

# Mobile solutions for eHealth reflected through three narratives of Nepalese pregnant women

Abha Pokharel

Master's Thesis



ITÄ-SUOMEN YLIOPISTO

School of Computing

Computer Science

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UNIVERSITY OF EASTERN FINLAND, Faculty of Science and Forestry,  
Kuopio  
School of Computing  
Computer Science

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Abstract: 150-500 words

This Master's thesis examines the applicability of mobile eHealth services through the pregnant women stories, assisting them to live independently. Mobile technologies have gained popularity in different areas of health sector for past few years. Combining mobile technologies in health services are growing research interest among researchers, mobile application developers and health professionals. The research has involved studying and reviewing of available literature that is relevant to the research questions. It is found that there might be some attributes that are related to enhancing the quality of life of the pregnant women. Mobile eHealth technologies can play an important role to enhance and support independent living of the pregnant women. Moreover, it was found that the mobile eHealth services should be user friendly and easy to use.

The result of the thesis shows that mobile eHealth services can be a suitable solution for the pregnant women with different health conditions and are living in out of reach areas. Thereby, assisting them to live independently. It is necessary to analyze the requirements of the pregnant women and their technological skills before the deployment of mobile eHealth services. Also, mobile technologies and health management system should be studied before the deployment of any mobile eHealth services so that it can work effectively according the requirements of the pregnant women.

Keywords: Maternal care, Mobile eHealth services, Pregnant women, Mobile technologies, Quality of life

## **Foreword**

This thesis is made to the School of Computing, the University of Eastern Finland, as a result of master's degree study.

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## Abbreviations

WHO	World Health Organization
MMR	Maternity Mortality Rate
UNICEF	United Nation Children's Fund
UNFPA	United Nation Population Fund
SBA	Skilled Birth Attendant's
IRIN	Integrated Regional Information Network
HMI	Health Market Innovation
MAMA	Moible alliance For Maternal Action
ANC	Antenatal Care
PNC	Postnatal Care
MDG	Millenium Development Goal
ICT	Information Communication Technology
SMS	Short Messaging Service
DHS	Demographic Health Survey
NDHS	Nepal Demographic Health Survey
CB-NCP	Community Based Newborn Program
OWH	Office On Women's Health
mHealth	Mobile Health
eHealth	Electronic Health
SIIA	Software And Industry Assiation
ISV's	Internet Service Provider
ASP's	Application Service Provider
MIS	Management Information System
CM	Content Management
EMR	Electronic Medical Record
IMS	Intelligent Medical Server
PPHS	Patient Personal Home Server
RFID	Radio Frequency Identification
IMHMS	Intelligent Mobile Health Monitoring System
VoIP	Voice Over Internet Protocol
CNN	Cable News Network
IM	Instant Messaging
ITU	International Telecommunication Network
WAHA	Women's And Health Alliance International
ART	Antiretroviral Therapy
PEF	Peak Expiratory Flow

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# 1 Introduction

World Health Organization (WHO), defines maternal health as health of the pregnant women during pregnancy and after childbirth. Low resource countries in Asia and Africa are in scarce of good maternal care. According to WHO, increased maternal mortality rate (MMR) shows the low quality of maternal health care provided to the mothers. Most of the maternal deaths were occurring due to low access to the services that include regular checkups and emergency services. (WHO, 2014)

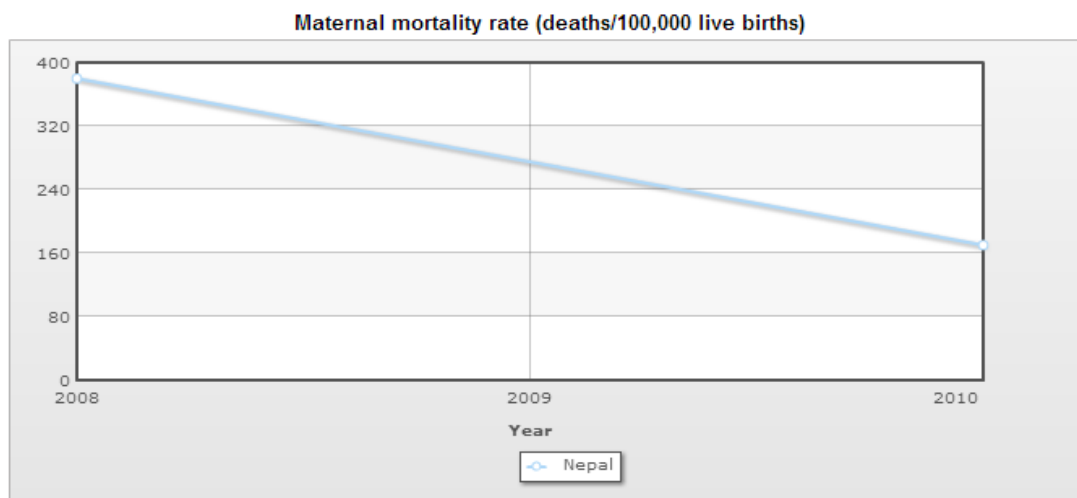
During the year 1990- 2010, decline in maternal deaths was up to 47%. Some of the reasons behind the decrease in maternal mortality might be due to improved medical technology and services for contraception and family planning (WHO, 2014). Successive improvement in medical technology and services are making present generation people to work more comfortably than previous generations people. Medical professionals of previous generations had to do much more hard work because at that time diagnostic technology and computerized machines were less in use than today's generation. For example, today's generation computerized machine monitor patients continuously. More diagnostic test is done due to the automated laboratory machines are used that performs quicker and more accurately. In today's generation, the main cause of the problems and their solution are known beforehand to the researchers. So, they do not have to dig many similar problems. Manual work is reduced that save the time for all researchers, medical practitioners and patients. Moreover, these can also be some factors to reduce maternal death case that was 10 or 15 years before.

According to United Nations Population Fund (UNFPA), the fifth millennium development goal aims at improving maternal health with the aim of reducing MMR by 75% between 1990 and 2015. Moreover, notably 75% decrease in MMR is already found in 10 countries between year 1990 to 2010 than the targeted year 2015. (See Table 1) (UNFPA, 2012)

**Table 1. Reduction MMR percentage of 10 different countries from the year 1990-2010 (UNFPA, 2012).**

<b>Name of the Countries</b>	<b>MMR %</b>
Estonia	95%
Maldives	93%
Belarus	88%
Romania	84%
Bhutan	82%
Equatorial Guinea	81%
Islamic Republic of Iran	81%
Lithuania	78%
Nepal	78%
Vietnam	76%

According to Integrated Regional Information Networks (IRIN), there might be some factors which are associated with the declining of MMR in Nepal. Factor such as improvement in the skills of midwives, nurses and doctors, family planning program, womens education, empowerment, wealth and living standards. In the absence of the professional midwives, pregnant women depend on certified skilled birth attendants (SBA). Government certifies them in particular midwifery skills and counseling provided by female community health volunteers. In 1988, the Government initiative for SBA was launched to fight against maternal and neonatal deaths. (IRIN, 2013)



Waiting

Country	2008	2010
Nepal	380	170

**Figure 1. MMR (deaths/100,000 live births) in Nepal from 2008-2010 (indexmundi, 2011).**

MMR include the deaths of pregnant women during pregnancy, childbirth or 42 days of termination of pregnancy (indexmundi, 2011). From the presented figure, there was some reduction in maternal mortality rate within two years of time (2008- 2010), but still it is higher than other developing countries (Figure 1).

In Nepal, for carrying out adequate maternal health care and services all around the country, there are some barriers in terms of geographical difficulties, diversity in culture and religion, lack of transportation, lack of time due to heavy work load and lack of skilled medical professionals. These barriers affect the proper utilization of the health services. Baral et al., (2012) observed that lack of awareness of obstetric danger signs, lack of decision making power and inability to pay the services are some factors affecting proper utilization of the services. Moreover, lack of awareness of maternal signs, decision making and lack of money, increase the rate of maternal deaths. However, some of these barriers can be made affordable with the utilization of technology. (Health Market Innovation, 2014)

For example, Mobile alliance for maternal action (MAMA) is a mobile information program in three countries India, Bangladesh and South Africa. It takes into account of each country context and requirements for providing thousands of women with

vital health information. It also serves as a case study to illustrate diverse approaches to establish a mobile health program. Different health information is provided to the pregnant women in a voice message with different characters playing the role of doctor, mother in law, mother or a pregnant woman. Stories in voice message are in educational format along with entertainment. MAMA voice messages include dialogues from a doctor for iron rich foods to the pregnant women and time for medical checkup. (MAMA, 2013)

This Master thesis aims at helping upcoming researchers who are making mobile eHealth services for low resource countries. This study will help mobile eHealth services developers for getting some knowledge about the service structure of low-resource country like Nepal. It will help to provide some examples of the mobile eHealth services for the pregnant women supporting them to live independently. In this thesis, general service structure related to the maternal care and requirements of the pregnant women of Nepal were studied in order to utilize it in mobile eHealth services. Also, mobile eHealth services and mobile technologies that supports the pregnant women were studied. By analysing the pregnant women requirements along with understanding of the mobile eHealth services and available technologies, narratives were created. From the available narratives, specific technological solution for the pregnant women requirements that occurs by the use of the mobile technology along with its benefits and limitations were provided.

## 2 Background

Mobile communication offers an effective means to bring health care facilities in the developing countries. Due to the rapid popularization of mobile phone, people who are not able to use fixed-line phone or computer are able to use a mobile device for daily communication and data transfer. Recently in one study found that 64% of the population uses mobile phone in developing countries. Increasing use of mobile technologies is the central element to promise mobile technologies for health. (Vital wave consulting, 2011)

Indeed, the growing need of mobile technologies will not entirely replace the existing health care facilities. Existing health care facilities are still necessary and applicable. In maternal care, a new impulse is needed to improve maternal health and reproductive health in developing countries. To prioritize among technologies, again mobile phones can be a priority to improve maternal health services because in developing countries, there is plentiful access to mobile technology even while other technologies and health infrastructure are scarce. Millennium Development Goal (MDG) five, calls for improving the maternal health and the target six, calls for a reduction of MMR by three quarters between (1990- 2015). The goal is not only to reduce the MMR, but there are other factors to consider like reduction in chronic disease like HIV, reduction in poverty, reduction in child mortality, providing healthy food, education and promoting the lifestyle of the pregnant women. (Alumanah, 2012) For achieving these goals, only current health services will not be not enough. It is imperative to develop human resource effectively and efficiently. In this regard, Information Communication Technology (ICT) can be a pathway to facilitate such goals. As a result, providing electronic health services through mobile to reduce MMR needs to be considered critically.

Han, Park and Kurkuri described mobile eHealth services as a service in which mobile service user receives the real-time health management service through a mobile device (Han et al., 2006). For example, in developing countries, mobile technology will support increasingly inclusive health care system by providing real time health care and diagnosis for the areas where there is scarce or absent of health

services (Vital wave consulting, 2011). Therefore, integrating mobile technologies into current health services provides diversity in health service delivery.

Moreover, one important function of mobile eHealth services is to adapt to the personal user environment and to provide comfortable services to its user. For mobile eHealth service, it should also include the medical guidance, warning and limitations from an early stage of care. In mobile eHealth services, to assist independent living for pregnant women, both mobile technologies and health management system plays a significant role. Short Messaging Service (SMS) and voice communication, are examples of traditional mobile technologies and internet enables the use of certain software (e.g. health management applications, eGames). Blood pressure management, stress management and blood sugar management are some examples of health management system. Health management system uses mobile phones and biosensor attached to the phone. (Han et al., 2006) The thesis focuses on pregnant women and their health care needs. Mobile services in health care support pregnant women requirements, assisting them to live independently and improving their quality of life.

## **2.1 Research problem**

Like other developing countries, maternal care is inadequate in Nepal. The method and techniques to assist the pregnant women is traditional based health services without the integration of ICT in health services. There are health professionals and practitioners who are unaware or have very little experience of ICT in health services. The problem is not only of health professionals or practitioners, but some other factors might also hinder the integration of ICT in health services.

This thesis is based on the assumption that, the poor maternal care and inadequate health care services for the pregnant women are attributable to lack of mobile eHealth services and its inability to probe into the real life stories. It is common that some of the pregnant women have some inherent difficulties that affect their quality of life. These difficulties may be income, family and relationships, culture,

education, health and nutrition, social care, geographical difference, etc. Such difficulties might hinder their capabilities to perform in other real life situations. Health problems like blood pressure, diabetes is common in Nepalese society. Other health related chronic disease is HIV/AIDS and asthma. The burden of such sexually transmitted disease and nutrient deficiency is the cause of low quality of life in other low-income countries. (Baral et al., 2012) It is an alarming situation in Nepal and has led many pregnant women with poor quality of life.

The researcher intends to understand the problem through the real life stories of Nepalese pregnant women, their difficulties affecting their quality of life. The findings from the stories are meant to provide some guidelines, to help further mobile eHealth services researchers to think, thereby aiding in the development of mobile eHealth services. Also, there are no such mobile eHealth services interventions, yet in Nepal to help and assist the pregnant women for independent living, for which the researcher sort to find out some of the technologies to augment the current health services in low economic countries.

## **2.2 Objectives and research questions**

The objectives of thesis research are:

- To listen pregnant women, health related problems through their life stories.
- To understand the pregnant women real life difficulties affecting their health.
- To understand different mobile technologies to aid maternal care.
- To understand simple, cost-effective and curative mobile eHealth services to aid maternal care.

The objectives of the thesis are researched by studying the following research questions:

1. What are the health related problems of the pregnant women?
2. What kind of real life difficulties the pregnant women face and how it affects their health?
3. What kind of mobile eHealth services are there to support maternal care?

4. How mobile eHealth services can help maternal care?

## 2.3 Structure of the thesis

This Thesis consists of eight chapters.

