



DESIGN AND DEVELOPMENT OF A MOBILE APPLICATION FOR
SEARCHING JOB FOCUSING ON ILLITERATE PEOPLE OF
BANGLADESH: TOWARDS REDUCING THE DIGITAL DIVIDE IN
DEVELOPING COUNTRIES

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APPROVAL

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DECLARATION

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I have duly acknowledged all the sources of information which have been used in the thesis

This thesis has also not been submitted for any degree in any university previously

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12 December 2018

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ABSTRACT

The purpose of this thesis is to design, develop, and evaluate a mobile application for illiterate people in Bangladesh following Design Science Research approach. We first conducted a requirement elicitation study with 40 illiterate people in Bangladesh to identify their needs. From this study, we found a set of design principals to make the user interface (UI) intuitive for illiterate people. The design principals include developing the application in native language, use of voice, symbols, pictures, and minimal amount of texts in the UIs. Then, a mobile application (Chakuri-Bazaar) was developed following these design principals. Finally, the application was evaluated with 40 illiterate people through a field study. The findings of the evaluation study suggest that the application was effective, efficient, and the users were satisfied in terms of its ease of use, ease of learning, willingness to use it in future, and willingness to recommend it to others.

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LIST OF ACRONYMS

Symbols	Definition
ICT	Information and Communication Technology
IT	Information Technology
UNESCO	United Nations Educational, Scientific and Cultural Organization
UI	User Interface
HCI	Human Computer Interaction
ICT4D	ICT for Development
VoIP	Voice over Internet Protocol
MRP	Machine readable passport
NID	National Identity Card
MRV	Machine readable visa
BTRC	Bangladesh Telecommunication Regulatory Commission
UX	User Experience
URSULA	User-interface Recommendations in Support of Universal Literacy Accessibility
HUDS	Hypothetical User Design Scenarios
AUI	Augmented User Interface
WOZ	Wizard of Oz
DSR	Design Science Research
BaaS	Backend-as-a-Service

CHAPTER I

INTRODUCTION

This chapter firstly introduces the research background. Then discusses the research motivations and highlights the research problems followed by the research objectives. Next, presents the scope of the thesis. Finally, the organization of the remaining chapters is presented.

1.1 Research Background

The Information and Communication Technologies are currently being used in providing information as well as a numerous number of benefits to the people of different nations regardless of the background like financial, academic, political and the like. It brings everyone under the same roof with the help of wireless networks, mobile phones and Internet. ICT has expanded so fast that in every aspect of our day-to-day life, we need to seek the help of ICT. From education to business, mother's womb to tomb, farming to office work ICT has expanded its branches in everywhere. With the help of ICT, people of different level accessing the information, which is needed, within a very short time over telecommunication and taking actions properly with the help of experienced guidance.

In this era of Information Technology (IT), since ICT plays important roles for everyone, it cannot be excluded from any of the task that is required for the human being. That is why support of ICT is also important for both the literate and illiterate people. In the worlds perspective, it has been seen that still majority of the people is illiterate in the developing country. For example, developing country like Bangladesh has an adult literacy rate of 72.76% in 2016 and 47.08% in 2011 [1]. Therefore, it is visible that a significant portion may be remaining behind the screen of ICT, as to take support of ICT solutions one need to be literate

(capable of reading and understanding). Other related demographic information is shown in table 1.1.

Table 1.1: Demographic Statistics of Bangladesh

Serial	Demographic Features	Statistics
1	Population in Bangladesh, 2018 [2]	166,368,149
2	Rural population (% of total population) in Bangladesh [4]	64.96%
3	Adult literacy rate, 2016 [3]	72.76%
4	Adult literacy rate, 2011 [3]	47.08%
5	Mobile Phone subscriptions, Feb 2017 [5]	129.584 million
6	Internet Subscribers has reached, January, 2018 [6]	80.829 million

In case of illiterate people, searching job for their livelihood is a very crucial and typical issue. However, there are number of barrier for finding an appropriate job for them. They have no way other than taking help of their surrounding literate peoples. Sometimes, they need to take help from newspaper and job search agency. Here, reading newspaper is also a barrier for the illiterate people. There are some websites related with searching job, which are also not convenient. Therefore, ICT support which is highly required for the betterment of illiterate people does still not exist. Therefore, ICT solutions acceptable by the illiterate population are recommended for the acceleration of any nation.

Therefore, this thesis focused to the development of mobile application for illiterate people to reduce the digital divide. Thus, this is will broadly cover as well as grounded in three general research fields', that includes, Human Computer Interaction (HCI), Mobile User Interface (UI) design, and ICT for Development (ICT4D). The outcomes of this research will greatly contribute in these areas as well.

1.2 Motivation and Research Problem

The most of existing applications which are developed as an ICT solution are generally text-base, which are not adaptable and usable by the illiterate people as most of them don't have the knowledge of reading text [13]. Moreover, a limited number of researches has been carried out that focuses on designing user intuitive interfaces for the illiterate people that may enhanced their user-experiences towards using and adapting the mobile applications. Again, a very less number of applications were developed in Bangladesh, which are developed focusing on illiterate people let alone solutions for searching jobs.

To develop such ICT solution (e.g., mobile applications, software systems, etc.), few key issues need to be addressed like how illiterate people are experienced with using the smartphone, how they interact with the application, how much time they spend with the application, their key requirements, how the UI should be designed to make it more flexible and easily readable [13].

Again, searching a job is an important activity for people. This activity is particularly more difficult for illiterate users because they do not have access to traditional job search [7]. An ICT solution is required for supporting job search for illiterate users.

Furthermore, according to UNESCO, Bangladesh is number 114th in the ranking of world literacy rate [1]. Since, a noticeable percent of population in Bangladesh are illiterate, thus developing any kind of ICT solutions (including mobile application) for the general mass in context of Bangladesh, will not be usable and adaptable for the illiterate people in Bangladesh, which in turn may lead to the digital divide in context of Bangladesh. Thus, ICT based research and development focusing to design and develop usable application for illiterate people may also contribute to reduce the digital divide especially in context of Bangladesh.

1.3 Research Objectives

Information and Communication Technology (ICT) has improved societies in different ways. Actually, people consider technology to be a tool that can help them to perform their daily functions efficiently and effectively [7]. Hence, most of the ICT solutions focus the educated users and ignore 774 million illiterate people throughout the world. Illiteracy is a major hurdle in socio-economic development. Therefore, an ICT solution is important which will provide an interface for these focused people especially in context of developing countries like Bangladesh [8]. Therefore, the objectives of the thesis were two folds. These are:

- Firstly, to understand the challenges of illiterate people and the design requirements for the development of a mobile application for job search to reduce the digital divide.
- Secondly, to design and develop a usable mobile application for job searches considering the requirements of illiterate people in Bangladesh.
- Finally, to evaluate the usability of the developed application for validating the design principles.

1.4 Thesis Scope

Although this thesis covered the area of Human Computer Interaction (HCI), Mobile User Interface (UI) design, and ICT for Development (ICT4D) in a broader perspective, but due to the limited time frame and other constraints the scope of the thesis are defined based on the following considerations: Firstly, illiterate people may have many barriers to use the ICT solution but these thesis focuses only the usability (ease of use) issues of using any application. Secondly, usable solutions are required for the illiterate users for different purpose like receiving health service, learning basic education, and the like. Despite of having many necessities of using ICT by the illiterate people, only job searching issue is considered in this

thesis as an example case. Thirdly, though a number of issues are related to create digital divide in any developing country including social factor (age, gender, ethnicity, etc.), economic factor, and the like; but this thesis only consider the issues which are required for developing user friendly ICT application that may help them to easily learn and adopt the applications. More specifically, this research work focuses on the design issues that should be considered during the development of any ICT solutions/ applications for the illiterate people.

1.5 **Organization of the Remaining Chapters**

The thesis was organized as follows:

Chapter-II firstly discussed about the ICT uses for illiterate people in general. After that, we discussed about the digital divide. Then we explained the theoretical background of HCI (Human Computer Interaction). Then we discussed about the existing applications that are explicitly developed for the illiterate people. Finally, the related work that focuses on the illiterate people and HCI are briefly discussed. This chapter is also concluded with a critical summary that highlights the research gaps and open issues for further research.

Chapter-III briefly introduced two empirical studies: one conducted for requirements elicitation to develop an artefact (an app) for job search and another study was conducted for the evaluation of the.

Chapter-IV briefly discussed the participants profile, study procedures, data analysis and the study findings.

Chapter-V discussed the development of the key artifact of this thesis. At first, the conceptual framework based on the outcome of need findings has been described briefly followed by the process of back-end and front-end development. An elaborate discussion on User Interface (UI)

sketching, Interface sign and voice direction selection have been also shown in this chapter. Finally, the processes of application development with some use case scenario have been depicted in the last part of this chapter.

Chapter-VI briefly discussed the participants profile, study method, data analysis and findings.

Chapter-VII briefly discussed the main outcomes, thesis contribution, the limitation of this thesis and the future research implications.

CHAPTER II

THEORETICAL BACKGROUND AND RELATED WORKS

This chapter firstly discusses about the ICT uses for illiterate people in general. After that, we discussed about the digital divide. Then we explained the theoretical background of HCI (Human Computer Interaction). Then we discussed about the existing applications that are explicitly developed for the illiterate people. Finally, the related work that focuses on the illiterate people and HCI are briefly discussed. This chapter is concluded with a critical summary that highlights the research gaps and open issues for further research.

2.1 Use of ICT for Illiterate People

In the past few decades, Information and Communication Technologies (ICT) have provided society with a vast array of new communication capabilities. For example, people can communicate in real-time with others in different countries using technologies such as instant messaging, voice over IP (VoIP), and video-conferencing. Social networking websites like Face book allow users from all over the world to remain in contact and communicate on regular basis. Modern information and communication technologies have created a "global village," in which people can communicate with others across the world as if they were living next door. For this reason, ICT is often studied in the context of how modern communication technologies affect society [8].

Every day people are adopting the services provided by ICT. For example, in context of Bangladesh, ICT services includes, Machine readable passport (MRP), NID, Issuing driving license, Machine readable visa (MRV), Tax payment etc. A significant portion of people of

developing countries is illiterate. For example, in India illiteracy rate is 37% [9], in Pakistan 42% [10], in Bangladesh 39% [11] of people are illiterate. Illiteracy has been dramatically decreasing over the 20th century, but there still are large areas of the world where reading and writing skills are scarce, preventing further development, as well as basic communications between organizations and individuals [7]. Thus to reach the services of ICT to all citizen of a country, nowadays the world is more concern to develop new technologies for illiterate people and the people who are illiterate in the field of ICT. Developing countries have been facing more challenges in this field [8].

2.2 Mobile Applications for Illiterate People

A number of mobile, desktop and web-based applications have been developed in Bangladesh for the illiterate people for various purposes. These applications are mainly use Bangla fonts to help the illiterate or semi illiterate people to navigate the applications and some other use icons based applications to support this illiterate people. The summery of few existing applications is provided in table 2.2

Table 2.2: Summary of existing mobile applications

Serial No	Application Name	Brief Description	UI features focusing to illiterate people
1	Sheba.xyz [14]	This application is mainly developed on android platform. The focus of this application is to buy and schedule home services. It mainly connects the verified service providers with the customers on demand basis.	Icon based interaction.
2	Pathao [15]	This application is mainly developed on android platform. The	Graphical (map) based location search.

		aim of this application is to share one's ride and make profit.	
3	Uber [16]	This application is mainly developed on android platform. By share one's ride with one's car and drop the passenger to their destinations.	Driver can see the passenger pictures. Payment by cash. Easy rating process. Location based search for the ride.
4	Vara koto [17]	This application is mainly developed on android platform. The purpose of this application is to calculate the fare and fare comparison for all types of city transportation. Calculates the estimated fare of any two given destination of various transportation mode.	Autosuggestion during searching a location.
5	DMP [18]	This application is mainly developed on android, IOS and for windows phone. The aim of this application is to put the police services at citizen's doorsteps by searching nearest police station from any location of the city, Dhaka, Locating Police stations on map, by Informing police about any incident.	Icon based interaction.

