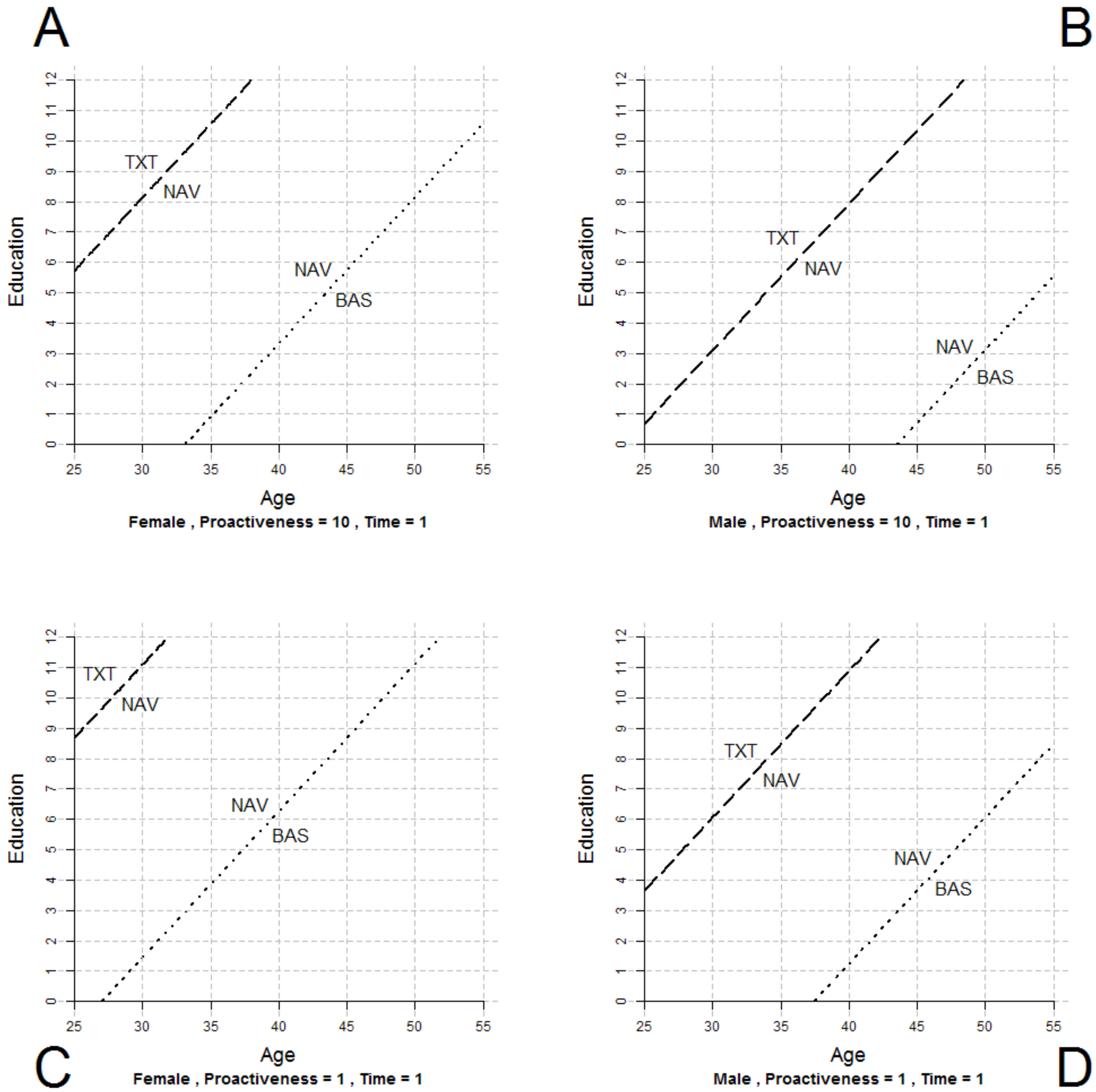

Figure F.18: Class Boundaries (1/2) for User Types: BAS/NAV (dotted), NAV/TXT (dashed) and TXT/SAVE (solid).

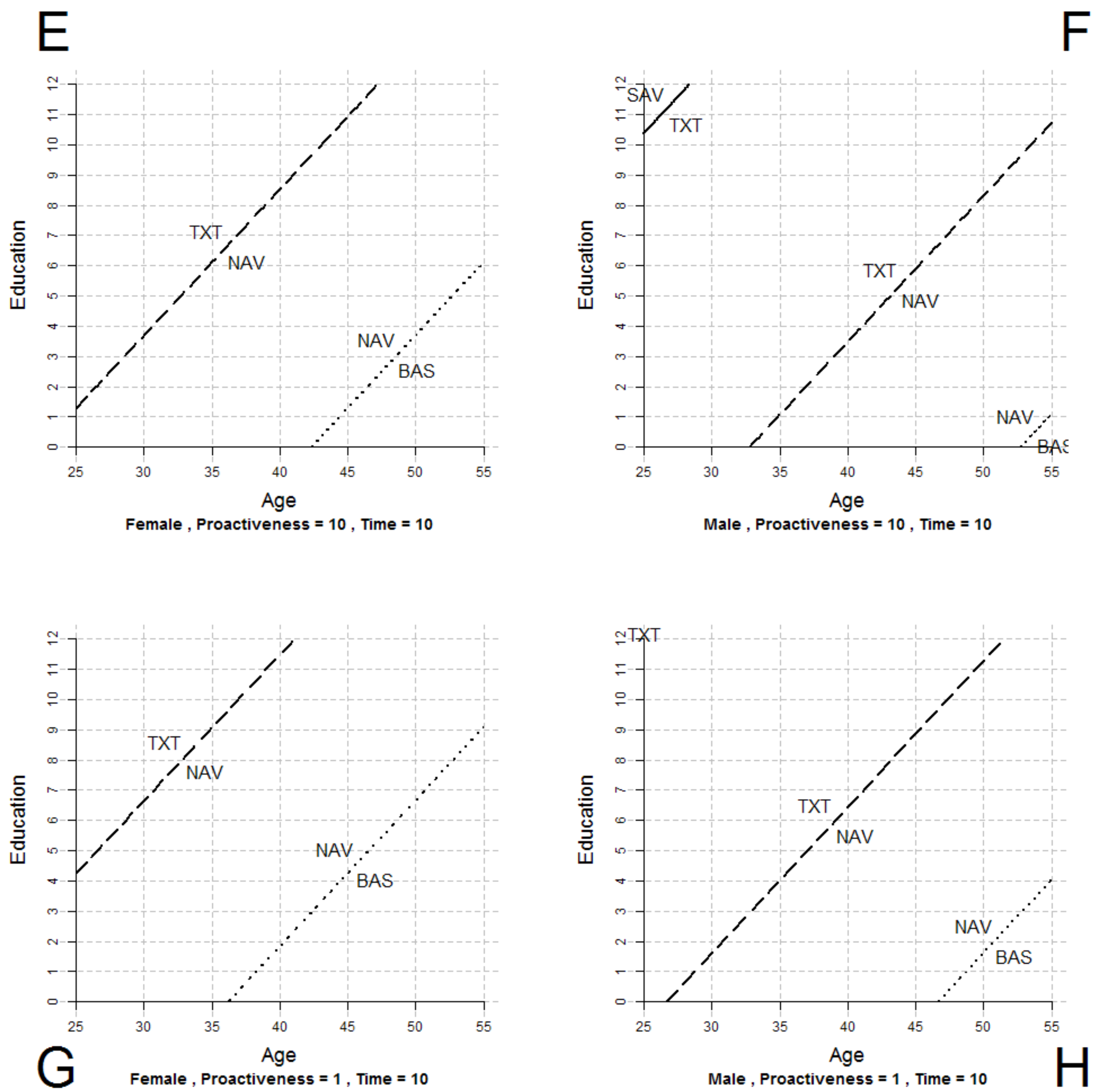

Figure F.19: Class Boundaries (2/2) for User Types: BAS/NAV (dotted), NAV/TXT (dashed) and TXT/SAVE (solid).