**Chapter four** is composed of maternal care in Nepal, general description of maternal care and its types, short description of Nepal and finally it includes some of the specific facts about Nepalese maternal care. Maternal care in Nepal includes the description of maternal care in Nepal, who is providing the maternal care services in Nepal and what kind of maternity care services are available. Next part includes the general description of maternal care and types of maternal care, i.e. antenatal care and postnatal care. Particular facts include the distinct pattern followed by a Nepalese maternal hospital in antenatal care and postnatal care.

**Chapter five** includes attributes of the pregnant women as a user group and data obtained from Nepalese women. Attributes of the pregnant women described in this chapter are crucial for the pregnant women from different perspectives such as health and technology to improve their quality of life. Only this factor is not sufficient for improving their quality of life. Additionally, it includes the pregnant women problems or issues that they face in their everyday life. It further shows factors related to the acceptance and non-acceptance of the technology based on the skill and system requirements. This chapter shows that a pregnant woman behavior is crucial factor for determining acceptance and non-acceptance of the technology. Moreover, this chapter includes the data that are collected from the Nepalese pregnant women about their lifestyle.

**Chapter six** includes mobile eHealth services definition, different mobile technologies used in the eHealth services and examples of mobile eHealth services used in maternal care. This chapter initially provides a brief description of mobile eHealth services and various technologies with their purposes. These are an important part in this chapter because these technologies enable communication



irrespective of time and place. It also shows that data received from eHealth services are sent to the mobile device through the wireless channels. Further, it describes some examples of mobile technologies used for the pregnant women in low resource countries and different technologies to assist them along with their results.

**Chapter seven** consists of three real life stories of the pregnant women and applicability of mobile eHealth services studied through their life stories. Presented stories helped researcher to brainstorm the solution for a particular problem. After the description of the stories, identification of different issues and problems, their causes, requirements and solutions are proposed and evaluated. Later, a particular solution is provided by defining how it works in real life. Finally, the benefits and limitations of the solution are described.

**Chapter eight** covers the discussion part of the thesis work.

### **3 Methods and materials**

There are two research approaches used in this thesis which are literature survey and qualitative approach. As a qualitative approach, narrative research is used (Cresswell, 2013). Initially, a central framework for the thesis is created (Figure 2). Based on this framework, theories of the existing information are classified under concepts. In this thesis framework structure, concepts are defined in the initial phase and then the relationships between the concepts are defined later. This framework helped in generating the research questions. Topics are also described in detail in the structure of the thesis.

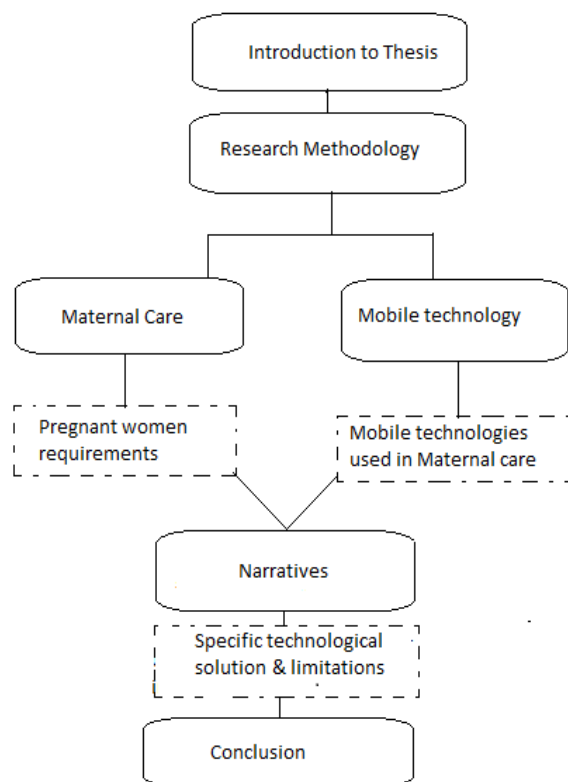
Both maternal care and mobile technology are an important part of this thesis. For maternity care, it is necessary to understand the pregnant women requirements such as their health related queries and problems they face in their day to day life. Some mobile technologies used in different developing countries support the maternal care. For that, some literature related to the mobile technologies in maternal care are studied. Literature helped to find the possible ways of using it in low resource countries like Nepal. In literature survey, existing literature that is closely related to the maternal care and mobile technology are selected and studied.

The qualitative approach in this thesis includes the use of narrative research. Pinnegar and Daynes suggested narrative research, as a method that begins with the experiences of lived and told stories of the individuals. Further, he suggested that the narrative can be a method as well as a phenomenon of study (Pinnegar et al., 2006). Cresswell suggested the procedure of implementing the narrative research be focused on studying two or more individuals, gathering the collection of their stories and reporting their own experiences, chronologically ordering and using the meaning of those experiences (Cresswell, 2013).

A biographical study is a form of narrative research that is carried out where the researcher writes and records the experiences of other individual's life (Cresswell, 2013). As a biographical study, data from relevant sources has been collected, i.e. pregnant women of Nepal. Nepalese pregnant women's life stories about their experiences in the pregnancy period, culture, family and relationships, work and

economy are studied. As an empirical material, secondary data came from the discussions with the Nepalese nurse, according to her experience with the Nepalese pregnant women. The pregnant women in this study are not discussed with their names, but the names are all changed. The nurse is a researcher's own sister. While collecting the data from the pregnant women, it became easy to get the pregnant women data from her as she is working in the maternity ward of the hospital. She told a number of stories about different types of patient that she met in the hospital. These narratives are chosen because in Nepalese society, there are very few pregnant women who are suffering from such chronic disease like diabetes, HIV and asthma.

The research work is developed with the help of the required academic materials like journals, scientific articles, books, publications, Nepalese and other international websites. Most of the studies related to the topic are compared to the studies related to other low resource countries. The thesis is guided by the review of relevant literature that makes it an integral component of the scientific process.



**Figure 2. Structure of thesis framework**

## **4 Maternal care in Nepal**

Nepal is one of the few countries in the world, where the female life expectancy is less than the male. Low life expectancy is one of the consequences for high child mortality and maternal mortality. Around the world, every 90 seconds there occurs a complication due to which mother dies during pregnancy period, resulting in more than 340 000 maternal deaths every year (Hogan et al., 2010). Maternal mortality rate is an indicator of human development deprivations that women face in Nepal (Nepal South Asia Center, 1998). According to one survey, the usage of maternal care is inadequate and poor in Nepal (Baral et al., 2012).

Maternal care in Nepal is provided by the Government hospitals (public hospitals), private hospitals and health care centers or health posts. In some rural areas of Nepal, public or private hospitals are not available, but public health posts are available. Public health posts are small with very few staffs like three to four staffs including one doctor. They are very cheap in cost as compared to the public hospitals. Public and private hospitals are near city center. Public hospitals offer very affordable medical treatment as compared to private hospitals. However, comparing to services they are pretty slower than the private hospital. Most of the people living in city areas go to private hospitals due to easy access to health care services. Maternal care services in Nepal include the services such as family planning, regular health checkups during antenatal care and postnatal care, utilization of skilled birth attendants and utilization of delivering care (Baral et al., 2012).

## **4.1 Maternal care**

Maternal care refers to health care during pregnancy, childbirth and the postpartum period. After the childbirth, maternal care is about the quality of the relationship that is established by a mother to her child that is maintained throughout the period until the child reaches twelve to fifteen months. (WHO, 2014) Maternal care for mother includes antenatal care and postnatal care. In the next part antenatal and postnatal care in the context of Nepal are described.

### **4.1.1 Antenatal care**

Antenatal care (ANC) phase starts from receiving care from health care professionals during 8-12 weeks till 41 weeks of pregnancy. ANC helps pregnant women to make plans that are right for them in terms of their nutrition, food habits and daily exercise. ANC involves a series of appointments to a specialized midwife, nurse, or doctor specialized in pregnancy and childbirth. (Frimleypark, 2005)

WHO recommends four ANC scheduled visits for low risk pregnancy. These visits include the iron and foliate supplementations, TT vaccinations, serologic screening and treatment of syphilis, malaria prevention and routine measurement of mother weight and these visits are recommended for a healthy delivery. (Lumbiganon, 1998)

According to Demographic health survey (DHS), the situation of ANC is very poor among Nepalese married women (DHS, 2004). Another report from Nepal Demographic Health Survey (NDHS) focuses on the outcome measures of the determinants of antenatal health services used among Nepalese married women and the analysis focuses on two outcome measures: (NDHS, 2001)

- A measure of whether a woman had received any antenatal care during her last pregnancy. The analysis of (n= 3,283) Nepalese married women of whom 48.3% received any antenatal care.
- A measure of whether a woman had received antenatal care four or more times during her last pregnancy. The analysis is limited to women who received some antenatal care (n= 1,586). With some missing values, the analysis is based on

1,581 women, of whom 29% had made at least four antenatal visits during their last pregnancy.

According to NDHS study, 82% of the women received antenatal care in urban areas versus 46% of the women in rural areas. In urban areas, 44.5% of the women give birth in a health facility versus 6.6% of the women in rural. The study shows that there is a huge gap in ANC between urban and rural areas women. (NDHS, 2001)

#### **4.1.2 Postnatal care**

According to National Institute for Health and Care Excellence (NICE), postnatal care (PNC) phase starts after the birth of a child and last up to six- eight weeks. The purpose of PNC is to help baby, mother and her whole family. PNC plays an important role for succeeding a healthy life structure for newborns as well as mothers. PNC is as important as ANC. Postnatal care provision includes a majority of health care services such as routine clinical examination and observation of a woman and her baby, routine infant screening to detect potential disorders and support for infant feeding. (NICE, 2014)

According to the Community Based Newborn Care Program (CB-NCP, 2009) in Nepal, there are various causes of newborn deaths such as infection, birth asphyxia and preterm birth. Three quarters of all newborn deaths occur during the first week of life and 25%- 45% deaths in first 24 hours. This period is critical, where most of the maternal death occurs. There are several underlying factors for the cause of newborn and maternal deaths, both in hospital and at home. The factors of the low quality of maternal care include, (CB-NCP, 2009)

- Household work pressure
- Lack of husband and family support in household work
- Lack of skilled care at pregnancy
- Inadequate access to and utilization of quality care
- Poor maternal nutrition
- Low institutional deliveries

## 4.2 Nepal



Figure 3. Nepal (Embassy of Nepal (nepembassy), 2014)

Nepal is a landlocked and a developing country in Asia (figure 3). It lies between India and China. The capital city of Nepal is Kathmandu. Nepal is a Himalayan country. Mountains and the foothills cover half of the Nepal and it has eight out of ten world's highest peaks. Nepal is rich in the world in terms of geography and biodiversity. It has plain and tropical Terai region in the southernmost part, the Hilly region in the south part and cold area comparable to the polar region in the northern part. Although, Nepal occupies only 0.03% of the total land of the world and 0.3% of Asia, the country has extreme different geographical topologies and climate. It is also very vulnerable to the climate change and natural disaster like landslides, drought and floods. The hilly and mountainous region is very prone to natural disaster than Terai. Climatic change and natural disasters cause the bad condition of the road, due to which there is one or two days traffic jam in some areas of Nepal.

The population of Nepal has reached 26.49 million of which male and female proportion are equal (Ministry of Health and Population Division (MOHP), 2011). Population census in Nepal, is calculated in every 10 years. According to the 2001

census, the average growth rate of the population is 2.25 percent. About one third (30.8%) live below the poverty line.

The Nepalese caste system is traditional that consists of four broad classes: Brahmin, Kshatriya, Vaishya and Sudra. The caste system was written in a civil code in 1854 by Jung Bahadur Rana. Ethnic and indigenous people do not fall into this class. Brahmin and Kshatriya are the superior castes and Vaishya and Sudra are the lower caste. In the medieval period people lost their status due to the demotion to the caste. They were banned to enter the temple, receiving education, listening to high caste teaching, digging ponds and participating in festivals. However, in the 21st century with the overthrow of Nepali monarchy, Nepal moved towards a federal republic, the lower caste and ethnic people have every right as superior caste has.

In Nepal, there is a rapid expansion in mobile service. Nepal telecommunication authority has claimed that 75.5 percent of the total population are using the mobile phone service during the start of 2014 (Ramesh, 2014). Network coverage in the rural areas has expanded, where the telecom service is the greatest need. However, as compared to the voice service, internet service in a mobile phone is less in demand. Nepal Telecoms, Code Division Multiple Access (CDMA) mobile lines are very famous for having good network coverage and call quality as compared to postpaid NTC or prepaid Namaste mobile lines. However, in general prepaid mobile phones are most commonly used in rural and city areas due to smooth transfer fund from mobile to mobile and easily available mobile vouchers.

### **4.3 Facts about Nepalese maternal care**

Nepalese maternal care includes particular pattern where Nepalese public and private hospital follow a pathway from preventive interventions in ANC to screening and finding out high risk pregnancy, referral and hospital based obstetric care for the ANC. Maternal health care is a national priority, and the pattern is substantial that can be obtained with multiple coordinate functions of various services. (Jahn et al., 2001) WHO recommends at least four ANC visits for an uncomplicated pregnancy,



which is low in Nepal (Baral et al., 2012). Figure 4 presents the recommended maternity health services (Jahn et al., 2001).