2.3 Digital Divide and Illiterate People

The digital divide refers to the difference between people who have easy access to the Internet and those who do not. Digital divide is a term that refers to the gap between demographics and regions that have access to modern Information and Communications Technology (ICT), and those that do not or have restricted access. This technology can include the telephone, television, personal computers and the Internet [19]. Digital divide affects the social aspect of people life, such as formation of social circle and communications. The recent rise of social

media in the past decade such as Facebook, twitter & Instagram. People have imported part of their lives into the virtual world and uses such platforms as a mean of communication. People without access to such platforms will be treated as an outcast. Those people will be excluded by their peers, giving them a huge disadvantage in life. These impacts badly on social life and the development for a country. If we divide the society in respect to illiterate and literate, people than it comes also with a point, which describes the digital divide. The digital divide is one of the main challenges to develop a society. Interaction between human and computers has greatly increased as we embark on the twenty-first century. The ability to access computers and the internet has become increasingly important to completely immerse oneself in the economic, political, and social aspects. However, not everyone has access to this technology. The idea of the "digital divide" refers to the growing gap between the underprivileged members of society, especially the poor, rural, elderly, and handicapped portion of the population who do not have access to computers or the internet; and the wealthy, middle-class, and the people who living in urban and suburban areas that have access [20].

Now a day, the issue of the "digital divide" cannot be ignored. In our society, where the distribution of wealth is already heavily unbalanced, access to computers and the Internet is unbalancing the situation even more. Those with computers and access to the Internet are becoming even richer through the power of information, while those without them are becoming even poorer in comparison. According to William Kennard, "In a society where increasingly we are defined by access to information and what we earn is what we learn, if you don't have access to technology, you're going to be left in the digital dark ages. That's what the digital divide is all about" [21]. The digital divide will not close unless there is an initiative to seal the gap. With socio-economic divisions already present in today's society, the digital divide is compounding the effects. It is not just the cost of computers that results in the digital divide, but also the presence of widespread illiteracy among overlooked populations. In developing

countries, out of four adults one is illiterate or has limited literacy skill. Technological literacy cannot be promoted if basic literacy skills are lacking [22].

In Bangladesh, about 64.96% people are rural, and the number of illiterate people is 39%. According to BTRC, the total number of Internet Subscribers has reached 80.829 million at the end of January 2018. Therefore, these statistics clearly show a pictorial view of digital divide in context of Bangladesh. Though despite this, to achieve the goal of vision 2021 (i.e. Digital Bangladesh) it is utmost important to focus on developing information technology application to reduce such digital divide.

In Bangladesh, already taken number of steps to reduce the digital divide. Now a day, many mobile applications are using Bangla fonts to support these large illiterate people. Most of our govt. services are now focusing to develop its services focusing these audiences. Bangladesh has its vision 2021 to make the country digitized [23]. The objective to make the country digital will remain incomplete without these large illiterate people.

2.4 Human Computer Interaction

Human-Computer Interaction (HCI) is a field of study focusing on the design of computer technology and, in particular, the interaction between humans (the users) and computers. It encompasses multiple disciplines, such as computer science, cognitive science, and human-factors engineering. While initially concerned with computers, HCI has since expanded to cover almost all forms of information technology design. One important HCI factor is that different users form different conceptions or mental models about their interactions and have different ways of learning and keeping knowledge and skills. In addition, cultural and national differences play a part. Another consideration in studying or designing HCI is that user interface technology changes rapidly, offering new interaction possibilities to which previous

research findings may not apply. Finally, user preferences change as they gradually master new interfaces.

2.5.1 Usability

Usability is the measure of a product's potential to accomplish the goals of the user. In information technology, the term is often used in relation to software applications and Web sites, but it can be used in relation to any product that is employed to accomplish a task. For example, a toaster, a car dashboard, or an alarm clock [24]. Some factors used in determining product usability are ease-of-use, visual consistency, and a clear, defined process for evolution. The primary benefits to users are that they are able to achieve their tasks easily and efficiently. Usability studies increase user satisfaction, and save on development and redesign efforts.

Users no longer tolerate applications that are slow to use, ugly to look at, and difficult to navigate. Slow loading speeds and bad functionality will drive your visitors away, significantly boosting your bounce rates whilst reducing your conversions. However, if you take the time to understand the needs and the motivations of your visitors, you can tailor your content accordingly, along with your overall user experience. Usability is the measure of the quality of a user's experience when interacting with a product or system - whether a web site, software application, mobile technology, or any user-operated device [25].

Usability is defined by five quality components [26]:

- Learn ability: How easy is it for users to accomplish basic tasks the first time they encounter the design?
- Efficiency: Once users have learned the design, how quickly can they perform tasks?

- Memo ability: When users return to the design after a period of not using it, how easily can they reestablish proficiency.
- Errors: How many errors do users make, how severe are these errors, and how easily can they recover from the errors?
- Satisfaction: How pleasant is it to use the design?

It is easy to specify usability metrics, but hard to collect them. Typically, usability is measured relative to users' performance on a given set of test tasks. The most basic measures are:

- success rate (whether users can perform the task at all)
- the time a task requires
- the error rate and
- Users' subjective satisfaction.

The ISO/IEC 9126-4 Metrics recommends that usability metrics should include [27]:

- Effectiveness: The accuracy and completeness with which users achieve specified goals
- Efficiency: The resources expended in relation to the accuracy and completeness with which users achieve goals.
- Satisfaction: The comfort and acceptability of use

Five Benefits of Usability Testing [28]:

1. Finding out if users are able to complete the tasks at hand successfully without any issues.
2. The amount of time it takes to complete specified tasks the site intends for you to complete will be revealed.
3. Satisfaction scale of users with your website.

4. Find changes that may need to be implemented to improve user performance and enjoyment.
5. Evaluate the performance to see if it meets your usability goals.

It is usually performed to understand the real world, check conformance to standards, compare alternative design solutions and assess the design against requirements/goals. The goals of usability evaluation are

- To assess the extent of system functionality by enabling a user to perform desired tasks.
- To assess the effect of interface on user i.e. easy to learn, easy to use, enjoying to use, challenging, etc.
- To identify usability issues like the design that cause unexpected results or confusions.

2.5.2 User Experience

User experience is defined as the overall experience of a person when using a product (such as a website or a mobile application), specifically referring to how easy or pleasing the product is to use. Digital user experience encompasses all aspects of a person's interaction with your web or mobile site including behaviour, actions, perceptions and satisfaction. Putting an emphasis on user experience will not only benefit a customer but will consequently deliver results for a company. User Experience (UX) Design is part of the design process. However, UX is more focused on the overall experience than just the look of the site. UX involves designing and planning an experience and creating a workflow for the users of a website or app [24].

In terms of design, user experience is just as important as visual identity. It does not matter what your site or app looks like if people do not know how to interact with it. In addition, they

need to enjoy that interaction. While UX is important for any digital product, it is even more important for certain types of digital products: complex sites or applications, retail or online sales, start-up sites and businesses, small-budget projects and projects or sites that are expected to last a long time. UX is key for complex sites because users must be able to easily navigate the site and understand how to use it. Neglecting UX can result in a sloppy site that people will not come back to. Developing an interaction-rich experience will drive users back to a site. One of the most complex types of sites can be those that include retail or online sales. Not only does the site have to be well organized, it also has to have clear and easy to use signals for how to make a secure purchase. This is also true of sites that are expected to be around for extended periods, such as retail sites. Consider Amazon.com, it has worked using the same basic UX for years. User experience is key for small and start-up businesses as well because the site is their first impression to users. This debut matters when it comes to directing future traffic and business to your product. Five goals of User Experience can be listed as [30]:

1. Satisfying: When a user using an application, it must be noted that the user is satisfied after using the application.
2. Clear language: If the language of the application is not clearly readable and understandable then the goal of user experience will not be fulfilled.
3. Informative feedback: When a user using an application it must be assured that the users are getting the information what they are actually looking for.
4. Consistent: The design must be consistent. Any different icons and logos, which are not corresponding with the application, will break the user experience goals.
5. Enjoyable: A user have to enjoy the application while they are using the application. It is prior conditions to achieve user experience goals.

2.5.3 Semiotic Design and Analysis

Semiotics is a discipline, in which culture, society and natural phenomena are explored as signs. The fundamental question in semiotics is how meanings are formed. Semiotic research approaches signs as existing in various forms: pictures, words, letters, objects, natural objects, gestures, phenomena and actions. Semiotics explores the content of signs, their use and the formation of meanings of signs at both the level of a single sign and the broader systems and structures formed by signs. Semiotics as a discipline includes several distinguished traditions, each using its own terminology and concepts [31].

Semiotic analysis signifies a method designed for the analysis of special texts in spite of the standard in which it is offered. In support of these purposes, special text can be any message conserved in a structure having an independent existence. It may possibly develop ergonomic plan or a structural analysis in circumstances where it is essential to make sure that individuals are able to interconnect more efficiently with their surroundings. The mode of interaction can vary; it can be a large-scale as found in structural design, or a small-scale as found in the design of instrumentation for individuals [31].

Semiotics can be described as the study of signs. Not signs as we normally think of signs, but signs in a much broader context that includes anything capable of standing for or representing a separate meaning. Semiotics is important for designers as it allows us to understand the relationships between signs, what they stand for, and the people who must interpret them - the people we design for. The science of semiology seeks to investigate and understand the nature of signs and the laws governing them. Semiotics represents a range of studies in art, literature, anthropology, and the mass media rather than an independent academic discipline. The disciplines involved in semiotics include linguistics, philosophy, psychology, sociology, anthropology, literature, aesthetic and media theory, psychoanalysis and education. Therefore, Semiotics is the study of meaning making. This includes the study of signs and sign processes,

indication, designation, likeness, analogy, metaphor, symbolism, signification, and communication. Semiotics is closely related to the field of linguistics, which, for its part, studies the structure and meaning of language more specifically [31].

2.6 Fitt's Law

Fitts's Law is basically an empirical model explaining speed-accuracy trade off characteristics of human muscle movement with some analogy to Shannon's channel capacity theorem [32]. Today, with the advent of graphical user interfaces and different styles of interaction, Fitts' Law seems to have more importance than ever before. In the Fitts' Law description of pointing, the parameters of interest are:

- a. The time to move to the target
- b. The movement distance from the starting position to the target center
- c. Target width

Fitts's started his work making an analogy of the human motor system to the well-known Shannon's channel capacity theorem and started with the equation- i:

$$C = B \log(S / N + 1) \dots\dots\dots (i)$$

in the above equation, C represents the effective information capacity of the communication channel, B represents the bandwidth of the channel, S and N represent signal and allowable noise power levels respectively. Fitts's claimed that the distance (A) can be thought as signal power, the width of the target (W) can be thought as the allowable noise. As powerful transmitters carry more information, it becomes harder to receive when the allowable noise level increases. Similarly, it takes longer to hit targets which are further away and smaller. With this analogy, he derived the equation -ii, which is now known as Fitts's Law

$$MT = a + b \log_2(D / W + 1) \text{ ----- (ii)}$$

Fitts' law is widely applied in user experience (UX) and user interface (UI) design. For example, this law influenced the convention of making interactive buttons large (especially on finger-operated mobile devices)—smaller buttons are more difficult (and time-consuming) to click. Likewise, the distance between a user's task/attention area and the task-related button should be kept as short as possible [33].