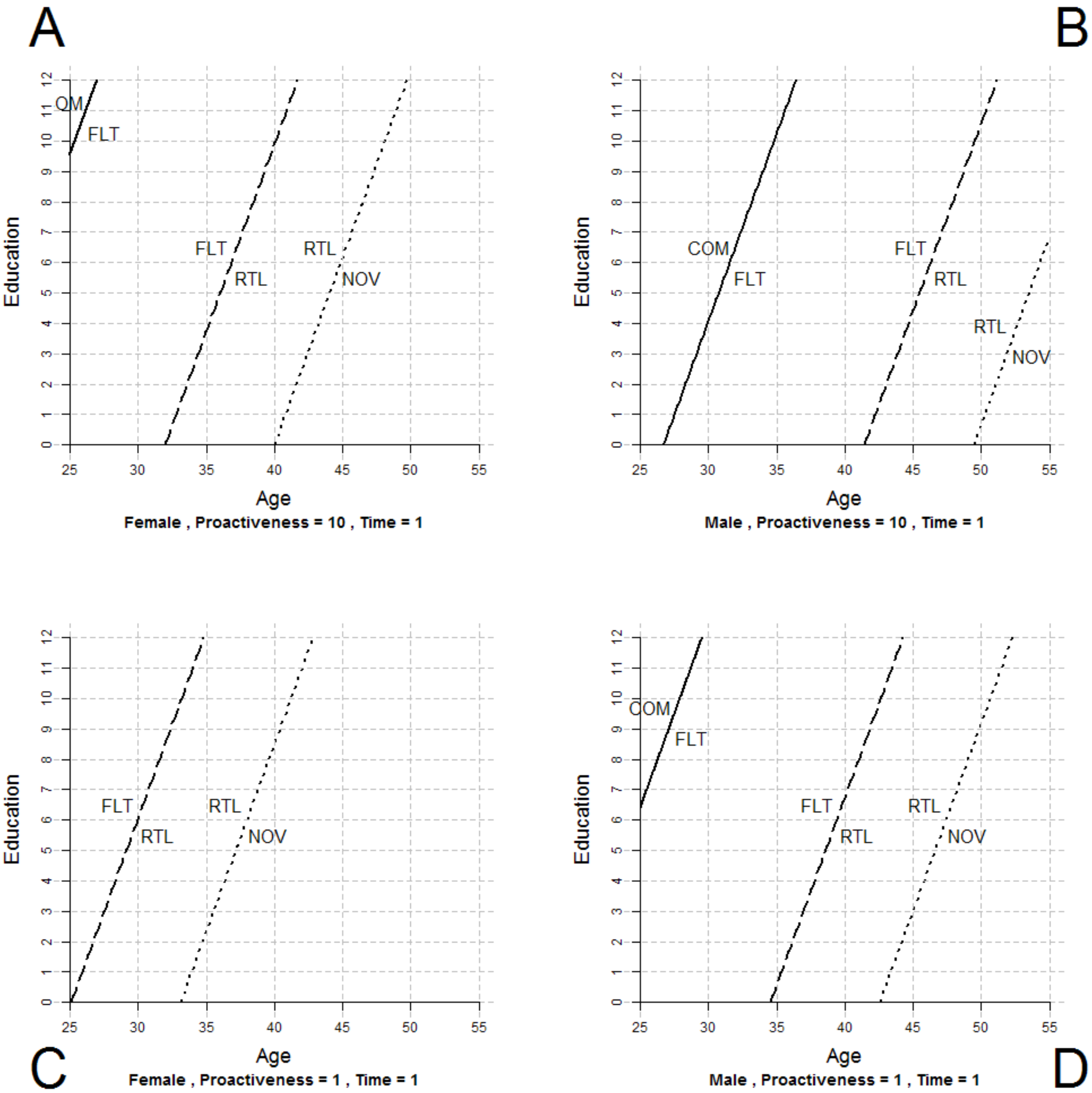

Figure F.20: Class Boundaries (1/2) for Stages of Usage: NOV/RTL (dotted), RTL/FLT (dashed) and FLT/COM (solid).

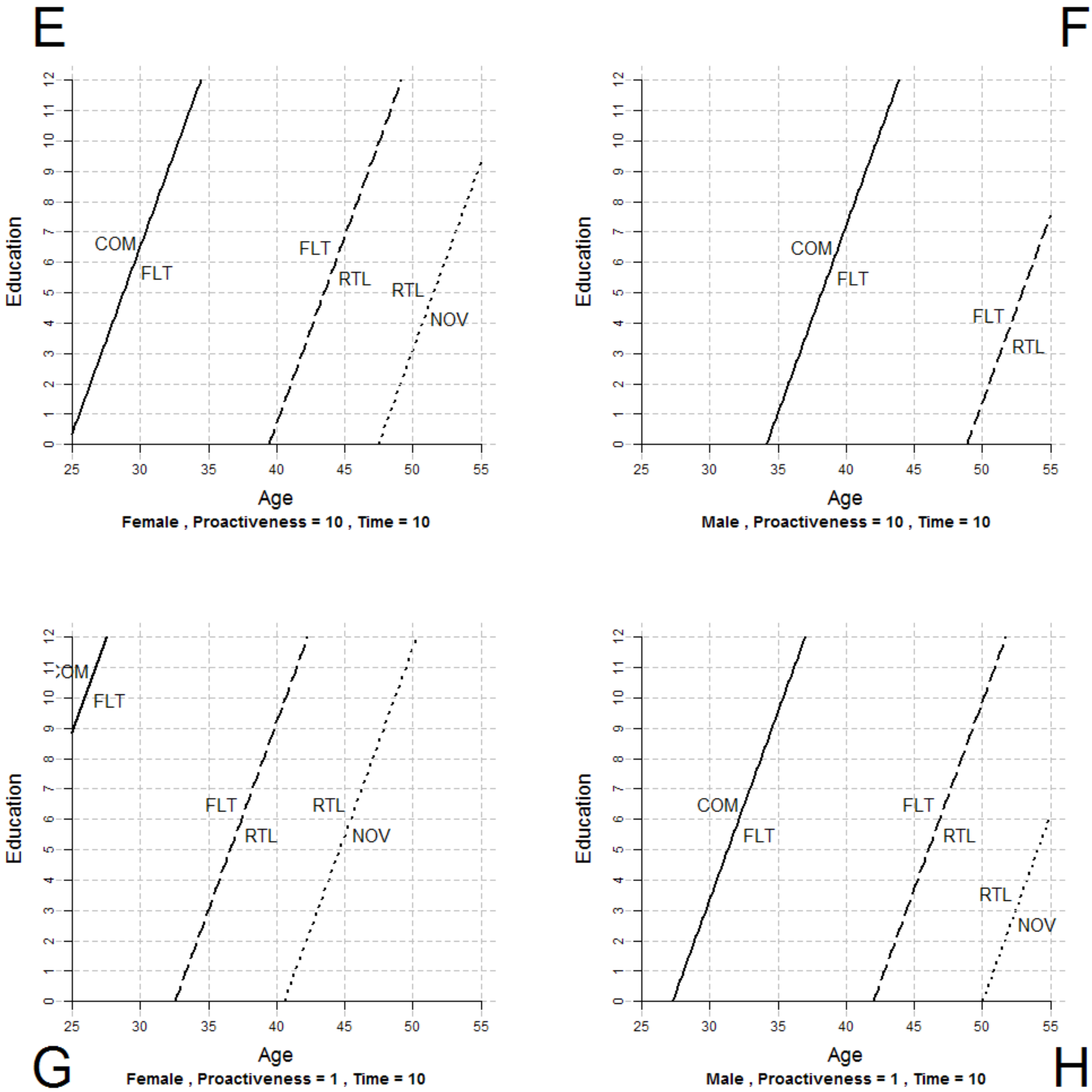

Figure F.21: Class Boundaries (2/2) for Stages of Usage: NOV/RTL (dotted), RTL/FLT (dashed) and FLT/COM (solid).