Government of Nepal aims to improve the percentage of ANC visits to 80% by 2017. Use of ANC in Nepal was 9% in year 1996, 14% in 2001 and 29% in 2006. In 2006, it was found that ANC care varied among Nepalese women, which was below Nepal Government target. Women who lived in an urban area are twice as likely to access ANC as rural areas women. (Baral et al., 2012)

PNC visit is also important for a mother to know about caring herself and her newborn. In Nepal, the safe motherhood program of Nepal recommends at least two PNC checkups and iron supplementation for 45 days after the delivery. From a survey, it was found that in Nepal, 33% of Nepalese women receive PNC. One in five women receives PNC care within four hours of delivery, and more than four women (27%) receive PNC within the first 24 hours and 4% women receives within 1-2 days after the delivery. (Baral et al., 2012)

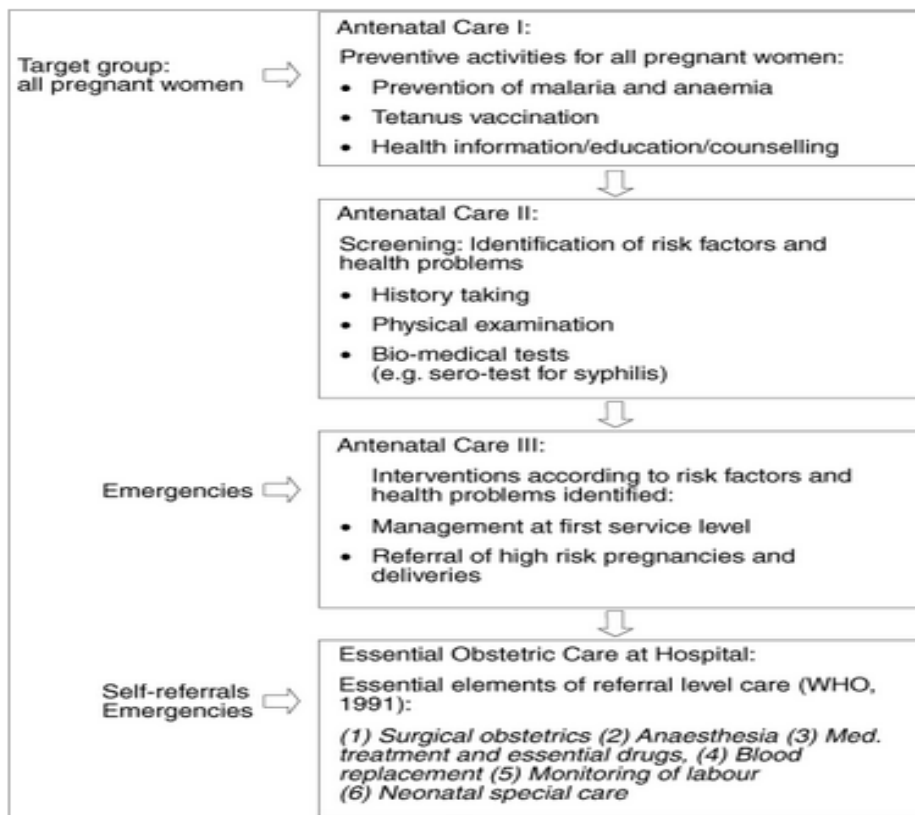


Figure 4. Maternity services organization (Jahn et al., 2001)

## **5 Defining pregnant women as a user group**

Pregnancy is a process of carrying a developing embryo or fetus inside the female body. It lasts for nine months and has three trimesters i.e. first trimester, second trimester and third trimester. The first trimester is 0 to 13 weeks; second trimester is 14 to 26 weeks and third trimester is 27 to 40 weeks. Pregnancy is detected through female last menstruation period. Pregnancy positive result is determined by the urine test, blood test, ultrasound, detection of fetal heartbeat, or an X-ray. At these stages of pregnancy, pregnant women go through various physical and mental changes. (MedicineNet, 2014)

The first trimester is most crucial to a baby's development. During this period baby body structure and organ system develop. In this trimester pregnant women experience morning sickness, fatigue, moodiness and darkening in some part of the skin. Also, breast starts for lactation resulting painful soreness. Second trimester is often called golden period of pregnancy due to the disappearance of unpleasant moment of early pregnancy where they experience decreased nausea, better sleeping patterns and increased energy level. Also, baby's first flutter is felt during this period. The third trimester is the last trimester. Pregnant women are very anxious at this time for the birth of the baby. Some of the physical symptoms for this trimester are sleeping problems, shortness of breath, hemorrhoids, urinary incontinence and varicose veins. (Office On Women's Health (OWH), 2014; MedicineNet, 2014; WebMd, 2014)

## 5.1 Attributes necessary to enhance the quality of life of pregnant women

Quality of life is the combination of different life conditions and satisfaction with those life conditions. Personal values, expectations and aspirations are taken into account while considering the quality of life. (Felce et al., 1995)

There are several attributes affecting the quality of life of pregnant women (figure 5). These attributes include health and nutrition, government and social care, physical activities, education, culture, family and relationships, dependent or independent living, economic condition, healthcare and technology. Health and nutrition, government and social care, physical activities, education and economic condition are discussed in pregnant women's lifestyle in subsection 5.1.1. Culture, family and relationships, independent or dependent living are described both in subsection 5.1.1 and 5.2. Pregnant women, health care is discussed more carefully in subsection 5.1.2. Pregnant woman's attitude towards technology is discussed in subsection 5.1.3. Pregnant women's income and expenditure are discussed in subsection 5.1.4.

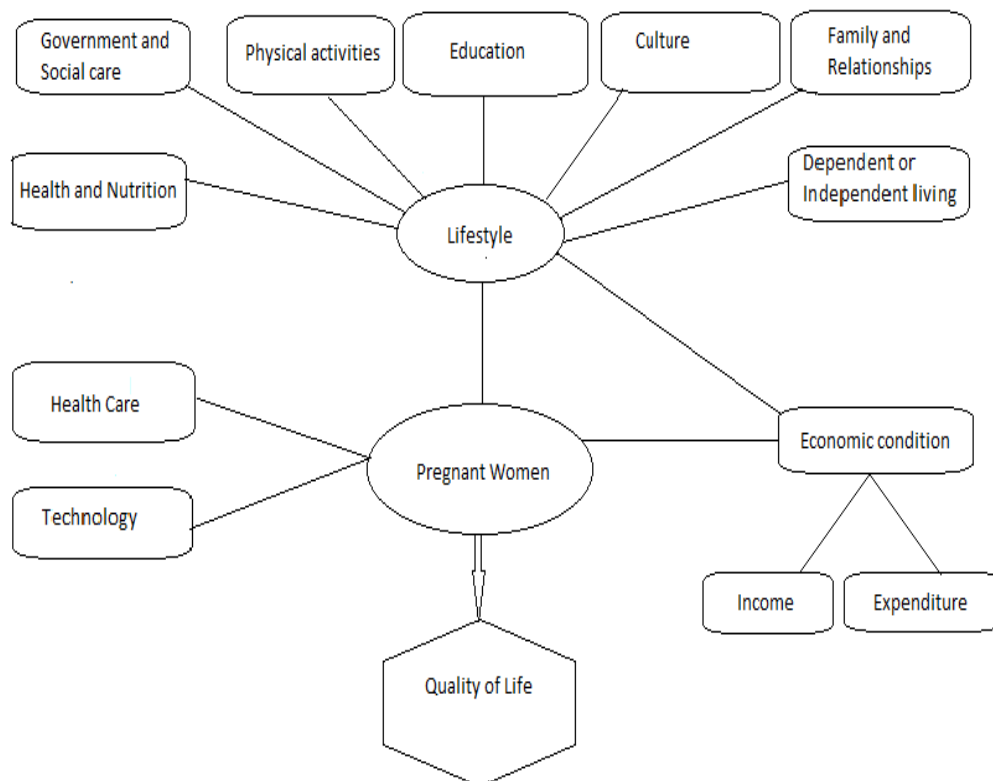


Figure 5. Attribute necessary to enhance the quality of life in pregnant women

### **5.1.1 Pregnant women's lifestyle**

Pregnant women's lifestyle is one of the factors of quality of life. All pregnant women around the world do not have the same lifestyle. The cultural background, educational background and economical condition affect her lifestyle. Geographical differences and various facilities provided by the government are also some factors that affect the lifestyle of the pregnant women.

In this thesis, the lifestyle of the pregnant women is studied by interviewing Nepalese women (see section 5.1.5), in addition to the fact that the author of the thesis is also Nepalese. Good quality of life of pregnant women includes improvement in the food habits, medical care, technologies, government support, and awareness (Baral et al., 2012; Mitra et al., 2012). These are encouraging factors that allow pregnant women to live their daily life in a good way and only one factor is not sufficient for maintaining the quality of life as shown in figure 5.

Good health and nutrients improve the overall quality of life. The immune system works well, as well as it fights better with the diseases. Healthy eating is one of the key sources for achieving a healthy life. Pregnant women with a healthy diet plan pattern experience a greater level of health in their daily life and social activities. So, pregnant women need to pay more attention towards the food intake patterns (Mitra et al., 2012). Nutrient deficiency can cause severe weight loss, infections or diarrhea (WebMD, 2014). Nutrient deficiency and burden of sexually transmitted diseases are the causes of low quality of life in low-income countries (Baral et al., 2012).

Government organizations and other social care services are dedicated to help pregnant women for medical care and support at no cost in some countries (Babycenter, 2014). In Nepal, educated women living in the urban areas of central and western region are more likely to use the maternal services than the women with less education and lower socioeconomic groups than other regions. Also, pregnancy care expenses come from either husband's income or from her own occupation. There are no such government or social benefits, provided to help the pregnant women. One review suggested that the Government should give more priority to Nepalese women having lower socioeconomic groups by providing them schemes

such as partial funding, community payment, private insurance or social insurance through subsidies (Baral et al., 2012).

Physical activity is one factor in improving quality of life. Physical inactiveness increases, many adverse health conditions like obesity, cardiovascular diseases and diabetes (Rejeski et al., 1996; Stewart et al., 1991). Therefore, it is necessary to encourage all the women to be physically active to achieve healthy quality of life (Wolin et al., 2007). Encouragements for joining different pregnancy exercise classes and getting engaged in some activities are an essential part of pregnancy care. The midwife should encourage such activities to pregnant women by providing various exercise tips with their benefits. Physical activity is one factor in controlling the future obese situation (Weir et al., 2010).

Economic condition comes from work history of women and it has an impact on quality of life. Lower income women who receive less prenatal care and experience high level of stress, are likely to get premature babies (Thomson et al., 2006).

Education attribute is another important factor for healthy quality of life for the pregnant women (Baral et al., 2012). In Nepal, there are women who have never attended school, who have primary education and who have higher education. These levels of education affect Nepalese women in terms of utilization of health care services. Studies in Nepal shows that women who have a better socioeconomic status like education, employment and income source have better utilization of the maternal health services than women with low socioeconomic status and geographical difference. (Matsumura et al., 2001; NDHS 2001)

Culture, family and relationships, independent or dependent living attributes are essential for pregnant women in getting motivated for healthy quality of life. Cultural norms and values in Asian country and Western countries are different.

For example, cultures differ in body language, communication, social behavior and dressing style. Body language in Nepal is culturally specific. In Nepalese culture, direct eye contact with seniors is not considered a good behavior and lowering the eye marks a sign of respect. In Western countries, direct eye contact done during communication is respectful and marks the way that someone is listening.

Communication style in Nepal is polite. While communicating, respectful words are meant for powerful and senior people. Spoken language has both polite and less polite words. Less polite spoken words are used to juniors and children. Greetings are very necessary in Nepal. Gifts are given to juniors from their seniors in festivals and occasions. Dress is also different from western countries. In Nepal, most of the women wear Sari and Kurta. In old times, women wearing pants and skirts were not well regarded. Nowadays, working women wear pants and skirts.

### **5.1.2 Pregnant women's health care**

Advancement in the medical field and availability of health institutions in different places are somehow helping the pregnant women to maintain a healthy quality of life. Health care is essential for the pregnant women and it include services such as ANC and PNC (Mitra et al., 2012).

Better utilization of ANC facilities and other resources are important factors to educate mothers about the importance of their health. It can drastically reduce some complications and danger to mother and child (Baral et al., 2012). If there are any obstetric complications, effective and immediate care is vital. For both ANC and PNC, skilled assistance and adequately equipped health care institutions are the important factors for delivery and reduction in MMR. (Matsumura et al., 2001).

PNC plays an important role in educating mother about caring herself and her newborn. Since a large number of maternal and neonatal deaths occur during the 24 hours and the first two days after the delivery. So, it is important to monitor the complications that might arise from the delivery. In Nepal, it is recommended that there should be at least 2 PNC checkups and supplementation of iron for 45 days after the delivery (Baral et al., 2012).

### 5.1.3 Pregnant women's attitude towards technology

In today's world, new technology has developed very creative applications to health care. These new creative applications are able to gather considerable attention from researchers and government due to which there is an investment for research and development of technology from both Government and the Non-Government side (Coughlin et al., 2007). Biomedical diagnostic technologies are improving the lives of the pregnant women due to which day by day researchers are being more focused on information and communication technology (ICT) for health.

For example, Millenia2015 women and health (WeHealth), *“an international working group focus and investigate on women's access and ICT's use of health that has given particular attention to women living in conflicts, refugee camps and natural disaster. According to WeHealth, it conducts a research in areas like women empowerment, healthcare improvement and digital solidarity.”* (Alumanah, 2012)

ICT new innovative ideas are supporting pregnant women. It is used to monitor, manage and motivate pregnant women, helping them to live in an easy way during their pregnancy. For efficient utilization of ICT, education and awareness to the pregnant women is an important factor. Childbirth educator who uses traditional methods of teaching to the pregnant women does not view ICT as a competitor, but as a potential source of the information and community building for the pregnant women (Romano, 2007). Pregnancy information on the internet is considered as the fastest method as compared to the reading materials found from libraries. Some pregnancy websites like WebMD (<http://www.webmd.com/family-pregnancy>) and Babycenter (<http://www.babycenter.com/pregnancy-health-problems>) are considered as the reliable sources for getting pregnancy information. However, there are other sources that may or may not be reliable. Pregnancy website sources provide news and videos information's about each and every detail of the entire pregnancy. Weekly growth of the baby, caring for the pregnant body, exercises, food and nutrient details are easily accessible from the internet. Discussion forums and expert doctor answers are also available for different queries related to pregnancy.

In western countries, the internet is the most common and fastest way to obtain the pregnancy information that is focused on western world setting. However, there are

very few information for other population in different parts of the world. (Maniam et al., 2007) For low resource countries, the situation is entirely different. For example, in Nepal, English language proficiency is the main problem for many pregnant women for getting information through internet. Most of the information sources are not available in mother language and the health care sector is also not developed like western countries.