2.7 Literature Review

Based on the different research study and discussion if we conclude the whole scenery in one single line then we can define ICT is more powerful tool for the people who are illiterate and developing application for these focused people we can easily breach the digital divide specially in developing countries. The world is more concern in developing application for these focused people nowadays. Different research shows that illiterate people can easily access the audio based, icons based application than the application, which have more texts, and commands to do. The success rate is more than the failure rate for the people who are illiterate in ICT. People can easily navigate, access, and get their desired task what they want to do in the applications, which have more icons and audio than the applications, which are based on texts.

Goetze & Strothotte [34] discussed the issues related to web access for users who have very poor language skills (functionally illiterate people). They present the design and a prototypical implementation of a browser that provides interactive reading aids to such persons. The proposed IGAR-Browser helps both for information retrieval and learning for the people who are functionally illiterate. The design and implementation of this research can be used to help

people trying to read web pages, to decipher text, and to remember its content. The methods they used mainly picture vs. speech Readers who are not able to read a text can be aided with pictures explaining a text or they can be helped by hearing someone read the text to them. Principles and assumptions, they founded out some assumptions that a functionally illiterate people at least know to operate a browser and operate a webpage. Providing graphical aids, graphical structure helps them to figure out what things they need to do at the time of operating the webpage. The main limitations in this paper mainly the user can only read the information. Users cannot write and do any actions in the site.

Medhi, Sagar & Toyama [8] discussed mainly Presented two text-free user interfaces applied to the particular applications of providing information about employment opportunities for domestic laborers and a digital map designed for illiterate and semiliterate subjects. The proposed text-free UI and the map help the illiterate/ semi-illiterate people to search domestic jobs and digital map helps them to navigate the city. The methods mainly the used, ethnographic UI design; they used this method so that the visitors/users can easily understand visually what the UI wants to say to them. Target community, the domestic slum labors in Bangalore is the target users. Text Free UI, UI only with graphical representation and structural design. Map, map for navigating the city. Comparison of results, after collecting data from the target communities they compared with the text-free and text-based UI. The limitations in this paper mainly, the need help most cases, like some participants face difficulties to understand and perform task like navigating the map and find the specific location.

Khan, Hussain, Shah, Iqbal & Shafi [35] discussed about a job search website for illiterate population of KPK province of Pakistan. This paper proposed ICT solution to help illiterate people of Mar-dan, KPK, Pakistan in searching an appropriate job. The methods they used,

ethnographic study so that users can easily visualize the job. Usability evaluation so that users can perform specific task with effectively, efficiently and after performing the task user can feel comfortable. For this paper the limitations mainly are the cultural issues, this paper is written for only a specific region of Pakistan that's why the proposed approach can be harmed or problematic for other regions. Fixed language, as they targeted a specific region their language is also fixed. Computer knowledge, sometimes user needs some previous knowledge to operate. Internet is a challenge, most cases internet is not available in the rural and illiterate people. Money Issue, as to operate a website you need internet connection that need some cost. Need a mobile/computer = Computer/mobile is still not available to all type of laboring people.

Medhi, Prasad & Toyama [37] discussed about the illiterate and semi-illiterate users of computers through audiovisual representation so that the health data can be easily collected. Using different representations like text, static drawings, static photographs, hand-drawn animations and video, each with and without voice annotation; they showed that voice annotation generally helps the target community most. The methods they used mainly, they compared ten different kinds of representations – text, static drawings, static photographs, hand-drawn animations and video, each with and without voice annotation – to see how comprehensible they were for an illiterate audience. Choice of Domain, they selected a specific field with different criteria so that their specific goal can be achieved. Design group who help the researchers to make sketch, create videos, and make animations. The main limitations of this paper are they need a big team to perform the experiment and they need huge participants to conduct the experiments, which is time consuming.

Prasad, Medhi, Toyama & Balakrishnan [36] discussed an asynchronous peer-to-peer communication capabilities of email can be made accessible to illiterate populations in the

developing world. The most common asynchronous communication tool, email, which has had a profound impact on the lives of the world's literate population, is essentially inaccessible to illiterate people. This paper mainly focused on this. The methods of this paper are the initial designs and mental models; initially they designed a prototype based on text-free and implemented on the target community with their mental models. Revised the prototype, after their initial prototype design they revised the prototype with their target audience and implement a new prototype. After designing the third prototype, they finalized the design. The limitations are mainly of this paper are the users were unable to follow multiple linear audio instructions, and most often just followed the first or last in the series. Some users need time to complete the full process on an average 5 to 20 minutes in stage 1 and 5 to 10 in stage 2.

Huenerfauth [33] discussed the user-interface recommendations in support of Universal Literacy Accessibility (URSULA) project is to create a set of guidelines for developers of computer user interfaces who are interested in making systems accessible to illiterate users. This paper traces the initial stages of URSULA(User-Interface Recommendations in Support of Universal Literacy Accessibility) work, and it demonstrates how a conceptual interface design approach, Hypothetical User Design Scenarios (HUDS), can be used to drive the design process. The methods they used in a HUDS (Hypothetical User Design Scenarios), the design tool used for the URSULA project, the designer specifies a potential user of the system with a detailed information/application need and a particular set of environmental factors. All locations, organizations, individuals, and important issues that might affect how the designer should think about the interaction are identified and described. The designer describes a situation that would motivate the user to use the system. Constructs a script for the interaction between the user and the interface. The limitations of this paper are no proposed UI is highlighted. The typical Computer user also faces technological literacy challenges. Major

challenge is to educate their communities about the value of information and communication technologies.

Gavaza, Thinyane & Terzoli [29] discussed about a standard toolkit and a set of guidelines that can be used by developers to design UIs such that even novice, illiterate users require no intervention to use them. This paper describes an investigation into UIs to develop an augmented user interface (AUI) that can be used by illiterate and semi-literate users. They mainly focused on getting an idea of how the users think the UI must look like; we are going to use the Wizard of Oz (WOZ) experiment. The main limitations of this paper are that there is no proposed GUI and the UI guidelines are not highlighted.

Akther [38] discussed an improved understanding of how semi-literate and illiterate people can access information through ICT. The general objective of my project is to contribute to a better design of communication technology for supporting informal learning processes related to healthcare and adult education systems in the rural areas of Bangladesh. It is worldwide expected that Information and Communication Technology (ICT) can provide real value of life to illiterate and semi-illiterate people through ICT development within different information domains. They considered as a theoretical framework to create ICT-based informal learning environment for low literate people that can build a sustainable ICT development. The ethnographic research method will be used to process new understandings of ICT for semi-literate and illiterate people. The action research method will be used as a framework for this research project, which is linked to the plans and activities of the project. The main limitation of this paper is that no proposed guidelines given which described in the paper.

Alduhailan & Alshamari [20] discussed the influence of adopting a text-free user interface on the usability of a web-based government system with illiterate and semi-literate people. This research aims to examine the impact of text-free user interface on usability while illiterate and semi-illiterate use e-services. This can be achieved after proposing a consolidated framework, which will adopt culture, users' needs and usability guidelines, to develop text-free user interface for a local e-service. Methods mainly they went through is the selection and development of text-free web-based system, participants recruitment, task selection and task environment, after that they measure the usability with their target participants. The main limitations of this paper are it focuses only web-based system and it is developed only for a specific region Saudi Arabia.

Rahman & Fukuda [21] discussed some recommendations related to developing user interface especially suitable for the print illiterate people. This research aims to develop a user interface for the print illiterate people in a remote village in Bangladesh. The focus was on developing a user interface that an illiterate person can operate independently. They developed the UI and compare the result with successful completion. After that, categorize performance with age wise and finally observe the result. The limitations are mainly, the users need basic computer training and it was difficult for a first-time user to remember the workflow after listening the audio instruction.

2.8 Chapter Summary

This chapter mainly describes on the user experience and the usability of the applications for the people who are illiterate and lacking behind in the field of ICT, the ICT uses for the illiterate people, application development for illiterate people, about digital divide and illiterate people. Different research showed about the importance and the effect of text free interfaces for the illiterate people and the effect to use icon-based UI for these targeted people but none have showed the effect and importance to use icon based UI using semiotic methods and the importance of using a icons based interfaces in the developing countries specially in Bangladesh for the illiterate people. Our research mainly highlighted this factor.

CHAPTER III

RESEARCH METHODOLOGY

This Chapter briefly introduced two empirical studies: one conducted for requirements elicitation to develop an artifact (an app) for job search and another study was conducted for the evaluation of the.

3.1 Design Science Research Method

Design science is a problem-solving approach that focuses on how to develop and produce artifacts having desired properties. A Design Science Research (DSR) approach was followed to develop a Human-Computer Interaction (HCI) artifact to help practitioners to design and evaluate the web interfaces. Design science is described as an innovative problem-solving activity which aims to create innovations that define the ideas, practices, technical capabilities and products having desired properties through which analysis, design, implementation and use of software systems can be effectively achieved. In other words, DSR focuses on the creation of innovative IT-artifacts to solve real-world problems [39]. DSR thus provides new knowledge, technical capabilities, practices, and products through the design of innovative artifacts and the evaluation of performance of these artifacts.

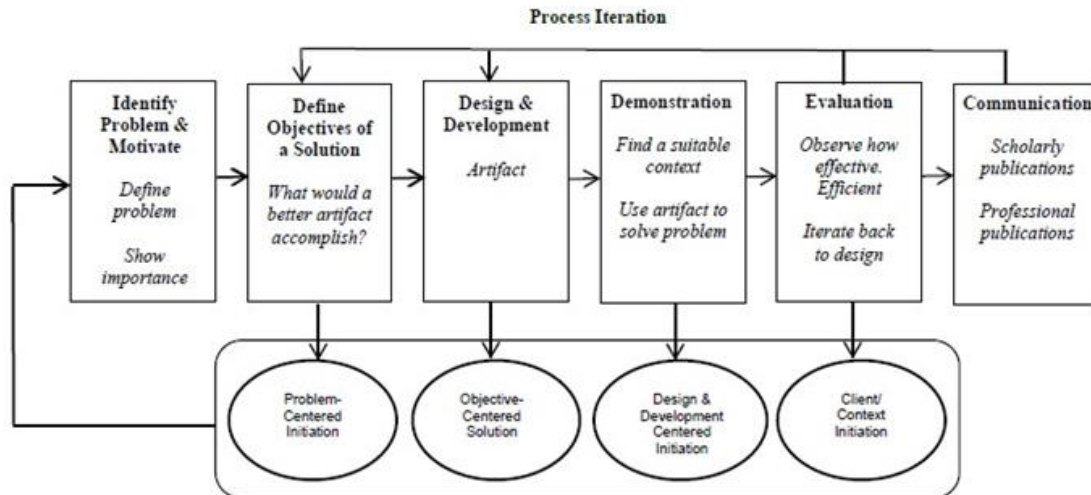


Fig 3.1: Design Science Research Methodology Process Model [39]

Design science research is fundamentally a problem-solving process (Hevner & Chatterjee, 2010). DSR creates and evaluates IT artifacts intended to solve an understood research problem and follows a rigorous process to create the artifacts. The activities of DSR are presented in fig 3.1 and briefly discussed below [39]:

- I. Identification of problem and motivation: This research specifies research
- II. problems and justifies the need and the value of a solution. The main motivation of this research is to find a solution in where the illiterate people and the people who are illiterate in ICT uses, they can easily use any applications that are easy to understand and use.
- III. Define objective of a solution: To understand the challenges and needs of illiterate people for the development of a mobile application for job search. An empirical user study through semi-structured interviewing approach was followed to attain this objective.