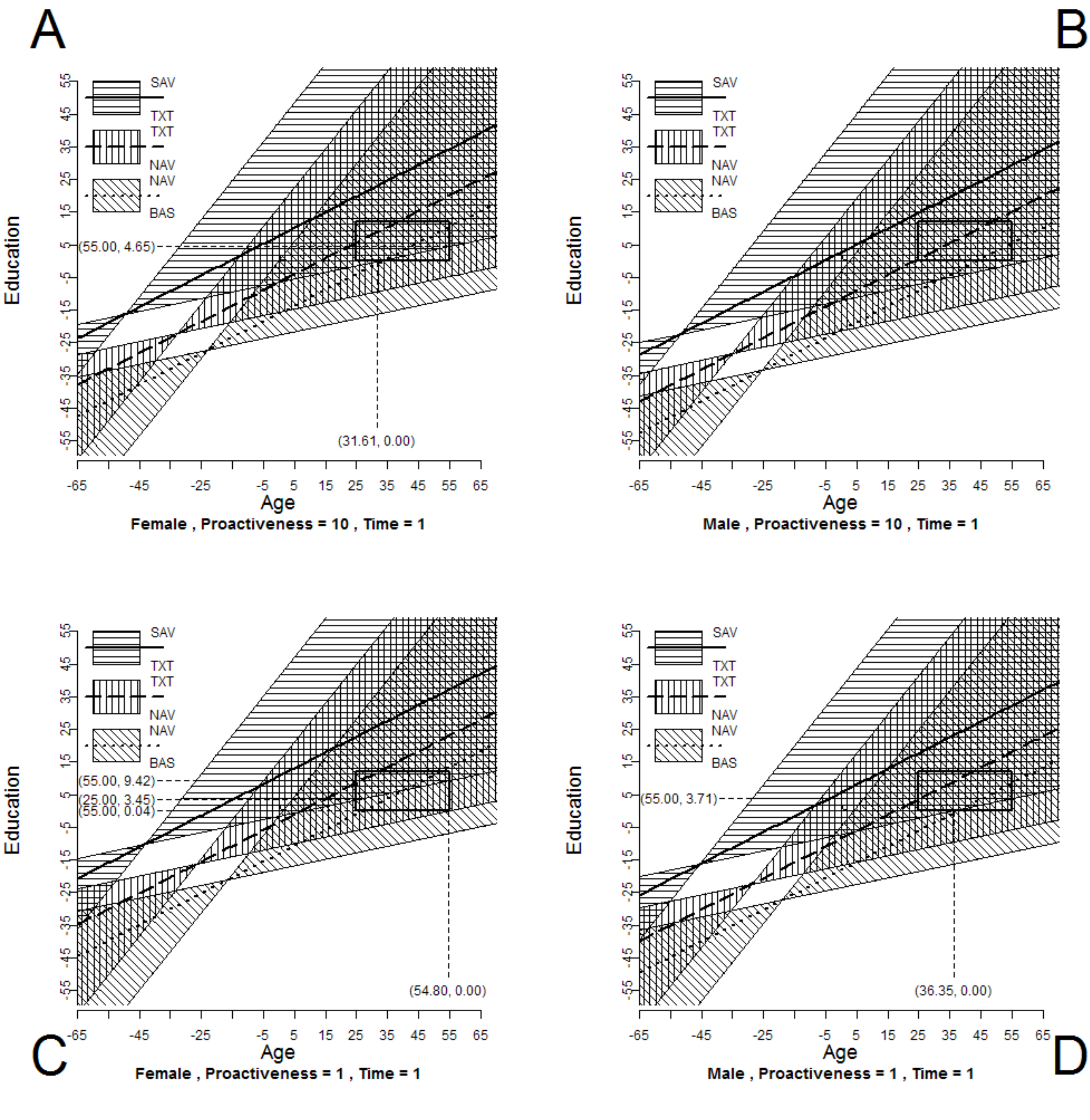

Figure F.22: 95% Confidence-Intervals (1/2) for the Class Boundaries for User Types.

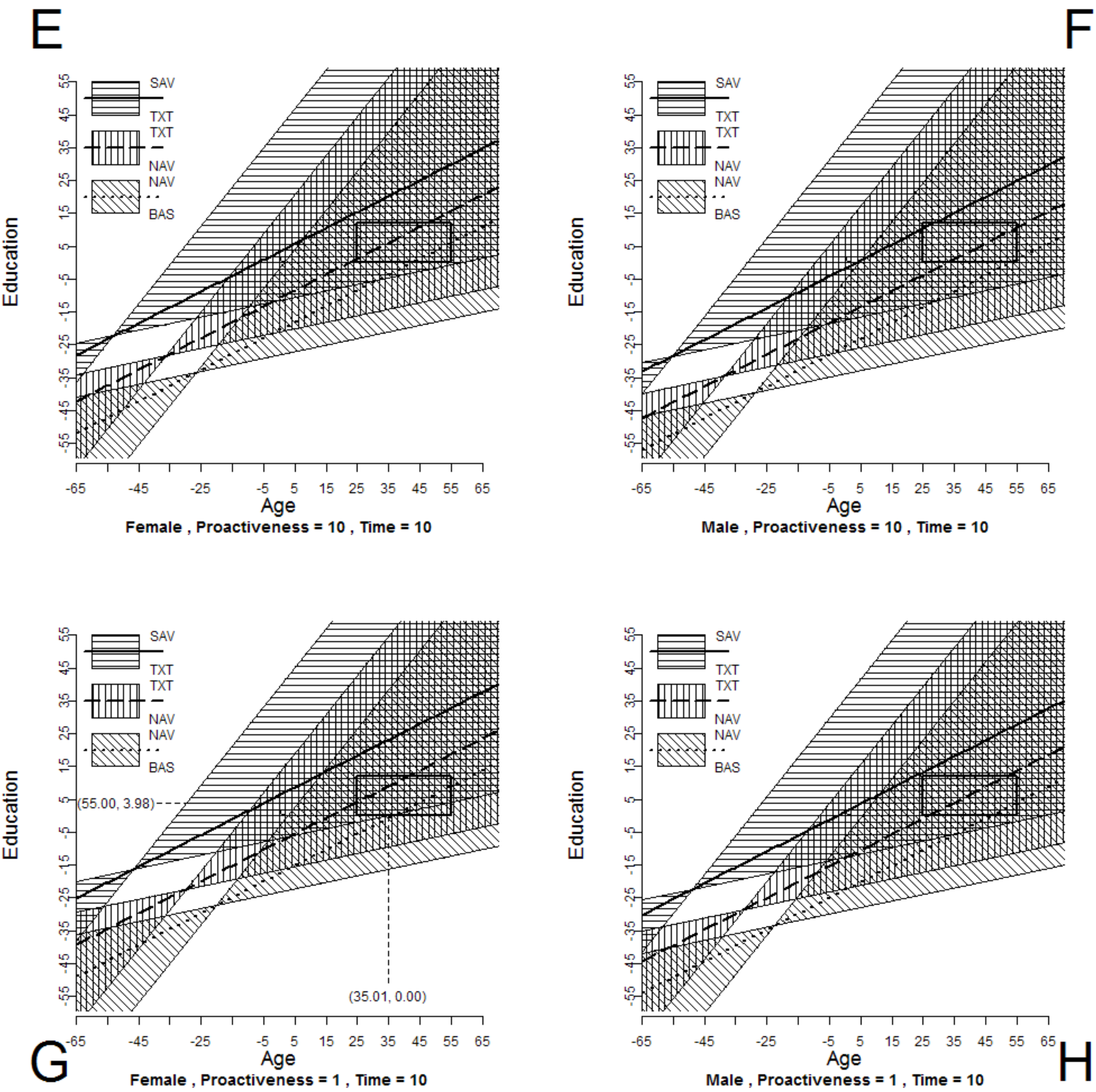

Figure F.23: 95% Confidence-Intervals (2/2) for the Class Boundaries for User Types.

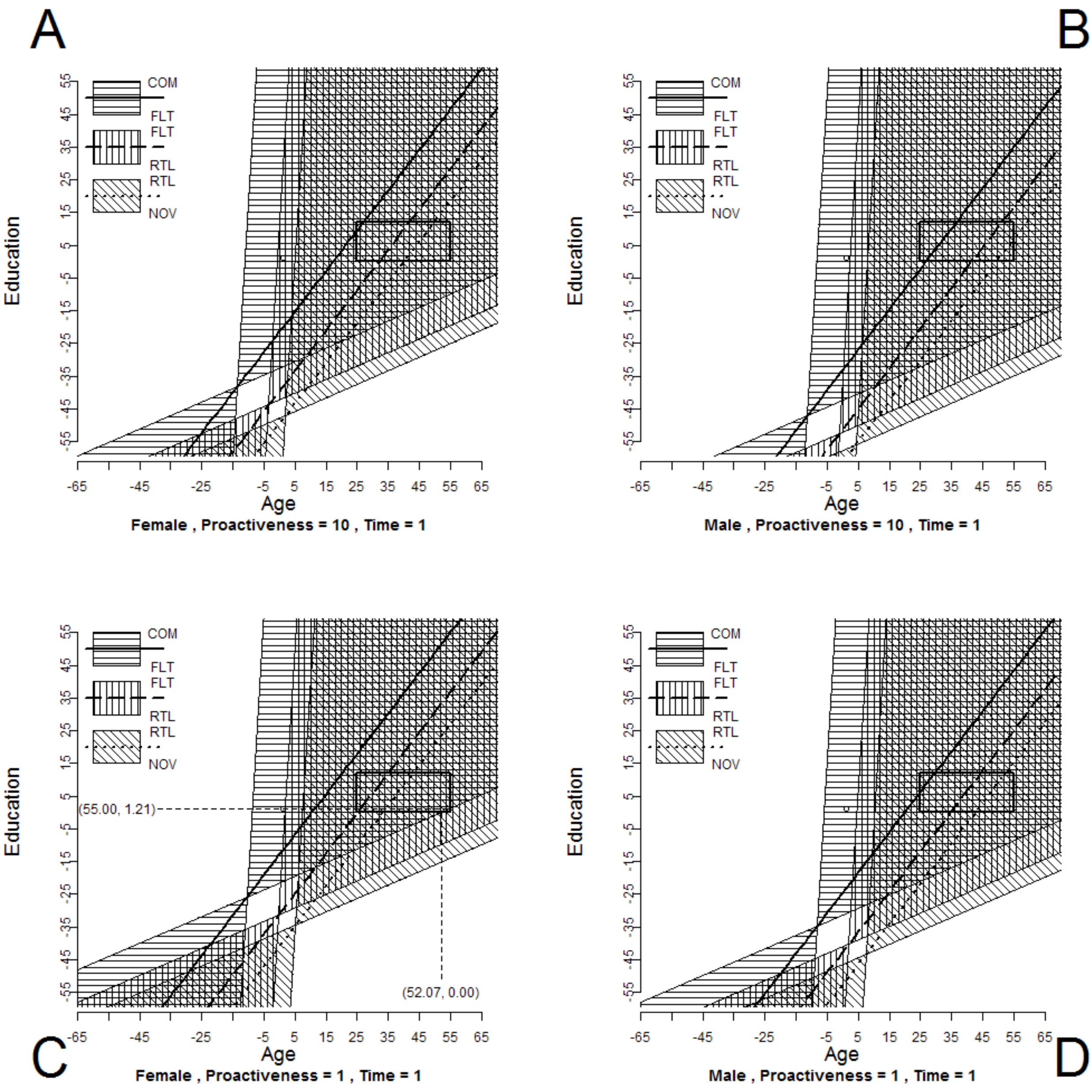

Figure F.24: 95% Confidence-Intervals (1/2) for the Class Boundaries for Stages of Usage.