Education is the key for better quality of life. In Nepal, education is one of the variable that measure the household and women's status. Education variable has "less than primary" and "more than primary (higher education)" categorization. "Less than primary" categorization of women includes women who have never been to school or women who have less than primary education and are referred as unskilled women. "More than primary" categorization includes women who have attended the primary schools as well as women with higher levels of education and are referred as skilled women (Matsumura et al., 2001).

Categorization is done in figure 6 as skilled and unskilled women. Skills of the pregnant women also play a vital role in determining acceptance and non acceptance of the system developed for the pregnant women. Based on the participation to use the system, the pregnant women are classified as active and non-active pregnant women.

For example, in personalized blood pressure measurement systems, individual act as the primary consumer for measurement of data where the feedback is important to give to them that motivates them to take the next measurement. (ihealth, 2014) If the participant is active then she takes the feedback and participate in next measurement, but if feedback is not taken or does not participate in next measurement then she is inactive participant.

Firstly, it is important to provide the feedback in an understandable form on when and how individual wants it. If an individual understands it in the right way, then the device becomes worthy to use. Therefore, based on the skills and participation it causes implications on the system design. (Coughlin et al., 2007)



The example shows that the personalized system at home should be easy to use.

Secondly, in the case of health monitoring, it makes independent living of the pregnant women entirely dependent on the monitoring. Therefore, to be dependent on technology, she has to be aware and accept the technology. (Coughlin et al., 2007) Also, the pregnant women are able to accept the inconvenience caused due to the usage of those technologies.

Thirdly, in case of any system that are used to generate alarms notifying the emergency condition, it becomes necessary for the system to be reliable in terms of data transfer, system function, interpretation and measurement of data. Occurrence of problem in the system reduces the acceptance of the technology. Here, the pregnant women can have a question like this, does the system work when most needed?

In the case of new technologies, people are unaware about it unless they use or they see other using it. After the use of the technology, some see and feel certain changes in their personal or family life and they say that they are satisfied with the technology.

For example,

*GlicOnline, “diabetes treatment automation service and a Java software that runs on mobile and internet access devices. The program allows logging patient's blood sugar level, counting carbohydrates and calculating the insulin doses in real time and the result is diagnosed by physicians. The mission of GlicOnline Company is to improve the quality of life of diabetic patients. GlicOnline helps diabetic patients of Brazil for calculating their insulin dosages. Approximately, 94% of the patient's have reported that the system has improved their lifestyle.” (Center for Health Market innovation (CHMI), 2010)*

*Operation ASHA, “the registered non-profit organization that has taken tuberculosis (TB) treatment for 6.1 million individuals living in disadvantaged areas. The operation ASHA system has three parts, notebook computer, a USB fingerprint reader and GSM modem that uploads the visit log to a central location. Patient scans their finger overtime, and they take medication. The logs are visualized in the central office for medication delivery. An SMS notification is sent to managers whenever the*

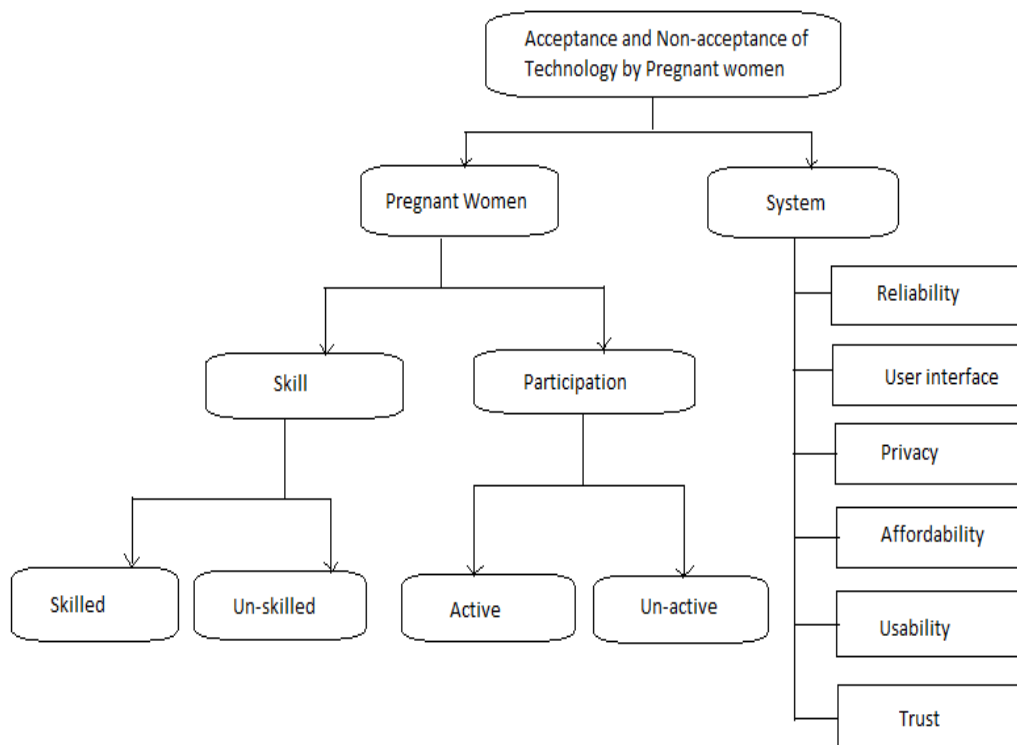
*dose is missed. Then he contacts the patient and health worker for timely supervision and counseling. The death rate of patients in India has decreased from 6% of the patients to 2% of the patients in treatment as claimed by operation.”ASHA (CHMI, 2010)*

*RapidSMS, “is a project work to assist UNICEF and Government of Malawi. According to RapidSMS project, it quickly responds to child malnutrition by opening the communication channels between the Lilongwe decision makers and health workers in the field. RapidSMS allows health workers to enter child data through a feedback loop system and instantly alert the field monitor of their patient nutritional status. The implementation of RapidSMS has shown an increase in data quality and decrease in data transmission delay as compared to the paper based system.” (CHMI, 2010)*

So, acceptance and non- acceptance of the technology depends not only on faith and prediction, but with the work satisfaction provided from the systems.

The above examples show the requirements of the system for accepting the system. Features like reliability, user interface, privacy, affordability and trust of the system are the basic requirements of the system (CHMI, 2010). Also, system or sensor device should function properly in a similar manner and should be reliable.

Privacy is the key factor for many pregnant women and privacy is obtained only after the availability of accurate and proper data. So, firstly it is necessary to focus on the availability of accurate data and then privacy. Also, the device needs to be cost-effective and affordable and battery life needs to be considered. Trust in the technology and the system comes only after the use and experience of the system and then remains as a trademark. So, it is very necessary to provide the services in real-time. Trust in a system depends on usability, reliability, battery life, privacy and others(CHMI, 2010).



**Figure 6. Factors for determining acceptance and non-acceptance of technology by pregnant women**

#### **5.1.4 Pregnant women's income and expenditure**

Pregnant women's income and expenditure is an attribute of the health related quality of life (Reisine, 2005). Care cost is an important factor for the pregnant women. Care cost means the money that is being spent for caring purpose for the pregnant women. It includes components like diet cost, housing cost, medical service, daily health care cost, entertainment cost, nursing cost and any other daily costs. Care cost of the diet is more important in pregnancy as compared to the other cost factors.

Among all costs, medical service cost mainly increases with the increase in particular risk in pregnancy. Care cost in pregnancy with chronic diseases can be reduced by the use of remote monitoring where continuous observation of chronic conditions can be done. For example, Telemedicine is common in today's world that gives time to time information to the pregnant women from clinics to improve the condition of

some chronic diseases such as diabetes, which ultimately saves money as compared to the costly service of the hospital (Dalfra MG et al., 2009).

The physiological factor of the pregnant women determines the diet cost. The amount of energy needed and food intake increases, the diet cost as diet cost fluctuate during the pregnancy. Diet cost increases in the later period of pregnancy. If the pregnant women have the good hobbies, it will help in maintaining the physical and mental health that ultimately reduces the care cost.

Income plays a vital role in fulfilling all the requirements of care cost of the pregnant women. Income depends on the factors like occupation, job history, saving, property, government support, insurance and income supported by husband (Neumark et al., 1998). During the pregnancy, financial support or benefits from government adds on the source of income for the women.

## **5.2 The data collected from the Nepalese women**

The lifestyle of Nepalese people is different from western countries people. The main religion is Hindu. In rural areas of Nepal, most of the pregnant women live in a joint family.

Joint family means that a couple and their children living together under one roof with patrilineal relatives. A single family represents the couple and their children living away from their patrilineal relatives, under a different roof.

The data were collected from ten Nepalese pregnant women. Seven of the pregnant women live in a single family and rest three live in a joint family. Also, five of them are working or studying and rest five are dependent on their husband. Summary of the demographic data is presented in Table 2.

**Table 2. Demographic data of the informants**

<b>Age and employment</b>	<b>Family structure</b>
Informant A (29 years) –Household	Single family
Informant B (24 years) –Household	Single family
Informant C (22 years) – Programmer	Joint family
Informant D (23 years) - A nurse and student	Single family
Informant E (28 years) - Business women	Single family
Informant F (27 years) - Bank employee	Single family
Informant G (27 years) – Household	Joint family
Informant H (28 years) – Household	Joint family
Informant I (26 years) - Beautician and student	Single family
Informant J (26 years) – Household	Single family

Seven pregnant women had shifted up from a joint family to a single family. Single family pregnant women are independent in activities like cooking, shopping and participation in any extra community and social life. In a single family, husband seems to be busy most of the times with his 9am -17 pm office work schedule. Later, at home, he is busy with child's homework and his own office work. In most cases of single families, women are housewives.

Informant I, a beautician shifted to a single family after spending more than five years with a joint family. She said, *“I feel the transition to a singular family is safe*

*and very favorable to me. The decision to separate from the family was not a conscious, but was circumstantial.*" By circumstantial situation, she means that her mother in law died after her sister in law get married. Also, brother in law went abroad for further studies. She lives alone at home and her husband lives far away from home due to job posting and he visits her sometimes. Her children stay at school, and they visit her in a month.

During a joint family, at her first pregnancy, she was nurtured and pampered. Cooperative in-laws helped her to get out of mood swings, household work and shopping. She further said, *"I missed that warmth, cooperation in my second pregnancy."*

During a joint family, Informant I was more responsible for each of the family members in household work like preparing food, cleaning house, washing clothes and kitchen utensils. In a joint family, she was getting much help from her mother in law, sister in law than as compared to a single family.

Informant D, a private hospital nurse said, *"I have never lived in a joint family since my childhood. After marriage, we have been living for six years as a single family. We are often visited by my parents and parents in law. My first pregnancy was not as difficult as my husband is supportive and caring. Since we are both working, we understand each other's feelings and situations."*

Five of the interviewed pregnant women participate in household work, caring their children and husband. They are dependant to husband's income as well. According to country briefing paper, around 40% of the women are economically active, many are unpaid family workers involved in subsistence agriculture (Acharya et al., 1999). Also, comparing men and women, men have more active participation in family, community, social life and they travel in different places like a gallery, park, zoo, theatre and cinema without any restrictions.

Moreover, Informant D is getting full support from his husband. Informant I is also getting support from family in household works. The culture is different in Informant D and Informant I family. Informant I being in a joint family, she is responsible for taking care of everyone in her house. Informant D has single family and both

husband and wife take care of their family. So, in this context culture, family and relationship is an important part in achieving quality of life.

Independent and dependent living attribute is clearer from the fact inferred from section 3.1.5. Household women (Informants A, B, G, H and J) are dependent on their husband for a living, whereas the rest of the women are independent.

### **5.3 Summary of the requirements related to pregnant women as a user group**

This section consists of the essential requirements of the pregnant women that came from the studies of the above section. These requirements are related to the entire mobile device manufacturers, doctors, pregnant women, their families and technological people.

For knowing pregnant women requirements, it is necessary to know about their lifestyle. Lifestyle of pregnant women's means their cultural background, geographical difference, education background and others.

It is necessary to know the status of the pregnant woman, whether she is living alone or living as a couple. Then it is easy to prioritize the necessities to create a mobile eHealth services. For example, if a pregnant woman is suffering from diabetes and is living alone, some assistance through mobile eHealth services may require in order to live her independently. However, if she is living as a couple, her partner can be helpful to some extent or if she may want her own privacy then in that case mobile eHealth services may not be required.

In one case study, a telemedicine system is assigned to 276 pregnant group of women who have gestational diabetes and type one diabetes. Among them, some were assigned to telemedicine group and others in a control group. The telemedicine group has to give their blood glucose test every week and had their medical examination once a month. The evaluation from telemedicine system for glucose monitoring showed the improved pregnancy outcome for telemedicine group of women with

gestational diabetes. The outcomes were: fewer visits to clinics, more independent living, better acceptance of their diabetic condition, lower level of frustration and improved quality of life. (Dalfra MG et al., 2009)

It is necessary to find out whether the pregnant women are active or not active in any daily activities. It ultimately makes an effect on her health conditions and lifestyle (Wolin et al., 2007). It is necessary to find out if the pregnant women have any health problems. From the health problems, technological people can get the required information's necessary to build mobile eHealth services. By using such services, doctors and nurses can provide the feedback to their patients according to their health conditions.

For example, Rapid SMS system in Malawi helps in collecting the data from pediatric patients using the mobile phones. By using such services, SMS (Short Messaging Service) delivery time for providing the feedback to pediatric patients reduced from three months to only two minutes. (CHMI, 2010)

It is necessary to focus on dietary and nutrition of the pregnant women as it is one of the factor to keep the pregnant women physically healthy. There is a necessity to focus on the pregnant women's basic daily living support such as transport, shopping, laundry, cooking and others. It helps to know about the physical and mental ability of the pregnant women. For example, during pregnancy, it is very common to forget the intake of prenatal vitamins. For some, it gets even worse and more frequent with the forgetful habit. By considering these problems, it will help developers to develop mobile eHealth services.