- IV. Design and development: To achieve the objective of this research we design an application based on the requirements of the participants and then developed the application.
- V. Demonstration: After developing the application we tested the application within a small focused group and find out our motivations and objectives are fulfilling or not.
- VI. Evaluation: When the application was tested perfectly then we move for the real focused users and evaluated the application in practical.
- VII. Communication: While conducting the whole process every time we took the help of different expert groups, journals and different sources and completed the whole evaluation process.

The DSR process activities guide us on what we have to do next at any stages of our research progress. The DSR method also provides an insightful guideline to understand the research entry point to initiate a research project, for example, ‘problem-centred initiation’ was the research entry point for this research project. Because, from the literature review, we found that semiotic means were not available in the existing literatures, while it was required for UI practitioners to design and evaluate web interface signs to make them intuitive for end-users. This finding of the first step of DSR activity (problem identification and modification) led us to look for defining suitable objectives of a solution.

3.2 An Artifact Developed Using DSR Approach

In this thesis, an artifact - a mobile application, that was developed for illiterate people of Bangladesh for job search. Therefore, the methodology followed in the research is based on the Design Science Research (DSR) approach [39].

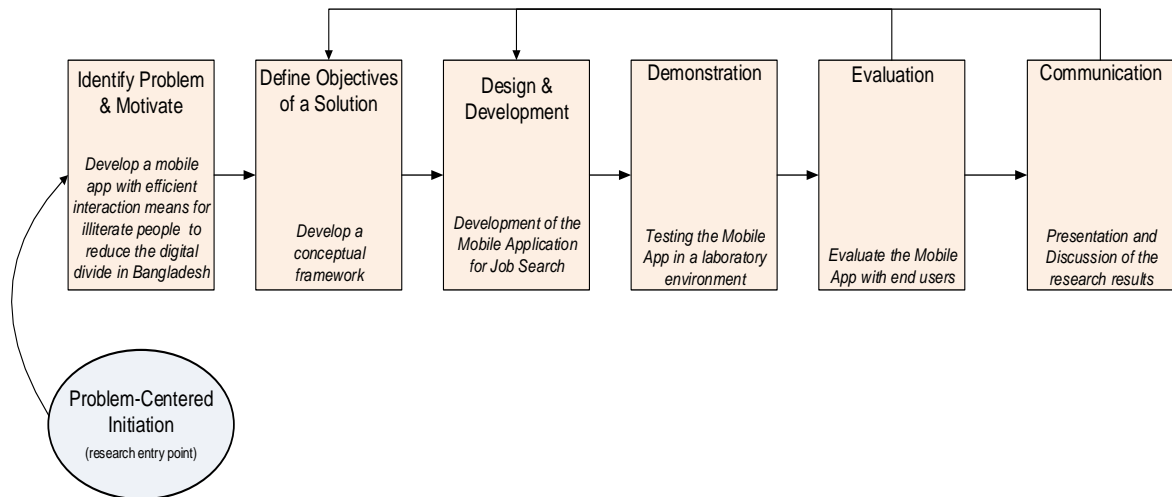


Fig 3.2: Overview of the research methodology.

A systematic literature review has been carried out focusing to user interfaces for illiterate people. The outcome of the literature review and studying the present statistics of the illiterate and IT illiterate people in Bangladesh, the research problem is formulated as to reduce the digital divide illiterate users need an efficient means of interaction to use the mobile applications. To understand further the user needs and conformance of the identified problem, a user study was carried out following the semi-structures interview to understand the challenges and needs of the illiterate people to use the mobile app as they cannot read and write. Based the study findings a conceptual framework was proposed to design and implement a mobile application. The conceptual framework was materializing in the step of design and development. The developed mobile application was demonstrated in an academic environment to assess its effectiveness and efficiency. The evaluation study was replicated with 30-40 illiterate people to measure the effectiveness & efficiency of the application and user satisfaction. The research outcomes was discussed and communicated with the expert to get their continuous feedback. The evaluation and communication feedback was considered to refine the developed application.

3.3 DSR Principals to Develop the Artifact

This DSR approach suggest creating and evaluating IT artifact intended to solve an understood research problem and follows a rigorous process to create the artifacts. This thesis follows the principals of DSR in the following ways [39]:

- a) Creates an artifact to solve identified problems: This research creates an artifact i.e., the mobile application for the illiterate people as an artifact.
- b) Follows a rigorous process: To make this design research rigorous, a set of empirical studies are carried out following the activities of the DSR process model described by Peffers et al (2008) [39].
- c) Evaluates the created artifact: The mobile application was evaluated to assess its effectiveness, efficiency and user satisfaction using an extensive empirical study. The evaluation study was conducted with focused end users (illiterate people).

3.4 Requirement Elicitation

The objective of this study was to design a mobile application for job search that will help the illiterate people to navigate and operate easily and reduce the digital divide from the developing countries especially in Bangladesh. Therefore, the aim of requirement elicitation study was to understand the need of developing a job searching and job posting application for illiterate people and to find out the requirements of such application. The study was conducted in Bangladesh using semi-structured interview. The interview has been conducted forty (illiterate people). During the interview, they were asked some specific questions related to biographical profile, the possible barrier of using any mobile application and getting employment, and their requirements to have an application to looking for a job.

3.5 Evaluation Study

The objective of this research was to evaluate the usability mobile application developed for job search considering the requirements of illiterate people. The evaluation study was conducted with forty participants through field study. In this study, participants were asked to perform a set of tasks using the application. A number of related data were collected during the task-completion sessions. Feedback responses were also collected from each participants at the end of test-session. The study was analyzed using the statistical approach.

CHAPTER IV

REQUIREMENTS ELICITATION

This chapter briefly presents the participants profile, study procedures, data analysis and the study findings.

4.1 Study Objective

The objective of requirement elicitation study was to understand the context of use, as well as specify user requirements for developing a job searching application for illiterate people in Bangladesh. In many product development initiatives, users are not generally brought into the development process until a brief design for a new product has been produced. Prior research suggests that failing to adequately study users at the beginning of the design and development process may result in incorrect and incomplete assumptions about user's preferences, capabilities, and challenges. Consequently, designing a product with such assumptions would eventually lead to commercial failure. Taking this into consideration, we conducted a user research with 40 illiterate and semi-literate people in Bangladesh.

4.2 Participants Profile

In our study, the participants were chosen using Snowball Sampling method. One bike mechanic was known to one of the authors, with whom we started and recruited more participants. A total of 40 (30 male and 10 female) participants were recruited. The participants' profession includes rickshaw puller, security guard, bike mechanics, barber, CNG driver, electrician, washer woman and washer man. The participants' average age was approximately 36 years and ranged between 18 to 55 years. None of them were capable to read or write in English but 7 of them could read texts in Bengali (their mother tongue). 11

participants had a very little experience with computer usage, mainly related to downloading songs, movies and pictures, playing games, and typing some texts. The other 29 participants did not have any experience with computer. Furthermore, 13 participants had experiences with feature phone usage mainly for phone call and text messages; 20 participants had experiences with smart phone usage mainly to enjoying music, movies, video songs, capturing photos, and phone calls. The remaining 7 participants had no experiences either with smart or feature phones.

4.3 Study Procedure

The study was conducted using a semi-structured interview approach through field study. The interviews were conducted in Bengali. First, they were asked about their demographics such as age, experiences with computer and mobile usage, education, etc. After that we probe them to understand how they seek for jobs; what kinds of difficulties they face in their job search; whether they ever tried to get a job through online; if yes, what kinds of difficulties they faced. Furthermore, we also probe them why do they prefer to search or get a job through online, and what kind of interface features would make their interaction easy. During the interviews, a careful approach was followed to make sure that the participants were encouraged to talk as freely as possible about the issues that were probed. Additional questions were asked to clarify the themes that emerged from the interviews. At the end of the interview, the participants were asked if they want to add any additional issues that we did not cover in the interview. Altogether, these approaches helped us gather a very rich interview dataset. All the interviews were audio recorded, and subsequently transcribed. Field notes were also taken at the time of interviews. The duration of interviews was between 15 to 20 minutes. A few pictures of data collection are showed below:



(a)



(b)



(c)



(d)

Fig 4.3 Data collection through field study

4.4 Study Outcomes

The data was analyzed and coded using grounded theory method. The researchers read the data carefully and assigned keyword or code to the portion of data that represents a common theme. Three researchers were involved in the data coding and categorizing. First, two researchers coded and categorized the sample data separately. After completing coding, the researchers then met to compare the coding and classifications. The inter-coder agreement calculated as the sum of all the agreements divided by the sum of all agreements and disagreements was

0.88. The disagreements were resolved by discussion. A third researcher was involved in this discussion. In practice, the disagreements were resolved by consensus. Using an iterative process, three researchers read, sorted, reread, and recombined the data until consensus was achieved.

We observed that the codes could be categorized into three broad categories: need for digitalization of job search, barriers to adopt digitalization and design principles. The categories and codes are presented in Table 4.4 with sample quotes from the data.

Table 4.4: Summary of the codes and categories with sample quotes

Categories	Features	Example quotes (After Translation)
Need for Digitalization	Victimization and Cheating	One person (known indirectly to me) manage this Rickshaw for me with a condition of depositing 200 Taka [2.39 US dollar] per day to the owner of this rickshaw. I did not know the owner. I have deposited 200 Taka since last 3 months to that person; suddenly I knew that the actual deposit fee was 150 Taka [1.79 US dollar] per day.
	Unemployment	Two persons from our village are used to call me to give construction job, when needed. I stay at home, if they do not call me. I don't know where I should go and to whom I should contact to get a job during my free days.
	No direct relationship with job providers	I am driving this CNG for the last 25 days, every day I took this CNG from this garage, returned here at night, and deposit daily 700 Taka [8.36 US dollar] to the supervisor of this garage. I do not know the owner of this CNG, so I cannot convince the garage staff about some mechanical problems of this CNG. It is a problematic because the CNG became idle most of the time in a day but garage-supervisor don't repair or reduce my daily deposit charge. If I had direct relation with the owner, I may ask the repairing money.

Barrier to digitalization	Lack of technology experience	I do not know how to use a computer, but I have seen it in different offices, houses and shops I have a feature phone and I know a little how to use it, but I do not know anything about smart phone; maybe it is costly! I do not know what Internet is and how to use it I cannot really do much with mobile application, as I cannot read.
	Price of technology	I earned only 1500 Taka [18 US dollar] in a week and I have family, I cannot afford the cost of a smart phone.
Design Principle	Picture	I can easily recognize different profession (job) seeing their pictorial gesture; for example, a uniformed person beside a CNG driver.
	Voice Guide	A slow and simple Bengali voice instruction can be a good help to use the system.
	Voice-entry	Oh! Sure! Only by speaking (voice record), I can apply, it would be easy for me!
	Symbols	Yes! I understand many symbols, for example, an audio (mike) sign represent hearing.
	Less Amount of Texts	Although I know a few Bengali alphabet. I cannot read text properly. If you use only a few texts, I may try to remember or memorize those.
	No text Entry	I can't write; so, I cannot do anything by typing text
	Less Taps	I can learn an application, if I need to complete only a few steps (clicks).
	Light Weight Application	I use applications but my phone is very slow.
	Native Language	For me, it would be good if you use Bengali voice and text in interface.