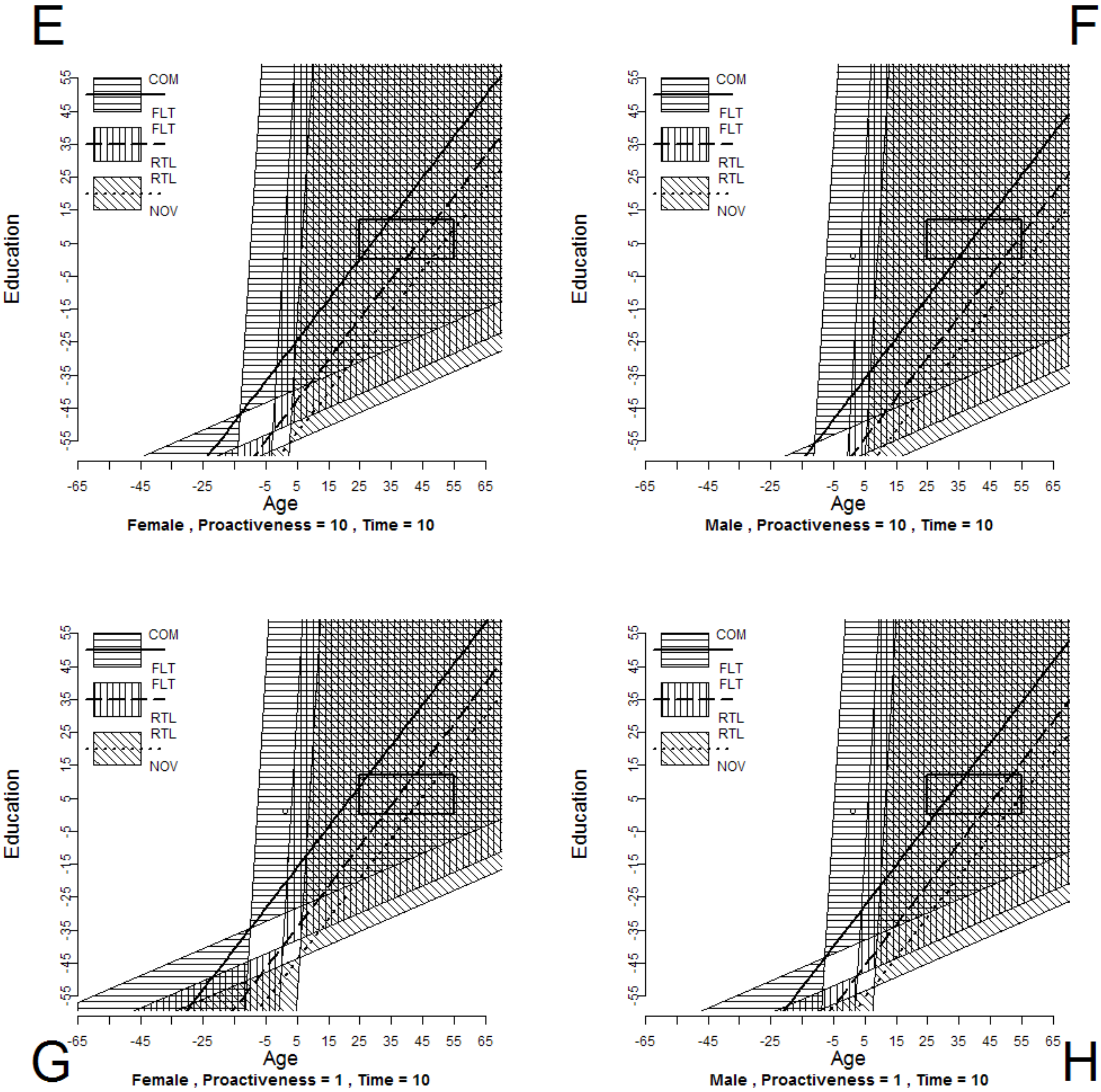

Figure F.25: 95% Confidence-Intervals (2/2) for the Class Boundaries for Stages of Usage.

Bibliography

Anja Achtziger and Peter M Gollwitzer. *Motivation and volition in the course of action*. Bibliothek der Universität Konstanz, 2008.

Surabhi Agarwal. Internet users in india expected to reach 500 million by june: Iamai, 2018. Retrieved April 15, 2018, from https://economictimes.indiatimes.com/tech/internet/internet-users-in-india-expected-to-reach-500-million-by-june-iamai/articleshow/63000198.cms.

A Agresti. *Categorical Data Analysis*. Wiley Series in Probability and Statistics. Wiley, 2013. ISBN 9781118710944. URL https://books.google.co.in/books?id=6PHHE1Cr44AC.

Icek Ajzen and Martin Fishbein. Belief, attitude, intention and behavior: An introduction to theory and research, 1975.

G. W. Allport. *Attitudes*, pages 798–844. Clark Univ. Press., 2018.

Sudhir Anand. Human development index: methodology and measurement. Technical report, Human Development Report Office (HDRO), United Nations Development Programme (UNDP), 1994.

John R Anderson. Act: A simple theory of complex cognition. *American Psychologist*, 51(4):355, 1996.

John R Anderson. Human symbol manipulation within an integrated cognitive architecture. *Cognitive science*, 29(3):313–341, 2005.

Yaw Anokwa, Carl Hartung, Waylon Brunette, Gaetano Borriello, and Adam Lerer. Open source data collection in the developing world. *Computer*, 42(10):97–99, 2009.

Amy Antonio and David Tuffley. The gender digital divide in developing countries. *Future Internet*, 6(4):673–687, 2014.

Javed Anwer. Minister climbed on tree with a phone and it shows digital india is still a pipe dream, Jun 2017. URL http://indiatoday.intoday.in/technology/story/minister-climbed-on-tree-with-a-phone-and-it-shows-digital-india-is-still-a-pipe-dream/1/972798.html.

Uzmi Athar. Agri apps have little relevance for farmers of a village in darkness, 2017. URL http://www.thehansindia.com/posts/index/Commoner/2017-06-26/Agri-Apps-have-little-relevance-for-farmers-of-a-village-in-darkness/308723.

Albert Bandura. Toward a unifying theory of behavioral change, 1977. ISSN 0033295X. URL http://www.apa.org/pubs/journals/rev/.

Albert Bandura. Self-efficacy: Toward a unifying theory of behavioral change, 1978. ISSN 01466402.

F C Bartlett. *Remembering: A Study in Experimental and Social Psychology*. Cambridge books online. Cambridge University Press, 1995. ISBN 9780521483568. URL https://books.google.co.in/books?id=WG5ZcHGTrm4C.

Simon Batchelor, Nigel Scott, and David Woolnough. Good practice paper on icts for economic growth and poverty reduction. *DAC Journal*, 6(3), 2005.

George M Beal and Joe M Bohlen. *The diffusion process*. Agricultural Experiment Station, Iowa State College, 1957.

Patricia Benner. From novice to expert. *Menlo Park*, 1984.

Hugh Beyer and Karen Holtzblatt. *Contextual design: defining customer-centered systems*. Elsevier, 1997.

Yuthika Bhargava. Desktop, notebook see more demand in rural areas, 2015. Retrieved Sep 01, 2017, from http://www.thehindu.com/business/Industry/desktop-notebook-see-more-demand-in-rural-areas/article7434548.ece.

D Bhatnagar, A Dewan, MM Torres, and P Kanungo. Drishtee telecenter initiative. *Empowerment Case Studies*, 2003.

L G Birta and G Arbez. *Modelling and Simulation: Exploring Dynamic System Behaviour*. Simulation Foundations, Methods and Applications. Springer London, 2013. ISBN 9781447127833. URL https://books.google.co.in/books?id=td29BAAAQBAJ.

Craig Blurton. New directions of ict-use in education. *Retrieved on September 26, 2016*, 24:2012, 1999.

Pierre Bourdieu. The berber house or the world reversed. *Information (International Social Science Council)*, 9(2):151–170, 1970.

B Bowonder, Vinay Gupta, and Amit Singh. Developing a rural market e-hub: The case study of e-choupal experience of itc. *Indian Planning Commission Report*, 2002.

Rollin Brant. Assessing proportionality in the proportional odds model for ordinal logistic regression. *Biometrics*, pages 1171–1178, 1990.

Francesca Bray. Gender and technology. *Women, science, and technology: a reader in feminist science studies, 3rd edn. Routledge, New York*, pages 370–384, 2013.