It is important to motivate and encourage the pregnant women for supporting independent living to achieve better quality of life. For this, mobile eHealth services might be helpful or useful solution. If the service remains unused, then it will be more difficult, tedious, expensive, and time consuming to do things manually (Dalfra MG et al., 2009).

It is important to keep track of the pregnant women's physiological health records, as it helps to provide the feedback and improve their health conditions (CHMI, 2010).



As some pregnant women have limited skills and for them it is necessary that mobile eHealth services provided are automated, reliable, flexible and easy to use.

It is necessary that the pregnant women are aware about mobile eHealth services and its benefits. It allows them to know about the acceptance or non-acceptance of the services (figure 6).

It is necessary to maintain the pregnant women's privacy from public and for that system security is the main concern (WebMD, 2014). Therefore, for the mobile eHealth services to be effective, it should be secure, flexible, usable, affordable, user-friendly and trustworthy (CHMI, 2010).

## **6 What is Mobile eHealth services?**

Mobile health (mHealth) emerged as a sub segment of electronic health (eHealth). There is no such widely used definition for both of these fields. The public health community has given these working definitions. (Vital Wave Consulting, 2011)

mHealth: Use of mobile communication technologies such as mobile phones and PDAs for health services and information.

eHealth: Use of information and communication technology (ICT) devices such as computer, mobile phone and communication satellite for the health services and information.

According to Vital Wave Consulting, both mHealth and eHealth are inextricably linked. They both are used to improve health outcomes and their technologies worked together (Vital Wave Consulting, 2011). With the low cost handsets and the penetration of mobile network globally, persons who do not have access to local landline telephones are using mobile phones on a regular basis. Mobile eHealth services can be personalized because the data collected and the conditions receiving the services are personal to the individual user (Vital Wave Consulting, 2011).

Health system in developing countries faces considerable challenges in providing high quality, affordable and universally acceptable health care facilities. In that response policy makers, donors and implementers are searching innovative approaches for improving the current situation of epidemics and health worker shortage. The explosive growth of mobile communications has given a new hope for the improvement and promotion of quality health care facilities. (Vital Wave Consulting, 2011; WHO, 2012)

Developing countries have an unprecedented increase in mobile phone and internet users due to the decline in price of devices and services. In that response, health program implementers and policymakers are exploring the way through which eHealth and mHealth can address the challenges faced by Government and market in terms of the availability, quality and financing of health care. There has been some increased interest, discussions and literature published for the implementation of

eHealth programs and policies. However, less implementation of such eHealth based programs and policies. (WHO, 2012)

## **6.1 Technologies in Mobile eHealth services**

Traditional face to face health services was the most common method provided by the health service provider that existed for a long time until the advent of ICT. In spite of the fact of the existence of mobile eHealth services, traditional method of health service is still being practiced and most common. In reality, it is unprofessional and unpractical to overcome or replace traditional method of health service by mobile eHealth services. It is necessary that they work together filling each other's gap and complement each other with their good and bad aspects. There are many methods for using ICT in health services and each of them are used in different ways for the same purpose.

WHO have categorized some technologies used in eHealth services according to the type of device used and means of using e-services. Software, voice and text messages, internet and video conferencing are means of using e-services while phone, camera and computer are examples of devices. The devices and means of using e-services are listed below: (WHO, 2012)

Devices:

- Camera
- Computer
- GPS
- PDA or tablet computer
- Phones: smart phones, cell phone, landline
- Radio
- Remote/portable diagnostic tool
- Smart card
- Unique ID (e.g., biometric scanner, RFID)
- Other

Means of using e-services:

- Software
- Voice
- Text messaging
- Internet
- Video conference

There are some main purposes for which above technologies are used: (WHO, 2012)

- To extend geographic access
- Facilitate patient communication
- To improve diagnosis and treatment
- To improve data management
- To streamline financial transactions
- Mitigating fraud and abuse

There is a benefit that mobile communication technologies enable communications among individuals irrespective of time and place (Agar, 2003). It is beneficial to work in remote areas since the technology is a way to reach people faster. Moreover, there are several specialized health related software applications developed, tested and marketed to use in mHealth field. For example, a blood pressure management application in mobile phone uses the bio signal from personalized wireless blood pressure monitor such as iHealth blood pressure monitor. (iHealth, 2014) The application displays values of systolic/ diastolic numbers, measurement time, heart rate and pulse. It also keeps track of physical activities and the daily diet as part of daily health. There are other mobile applications in the form of gamified or social wellness solutions, developed in high income countries which are also used in low and middle income countries (Vital wave consulting, 2011). Indeed, it is very interesting that digitizing the real life situation in the form of the game or some applications takes a person to the realities of life. It also acts as a very useful tool for sharing one personal experience privately.

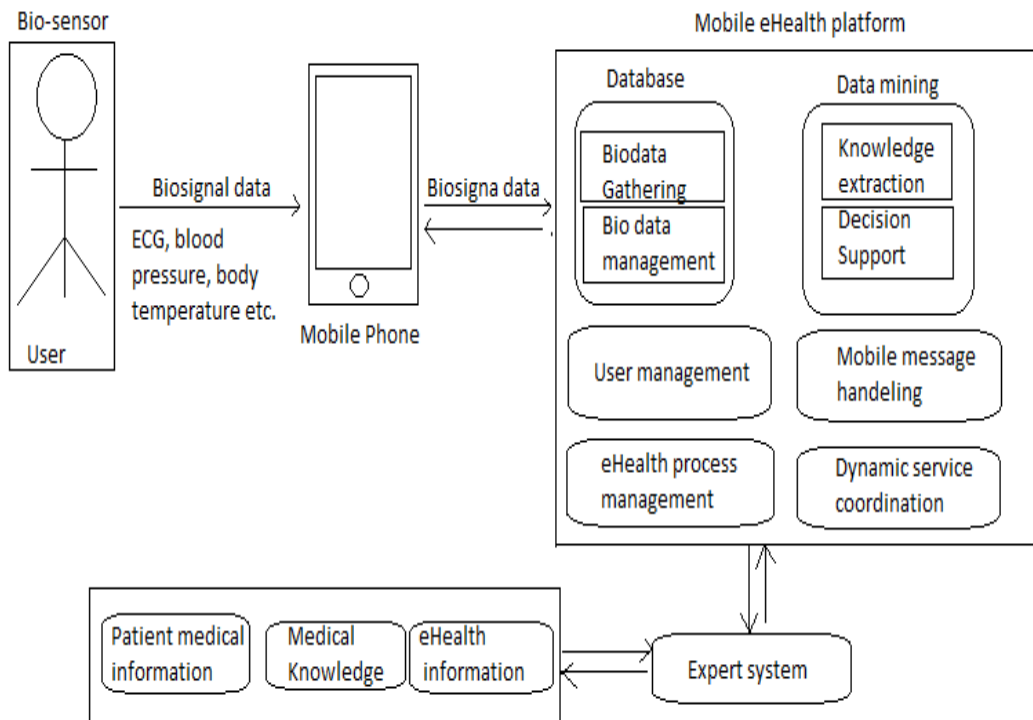
Regarding means of e-services defined by WHO, basic SMS services and real time voice communication services serves as the backbone of wireless and mobile technology (i.e. an ordinary cell phone or smart phone) that are explained in more detail in the following pages.

### **6.1.1 Software applications**

In mobile eHealth care services, mobile phones provide promising software applications for personalized health care and management service. Software and Information Industry Association (SIIA), define software as a service that includes software licensing and delivery model where associated data are centrally hosted by application service provider (ASPs) or independent software vendors (ISVs) and the application is licensed on a subscription basis. (SIIA, 2001) Software on mobile phones enables data collection, support clinical decisions or conduct business intelligence, management information system (MIS) and content management (CM).

In mobile eHealth services, software enables in delivering the service processes commonly from application service provider (ASP). Software as a service is providing access and management to the commercially available application. Therefore, service benefits both vendor and customer. (SIIA, 2001) For example, in a mobile eHealth service, the user receives real-time health management service as personalized service from the application service provider. User is charged with certain amount for using the service and is benefited with the personalized health management service that can be used anywhere and at any time. (SIIA, 2001; Han et al., 2006)

In mobile eHealth services, real time health management process includes various steps (figure 7). The first step includes gathering of periodic or random input, i.e. capturing the biodata signal of users like pulse rate, ECG, blood pressure, body temperature, etc. Biosensor is attached to the user or to a mobile device for capturing the data. The second step is bio data gathering and management. Huge amount of data is gathered and handled. Therefore, huge temporal database management is an essential technology in mobile eHealth services. Then there comes the next step of data mining process that includes knowledge extraction and decision support. The last component of mobile eHealth services process is mobile health service platform that supports all of the diverse services. It is the middleware for supporting and integration of diverse services such as, biodata capturing, handling, storing, managing and analyzing modules that can be shared between the mobile eHealth services. (Han et al., 2006; WHO 2012)



**Figure 7. Mobile eHealth services processes (Han et al., 2006)**

Mobile eHealth services can be used in some emergency or severe conditions of the patient. For example, according to Shahriyar, the use of (Intelligent Mobile Health Monitoring System) IMHMS can be one solution for some severe emergency. IMHMS includes, intelligent medical server (IMS), patient personal home server (PPHS) and intelligent medical server (IMS). In case of emergency, an alert SMS can be sent to the hospital by a patient so that the situation is observed by a doctor from the specific threshold that is learned from IMS. IMS can learn from previous treatment records of a patient. Patient records are received from mobile that act as the PPHS. IMS receives the data from PPHS. Whenever a doctor examines the treatment results, it is then stored in a central database. After results are mined through data mining technology, information is processed. The feedback is sent to the mobile or informs the medical authority in case of emergency situations. Medical authority can take the necessary measures. (Shahriyar et al., 2009)

IMS is controlled and monitored by physicians. After the information's are mined, they are stored in the database and an important general health information is obtained. In the hospital large numbers of patient are connected to the IMS using PPHS. Security is an important aspect for each patient. So, Radio-frequency identification (RFID) can be used in terms of security. RFID is an automatic identification method for storing and remotely retrieving data using the device called RFID tags. RFID tags are for the purpose of identification using radio waves. Security can be provided by using RFID tag to each patient. (Shahriyar et al., 2009)

### **6.1.2 Voice**

Health care services through mobile voice communication are one of the commonly used services. Traditionally, most mobile health care services use voice communication that is easily incorporated through telephone networks. Voice service includes VoIP (Voice over internet protocol) and hotline. (WHO, 2012)

Health care services through a voice communication are created to deliver health care advice by trained health care professionals on mobile or over the internet. It is the most common way for health care professionals for giving advice to their patients if they are illiterate or lack other form of communication such as text messaging, instant or web based messaging. However, voice communications are more expensive than short messaging service (SMS) in mHealth projects. In mHealth projects literate populations choose an SMS service rather than voice communication service due to high level of satisfaction, lower cost, high delivery success and a higher level of intent to change behavior (WHO, 2012).

### 6.1.3 Text messaging

Text messaging on mobile includes SMS and multimedia messaging service (MMS) (WHO, 2012). SMS is one of the components of phone, web or mobile communication system. MMS is the standard way of messaging that includes multimedia content to or from mobile. MMS extends the core SMS of 160 character length message with possibility to add other media formats e.g. pictures or music. According to Cable News Network (CNN), the famous use of MMS is to send photographs, although it includes videos, ringtones and text pages (CNN, 2012).

Text messaging service is ubiquitous and is used where the mobile service is available. For most mobile phone user, mobile function that comes first is SMS than voice communication, especially for age 15-35 years, due to its low cost service and high delivery success (Adesina et al., 2010; Mosio, 2014). Text messaging service is most practical whenever voice communication is impossible, unacceptable or impractical. As compared to a voice message, text message is more satisfying to users because of its fast delivery success and error free structure. SMS communication is related to the non formal writing styles including some misspellings and short abbreviations (Adesina et al., 2010).

Text messaging and automated SMS alert in eHealth care services are very beneficial and scalable method of providing outreach services for a wide array of health issues. One of the study shows that these services are beneficial for hard to reach areas and populations and they provide further benefit to the patients offering recipients confidentiality in the environment where the chronic disease such as HIV/AIDS is a taboo (Vital wave consulting, 2011; Adesina et al., 2010).

For example, Mosio, *“mobile software company provides text messaging and mobile web solutions for business and organizations that are related to clinical research, healthcare, hotlines, libraries, education and hospitality. The company has made the patient support system very simple through text messaging service. Automated Text message alert and reminders are sent to patients, and one example is presented in figure 8. Prescription refill, medication reminders and test results are some viable uses of Mosio’s technology. Mosio has another format of chatting called two-way text chat that save money over phone calls along with more efficient communication.*



*It is used for gathering quick feedback, discharge support that ask questions or confirm appointments.” (Mosio, 2014)*



**Figure 8. Automated text message sample by mosio (Mosio, 2014)**

#### **6.1.4 Internet**

In mobile eHealth services, the use of internet service includes email, website and instant messaging (WHO, 2014). Email message includes text or image that is sent from one device to another for exchange of information. Email is free, although both sender and recipient needs to have their own email address and needs to be connected to the internet. Getting an email address is very easy through the mail servers such as Gmail, Hotmail or Yahoo. In health service, health care professional finds email easy to use due to easy accessibility, free of cost and a simple logistical setting (Zamani, 2009).

In mobile eHealth services, website act as a significant source of information for different age groups, whether looking for the information about a particular illness or condition, exploring treatment options, comparing prescription, drug prices, searching for health providers or following some health related policy. (Vital wave consulting, 2011; WHO, 2012) Internet users need to be careful to seek health

information online because it may be inaccurate, incomplete or even dangerous. So, it is challenging to seek out health care information critically, to learn and to be proficient in accessing the health information on the internet. (WHO, 2012)

Instant messaging uses text based chat with two or more participants over the internet or other types of network. Also, instant messaging includes private network chatting between two users. It is suited for immediate communication because the message is delivered fast and in real time. In health care services *MediMob* claimed that, it is one of the secured IM service architecture which provide services for desktop as well as mobile devices (Bones et al., 2006).