In the following sub-sections, we describe each of these categories in detail.

4.4.1 Need for digitization

One of the most important themes that emerged from the data was the need for digitalization. The participants highlighted problems such as victimization and cheating, unemployment, and no-direct relation with job provider, which points to an immediate need for digitalizing the job

search process for them. The participants mentioned that they experienced much difficulty to find a job. They remain unaware about any job posting or vacancy announcement and mostly depend on few personal contacts to find a job. This process takes a lot of time and most of them remain unemployed for a long time. In fact, if their personal contacts do not help them, they become jobless and stay idle at home. Often, they also become victim of cheating, as they cannot directly contact the employer. Many participants stated that they have been cheated in different ways.

4.4.2 Barrier to Digitization

Although the participants realized that digitalizing their job search process would help avoid the problems they have been facing, they also raised several barriers that might limit their adoption and use of such digital services. Most of the raised problems are related to either lack of experience with technology or price of the technology. For example, although some participants had experience with computers and smart phones, the remaining ones raised the issue of their unfamiliarity with computer, smart phones, and the Internet. Almost all of the participants mentioned about the high cost of acquiring smart phone and Internet services. Finally, although some participants had little experience with mobile applications, they mentioned that they could not really get the most of it due to their lack of reading abilities.

4.4.3 Design Principles

One of the main goals of this study was to identify some design principles for developers. The study revealed nine features to make the user interfaces intuitive for illiterate and semi-literate people. The most important features that came from the interview data are voice-guide, pictures, no text-entry instead voice-entry and native language. Participants preferred voice

instructions in Bengali in every page to inform them what the page is about, how and what they can do on this page. Some of them also suggested that there should be an option to listen the voice-guide repeatedly. About the profession or job category, almost all participants mentioned that they could easily find out the job category by seeing the real-world picture or sketches of a job like tea maker, bike mechanic, driver, rickshaw puller, etc. More than two third participants raised their voice against text entry since they cannot read and write. They favoured to fill the application form by providing voice (voice-entry). Finally, since none of participants had English or any other foreign language proficiency, they preferred only the native language (i.e., Bengali) for voice-guide and UI texts. However, regarding UI texts, they preferred very limited amount of texts, and emphasized more on to have symbols and pictures. They stated using the symbols that they experience in their daily life. For example, a mike [sound icon] can be used for voice, since in Bangladesh the mike sign is used for music and other voice instructions. They also stated to finish their tasks with a smaller number of taps. Finally, it is very important to design a light weighted application. As we discussed earlier, the Internet service in Bangladesh is slow as well as very expensive for our target group (see the barriers). Thus, a lightweight application is very critical.

In sum, the requirement elicitation study showed that illiterate people understand their need for digitalization and wanted to have such application for job search purpose despite having the barriers. Most importantly, they also provided some design guidelines to develop a user-friendly intuitive interface that would provide easy interaction with the application. Consequently, we provided the found design guidelines to the developer team to develop the application.

CHAPTER V

DESIGN AND DEVELOPMENT

This chapter discusses the development of the key artifact of this thesis. At first, the conceptual framework based on the outcome of need findings has been described briefly followed by the process of back-end and front-end development. An elaborate discussion on User Interface (UI) sketching, Interface sign and voice direction selection have been also shown in this chapter. Finally, the processes of application development with some use case scenario have been depicted in the last part of this chapter.

5.1 Conceptual Framework

From the analyse of need findings, the following result has been found that, most of the illiterate people are generally not habituated with using Smart Phone for finding ways of making livelihood other than only hearing songs, enjoying movies and communicating purpose like phone calling and receiving. Price of smart phone is very low, so it is not a very big issue to afford one for anyone. There are many ICT based mobile application for job finding, which may help people a lot, but they are always in doubt how they will use those application. For finding a job, they generally face many difficulties as they ask people around them whether any job is available for them or not. It takes a lot of time and most of them remain unemployed for a certain time, as they do not get any information of available job. Sometimes they also become victim of being cheated, as they cannot directly contact with the job provider or boss. Therefore, we have designed a framework to help them so that they can easily use the app for finding jobs in their sectors and which will be trustworthy. These are considered that smart phone is affordable, job seeking is difficult task, need easily usable application and making

availability of this app in the governmental places, our aim is to develop an app so that they can easily and efficiently use it. Keeping all the aspects described above, the key concepts that need to be integrated in the app are Bangla interface, voice direction, and usage of pictogram, audio information and animation.

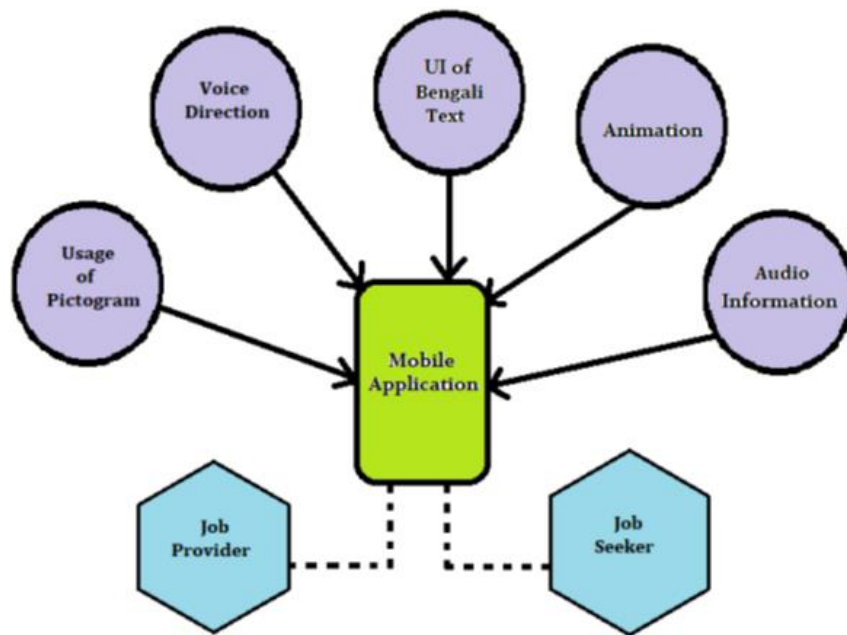


Fig 5.1: Conceptual Framework

The diagram in Fig: 5.1 show the conceptual framework of our design. Here the main stakeholders of this application are the **job providers** and the **job seekers**. They will be the man user of this application. The five main entities will make the application more suitable and easier for the stakeholders to use.

- i. Usage of Pictogram: Our need findings show that indication with pictures help illiterate people to understand any procedure easily even though they do not know how to read. Therefore, pictography is one of the prime characteristics of this application.

- ii. Voice Direction: Voice direction or indication will make the application more beneficial and supportive for the illiterate people. User can understand easily what to do in any particular stage by only listen.
- iii. UI with Bengali Text: As the research, work focuses the people of Bangladesh, so it is necessary to make the text in Bengali language font. It will help people to operate the application more comfortably with the help of their own mother tongue.
- iv. Animation: The usage of animation helps to focus important things. User can understand easily if a certain activity has more importance over another one.
- v. Audio Information: While providing information for a job application (job seeker) or for posting a new job (job provider), if there is an opportunity to provide audio information along with written information then the task gets easier for people with less education.

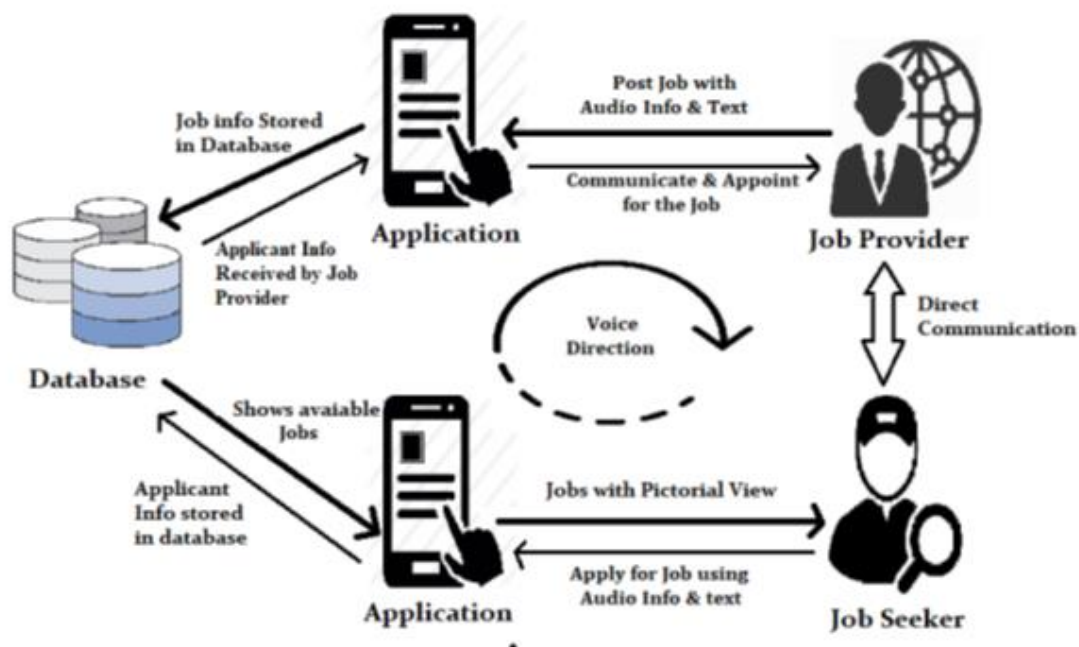


Fig 5.2: Conceptual Framework with Data flow

The developed app will have voice indication how to use the app. All the text is will be written in the regional languages. For Bangladesh, it will be developed in Bangla. It goes for voice direction. Job provider will circular for a job with both oral information and written information of a relevant job field. Each job field will have a real life pictorial view so that job seekers can easily find the job. Job seeker will be able to see explore different jobs and can apply for. In case of application, if job seeker cannot write, he/she will be able to provide information orally. All the applicants list for a particular job will be visible to the job provider and can directly contact with the applicant if job provider wish to recruit him. This is how the app is going to be work.

5.2 Front End Development

Job search Application the term mainly describes a platform where a specific audience will come to look for a specific job and a specific audience will come to offer jobs for them. What if, this type of platform is for illiterate people? If we plan to develop an application for this audience then what will be the actual needs for us? What are the things we need to consider if we really want to build an application for this targeted audience? We mainly consider these issues for our application to develop.

As our targeted audience are illiterate so we have mainly focused on text-free, icon based and audio interface for our front-end section. We have four-user interface and four interfaces for the people who will post the jobs. As by our application the illiterate people can apply and look for the jobs by specific job sketch and icon and by audio so we have segmented the interface by this strategy. After entering the application as a worker or job seeker, the interface will run according to their role. All the list of the jobs who are seeking workers will appear in the list and the user can navigate or apply for the job by the icons or by the audio, which will be given

by the job posters. A worker can see their salary, contractual information, skill required, last date to apply. If a worker cannot read then they can navigate also by the audio action. When they are ready to apply for a job then they can apply for the job by giving input of their own or by simply giving voice input, which will be showed by the specific job poster list. This is how the full interface for the worker will work.