Stuart K Card, Thomas P Moran, and Allen Newell. The model human processor- an engineering model of human performance. *Handbook of perception and human performance.*, 2:45–1, 1986.

John M Carroll. *Designing Interaction: Psychology at the Human-Computer Interface*. Cambridge Series on Human-Computer Interaction. Cambridge University Press, 1991. ISBN 9780521409216. URL https://books.google.co.in/books?id=coY6AAAAIAAJ.

Stephen J Ceci and Wendy M Williams. Schooling, intelligence, and income. *American Psychologist*, 52(10):1051, 1997.

Eric Chetwynd, Frances Chetwynd, and Bertram Spector. Corruption and poverty: a review of recent literature. *Management Systems International*, 600:5–16, 2003.

Cynthia Carter Ching, James D Basham, and Eunice Jang. The legacy of the digital divide gender, socioeconomic status, and early exposure as predictors of full-spectrum technology use among young adults. *Urban Education*, 40(4):394–411, 2005.

Jan Chipchase. Understanding non-literacy as a barrier to mobile phone communication, 2005. URL http://research.nokia.com/bluesky/non-literacy-001-2005/index.html.

Janghee Cho. Mental models and home virtual assistants (hvas). In *Extended Abstracts of the 2018 CHI Conference on Human Factors in Computing Systems*, page SRC05. ACM, 2018.

Mohammad Y Chuttur. Overview of the technology acceptance model: Origins, developments and future directions. *Working Papers on Information Systems*, 9(37):9–37, 2009.

Ronald H Coase. The nature of the firm. *economica*, 4(16):386–405, 1937.

Cynthia Cockburn, Roger Silverstone, and Eric Hirsch. The circuit of technology: Gender, identity and power. *Consuming technologies: Media and information in domestic spaces*, pages 33–42, 1992.

Allan Collins and Dedre Gentner. How people construct mental models. *Cultural models in language and thought*, 243, 1987.

Deborah R Compeau and Christopher A Higgins. Computer self-efficacy: Development of a measure and initial test. *MIS quarterly*, pages 189–211, 1995.

Benjamin R Cowan, Nadia Pantidi, David Coyle, Kellie Morrissey, Peter Clarke, Sara Al-Shehri, David Earley, and Natasha Bandeira. What can i help you with?: infrequent users' experiences of intelligent personal assistants. In *Proceedings of the 19th International Conference on Human-Computer Interaction with Mobile Devices and Services*, page 43. ACM, 2017.

Kenneth James Williams Craik. *The nature of explanation*, volume 445. CUP Archive, 1967.

John D'Ambra, Concepción S Wilson, and Shahriar Akter. Application of the task-technology fit model to structure and evaluate the adoption of e-books by academics. *Journal of the Association for Information Science and Technology*, 64(1):48–64, 2013.

Philip Darbyshire. Skilled expert practice: is it 'all in the mind' a response to english's critique of benner's novice to expert model. *Journal of Advanced Nursing*, 19(4):755–761, 1994.

Fred D Davis. Feb 0 3 1986. *PhDThesis - Massachussetts Institute of technology*, 1986.

Fred D Davis. Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS quarterly*, pages 319–340, 1989.

Fred D Davis and Viswanath Venkatesh. A critical assessment of potential measurement biases in the technology acceptance model: three experiments. *International Journal of Human-Computer Studies*, 45(1):19–45, 1996.

Fred D Davis, Richard P Bagozzi, and Paul R Warshaw. Extrinsic and intrinsic motivation to use computers in the workplace. *Journal of Applied Social Psychology*, 22(14): 1111–1132, 1992a. ISSN 1559-1816. doi: 10.1111/j.1559-1816.1992.tb00945.x. URL http://onlinelibrary.wiley.com/doi/10.1111/j.1559-1816.1992.tb00945.x/abstract{%}5Cnhttp://dx.doi.org/10.1111/j.1559-1816.1992.tb00945.x.

Fred D Davis, Richard P Bagozzi, and Paul R Warshaw. Extrinsic and intrinsic motivation to use computers in the workplace1. *Journal of applied social psychology*, 22(14):1111–1132, 1992b.

Antonella De Angeli, Uday Athavankar, Anirudha Joshi, Lynne Coventry, and Graham I Johnson. Introducing atms in india: a contextual inquiry. *Interacting with Computers*, 16(1):29–44, 2004.

Nicola Dell and Neha Kumar. The ins and outs of hci for development. In *Proceedings* *of the 2016 CHI conference on human factors in computing systems*, pages 2220–2232. ACM, 2016.

Ashwini Deshpande and Manjishta Banerji. India's great education challenge: Low attendance, high rate of dropouts plague rural schools, 2017. Retrieved Sep 01, 2017, from http://www.firstpost.com/india/indias-great-education-challenge-low-attendance-high-rate-of-dropouts-plague-rural-schools-3378802.html.

Andrew Dillon and Michael G Morris. User acceptance of new information technology: theories and models. *Annual review of information science and technology*, 1996.

Ruchi V Dixit and Gyan Prakash. Intentions to use social networking sites (sns) using technology acceptance model (tam) an empirical study. *Paradigm*, 22(1):65–79, 2018.

Leslie L Dodson, S Sterling, and John K Bennett. Considering failure: Eight years of itid research. In *Proceedings of the Fifth International Conference on Information and Communication Technologies and Development*, pages 56–64. ACM, 2012.

Mark Doms. Communications equipment: What has happened to prices? In *Measuring capital in the new economy*, pages 323–362. University of Chicago Press, 2005.

J Donner, N Rangaswamy, M W Steenson, and Carolyn Wei. "express yourself" and "stay together": The middle-class indian family. In *Handbook of Mobile Communication Studies*, pages 325 – 338. 2008. ISBN 9780262113120. doi: 10.1201/9781420053890.

Hubert L Dreyfus. *What computers can't do: a critique of artificial reason.* Harper & Row, 1972. URL https://books.google.co.in/books?id=TsraAAAAMAAJ.

Hubert L Dreyfus, Stuart E Dreyfus, and T Athanasiou. *Mind Over Machine.* Simon & Schuster, 2000. ISBN 9780743205511. URL https://books.google.co.in/books?id=e9W9m_4q4pYC.

Stuart E Dreyfus and Hubert L Dreyfus. A five-stage model of the mental activities involved in directed skill acquisition. Technical report, DTIC Document, 1980.

Richard Duncombe and Richard Heeks. Information & communication technologies (icts), poverty reduction and micro, small & medium-scale enterprises (msmes). *A framework for understanding ICT applications for MSMEs in developing countries*, 2005.

Stephen P Dunn. *The Economics of John Kenneth Galbraith: Introduction, Persuasion, and Rehabilitation*. Cambridge University Press, 2010. ISBN 9781139492805. URL https://books.google.co.in/books?id=v_dbZYlNVUwC.

R Darin Ellis and Jason C Allaire. Modeling computer interest in older adults: The role of age, education, computer knowledge, and computer anxiety. *Human Factors: The Journal of the Human Factors and Ergonomics Society*, 41(3):345–355, 1999.

Martin Fishbein. A theory of reasoned action: some applications and implications. 1979.

UNESCO Institute for Statistics. International standard classification of education isced 2011, 2011. URL http://uis.unesco.org/sites/default/files/documents/international-standard-classification-of-education-isced-2011-en.pdf.

M Foucault. *Discipline and Punish: The Birth of the Prison*. Peregrine Books. Vintage Books, 1977. ISBN 9780679752554. URL https://books.google.co.in/books?id=AVzuf-r22eoC.

Christopher Frayling. Research in art and design. 1993.

Thomas L Friedman. The lexus and the olive tree. *New York: Farrar, Straus and Giroux*, 1989.

Marcelline Fusilier and Subhash Durlabhji. An exploration of student internet use in india: the technology acceptance model and the theory of planned behaviour. *Campus-Wide Information Systems*, 22(4):233–246, 2005.

M Gallagher. Ai in ict4d: Accumulated advantage, data driven bias and invisibility, and ethical care, 2018. Retrieved Aug 29, 2018, from https://www.panoplydigital.com/blog/ai-in-ict4d-accumulated-advantage-data-driven-bias-and-invisibility-and-ethical-care.

Rikin Gandhi, Rajesh Veeraraghavan, Kentaro Toyama, and Vanaja Ramprasad. Digital green: Participatory video for agricultural extension. In *Information and Communic-*

ation Technologies and Development, 2007. ICTD 2007. International Conference on, pages 1–10. IEEE, 2007.

Hemlata Gangwar, Hema Date, and R Ramaswamy. Understanding determinants of cloud computing adoption using an integrated tam-toe model. *Journal of Enterprise Information Management*, 28(1):107–130, 2015.

H Gardner. *Intelligence Reframed: Multiple Intelligences for the 21st Century*. Basic Books, 1999. ISBN 9780465026111. URL https://books.google.co.in/books?id=nOHsjJZB0J8C.

Judith Gebauer and Ya Tang. Applying the theory of task-technology fit to mobile technology: the role of user mobility. *International Journal of Mobile Communications*, 6(3):321–344, 2008.