### **6.1.5 Video-conference**

Video-conference allows two or more people in different locations to communicate simultaneously with video and sound transmissions. For video-conference one needs to have a camera for participant video, microphone for audio and means for transferring both audio and video remotely. Video-conferencing can be operated when the higher capacity broadband network is provided. Moreover, video-conferencing is a low-cost technology that connects different locations people and brings them together without traveling. (Down, 2009)

Video-conference technology is dynamic and affordable therefore, it can be used for education, healthcare, business and commercial purposes. In educational setup, teachers can use this technology in the classroom for long distance learning, thereby bridging the gap between teacher and student. According to researcher's own experience, video conferencing at classroom has always been smooth for the ongoing lectures by the professor due to high capacity broadband network. However, at home there has always been a problem with the sound as it was due to poor broadband network quality. So, the network quality should be very good in order to run the conversation smoothly. In healthcare services, usage of video conferencing on a mobile device is an extension of face to face communication that shows how healthcare providers and patients interact with each other. For business and

commercial purpose, different sorts of private meeting can be attended through videoconferencing.

Due to the advancement of cloud services and wireless (3G/4G) connectivity, mobile and browser based video conferencing is inexpensive and accessible (Doyle et al., 2013; Coroama et al., 2013). In health care services, text messaging can be crucial in some situations due to quick delivery and response time. However, in some cases it is claimed that in favorable condition video-conferencing provide a wide range of facilities to multiple users from a nurse practitioners and health care givers to neurologists, pulmonologist, psychiatrist and other acute care specialists.

Telemedicine and telehealth, powered by *Vidyo*. Vidyo claims that its solutions are vital to those communities where doctors are scarce, cost are rising and communities lack access to care. It further claims that hospitals, research centers and physician clinics can be connected visually to their patient for routine checkup, home health services and stroke assessment and surgical consults. In Vidyo solution, for telestroke and tele neurology, specialists are using videoconferencing for scheduling, virtual official visits with patients in the rural areas where the hospitals or clinics have the scarcity of such on-staff neurologists. They said that the Vidyo platform has enabled to improve the clinical workflow and medical experts are able to connect in minutes from any location to observe patients just like as they are beside the patient. (Vidyo 2014)

## **6.2 Mobile eHealth services in maternal care**

Due to the geographical and demographic settings in rural communities of some developing countries are facing lots of challenges. One of the challenges is in the health sector about health awareness and health services. This chapter discusses a number of mobile eHealth services interventions for maternal care in low resource countries.

Mobile technology is considered as one of the fastest growing technologies in the world today. With the low cost and effective services, it is chosen as one of the tool

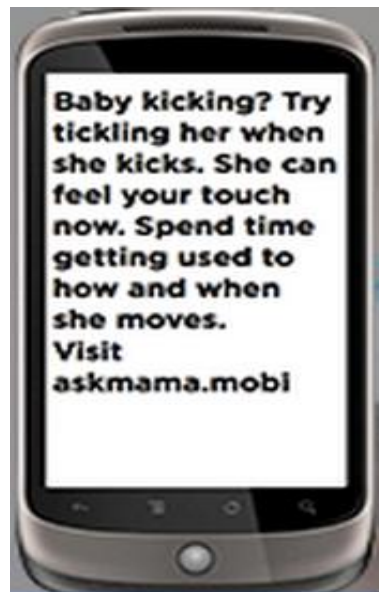
for improving the maternity care. Most of the low resource countries of Asia and Africa have the burden of maternal mortality rate. (WHO & United Nation International Children Education Fund (UNICEF), 2010). International Telecommunication Union (ITU) in 2009 expected an increase in the use of mobile phones by more than 50% by the year 2012 along with some improvement in maternal health care in Nepal through mobile technology (ITU, 2009). The technology can support various wireless networking standards like GPRS, WIFI and Bluetooth. They are considered as one of the powerful operating system available with a standardized programming language that have made phones smaller computing platform (Kanjo, 2007).



**Fig 9. Applications of health monitoring (Kanjo, 2007)**

In some countries, initiatives are already made to help the pregnant women for reaching out their problems to health professionals with the help of mobile eHealth services. (MAMA, 2011)

For example, Mobile Alliance for Maternal Action (MAMA), “is an organization that works for pregnant women and child health. MAMA claims that it works in 69 different countries with the projection to reach 141 million mothers. Based on the guidelines of United Nations International Children’s Emergency Fund (UNICEF) and WHO, voice and text message are sent to pregnant women by health professionals. MAMA message is offered free of charge. Messages include prenatal care, nutrition, vaccination and use of insecticide-treated bed nets. There are two different kinds of messaging subjects, core messages and topic-based message. The core messages are sent based on the subjects of “**age of child**” and “**stages of pregnancy**.” “**Stages of pregnancy**” messages are sent during five to 42 weeks of pregnancy (figure 10) and “**age of the child**” messages are sent to mothers until the child reach three years old. Topic-based messages include prevention of HIV transmission from mother to child, instant breastfeeding and postpartum family planning. Messages are built based on the key health behavior that can improve the pregnancy outcomes and child health.” (MAMA, 2011)



**Figure 10. Automated pregnancy text message sample by MAMA (MAMA, 2011)**

One of the MAMA sample messages sent to a pregnant woman is about the intake of iron rich food for the developing baby. Suggestions are given by describing how the iron helps in pregnancy.

*Sample Messages:* (MAMA, 2011)

*“Listen very carefully. Taro stems, cauliflower, spinach, red gram lentils, eggs, meat, chicken, fish and liver contain iron. Lemon and oranges will help the body to absorb iron. Take iron tablets regularly along with a meal.”*

*“It is the time to have the next tetanus toxoid vaccine. Just one more and your baby will be protected against tetanus. Go to your clinic now.”*

According to MAMA, it has been successful in creating culturally relevant health content, making the message localized at the country level.

According to Women’s and health alliance international (WAHA), mobile technology has been used in low resource country like Senegal, where MMR is highest. WAHA donated prepaid mobile phones to the villagers so that the pregnant women are able to establish the communication within the WAHA network of health community workers. These workers then call to the nearest health centers for the help and in case of any emergency, motorbike ambulance is arranged to take the pregnant women to the nearest hospital or health centers. (WAHA, 2014)

According to another young organization Jacaranda, is building a model for maternal and newborn health. It is an eHealth system that includes health management information system and electronic medical records (EMR) operable through mobile technology. In order to put low fees and scalable business, the organization has adopted mobile technology. Mobile technology with data connectivity and mobile broadband network is getting widely used. The advantages of mobile technology are its low cost and another may be its portability. In health management system, due to the advantages of mobile services such as low cost and portability, it facilitates both service provider and receiver (i.e. doctors, nurses and patients). For example, if a nurse is entering a blood pressure number through a mobile phone that is of low cost and portable in comparison to computer, patient can feel and understand that mobile phone is not intrusive, but it is a part of their work, not a distraction. Nurse can easily

enter the data immediately from any location of the patient without moving to the computer screen. (Jacaranda, 2011)

### **6.3 Summary of mobile eHealth services and technologies to assist maternal care**

In this chapter of mobile eHealth services, initially mHealth and eHealth are defined and then some mobile technologies that are related to mobile eHealth services are described. It further discusses the mobile eHealth services as personalized service with some examples. Most importantly, this chapter discusses about the technologies that are essential for mobile eHealth services. Mobile eHealth services and their technologies are based on WHO requirements. Means of using technologies such as voice, text messaging, internet and video conference are commonly available technologies in today's generation mobile phones. These technologies help in communicating to people irrespective of time and place. For health service in out of reach areas, wireless or mobile technologies can reach faster than health providers themselves. Further, in this chapter various eHealth services interventions are explained for maternal care in low resource countries. Moreover, some of the mobile technologies that are already in use for helping the pregnant women in some countries of Asia and Africa are also explained.

## **7 Applicability of mobile eHealth services studied through three narratives of pregnant women in Nepal**

Narratives in this chapter describe the life stories of several pregnant women suffering from chronic diseases. These life stories are obtained from researcher's sister. She is a nurse in the maternity ward of the hospital in Nepal and these pregnant women are her patients. All the real names of the patients presented in the stories are changed to some typical Nepalese names.

Story in chapter 7.1 is a real story that is told at, Mrs. Shrestha home. Mrs. Shrestha is a charming and talkative person. She often comes to the hospital for checkups and she is close to nurse. The story was told by Mrs. Shrestha to nurse when she was called to visit her home for a health checkup. The story began with her family background, education and habits. During their conversation, the nurse asked her questions such as, *“what medicines you take”* and *“how you remember to take it”* and *“to whom you call when there is an emergency situation.”*

Stories in chapter 7.2 and 7.3 occurred when the nurse was doing the checkup procedure at her hospital. The real stories were told in few week's differences.

The story explained in chapter 7.2 occurred when Mr. and Mrs. Kharel came for antenatal check up. The story began when the nurse asked him that why he was looking stressed and worried. He said that he was very upset about her wife's everyday situation. Further, he said that all of his family members are also upset about her condition. Then the nurse questioned them, *“what do you do for living”*, *“what is the health condition of Mrs. Kharel at home and the office”*, *“how about the HIV treatment and others.”*

Similarly, the story described in chapter 7.3 occurred when Mrs. Bogati got asthma attack and she was taken to the hospital. The whole story telling was started when the nurse questioned her *“when and where you got the attack”*, *“who is living with you and helping you at home”* and *“what is your husband doing”*. Mrs. Bogati seems to be very nice and active woman, but due to her health condition she is not able to do things in the right way at both home and office.



Incidents and events presented in the narratives are followed by analysis. Mobile eHealth services support and suggest the best possible solution for above narratives that relates to the pregnant women requirements. Narratives focus on those pregnant women who are not aware of the technologies in mobile eHealth services. Narratives reflect their issues and problems and based on them its cause is identified. Suggestions for possible solution are presented indicating the possibility to prevent or to solve the problem by using the mobile eHealth services. Later evaluation is done based on suggested solution that helps to analyze its advantages and disadvantages.

## **7.1 Mrs Shrestha story**

Mrs. Shrestha is 35 years old household women. She is married and has a single family with one daughter. She is pregnant with her second child. Her husband does the Government job and lives in a different city. Most of the times, he is busy at his work. He visits his family once in a month. Her daughter studies at grade eight. Mrs. Shrestha is having health problems like high blood pressure and diabetes. For those health problems, she takes medicines twice a day. She has a forgetful habit about taking medicines, so her husband calls twice a day for reminding her to take those medicines.

Mrs. Shrestha's s lifestyle is simple. She makes herself busy most of the time at home. She has one cow and two goats. She likes to watch television and work in her small garden. Most of the time, she is busy taking care of her domestic animals and household works. She also loves to visit her mother, brother and some relatives. She is a graduate but has no job. Her husband takes care of all the expenses. Her husband loves them and wants to be with them. However, he does not get much time to look after his family due to his busy time schedule.

One day, Mrs. Shrestha's neighbor called her husband, when he was working at office. She informed that his wife fainted in her garden while watering the plants. She said that, she was unable to take her into the house. It was a lucky moment that

nothing serious had happen to her as she waked up after a few minutes, but Mrs. Shrestha was very nervous about that situation. She was scared to be at home all alone since then. After that incident, her husband wanted to be aware of any such accidents so that he can find out the best solution for his wife without increasing her fear and nervousness. He is very much interested to use any kind of solution for avoiding such situation and other unwanted accidents and he had some questions to the nurse such as:

- *“Is there some personalized system for measuring the blood pressure or blood sugar level?”*
- *“Is there some technology for reminding his wife to take her medicine regularly?”*
- *“Is it affordable to use such technology at home?”*
- *“Does the technology works in emergency situations and how secure it is?”*

### **7.1.1 Identifying the issues and the cause of problems**

Mrs. Shrestha has the main issue of being alone at home. Her husband is working in another city and he does not have time to be with her. She does not have anyone to take care and assist her whenever she needs. Another problem is her forgetful habit.

The main cause of the problem is, she is alone most of the time. She thinks that her husband will call to remind her to take the medicine and to take the measurement for blood pressure and blood sugar. However, it is not always possible for her husband to call her. If he fails to do that someday, then she may lead to physical and mental weakness along with other new diseases.

### **7.1.2 Identifying the requirements**

Mrs. Shrestha needs some assistance to help her and to be with her all the time. She needs caretakers, nurse, or some technical device to assist her. Also, in everyday life situation her caretakers or nurse should be faithful towards her.

In this story, personalized health monitoring can be used. The device should be secured, reliable and efficient enough to maintain her daily life conditions. Additionally, the mobile device can be used that has a simple interface. Whenever, there is an alert message, it should be in a simple format, easily readable and understandable. Care cost is an important in Mrs. Shrestha's situation. Being jobless and dependent on her husband, she may not be able to pay money to caretakers or to nurse.

### **7.1.3 Suggesting the possible solutions**

Some of the possible solutions are:

- Mrs. Shrestha can stay in the hospital and the nurses will take care of her until her child birth.
- Her husband or some close relatives can stay with her 24/7 and take care of her.
- Mobile eHealth services can be used, to assist her with her daily needs. SMS reminder can be used for taking her daily medicine. Blood pressure monitor and blood sugar monitor can be used to measure, track and to keep records of her daily health. In the case of some severe emergency, SMS alert can be sent to the hospital.

#### **7.1.4 Evaluating the proposed solutions**

From the first possible solution, it is clear that if Mrs. Shrestha stays in the hospital most of her problems can be solved such as taking medicine regularly, regular exercise, measuring, tracking and recording her health conditions. Also, she can be more physically active, energetic and can deliver a healthy baby. However, in this case, her living cost becomes high. Though she is dependent to her husband's income, he may not be able to pay her care cost every month regularly. During her stay at the hospital, she can miss her daughter, home and everything that is related to her daily activities. Therefore, she might feel bad to adapt the new living conditions that may arise other different health issues.