5.2.1 Sketching the User Interface

Sketching the user interface is the primary step to develop the ultimate output of the application. Before sketching the interface, we consider the application goals, the requirements, and our targeted audience. In order to success and find the actual outcome the interface is very important for our case so we forwarded step by step after collecting all the required information to develop the final sketch. Few of the sketches of the final application are given below -

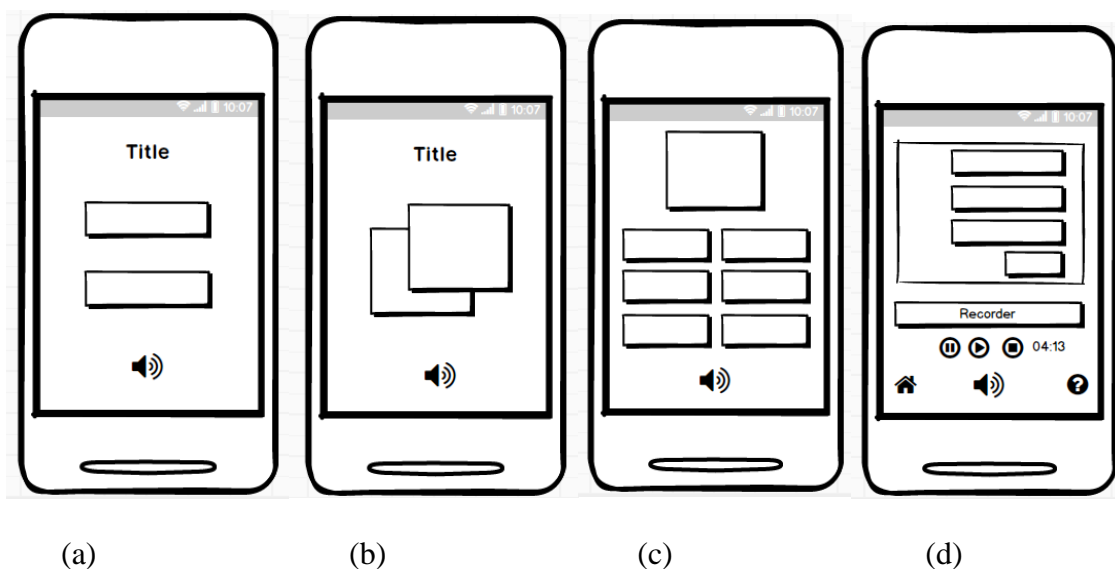


Fig 5.3: User Interface for Job Seeker

The primary sketch of the interfaces for the job seekers is done keeping all the prime entities of the conceptual framework in mind. The interfaces are designed in a very simple manner so that job seekers do not have to think with any complex issue. The sketch in fig 5.3 (a) is designed for primary selection of the stakeholders. A job provider or a job seeker only have to click there a button. In sketch 5.3 (b) the job criteria will be shown in a sliding manner. The sketch in fig 5.3 (c) indicates a job with its details and fig 5.3 (d) shows how a job seeker can apply for the job with audio information. Each interfaces has “voice direction” button along with “home” button for easy access to the home page.

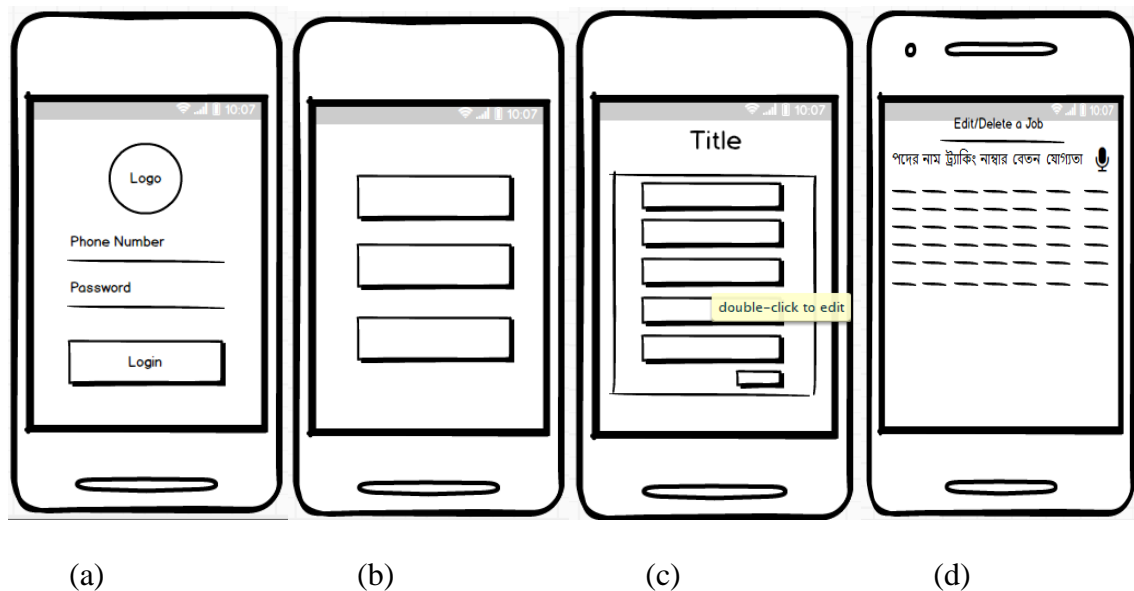


Fig 5.4: User interface for Job Provider





The interfaces for the job provider are also designed in an easy and understandable way. A job provider will enter into his/her own account by login (fig 5.4 (a)) and after entering one’s personal account, there will be some buttons with options to choose. The sketch in fig 5.4 (c) indicates how a job provider can post a new job by giving of information. Lastly, a job provider can edit or delete a job in the sketch 5.4 (d).




5.2.2 Interface Sign and Voice Selection

The study of signs or semiology helps to make meaningful communication. A combination of right text label, icon and voice direction can make the indication to a particular task more understandable. We have studied different symbols, signs, icons and found out which can be perfect for defining an activity. Before developing the main application we firstly documented and found the needs for these illiterate people who mainly are our target user. As our target users are mainly illiterate so we focused on text-free, icon based and audio interaction interface so that the user get help directly from the application. Before developing the application, we have prepared the icons which will be provided into the application, what will be the audio voice for the application and how the navigation will work for the audience.

Usage of iconography in the application will help the users to understand the illustrated meaning of a task easily. Popular icons should be used for the illiterate people so that they can navigate the application even without reading text. The following table 5.1 shows a list of few icons that will be very simple to understand and convenient to use for the users.

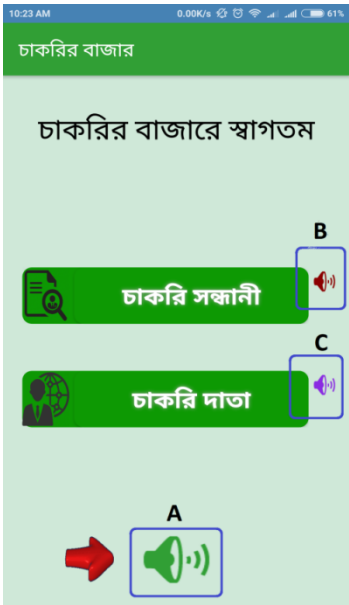
Table 5.1: List of icons

Icon symbol	Metaphorical meaning
	image of magnifying glass indicates to search something (job)
	image of corporate personal indicates the job provider
	home sign indicates that it can take to home page
	speaker sign indicates to listen to something that is a voice direction

	the mike sign indicates to speak out something or record something
	the arrow sign indicates to perform any particular that task with more importance
	logout icon indicates to get back from someone's profile

One of the main key features of the application is the voice direction in every interface. These voice directions will be given in Bengali language, as it is the mother tongue of the target users. Usage of own mother tongue will specially help the people with no education to navigate the application more conveniently. The following table 5.2 shows few instances of selection of voice direction in each interface.

Table 5.2: Instance of voice direction

Interface	Voice Direction
	<p>A. চাকরীর বাজারে আপনাকে স্বাগতম। আপনি যদি চাকরি অনুসন্ধান করতে চান তাহলে উপরের মেনুটি নির্বাচন করুন এবং এই সম্পর্কিত তথ্য জানার জন্য পাশের আইকনটি নির্বাচন করুন। আর আপনি যদি চাকরি দিতে চান তাহলে নিচের মেনুটি নির্বাচন করুন এবং এই সম্পর্কিত তথ্য জানার জন্য পাশের আইকনটি নির্বাচন করুন। (Welcome to Job Market. If you want to search job then select the upper menu and if you want to know the information regarding this issue, select the side icon. Again, if you want to provide a job then select the lower menu and if you want to know the information regarding this issue, select the side icon)</p> <p>B. পাশের বাটনটি নির্বাচন করলে আপনি আপনার কর্মক্ষেত্র অনুযায়ী চাকরি খুঁজতে পারবেন এবং নতুন চাকরিতে আবেদন করতে পারবেন। (If you select the side button, you can search and apply for a new job)</p>

	<p>C. পাশের বাটনটি নির্বাচন করলে আপনি আপনার অ্যাকাউন্টে ঢুকে নতুন চাকরি দিতে পারবেন এবং আপনার নিজের চাকরির তালিকাসহ চাকরিতে আবেদনকারীদের তালিকা দেখতে পারবেন। (If you select the side button, you can provide a new job and you can see your own job list with the job applicant list)</p>
--	--

As per semiology, there should be a right combination among the icons, pictography, text labels and voice indications. We design each component in such way so that a person with no education can navigate the application. Figure 5.6 shows the design of a job-searching component

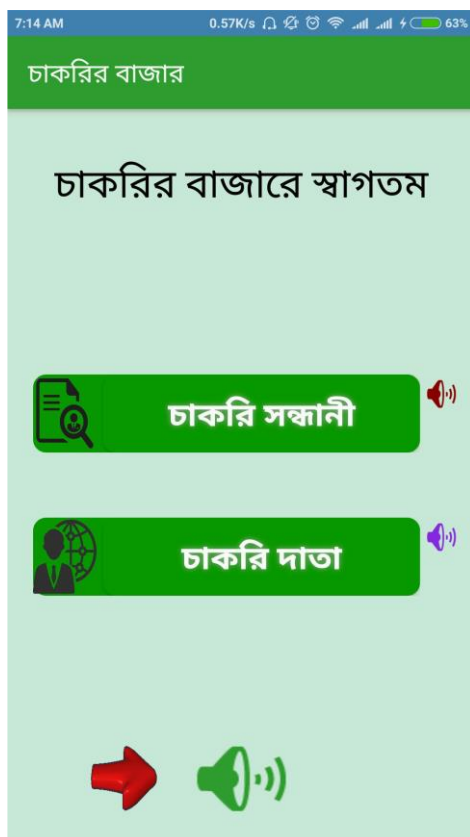


Fig 5.6: Design of a job-searching component

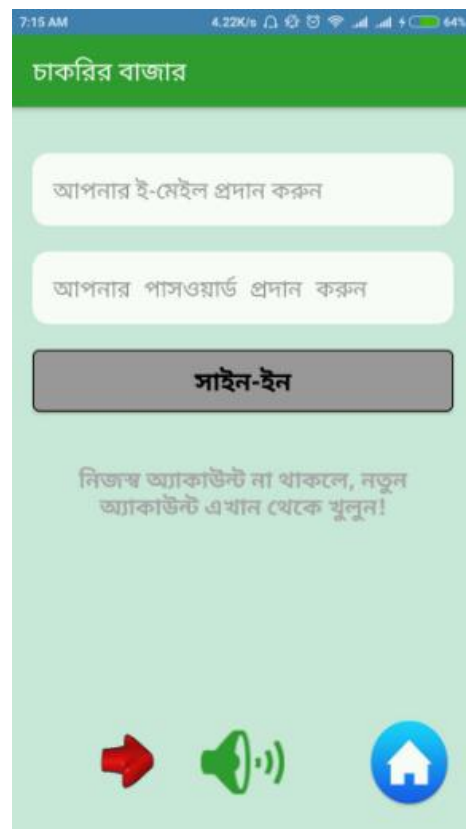
5.3 Application Development

This section gives a broad view of development of implemented mobile application using the proposed framework. The application has been developed in Android studio. We have used Java language for backend coding and XML for frontend coding. Firebase has been used for storing the data of users. Firebase is a Backend-as-a-Service (BaaS) and provides the features of real-time database, file storage and authentication. Figure 4 shows few of the snippets of our implemented model application. The whole application is designed with voice and pictorial indication for the illiterate and semiliterate people. The voice-guide in every interface of the application will help all users to understand what to do in the present state. A “Job Provider” needs to sign up to create a new account in this application. Then he needs to sign into his own

account to post a new job. While posting a new job a “Job Provider” must give a voice recorded description of the particular job. On the other hand, a “Job Seeker” can always access to jobs available in particular job field. One can apply for a job by providing recorded (compulsory) and written (optional) information. The application then goes to the particular job provider. The application has been developed with a user friendly graphical user interface for the illiterate persons.