David Gefen and Detmar W Straub. Gender differences in the perception and use of e-mail: An extension to the technology acceptance model. *MIS quarterly*, pages 389–400, 1997.

Dale L Goodhue. Understanding user evaluations of information systems. *Management science*, 41(12):1827–1844, 1995.

Neal Crasilneck Gross. The diffusion of a culture trait in two iowa townships. 1942.

World Bank Independent Evaluation Group. *Capturing Technology for Development: An Evaluation of World Bank Group Activities in Information and Communication Technologies*. 2011. URL http://ieg.worldbankgroup.org/Data/reports/ict_evaluation.pdf.

Dan Grover. Bots won't replace apps. better apps will replace apps, 2016. Retrieved Aug 26, 2018, from http://dangrover.com/blog/2016/04/20/bots-wont-replace-apps.html.

GSMA. Gsma, mobile economy 2015, 2015. Retrieved September 24, 2015, from http://www.gsmamobileeconomy.com/GSMA_Global_Mobile_Economy_Report_2015.pdf.

Babita Gupta, Subhasish Dasgupta, and Atul Gupta. Adoption of ict in a government organization in a developing country: An empirical study. *The Journal of Strategic Information Systems*, 17(2):140–154, 2008.

Jo Ann T Hackos and Janice C Redish. *User and task analysis for interface design*. Wiley, 1998.

Christine A Halverson. Activity theory and distributed cognition: Or what does cscw need to do with theories? *Computer Supported Cooperative Work (CSCW)*, 11(1-2): 243–267, 2002.

Roger Harris. Telecentres in rural asia: Towards a success model. *Europe*, 40(23.4):13–17, 2001.

Richard Heeks. Information systems and developing countries: Failure, success, and local improvisations. *The information society*, 18(2):101–112, 2002.

Richard Heeks. *The ICT4D 2.0 manifesto: Where next for ICTs and international development?* University of Manchester. Institute for development policy and management (IDPM). Development informatics group, 2009.

Robert K Heinssen, Carol R Glass, and Luanne A Knight. Assessing computer anxiety: Development and validation of the computer anxiety rating scale. *Computers in human behavior*, 3(1):49–59, 1987.

Anthony R Hendrickson and Patti D Latta. An evaluation of the reliability and validity of davis' perceived usefulness and perceived ease of use instrument. *Journal of Computer Information Systems*, 36(3):77–82, 1996.

Melissa R Ho, Thomas N Smyth, Matthew Kam, and Andy Dearden. Human-computer interaction for development: The past, present, and future. *Information Technologies & International Development*, 5(4):pp–1, 2009.

P Hough. *Understanding Global Security*. Taylor & Francis, 2014. ISBN 9781135042011. URL https://books.google.co.in/books?id=aFiLAgAAQBAJ.

Paul Hunt, Manfred Nowak, and Siddiq Osmai. *Human rights and poverty reduction: A conceptual framework*. UN, 2004.

IDC. India smartphone market finishes strong with 124 million total shipment units in 2017 after a brief slowdown in 2016, says idc, 2018. URL https://www.idc.com/getdoc.jsp?containerId=prAP43569518.

IMRB. The new sec system - imrb, 2011. Retrieved April 04, 2016 from imrbint.com/research/The-New-SEC-system-3rdMay2011.pdf.

J.A. Jacko. *Human Computer Interaction Handbook: Fundamentals, Evolving Technologies, and Emerging Applications, Third Edition*. Human Factors and Ergonomics. CRC Press, 2012. ISBN 9781439829448. URL https://books.google.co.in/books?id=dVrRBQAAQBAJ.

Anwar Jafri, Amitabh Dongre, VN Tripathi, Aparajita Aggrawal, and Shashi Shrivastava. Information communication technologies and governance: The gyandoot experiment in dhar district of madhya pradesh, india. *WORKING PAPER-OVERSEAS DEVELOPMENT INSTITUTE*, 2002.

Mahima Jain and Radhika Mervin. Atms in rural areas are still a far cry, 2016. Retrieved Sep 01, 2017, from http://www.thehindubusinessline.com/money-and-banking/atms-in-rural-areas-are-still-a-far-cry/article9382683.ece.

Vinitha Johnson. The gender divide: Attitudinal issues inhibiting access. *Globalization, technology diffusion, and gender disparity: Social impacts of ICTs*, pages 110–119, 2012.

Philip N Johnson-Laird. *Mental models: Towards a cognitive science of language, inference, and consciousness*. Number 6. Harvard University Press, 1983.

Philip N Johnson-Laird. Mental models and human reasoning. *Proceedings of the National Academy of Sciences*, 107(43):18243–18250, 2010.

S E Jørgensen and G Bendoricchio. *Fundamentals of Ecological Modelling*. Developments in environmental modelling. Elsevier, 2001. ISBN 9780080440286. URL https://books.google.co.in/books?id=6ZHMdsOnLxAC.

Anirudha Joshi, Girish Dalvi, Manjiri Joshi, Prasad Rashinkar, and Aniket Sarangdhar. Design and evaluation of devanagari virtual keyboards for touch screen mobile phones.

In *Proceedings of the 13th International Conference on Human Computer Interaction with Mobile Devices and Services*, pages 323–332. ACM, 2011.

Manjiri Joshi, Anirudha N Joshi, Nagraj Emmadi, and Nirav Malsattar. Swarachakra keyboard for indic scripts (tutorial). In *Proceedings of the 1st International Conference on Mobile Software Engineering and Systems*, pages 5–6. ACM, 2014.

D Kahneman. *Thinking, Fast and Slow*. Penguin Books Limited, 2011. ISBN 9780141918921. URL https://books.google.co.in/books?id=oV1tXT3HigoC.

Victor Kaptelinin, Bonnie Nardi, Susanne Bødker, John Carroll, Jim Hollan, Edwin Hutchins, and Terry Winograd. Post-cognitivist HCI: second-wave theories. *New Horizons*, pages 692–693, 2003. doi: 10.1145/765891.765933. URL http://portal.acm.org/citation.cfm?id=765933.

Ankit Kesharwani and Shailendra Singh Bisht. The impact of trust and perceived risk on internet banking adoption in india: An extension of technology acceptance model. *International Journal of Bank Marketing*, 30(4):303–322, 2012.

Sameera Khan. Don?t take my cell phone away!, 2017. URL http://www.thehindu.com/social/dont-take-my-cell-phone-away/article18414413.ece.

David E Kieras and David E Meyer. An overview of the epic architecture for cognition and performance with application to human-computer interaction. *Human-computer interaction*, 12(4):391–438, 1997.

G.J. Kim. *Human–Computer Interaction: Fundamentals and Practice*. CRC Press, 2015. ISBN 9781482233902. URL https://books.google.co.in/books?id=D4SbBgAAQBAJ.

Inge M Klopping and Earl McKinney. Extending the technology acceptance model and the task-technology fit model to consumer e-commerce. *Information Technology, Learning, and Performance Journal*, 22(1):35, 2004.

Marios Koufaris. Applying the technology acceptance model and flow theory to online consumer behavior. *Information systems research*, 13(2):205–223, 2002.

Kerrie Laguna and Renée L Babcock. Computer anxiety in young and older adults: Implications for human-computer interactions in older populations. *Computers in human behavior*, 13(3):317–326, 1997.

John E Laird. *The Soar cognitive architecture*. MIT Press, 2012.

Colin Latchem and David Walker. *Telecentres: Case studies and key issues*. commonwealth of Learning, Vancouver, 2001.

Younghwa Lee, Kenneth A Kozar, and Kai RT Larsen. The technology acceptance model: Past, present, and future. *Communications of the Association for information systems*, 12(1):50, 2003.

Xiaoming Li and Melissa S Atkins. Early childhood computer experience and cognitive and motor development. *Pediatrics*, 113(6):1715–1722, 2004.

Sylvan Lobo, Pankaj Doke, and Sanjay Kimbahune. Gappagoshti(tm): a social networking platform for information dissemination in the rural world. In *Proceedings of the 6th Nordic Conference on Human-Computer Interaction: Extending Boundaries*, pages 727–730. ACM, 2010.

Maria Lohan and Wendy Faulkner. Masculinities and technologies. *Men and Masculinities*, 6(4):319–329, 2004.

Ewa Luger and Abigail Sellen. Like having a really bad pa: the gulf between user expectation and experience of conversational agents. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*, pages 5286–5297. ACM, 2016.

Charru Malhotra, VM Chariar, and LK Das. Ict and societal concerns at the grassroots: Tarahaat experience in rural areas of tikamgarh district of madhya pradesh in india. *E-Governance in Practice*, pages 224–39, 2009.

Thomas W Malone. Toward a Theory of Intrinsically Instruction Motivating. *Cognitive Science*, 5(4):333–369, 1981. ISSN 03640213. doi: 10.1207/s15516709cog0504_2.

Giuseppe Mantovani. Social context in hcl: A new framework for mental models, cooperation, and communication. *Cognitive Science*, 20(2):237–269, 1996.