The second presented solution is to ask her husband or some close relatives to stay at her home, which can be less costly than the first solution. However, in this case the problem will not be completely solved because her husband should leave his job to be with her 24/7. Also, if relatives stay with her then it depends on how sincere and faithful they can be, when she has forgotten habit.

The third presented solution, i.e. Mobile eHealth services can be an appropriate solution as compared to two other suggestions in terms of cost, security and reliability. Also, she does not have to rely on her husband and relatives for any kind of reminders related to her health conditions.

#### **7.1.5 A specific solution for the defined problem**

A personalized health monitoring system can be used in Mrs. Shrestha's story.

For blood sugar measurement, a personalized diabetes management system can be one of the solution for Mrs. Shrestha. For example, *iBGStar* claims that it can be one solution for diabetes management systems. However, there are other similar personalized systems for diabetes, which can be used in the smart phone. *iBGStar* is one of them that has a blood glucose meter (figure 11). It can be used on its own, or if one has an Apple iPhone or iPod, then blood glucose meter can be connected to them. *iBGStar* claims that it helps to communicate and manage personal diabetes

information on mobile phone. It also provides the wireless transmission of blood glucose reading to the mobile phone through Bluetooth and then to database for maintaining an accurate diary. Moreover, it claims that by using this technology into iPhone or iPod, diabetes information is stored in the mobile application, which can be shared with doctors or family members under certain conditions like if they are using the same application, and if the device provides accurate information to depend on. (ibgstar, 2014)



**Figure 11. A personalized diabetes management system (ibgstar, 2014)**

iBGstar claims that diabetes management system offers (ibgstar, 2014):

- Track of blood sugar level readings, carb intake and insulin doses
- Blood glucose tags such as mealtime and exercise
- Integrated data management with dynamic graphing

For blood pressure measurement one of the solution might be personalized wireless blood pressure monitor such as *iHealth* blood pressure wrist monitor (figure 12). However, there are many other similar system that can be used with mobile devices. *iHealth* has a wrist monitor with small cuff which attaches in the wrist. It is similar to

a portable watch which can be taken anywhere at any time. It uses motion sensor technology for taking the accurate readings. It measures systolic/diastolic numbers, measurement time, heart rate and pulse. By using the iHealth device with mobile application (iHealth app) all the measurements are displayed in the application. (iHealth, 2014)

By using similar technologies, Mrs. Shrestha can take measurement time, a track of her physical activities and daily diet as part of her daily health. The measurement results coming from the system can be shared with family, friends and doctors. She can share her measurement results using any means such as by directly showing from the device itself or by using internet services. In iHealth application, visual dynamic chart can be created to track the record of progress and to compare the results that are against the historical averages.



**Figure 12. Personalized wireless blood pressure wrist monitor (ihealth, 2014)**

In Mrs. Shrestha's situation it might be efficient to use the personalized diabetes management and blood pressure monitor. It is cost effective, personalized, saves time and can be used anywhere and at any time as compared to the regular visit to the doctor.

For the forgetful habit of Mrs. Shrestha, she or her husband can set a regular voice reminder, or text message reminder to her smart phone. She can share her daily measurement results to her husband instantly. If she again forgets to take the medicine or the measurement then a warning message can be sent to the mobile.

According to Shahriyar, the use of (Intelligent Mobile Health Monitoring System) IMHMS can be one solution for severe emergency case. In the case of Mrs. Shrestha, SMS can be sent to the hospital during emergency situations. However, she should be connected to the hospital IMS server and also hospital should have all her medical records. So, that physicians can compare her previous medical records without any delay. By comparing her present situation any required actions can be taken by medical authority. For this kind of service, she and both hospitals should be connected to the internet.

In Nepal, there is no such system similar to IMHMS. So, one of the solution that might be suitable for her is to take the daily measurements of blood pressure and blood sugar level. By this way, she can track her health conditions on a regular basis. As her husband is aware of her situation from her message on a regular basis and if such fluctuation in pressure or sugar level is found, then he can inform her emergency condition in the hospital.

#### **7.1.6 Benefits and limitations**

There are some benefits of using the presented technologies. If Mrs. Shrestha uses eHealth mobile services, then she can be benefited in some way. She will not forget to take her medicine because the text message reminder will remind her to take the medicine regularly. She and her husband will be regularly informed about her health condition. If she does not take her medicine, measure her blood pressure and sugar level then the system will send alert text message to her mobile device to do that activity again. By this way, she can live alone in her home and can be healthy and safe. She can save a considerable amount of care cost and also her husband's time. The sound of the reminder should not be too noisy because she might be irritated for long term use.

However, there are some limitations for using the given system:

As personalized device, both diabetes management system and blood pressure wrist monitor can be used by Mrs. Shrestha. However, I think there are some conditions to be considered like, the device might not show accurate measurement in comparison

to others as diabetes measurement system and arm blood pressure monitor that are used by hospitals. In the case of blood pressure monitor used in wrist, the reading might not be accurate as claimed by iHealth. For, the diabetes management system, strips for using the blood may not be available, and other regular strips may not be compatible with the system. Also, the device is designed for iPhone and iPod and one should have these specific devices to use this system and may not work for other phones. For iHealth blood pressure monitor, one should follow the conditions such as positioning of the hand, and it further claims that the measurement result will not be 100% accurate. Use of wireless communications such as Bluetooth might make the iPhone battery to run down. In terms of cost, iPhone and iPod are more expensive than other phones. For people with a weak financial condition might not be able to afford both phone and personalized health management system.

In the case of severe emergency hospitals should use the proposed system or similar system like IHMS as presented, but in Nepal they do not use the system yet. If the proposed system is used in Nepal then there should be electricity and internet 24/7. Otherwise, the system becomes useless.

## **7.2 Mrs Kharel story**

Mrs. Kharel is 23 years old finance company worker. She is pregnant and lives in a joint family. Her father-in-law, mother-in-law and sister-in-law are living together. Her father-in-law and mother-in-law are 88 and 89 years old and her sister-in-law is studying bachelor's degree program.

She and her husband both have to look after their parents and they support their sister's education. Her husband works in a bank. Their economic situation, education and living style are good enough to maintain a good quality of life. At home, she is getting support for doing household work from her sister-in-law. Both father-in-law and mother-in-law are not able to walk much to support her. They just sit at home, watch TV and read books.



During her recent pregnancy, she found that she is suffering from a chronic HIV infection. Her husband forced her to take HIV infection treatment known as antiretroviral therapy (ART). Her doctor suggested that with ART treatment she may live several years since the treatment will help to keep the virus in check. Moreover, her doctor said that during ART she has to take care of herself doing regular checkups, plenty rest, daily exercise and a well balanced diet.

Her husband wants her to take the therapy, but she does not have any motivation. Due to the pregnancy and disease, she is not mentally and physically strong. She does not do her exercise, takes her food properly or even go to the office regularly. Whenever her husband reminds her to take the food she just ignores it. Her family and her husband are now getting tired of her situation and want her to be active like before.

### **7.2.1 Identifying the issues and the cause of problems**

In Mrs. Kharel's situation, the main issue is that she is demotivating herself to live. Her problem is not taking the food properly, not doing exercise, or she does not have any motivation to take ART therapy as suggested by her doctor.

The main cause of the problems is that Mrs. Kharel is depressed about her health and her upcoming baby. She is not getting any motivation to live normal life like before. Since, she lacks her daily nutrition, proper treatment and exercise which may further result into mental and physical weakness along with other diseases.

### **7.2.2 Identifying the requirements**

Mrs. Kharel needs some assistance for her living. For this she needs caretaker, husband, her family members or some device to assist her in living. Therefore, she can have a balanced diet food, regular checkups, exercise and plenty rest. Caretakers should be faithful towards her, reminding her to do everything on time. For

motivating her to live, HIV counseling can be made available so that she can understand how other HIV infected people live happily.

For taking balanced diet food at the appropriate time, technical method for monitoring her health can be made available. It should be reliable, secure and effective enough to remind her to take the food in the appropriate time. Also, it should be secured enough so that only her husband, family members and the doctor will get information related to her health. In this story, care cost is important to consider.

### **7.2.3 Suggesting the possible solutions**

Some of the possible solutions for above given story are:

- Mrs. Shrestha can have a caretaker to take care of her daily needs.
- Her husband or her sister-in-law can be at home to take care of her until she gets well.
- She can go to HIV counseling for the motivation to live her life like before and to see how other HIV patients live their life.
- A house monitoring system can be used for her so that it can predict best suitable time for her breakfast, lunch, dinner and exercise time. By tracking the appropriate time, an alert message can be made available on the mobile phone to remind her to do her activities in appropriate time.

### **7.2.4 Evaluating the proposed solutions**

In the case of Mrs. Kharel's story, the care cost will be high which is as similar to Mrs. Shrestha's story. So in this situation, mobile eHealth services solution might be better for her as it is not so expensive than other possible solutions. For HIV counseling, the traditional counseling process can be a bit expensive. Therefore, she can participate in eGames based on HIV counseling.

### 7.2.5 A specific solution for the problem

For Mrs. Kharel’s story, eGame based on HIV counseling (figure 13) can be one solution to motivate her and to see how other HIV patients live their ordinary life. House monitoring system might be another solution that can be used for her other activities that includes sleeping, waking, exercise and eating time.

For example, Youth e-collaborating in HIV/AIDS prevention, “is a project that has some multimedia games covering the topic of HIV/AIDS prevention. It aims to develop the games that are suitable for youths and trainers. The project allows to create a person’s own game by exercising creative thought and allowing different activities such as writing, drawing and reading. Thus, keeping an interest in different subjects such as science, history, music and literature that has a significant effect on the game design.” (Student Computer Art Society, 2009) Similar kind of eGames can be played to stimulate the awareness of HIV/AIDS. Mrs. Kharel can also play such eGames in her mobile at the same time she can learn some facts about HIV by answering questions and solving puzzles. However, there are several other similar e-counseling games that are cost effective. For such eGames, there is a need of internet connection.

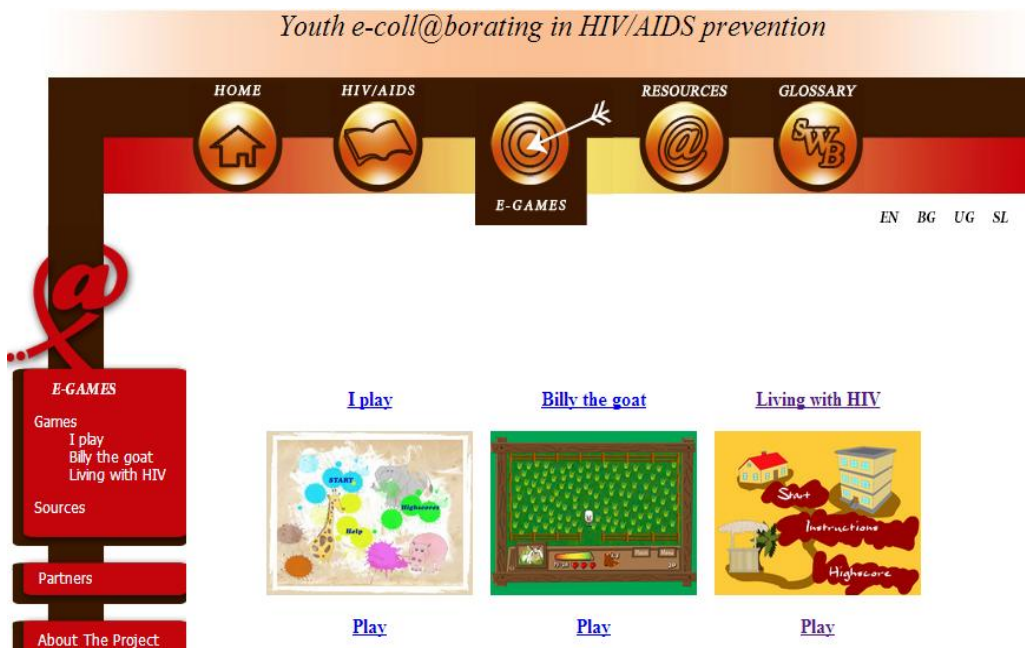


Figure 13. HIV counseling based eGames (Student Computer Art Society, 2009)

Another solution for Mrs. Kharel might be the house monitoring system. It can be used with different ambulatory sensors at home to monitor her activities such as contact and an accelerometer sensor (Steele et al., 2006). Use of simple contact sensor can be made available for opening and closing of the main door of her house, refrigerator door and other furniture's door inside the house. The contact sensor can also be used in the kitchen appliances like for gas lightening. (Hongtao et al., 2009) By this way, it will be easy to keep track of Mrs. Kharel's activities. Therefore, the system will track the activities such as sleeping, waking, eating and exercise time. With the use of wireless accelerometer in Mrs. Kharel's body, it will be easy to track her location and movement. Different time of her activities can be recorded and analyzed using the house monitoring system. All information can be stored in mobile through the wireless network. The system will predict the time for all activities and set an alarm. If she does not do such activities at given time, then warning alarm will be sent by the system.

For eating habit, eating time can be recorded in house monitoring system. Use of RFID in Mrs. Kharel's eating plate, spoon and other utensils will help to identify whether it is being used or not. Also, the weight sensor will help to identify, whether it is heavy (due to food) or empty. For example, if she is taking her lunch, then the combined information from the timer, wireless accelerometer and vibration sensor are collected from the spoon and plate. This information can be stored in the mobile through the wireless network. All of these collected information can be combined and analyzed. The system then predicts the time for the next meal considering the information taken from previous meal. Later, it can provide alarm at the most appropriate time.

### **7.2.6 Benefits and limitations**

Technologies presented in specific solution might benefit Mrs. Kharel. eGame for HIV/AIDS will motivate her to learn more things about HIV infection. It is cheap as compared to face to face HIV counseling method. However, it is not only about playing the game, but along with that she needs to understand the theme of the game and she should imply those learned lessons in her daily life activities. Also, she needs to have the motivation to play and continue the game on a regular basis.