(a)

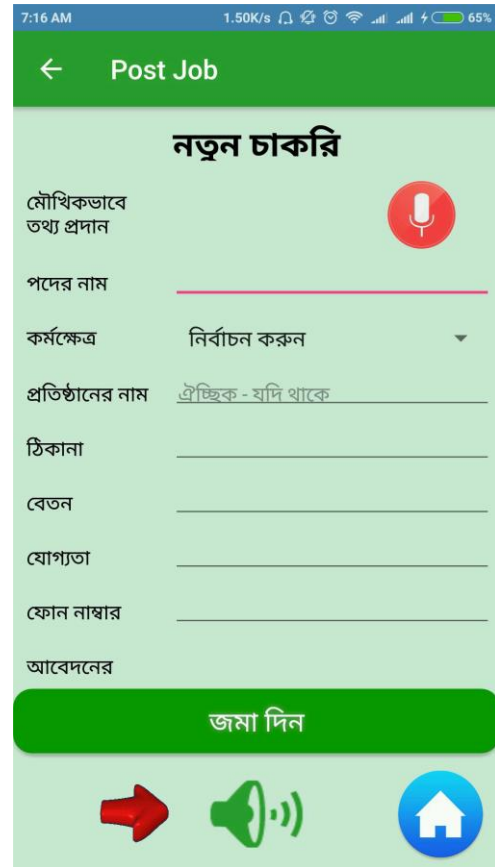


(b)

Fig 5.7: (a) The first interface of the application whenever a user will launch the application from their mobile. It has main two buttons for the job seekers and the job providers. (b) A job provider must sign in to enter into his/her personal account.



(a)



(b)

Fig 5.8: (a) The dashboard of the personal profile of a job provider. It has total three options i. Post a new job ii. List of previous jobs iii. List of job applicant (b) A job provider can post a new job by providing audio information (compulsory) and written information (optional).

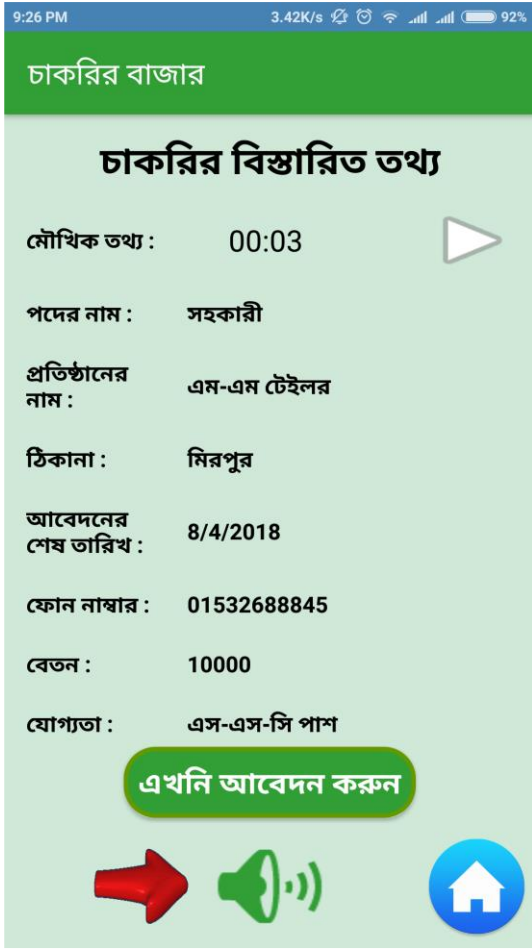


(a)

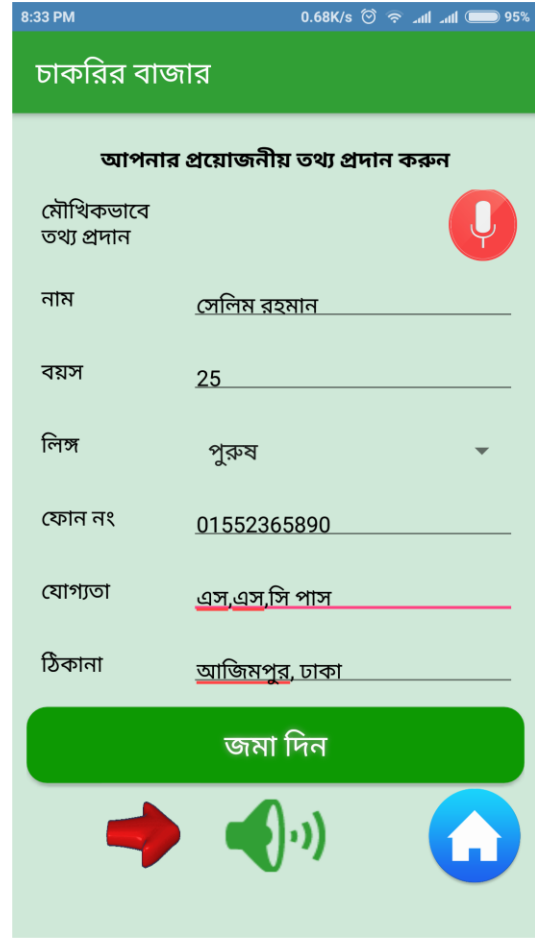


(b)

Fig 5.9: (a) A job provider can view his/her previous job list. If a job provider wants, he/she can also edit or delete a particular job. (b) A job seeker must first select a job field to search for a job.



(a)



(b)

Fig 5.10: (a) After clicking on a particular job, a job seeker can view the job details including the audio information provided by the job provider. (b) A job seeker can apply for a job by providing own audio information and written information.



(a)



(b)

Fig 5.11: (a) This recording fragment will appear whenever a job seeker or a job provider will have to provide their audio information. It has start, stop, and pause, cancel functionalities. (b) When a job seeker apply for a job the information, the details information can be viewed by the job provide.

5.4 Use Case Scenarios

In this subsection, we will show two use case scenarios of different types of job seekers and job providers

Use Case-1:

Stakeholders: The job provider has a barbershop and he knows how to read and write. He needs an assistant for his shop. On the other hand, the job seeker only knows how to read but does not know how to write.

Description of the scenario: While using the mobile application the stakeholders will complete the following tasks to fulfil their own demands.

1. The job provider will sign in to his own account (if he does not have one, then he will sign up first).
2. From the account dashboard, he will click the first button to post a new job.
3. First he will record an audio file containing all the requirements of his job. As he is capable of both reading and writing, he can also provide written information after completing the text fields. At last, he will click the submit button and successfully post his new job.
4. On the other hand, the job seeker will read the label of the search button and choose his job field (barber).
5. He will get a list of jobs provided by all the barber job providers. And after viewing all job details, he will choose an appropriate job.
6. As the job seeker does not know how to write, so he will only record the audio file and submit it. Then he will wait for the job provider to get acceptance.

7. The job provider will get a new application and he will listen to the audio file submitted by the job seeker. He will then contact with the job seeker if he wants.

Use Case-2:

Stakeholders: The job seeker does not know how to read or write. On the other hand, the job provider has a car-mechanic shop and he knows how to read and write. He needs an assistant for his shop.

Description of the scenario: While using the mobile application the stakeholders will complete the following tasks to fulfil their own demands.

1. The job provider will sign in to his own account (if he does not have one, then he will sign up first).
2. From the account dashboard, he will click the first button to post a new job.
3. First he will record an audio file containing all the requirements of his job. As he is capable of both reading and writing, he can also provide written information after completing the text fields. At last, he will click the submit button and successfully post his new job.
4. On the other hand, as the job seeker is illiterate so he will click on the speaker button (an arrow animation indicating the speaker button). A voice direction will be given to him and he will follow the direction.
5. He will click on the upper button (job search button) and enter into the job field's interface. There also, he will follow the voice direction and by observing the sketches, he will choose his car-mechanic field.
6. After that, he will click on a job and he can hear the job description from the audio file given by the job provider.

7. As per voice direction in each interface, he can easily apply for the job by giving audio information only.

8. Thus the application will go to the job provider. Moreover, after listening to the audio information provided by the job seeker, he will then contact with the job seeker if he wants.

CHAPTER VI

EVALUATING THE APPLICATION

This chapter briefly presents the participants profile, study method, data analysis and findings.

6.1 Participants Profile

A total of 40 illiterate participants were recruited from Dhaka city. Among them 23 were male and 17 females. Participant's monthly income varies from 12000 to 20000 Taka [in US Dollar 140 to 240]. Their professions were car mechanics, house cleaner, washerwomen, barber, handicraft worker, security guard, rickshaw puller, tea maker, CNG driver, and bike mechanics. Their average age was approximately 26 years and ranged between 17 to 49 years. None of them were capable to read or write in English but 15 of them can (weakly) read text in Bengali. A total of 17 participants out of 40 had experience with feature phones mainly for phone calls. 23 participants had experience with smart phones for calling app (Viber or Imo), music, and FM radio. None of the participants had experience with any mobile application or web portal related to job search.

6.2 Study Procedure

For each participant one test-session was carried out following the steps below.

- At first, the participant was briefed about the purpose of the study and his/her roles. The participant was also briefed that the goal of the study is not to assess him/her, rather to evaluate the mobile application, so that he/she behaves normally in the test session and provides honest opinion (if asked) about the overall system functionalities and performance.

- The test participant's demographic information was collected, and a test-consent form was signed with him/her.
- Then the participant was provided a short training (5-10 minutes) to demonstrate how to use the application for job searching and applying.

Next, the participant was asked to perform the following three tasks.

- a) Task1: Find out all the available jobs?
- b) Task2: Find the available jobs related to CNG driver?
- c) Task3: Apply for a job of security guard.

At the end, the participant was asked to complete a set of post-test questionnaires. The questionnaires include 5 questions, capturing overall satisfaction level, complexity of use (ease of use), learnability (ease of learning), intent to use the application in future and willingness to recommend to others. These questions were measured using 5-point Likert type scale with answer scale ranged from 1(strongly disagree) to 5(strongly agree).

Each test-session was audio-video recorded for later analysis. A few pictures of data collection are shown in Fig 6.2.



Fig 6.2: Evaluating the app through field study

6.3 Results and Discussions

The study data was analyzed to calculate the usability parameters defined by ISO, which includes effectiveness, efficiency and satisfaction.