Nikola Marangunić and Andrina Granić. Technology acceptance model: a literature review from 1986 to 2013. *Universal Access in the Information Society*, 14(1):81–95, 2015.

Richard E Mayer and Roxana Moreno. Nine ways to reduce cognitive load in multimedia learning. *Educational psychologist*, 38(1):43–52, 2003.

Indrani Medhi, Aman Sagar, and Kentaro Toyama. Text-free user interfaces for illiterate and semi-literate users. In *Information and Communication Technologies and Development, 2006. ICTD'06. International Conference on*, pages 72–82. IEEE, 2006.

Indrani Medhi, Meera Lakshmanan, Kentaro Toyama, and Edward Cutrell. Some evidence for the impact of limited education on hierarchical user interface navigation. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, pages 2813–2822. ACM, 2013.

Indrani Medhi-Thies, Pedro Ferreira, Nakull Gupta, Jacki O'Neill, and Edward Cutrell. Krishipustak: A social networking system for low-literate farmers. In *Proceedings of the 18th ACM Conference on Computer Supported Cooperative Work & Social Computing*, pages 1670–1681. ACM, 2015.

George A Miller. The magical number seven, plus or minus two: some limits on our capacity for processing information. *Psychological review*, 63(2):81, 1956.

Ajay Mittal, KP Chetan, Srinivasan Jayaraman, Bhushan G Jagyasi, Arun Pande, and P Balamuralidhar. mkrishi wireless sensor network platform for precision agriculture. In *Sensing Technology (ICST), 2012 Sixth International Conference on*, pages 623–629. IEEE, 2012.

Jana Moon. Changing role of indian women in television soap-operas : A case study. *Shiv Shakti International Journal of in Multidisciplinary and Academic Research (SSIJMAR)*, 5(1), 2016.

Geoffrey A Moore. Crossing the chasm. 2002.

Roger W Morrell, Christopher B Mayhorn, and Joan Bennett. A survey of world wide web use in middle-aged and older adults. *Human Factors: The Journal of the Human Factors and Ergonomics Society*, 42(2):175–182, 2000.

M Neeraj. Mobile internet users in india 2016: 371 mn by june, 762015, 2016. Retrieved Sep 01, 2017, from https://dazeinfo.com/2016/02/08/mobile-internet-users-in-india-2016-smartphone-adoption-2015/.

Allen Newell. Physical symbol systems. *Cognitive science*, 4(2):135–183, 1980.

Allen Newell, Herbert Alexander Simon, et al. *Human problem solving*, volume 104. Prentice-Hall Englewood Cliffs, NJ, 1972.

Sevanti Ninan and Sushmita Malaviya. Rural newspaper revolution. *The Hindu*, Jan 2004. URL http://www.thehindu.com/thehindu/mag/2004/06/27/stories/2004062700250400.htm.

Donald A Norman. Design Rules Based on Analyses of Human Error. *Commun. ACM*, 26(4):254–258, 1983. ISSN 0001-0782. doi: 10.1145/2163.358092. URL http://doi.acm.org/10.1145/2163.358092{%}5Cnhttp://dl.acm.org/ft{_}gateway.cfm?id=358092{&}type=pdf.

Donald A Norman. *The design of everyday things: Revised and expanded edition*. Basic books, 2013.

Julius Kambarage Nyerere. *The challenge to the South: The report of the South Commission*. Oxford University Press, USA, 1990.

OECD. *Measuring the Information Economy 2002*. OECD Publishing, 2002. ISBN 9789264099012. URL https://books.google.co.in/books?id=dfkih7bxr7kC.

Neil Patel, Sheetal Agarwal, Nitendra Rajput, Amit Nanavati, Paresh Dave, and Tapan S Parikh. Experiences designing a voice interface for rural india. In *Spoken Language Technology Workshop, 2008. SLT 2008. IEEE*, pages 21–24. IEEE, 2008.

Paul A Pavlou. Consumer acceptance of electronic commerce: Integrating trust and risk with the technology acceptance model. *International journal of electronic commerce*, 7 (3):101–134, 2003.

Stephen J Payne, Helen R Squibb, and Andrew Howes. The nature of device models: the yoked state space hypothesis and some experiments with text editors. *Human-Computer Interaction*, 5(4):415–444, 1990.

S Petter, D Straub, and A Rai. Specifying formative constructs in information systems research. *Mis Quarterly*, 31(4):623–656, 2007. ISSN 02767783. doi: 10.2307/25148814. URL http://www.jstor.org/stable/25148814{%}5Cnhttp://www.cis.gsu.edu/dstraub/present/2012/Petteretal2007.pdf.

Seppo Poutanen and Anne Kovalainen. Gender in inventions and innovations. In *Gender and Innovation in the New Economy*, pages 9–46. Springer, 2017.

Coimbatore Krishna Prahalad. *The Fortune at the Bottom of the Pyramid*. Pearson Education India, 2006.

Press Trust of India. 70 Retrieved Sep 01, 2017, from http://www.business-standard.com/article/economy-policy/70-indians-live-in-rural-areas-census-111071500171_1.html.

Robert D Putnam. Bowling alone: America's declining social capital. *Journal of democracy*, 6(1):65–78, 1995.

Nimmi Rangaswamy. Social entrepreneurship as critical agency: A study of rural internet kiosks. In *Information and Communication Technologies and Development, 2006. ICTD'06. International Conference on*, pages 143–152. IEEE, 2006.

Nimmi Rangaswamy and Edward Cutrell. Anthropology, development and icts: slums, youth and the mobile internet in urban india. In *Proceedings of the Fifth International Conference on Information and Communication Technologies and Development*, pages 85–93. ACM, 2012.

Nimmi Rangaswamy and Sumitra Nair. The mobile phone store ecology in a mumbai slum community: Hybrid networks for enterprise. *Information technologies & international development*, 6(3):pp–51, 2010.

Prasad Rashinkar, Anirudha Joshi, Mandar Rane, Shweta Sali, Salil Badodekar, Nagraj

Emmadi, Debjani Roy, Riyaj Sheikh, and Abhishek Shrivastav. Healthcare ivrs for non-tech-savvy users. *Information Quality in e-Health*, pages 263–282, 2011.

Jens Rasmussen. Skills, rules, and knowledge; signals, signs, and symbols, and other distinctions in human performance models. *IEEE transactions on systems, man, and cybernetics*, (3):257–266, 1983.

PA Ratna and Saloni Mehra. Exploring the acceptance for e–learning using technology acceptance model among university students in india. *International Journal of Process Management and Benchmarking*, 5(2):194–210, 2015.

Partha Pratim Ray. Translation of bengali terms in mobile phones: a simplified approach based on the prescriptions of conventional accent understand ability. *arXiv preprint arXiv:1208.0590*, 2012.

P Krishna Reddy and GV Ramaraju. E-sagu: The next generation it-based query-less cost-effective and personalized agro-advisory system. *eGovernance Case Studies by Dr Ashok Agarwal. www. csisigegov. org/casestudies/03_e_sagu. pdf. Accessed January*, 13:2012, 2006.

Phyllis Reisner. Formal grammar and human factors design of an interactive graphics system. *IEEE Transactions on Software Engineering*, (2):229–240, 1981.

Simon Robinson, Jennifer Pearson, Matt Jones, Anirudha Joshi, and Shashank Ahire. Better together: disaggregating mobile services for emergent users. In *Proceedings of the 19th International Conference on Human-Computer Interaction with Mobile Devices and Services*, page 44. ACM, 2017.

Simon Robinson, Jennifer Pearson, Thomas Reitmaier, Shashank Ahire, and Matt Jones. Make yourself at phone: Reimagining mobile interaction architectures with emergent users. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*, page 407. ACM, 2018.

E M Rogers. *Diffusion of innovations*. Free Press of Glencoe, 1962. URL https://books.google.co.in/books?id=zw0-AAAAIAAJ.

William B Rouse and Nancy M Morris. On looking into the black box: Prospects and limits in the search for mental models. *Psychological bulletin*, 100(3):349, 1986.

Debanjali Roy. Reality or myth: Representation of women in indian tv serials. *Global Media Journal*, 3(1), 2012.

Richard M Ryan and Edward L Deci. Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *The American psychologist*, 55(1):68–78, 2000a. ISSN 0003-066X. doi: 10.1037/0003-066X.55.1.68.

Richard M Ryan and Edward L Deci. Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American psychologist*, 55(1): 68, 2000b.

J D Sachs. *The End of Poverty: Economic Possibilities for Our Time*. Penguin Publishing Group, 2006. ISBN 9781101643280. URL https://books.google.co.in/books?id=pqla8IiF5dYC.

Amartya Sen. *Development as Freedom*. Oxford University Press paperback. OUP Oxford, 2001. ISBN 9780192893307. URL https://books.google.co.in/books?id=Qm8HtpFHYecC.

S Senthilkumaran and Subbiah Arunachalam. Expanding the village knowledge centres in pondicherry. *Regional Development Dialogue*, 23(2; SEAS AUT):65–84, 2002.

K Serr. *Thinking about Poverty*. Federation Press, 2006. ISBN 9781862876262. URL https://books.google.co.in/books?id=p4KRwtgiVawC.