The house monitoring system can be one solution that will remind her to do different activities regularly. It will provide an alarm with the help of sensor that is placed in the home environment. In that way, the system might support her to live independently and she can save her family members and husband's time. The house monitoring system is used for individual, who is living alone. It might be that her family members will be disturbed with the sensor positioning on different areas of the home. Also, the alarm should not be irritating to the person or her family members. In Nepalese context, most of the members in the family dine together and the utensils might get exchanged. Also, handling and maintaining such utensils that are attached to sensors might be problematic in everyday life situations. So, every member should be careful about everything related to the sensor. If the system is irritating and creating a problem to herself or her family members then in that case the system will not work for her.

In the context of Nepal, house monitoring system might be expensive to afford by most of the middle class families having chronic diseased member.

### **7.3 Mrs Bogati story**

Mrs. Bogati is 27 years old with a master's degree who works in a reseller company. She lives in a single family and is pregnant with her first child. She has been suffering from asthma since she was 17 years old. She and her husband do not have a good relationship because of his extramarital affair. He has a baby boy from his extramarital affair. Due to this reason she and her husband quarrel most of the time at their home. He spends most of the time with other women and comes to home like two or three days a week. Therefore, she is not able to get any help from her husband in her pregnancy. Due to her health problem, pregnancy and her work she gets weaker day by day. She easily gets tired if she does any household work. Therefore, she needs an assistance most of the time. She has a younger sister who is also studying and stays in her house. Whenever, she needs immediate assistance she ask her sister for help.

One day Mrs. Bogati's younger sister found her lying unconscious in the chair. Her sister was worried, and she called her friend to bring taxi to their home. After that, they took her to the hospital. After gaining consciousness, her sister asked her, "*why didn't you call me for help?*" She said that she was unable to find her contact immediately, she was out of breathe and after that she couldn't remember anything.

#### **7.3.1 Identifying the issues and the cause of the problems**

The main issue of Mrs. Bogati's story is that she was not able to have immediate help when needed. She has a younger sister to ask for help, but she cannot be with her all the time. The problem with her current mobile device is that it is not easy to operate or user friendly. She was not able to search the contact list and call whenever she is in need of immediate help.

In the situation of Mrs. Bogati, the cause of the problem is that most of the time she is alone at home and relationship with her husband is not good, making her in the state of constant mental stress. Also, she has a breathing problem and she is not able to shout for help.

### **7.3.2 Identifying the requirements**

In Mrs Bogati's story, she needs a mobile device with simple interface so that she is able to search contact details easily whenever needed. There can be continuous monitoring whenever she falls or has shortness in breathing. Monitoring should be reliable and effective. It should measure her breath regularly and send the information to doctors or nurses. It is necessary to provide feedback by doctors and nurses so that it will help her to improve the health conditions. Also, the data gathered should be safe and secured. Wearable biosensor can be made available so that if there is an emergency situation and nobody is there to help her or she is not able to use the mobile then the device should send an alert to her sister's mobile or care center for emergency help.

### **7.3.3 Suggesting the possible solutions**

Some of the possible solutions for the presented story are:

- According to MegaKoto, the company claims a complete mobile eHealth management solution for asthma. The realtime patient and doctor communication can be established along with the patient records and nursing support. (MegaKoto, 2014) There are also many other such asthma management systems and it is one of them.
- For immediate situation, one of the example and solution that might be used is find-me cares wrist watch. It is a personal mobile emergency alert system in the form of a watch (Carerswatch, 2014). Whenever, there is such immediate situation when a patient is unable to shout or search number in her mobile contact list then she can just press the button of her wrist watch so that a panic alert will be sent to her sister or care center. Therefore, they can come for immediate help.

### **7.3.4 Evaluating the proposed solutions**

In the case of Mrs. Kharel's story, mobile eHealth solution can work better for her. Use of mobile device with some developed and easy interface will be easy for her to track her health conditions time to time. It is cost effective and easy to carry with her

from one place to another. For acute case, a device like the above mentioned wristwatch can send a panic alert to her sister or healthcare center.

### 7.3.5 A specific solution to the problem

For Mrs. Kharel’s story, mobile eHealth solution can be a better option for chronic disease like asthma. Asthma self-care management system or similar system might be better for her. However, there are many other similar systems and it is one example among them.

For example, MegaKoto Ltd’s, *“mobile self-care management system integrates realtime patient and doctor communication along with the patient’s medical record and nursing support. The system requires peak expiratory flow (PEF) meter that is useful for monitoring asthma. Modern PEF meters are electronic devices, capable of storing the measured values in their internal memory. With the use of Koto mobile platform, as it claims that the measured value can be easily transferred to the mobile phone via Bluetooth, infrared or cable. The collected information is stored in the mobile device and it is available at any time in the form of graphical representation or log book. All these information are sent to the health care professionals so that after the analysis, feedback can be sent to the patient.”* (MegaKoto, 2014)

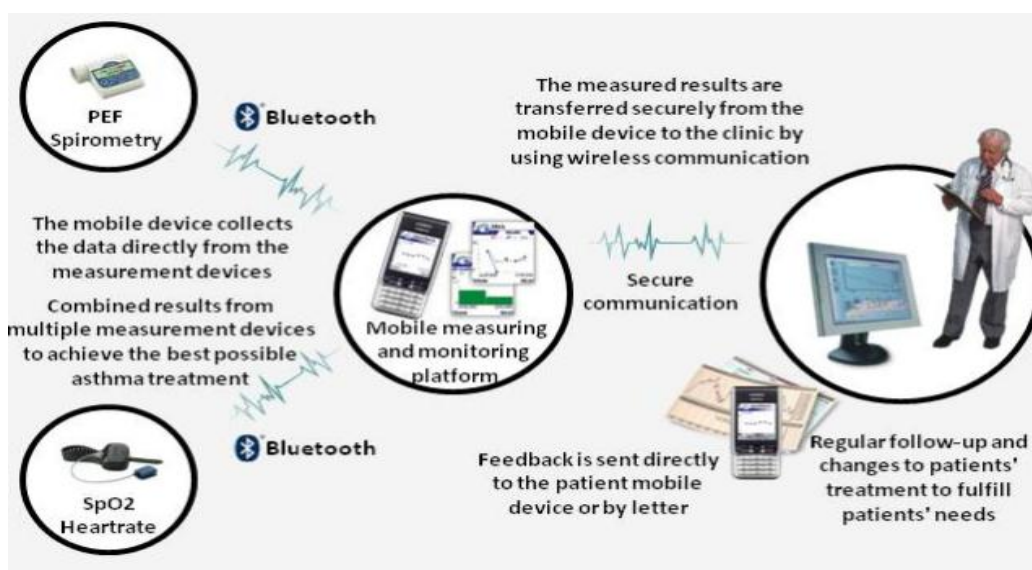


Figure 14. Mobile eHealth solution for asthma management system (MegaKoto, 2014)



In her situation, similar kind of asthma management system (figure 14) might work. The mobile device can collect the measurement and she will be informed about her health conditions regularly. It can be easy for her doctor to monitor the data and give feedback according to her health conditions.

For the immediate situation of Mrs. Kharel, similar devices like find-me cares wristwatch can be used. Find-me technologies have developed a particular mobile emergency alert system in the form of a wrist watch. It claims that it has the capabilities of telling time as well as the mobile phone's capability for a panic alert. Also, it has two way voice communications and tracking system allowing user itself to connect either to own relatives or friends 24/7.



**Figure 15. Find-me carers wrist watch (Carerswatch, 2014)**

### **7.3.6 Benefits and limitations**

The presented technologies can benefit Mrs. Kharel in some ways. With the use of provided technologies, the results might be accurate or available in real time. The system might provide instant feedback regardless of time and location and the treatment might be faster. Also, patient's privacy and security might be preserved with the secured connection.

However, there are some limitations for using similar asthma management technologies:

The measurement result might not be as accurate as claimed by the company. Since for real time availability of data, there should be internet and the feedback from doctors might be slow due to slow internet access. With the late received feedback, the situation of the patients may become worse. Also, for the people with less education the device might be complicated to use. For example, in the context of Nepal, language problem, slow internet access or load shedding problem might hinder in system usability.

Find-me wrist cares claimed that, the watch protects a personal safety of individuals. It works in high risk environments and cares for personal independence as well as care for people who are vulnerable in our community. However, these claimed statements may or may not be true.

There are some limitations for using similar kind of device like find-me wrist watch:

The device should not be heavy to wear. It should be user friendly and safe to use. It is not always sure that the user is wearing the watch or easily available during an emergency condition. If the user is not able to press the button in serious condition then it becomes useless and inefficient. The battery of the watch should be constantly checked, otherwise it cannot work during emergency situations.

#### **7.4 Summary of the applicability of mobile eHealth services solutions for pregnant women of Nepal**

Mobile eHealth service solutions that are used to assist the pregnant women of Nepal. It includes the use of personalized health monitoring system and house monitoring system. The means of using e-services for mobile technologies includes SMS, voice communication, video conferencing, internet, software (mobile applications, eGames) and wireless communications (Bluetooth and infrared). Health monitoring system used along with the mobile services includes blood pressure monitor, blood sugar monitor and wrist watch. Similarly, house monitoring system

used along with mobile services includes the use of an ambient sensor such as contact sensor and wireless accelerometer sensors. All of them are helpful to support independent living of pregnant women.

SMS alert is the most common technologies used in the above stories for immediate and severe conditions. In stories, SMS technology has been used because of simple outlook, low cost and high delivery success as compared to the voice communication or voice message. Another mobile technology is mobile applications, used in personalized health monitoring systems such as health application for blood pressure monitor (iHealth), diabetes management application (iBGstar) and KOTO mobile platform for asthma management. They both provide real time measurement information and feedback. However, they must have internet and electricity to operate. All of these applications get the measurement information from the monitoring device through wireless communications such as Bluetooth or infrared. Use of wireless communications might cause to slow down the battery of mobile devices. Therefore, for less usage of battery, Bluetooth or infrared should be shut off after the measurement information is transferred from the mobile.

Other mobile applications such as eGames used in HIV counseling simulates the real life situations. These kinds of games might help the HIV infected patients to understand other HIV people's life situations and making them capable of decision making regarding their own life and living choices. As compared to HIV related eGames, still traditional HIV counseling is famous and these kinds of eGames are not getting an ample space as compared to them, but in terms of maintaining the privacy, security and cost, these are the effective ones.

A house monitoring system used in stories includes ambient sensors that are smaller than health monitoring devices. The main disadvantages of this kind of sensors are limited possibilities in continuous monitoring, as they are not attached to the body like the health monitoring device. However, in case of health monitoring device, it should always in contact with the body for continuous monitoring. They are efficient and effective in terms of daily routine monitoring.

## 8 Discussion

This thesis work has been developed focusing on various literature related to developing countries along with the data obtained from Nepalese pregnant women. By relating to the pregnant women, the framework of my thesis helped me in developing the research questions. The priority is given to the literature information and the pregnant women requirements that are relevant to the research questions.

Being a Nepalese woman, my experience regarding the life of pregnant women in Nepal has challenges in terms of care, education, health facilities and geographical structure. The motivation to write this thesis in Nepalese context came from familiar Nepalese society and some experience gained from the challenges of pregnant women's life which especially focuses on the pregnant women suffering from chronic diseases. For the low resource country like Nepal, for the pregnant women who are suffering from different chronic conditions, mobile eHealth service solutions are chosen to be more supportive and practical. However, the mobile eHealth service solutions obtained from different technologies may or may not be applied to the pregnant women or might be applied to other individuals suffering from chronic disease conditions. However, somehow it can facilitate both of them and provide opportunities to diversify the general eHealth service method. In this study, the requirements of the pregnant women are not fully met, though there are some findings that are discussed through the stories.

Moreover, findings from the pregnant women requirements and mobile technologies helped to create a specific mobile solution. The life stories told by pregnant women make them reveal their life challenges. As a result, various requirements are obtained. The requirements are then studied along with the various mobile technologies. Then, various mobile solutions for eHealth examples related to the requirements are searched. For specific solution, closely related mobile solutions for eHealth are selected as a solution to the pregnant woman's problem. In Nepalese context, some of the proposed solutions may work for those who has a good income, good internet connection and electricity in their home. All of the studied pregnant women are from the capital city and almost all of them have a good source of

income. In some stories, both husband and wife work and in some only husband work. Nurse revealed that in integrating mobile eHealth solutions in context of Nepalese pregnant women comes with several challenges. For some of the mobile eHealth solutions like, asthma management system and intelligent health monitoring system, nurse attributed these challenges to the inability of hospitals to provide the needed support to integrate ICT into the health services. The fund in the hospital is generated internally, which is used for running the hospital. The incoming fund is defined and an additional charge cannot be added to this kind of mobile eHealth services carried out from the hospital. Nurse attributed that one factor for the inability to efficiently use of ICT in the health service of the hospital is due to inadequate finance. Another attribute that hinder the integration of ICT in health services is the maintenance of the system. Also, the worrying factor is both nurse and doctor do not have will power to use the mobile eHealth services to be connected to the patients.

I have learned much better during the writing process than collecting different data, facts or literature. Collecting information was just a part of my thesis, but using my knowledge to compare those collective information in context of my country taught me do some real research. At the starting phase, it was kind of frustrating that everything that I am hoping to write was not easy and I haven't figured out everything regarding my topic then I realized that I have only scratch the surface. I also realized that my research is not enough and best as I had hoped for. But, then I learned that it is ok not to be enough or best. Working on thesis make me keen to think deeply about more facts related to my country, people and it's culture. Different real stories make me rethink about the situation of other similar pregnant Nepalese women who are also suffering from chronic diseases. These different situations of pregnant women reminded me the truth of Nepalese society. Those things that I was unaware or ignored were clear to me during the research doing and writing process. I learned that both Nepalese pregnant women and their family members are curious the mobile eHealth services, but Nepalese hospitals are quite ignorant about that. Also, hospitals do not have good financial condition for utilizing the services and they do not have enough staff for maintaining the services.

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