6.3.1 Effectiveness

Effectiveness is the accuracy and completeness to achieve goals. Indicator of effectiveness may include the successful completion of tasks with minimum possible taps without repetitions. In this study, two variables were considered to measure the application's effectiveness: (a) tapping behavior (number of taps used to perform a specific task), and (b) number of attempts (how many times users tried to complete the task successfully).

6.3.1.1 Number of Taps - The optimal (minimum) number of taps required to perform the Task1, Task2 and Task3 were 2, 4, and 8, respectively. The results showed that participants tapped on average 2.30, 4.45, and 9.10 times to complete the Task1, Task2 and Task3, respectively; with minimum 2 and maximum 5 taps in case of Task1, minimum 4 and maximum 8 in case of Task2, and minimum 8 and maximum 12 in case of Task3 (see Table gg). Hence, on average, the participants took 0.30, 0.45, and 1.10 more taps than the optimal number of taps (i.e. 2, 4, and 8) to complete the Task1, Task2 and Task3, respectively, which is an indication of effective use of the application by the participants. Indeed, the participants took slightly more taps for Task3. However, as one can see, the complexity of Task3 is higher than the other two tasks. Thus, it deemed reasonable that some participants would require higher number of taps to complete the task.

Table 6.3: Results of Evaluation Study

Evaluation Metrics	Data Type	Task	Mean and SD	Min	Max
Effectiveness	Tapping Behavior	Task1	2.30 ± 0.69	2	5
		Task2	4.45 ± 1.18	4	8
		Task3	9.10 ± 3.14	8	12
	Number of Attempts	Task1	1.15 ± 0.36	1	2
		Task2	1.65 ± 0.77	1	3
		Task3	2.25 ± 1.00	1	4
Efficiency	Task Completion time	Task1	19.23 ± 2.12	16	26
		Task2	31.63 ± 3.18	27	38
		Task3	60.33 ± 9.64	48	95
	Number of times listened voice instruction	Task1	1.05 ± 0.22	-	2
		Task2	1.10 ± 0.41	-	4
		Task3	1.17 ± 0.47	-	5
	Number of times Asking help from researcher	Task1	0.03 ± 0.16	-	1
		Task2	0.15 ± 0.36	-	3
		Task3	0.20 ± 0.41	-	4
Satisfaction	Overall Satisfaction	-	4.48 ± 0.51	3	5
	Easy to Use	-	4.57 ± 0.42	3	5
	Easy to Learn	-	3.98 ± 0.98	3	5
	Future Use	-	4.23 ± 0.64	3	5
	Recommend Others	-	3.96 ± 0.93	3	5

6.3.1.2 Number of Attempts - On average, the participants took 0.15, 0.65, and 1.25 more attempts than the optimal number of attempt (i.e. 1 for each task) to complete the Task1, Task2 and Task3, respectively (see Table gg), which in turn indicate that participants completed their tasks effectively using the application. Again, due to the complexity of Task3, the participants took more attempts on average to complete this particular task.

6.3.2 Efficiency

Efficiency is defined as the resources expended to successfully complete a task. In this study, three variables were used to measure the application's efficiency: task completion time and number of times help asked for (number of times help asked from the researcher and number of times audio help taken).

6.3.2.1 Task Completion Time

The results showed that participants took on average 19.23, 31.63, and 60.33 seconds to complete the Task1, Task2 and Task3, respectively; with minimum 16 and maximum 26 seconds for Task1, minimum 27 and maximum 38 seconds for Task2, and minimum 48 and maximum 95 seconds for Task3 (see Table gg). To the best of the authors' knowledge, there has not been a study conducted on a mobile application for job search for illiterate and semi-literate people. Indeed, Khan et al. and Medhi et al. conducted research on job search web application for illiterate users. Thus, we decided to compare the task completion time of our study with Khan et al. and Medhi et al. A comparison of the task completion time of this study with these other studies shows that participants took much less time to search the job using the mobile application developed in this study, for example, average task completion time was 25 mins, and minimum task completion time was 12 mins (for group participation) and 23.5 mins (for individual participation) in case of and 1 min and 39 s in case of , while this study showed

much better results in terms of task completion time. These results indicate that participants completed their tasks efficiently using the application.

6.3.2.2 Number of Times Help Asked for

The UIs include the voice instruction on how to use the application as well as job details in Bengali. If the participants listen voice help multiple times, it gives an indication of poor UI design. Thus, listening the voice instruction once is considered optimal. The results show that on average, the participants listened 0.05, 0.10, and 0.17 more times than the optimal value (i.e. 1) to complete the Task1, Task2 and Task3, respectively (see Table gg). Ideally, participants are expected to ask no help from the researcher in case of an efficient UI. Our study results show that on average, the participants asked 0.03, 0.15, and 0.20 more times than the optimal value (i.e. 0) to complete the Task1, Task2 and Task3, respectively (see Table gg). These findings indicate that the user interface and voice instructions are clear, helpful and understandable to the participants. It also indicates that audio support is an efficient means for them to learn and perform task using the application.

6.3.2.3 Satisfaction

Satisfaction is the users' comfort with and positive attitudes towards the application. In this study, five questions were used to measure satisfaction and the results are shown in Table I. The results show that the average score of each satisfaction measure was high. The participants found the system was easy to learn (mean: 3.98) and easy to use (mean: 4.40). Their willingness to use the system in future (4.25) and recommend it to others (mean 3.95) was also overwhelming. Finally, the overall satisfaction score was 4.45, which indicated that participants were very satisfied with the application.

6.4 The Effects of Personal Characteristics of Participants

We investigated the impact of the personal characteristics (i.e., gender, illiterate vs. semi-literate, and smart phone experience) of the participants on the usability of Chakuri-Bazaar. The participants were divided into two groups based on gender and Kruskal-Wallis H tests were conducted to investigate differences in terms of effectiveness, efficiency, and satisfaction measures. The results did not reveal any significant difference between male and female. Next, the participants were divided based on whether they were literate or semi-literate and Kruskal-Wallis H tests were conducted. Again, no significant differences were observed in terms of effectiveness, efficiency, and satisfaction measures. Finally, in terms of smart phone experience, we observed that the experienced participants were slightly more efficient (in terms of task completion time) ($p < 0.05$) than the participants who did not have prior experience.

6.5 Analysis Using Fitts's Law

Fitts's law is a predictive model of user's navigation movement, which is primarily used in human-computer interaction and ergonomics. Fitts's law is used to model the act of pointing, either by physically touching an object with a hand or finger, or virtually, by pointing to an object on a computer monitor using a pointing device. This scientific law measures the time required to move to a target area is a function of the ratio between the distance to the target and the width of the target as the equation- ii:

$$MT = a + b \log_2(D / W + 1) \text{ ----- (ii)}$$



(a)



(b)

Fig 6.5: Application interface for calculating Fitts's Law

According to Fitts's law, we have calculated two movement time for the page of “Details information of job” and “List of jobs” as showed in figure 6.4 (a) and figure 6.4 (b) respectively. In figure 6.4 (a) we see that, the movement time for figure 6.4 (a) is 367.322 ms and in figure 6.4 (b) we see that the movement time for the pointing positing of two arrow is 525.49 ms. Here, we assume that the constant value of a is 50 ms and the constant value of b is 150ms and the distance between navigation button/pointing place d for figure 6.4 (a) is 100mm and the width of destination button w for figure 6.4 (a) is 30mm. Similarly, the distance between navigation button/pointing place d for figure 6.4 (b) is 80mm and the width of destination button w for figure 6.4 (a) is 10mm and we applied Fitts's law equation and calculated movement time for these two distance.

CHAPTER VII

CONCLUSIONS

This concluding chapter briefly presents the main outcomes, thesis contribution, the limitation of this thesis and the future research implications.

7. 1 Main Outcomes

The thesis provides the two main outcomes to obtain research objectives. The outcomes are briefly discussed below.

7.1.1 Understand the Challenges and Needs for Illiterate People

The thesis explore the challenges and design requirements to develop a mobile application for illiterate people. The necessities of having a job search mobile application for illiterate people was highlighted due to the challenges, the faced including victimization and cheating, unemployment, lack of direct relation with job providers; while lack of technology experience and price of technology were cited as key barrier to digitization the job searching process for illiterate people. As the design principals, the study revealed nine principals that need to be consider for developing usable mobile application for illiterate people. The design principals includes: use of picture, voice guide, voice-entry, symbols, less amount of texts, no-text entry, less tabs and the native language and the development of less-featured (on light weighted) application.

7.1.2 Design and Develop a User-Friendly Mobile Application

A mobile application for job search was developed considering the design principals revealed in the requirement elicitation study. The UIs were designed intuitively for illiterate people so that they can use the system without prior knowledge and education. Voice direction, Usage of picture, audio information, Bangla interface, uses of symbols were the key component that make the application usable for illiterate people. The application was also tested with 40 illiterate people and found that the application is effective, efficient and the participants were highly satisfied with this application.

7.2 Thesis Contributions

This thesis followed a rigorous approach to design, develop and evaluate an IT artifact following DSR method. Consequently, this paper provides three contributions for designers. First, we found that using limited texts and voice instructions is important for the design of mobile applications for illiterate people. Medhi came to similar conclusion in their study using web applications with illiterate people in India. In this sense, we confirm that their findings are valid also in Bangladesh for mobile applications. Second, we found that filling information through voice instead of text is another important design principle that should be provided to the illiterate people. Third, use of pictures and culturally relevant symbols in UIs are absolutely critical, as these help people understand the UIs functionalities better. Altogether, we believe our study provides a template for interaction design on mobile platform that can be used to build any other types of applications for illiterate people.

Furthermore, our study found a number of severe problems that the illiterate people have been facing in relation to their employment. Perhaps, digitalizing the process of job search would reduce some of these (if not all) problems. Given that the government of Bangladesh has

recently been emphasizing on building Digital Bangladesh, we suggest the policy makers to take necessary steps toward diffusion of such job search applications among illiterate people. We strongly believe that the findings of our study will be useful for such initiatives.

7.3 Limitation of the Thesis

7.3.1 Uses of Qualitative Analysis Approach

A qualitative data analysis approach was used in this thesis. Qualitative data analysis has its own limitation, because it depends on individual's experience, knowledge, cognitive power, and the like. To avoid bias in the analysis, the results were discussed with experts, using a systematic approach, while a review process was also part of the analysis.

7.3.2 Less Number of Participants

To conduct each of the study (requirement elicitation and evaluation study), we required only 40 participants from seven professional group. Considering more participants from more diversified profession may provide more optimum results.

7.3.3 Application Developed as Case Study

The study considered only one application as an example case to understand the design requirements to develop mobile application for illiterate people. Different applications may have different requirements and functions.

7.3.4 Method Used to Explore Design Principals

To find out the all-possible design consideration for designing mobile application for illiterate people only the semi-structured interview approach was followed. However, to validate the revealed factors an extensive empirical study was conducted following the user studies and post-test questionnaires.

7.4 Future Research Implications

Future research would be conducted to re-solve many issues that are observed through this research. Firstly, the requirement elicitation study was conducted following the semi-structured interview approach. Future research could be conducted using other methods like observation, On-site visit etc. for revealing the design principals and for evaluating the system (and design principals) methods like case study, longitudinal study etc. would be used to obtain more generalized outcomes.

Secondly, as the studies were conducted with only 40 participants from a limited number of professions, in future we will resolve this issue by recruiting many more participants of different professions.

Thirdly, another study can be carried out to compare the mobile app developed in this thesis with a text-based app that developed for the same purpose to find out which app works better for illiterate people.

Finally, to observe the training effects, a complete study can be carried out where one group of participants will get the short training on this mobile application and another group of participants will not receive any trainings.

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