Yogima Seth Sharma. Government hikes minimum wage for agricultural labourer, 2017. Retrieved Sep 01, 2017, from http://economictimes.indiatimes.com/news/economy/policy/government-hikes-minimum-wage-for-agriculture-labourer/articleshow/57408252.cms.

Tom Simonite. As artificial intelligence advances, here are five tough projects for 2018, 2018. Retrieved September 2, 2018, from TomSimonite.2018.

.RetrievedSeptember2,2018fromhttps://www.wired.com/story/as-artificial-intelligence-advances-here-are-five-projects-for-2018/.

Aaron Smith. Older adults and technology use, 2014. Retrieved April 04, 2016 from http://www.pewinternet.org/2014/04/03/older-adults-and-technology-use/.

Aditya Dev Sood. The mobile development report: The socio-economic dynamics of mobile communications in rural areas and their consequences for development. *Center for Knowledge Societies*, 2006.

Nancy Staggers and Anthony F Norcio. Mental models: concepts for human-computer interaction research. *International Journal of Man-machine studies*, 38(4):587–605, 1993.

K E Stanovich. *The Robot's Rebellion: Finding Meaning in the Age of Darwin*. Chicago Architecture and Urbanism Series. University of Chicago Press, 2005. ISBN 9780226771250. URL https://books.google.co.in/books?id=gib3SwqcH8AC.

Statista. Number of smartphone users in india from 2015 to 2022 (in millions), 2017a. Retrieved Dec 21, 2017 from https://www.statista.com/statistics/280914/monthly-active-whatsapp-users-in-india/.

Statista. Number of monthly active whatsapp users in india from august 2013 to february 2017 (in millions), 2017b. Retrieved Dec 21, 2017 from https://www.statista.com/statistics/280914/monthly-active-whatsapp-users-in-india/.

R J Sternberg. *Beyond IQ: A Triarchic Theory of Human Intelligence*. Cambridge paperback library. Cambridge University Press, 1985. ISBN 9780521278911. URL https://books.google.co.in/books?id=jmM7AAAAIAAJ.

Priyanka Surendran. Technology acceptance model: A survey of literature. *International Journal of Business and Social Research*, 2(4):175–178, 2012.

V Suresh, K Prabhakar, K Santhanalakshmi, and K Maran. Applying technology acceptance (tam) model to determine the factors of acceptance in out-patient information system in private hospital sectors in chennai city. *Journal of Pharmaceutical Sciences and Research*, 8(12):1373, 2016.

John Sweller. In R.E. Mayer, editor, *The Cambridge Handbook of Multimedia Learning*, chapter Implications of cognitive load theory for multimedia learning. Cambridge University Press, 2014.

Gabriel Tarde. *The laws of imitation, trans*. Henry Holt, 1903.

Telecom Regulatory Authority of India. Press release on telecom subscription data as on 31st jan, 2018, 2018. Retrieved Apr 05, 2018, from http://www.trai.gov.in/sites/default/files/TSDReportJan23032018.pdf.

Telecom Rgulatory Authority of India. The indian telecom services performance indicators january - march, 2017, 2017. Retrieved Sep 01, 2017, from http://trai.gov.in/sites/default/files/Indicator_Reports_050720174.pdf.

Rakhi Thakur and Mala Srivastava. Adoption readiness, personal innovativeness, perceived risk and usage intention across customer groups for mobile payment services in india. *Internet Research*, 24(3):369–392, 2014.

Indrani Medhi Thies, Nandita Menon, Sneha Magapu, Manisha Subramony, and Jacki O?neill. How do you want your chatbot? an exploratory wizard-of-oz study with young, urban indians. In *IFIP Conference on Human-Computer Interaction*, pages 441–459. Springer, 2017.

Victoria L Tinio. Ict in education, 2003.

Alvin Toffler. *Future shock*. Bantam, 1990.

Edward C Tolman et al. Cognitive maps in rats and men, 1948.

Rahul Tongia and Eswaran Subrahmanian. Information and communications technology for development (ict4d)-a design challenge? In *Information and Communication Technologies and Development, 2006. ICTD'06. International Conference on*, pages 243–255. IEEE, 2006.

UNDP, 2017. URL http://hdr.undp.org/en/humandev.

UNESCO. Education, 2016. URL http://www.unesco.org/new/en/education/themes/education-building-blocks/literacy/resources/statistics.

United Nations. *The Sustainable Development Goals Report, 2015*. Department of Economic and Social Affairs, 2017.

A van Agtmael. *The Emerging Markets Century: How a New Breed of World-Class Companies Is Overtaking the World*. Free Press, 2007. ISBN 9781416548225. URL https://books.google.co.in/books?id=GLj5hj7xN54C.

Sabine van Linden and Anita HM Cremers. Cognitive abilities of functionally illiterate persons relevant to ict use. In *International Conference on Computers for Handicapped Persons*, pages 705–712. Springer, 2008.

Viswanath Venkatesh. Determinants of perceived ease of use: Integrating control, intrinsic motivation, and emotion into the technology acceptance model. *Information systems research*, 11(4):342–365, 2000.

Viswanath Venkatesh and Hillol Bala. Technology acceptance model 3 and a research agenda on interventions. *Decision Sciences*, 39(2):273–315, 2008a. ISSN 00117315. doi: 10.1111/j.1540-5915.2008.00192.x.

Viswanath Venkatesh and Hillol Bala. Technology acceptance model 3 and a research agenda on interventions. *Decision sciences*, 39(2):273–315, 2008b.

Viswanath Venkatesh and Fred D Davis. A theoretical extension of the technology acceptance model: Four longitudinal field studies. *Management science*, 46(2):186–204, 2000.

Wayan Vota. Surprise! fishermen using mobile phones for market prices is the largest lie in ict4d, 2016. Retrieved Aug 29, 2018, from https://www.ictworks.org/surprise-fishermen-using-mobile-phones-for-market-prices-is-the-largest-lie-in-ict4d/#.W4Y7584zbZp.

Judy Wajcman. Feminist theories of technology. *Cambridge journal of economics*, 34(1): 143–152, 2010.

Max Weber. *Economy and society: An outline of interpretive sociology*. Univ of California Press, 1978.

Jane Webster and Joseph J Martocchio. Microcomputer playfulness: development of a measure with workplace implications. *MIS quarterly*, pages 201–226, 1992.

S Weisberg. *Applied Linear Regression*. Wiley Series in Probability and Statistics. Wiley, 2013. ISBN 9781118625958. URL https://books.google.co.in/books?id=U7FZmOcOnM4C.

Nikhil Welankar, Anirudha Joshi, and Kirti Kanitkar. Principles for simplifying translation of marathi terms in mobile phones. In *Proceedings of the 2010 international conference on Interaction Design & International Development*, pages 11–18. BCS Learning & Development Ltd., 2010.

WFP. Zero hunger, 2017. URL http://www1.wfp.org/zero-hunger.

WHO. Life expectancy increased by 5 years since 2000, but health inequalities persist, 2016. URL http://www.who.int/mediacentre/news/releases/2016/health-inequalities-persist/en/.

Susan Wiedenbeck. The use of icons and labels in an end user application program: an empirical study of learning and retention. *Behaviour & Information Technology*, 18(2): 68–82, 1999.

William Winn and Daniel Snyder. Cognitive perspectives in psychology. *Handbook of research for educational communications and technology: A project of the Association for Educational Communications and Technology*, pages 79–112, 1996.

Jen-Her Wu and Shu-Ching Wang. What drives mobile commerce?: An empirical evaluation of the revised technology acceptance model. *Information & management*, 42(5): 719–729, 2005.

Susan P Wyche, Thomas N Smyth, Marshini Chetty, Paul M Aoki, and Rebecca E Grinter.

Deliberate interactions: characterizing technology use in nairobi, kenya. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, pages 2593–2602. ACM, 2010.

Richard M Young. In Dedre Gentner and Albert L. Stevens, editors, *Mental Models*, chapter Surrogates and mappings: Two kinds of conceptual models for interactive devices. Psychology Press, 2014.

Jing Zhu. Intention and volition. *Canadian journal of philosophy*, 34(2):175–193, 2004.

Dieter Zinnbauer. What can social capital and ict do for inclusion. *Institute for Prospective Technological Studies (IPTS)–JRC–European Commission EUR*, 22673, 2007.

C E Zsambok and G Klein. *Naturalistic Decision Making*. Expertise: Research and Applications Series. Taylor & Francis, 2014. ISBN 9781317779599. URL https://books.google.co.in/books?id=Z-17AgAAQBAJ.

Publications Arising From This Research

- Devanuj and Anirudha Joshi. Technology adoption by 'emergent' users: the user-usage model. *Proceedings of APCHI '13.* ACM. 2013.
- Devanuj Balkrishan, Anirudha Joshi, Chinmay Parab, Chandni Rajendran, Nazreen Nizam and Sujit Devkar. Making and Breaking the User-Usage Model: WhatsApp Adoption Amongst Emergent Users in India. *Proceedings of IndiaHCI '16.* ACM. 2016.

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