



**ADAMA SCIENCE AND TECHNOLOGY UNIVERSITY**  
**SCHOOL OF GRADUATE STUDIES**  
**SCHOOL OF ELECTRICAL ENGINEERING AND**  
**COMPUTING**

**ONLINE KNOWLEDGE BASED SYSTEM FOR WOMEN'S**  
**CHOICE OF FAMILY PLANNING METHODS SELECTION**  
**AND SELF-DECISION**

**SINEDOS GEBRU**

**FEBRUARY 2016**  
**ADAMA, ETHIOPIA**

**ADAMA SCIENCE AND TECHNOLOGY UNIVERSITY**  
**SCHOOL OF GRADUATE STUDIES**  
**SCHOOL OF ELECTRICAL ENGINEERING AND**  
**COMPUTING**

**ONLINE KNOWLEDGE BASED SYSTEM FOR WOMEN'S**  
**CHOICE OF FAMILY PLANNING METHODS SELECTION AND**  
**SELF-DECISION**

**A Thesis Submitted to the School of Graduate Studies of Adama Science and**  
**Technology University in Partial Fulfillment of the Requirements for the**  
**Degree of Master of Science in Software Engineering**

**BY SINEDOS**

**GEBRU**

**FEBRUARY 2016**

**ADAMA, ETHIOPIA**

**ADAMA SCIENCE AND TECHNOLOGY UNIVERSITY**  
**SCHOOL OF GRADUATE STUDIES**  
**SCHOOL OF ELECTRICAL ENGINEERING AND**  
**COMPUTING**

**ONLINE KNOWLEDGE BASED SYSTEM FOR WOMEN'S**  
**CHOICE OF FAMILY PLANNING METHODS SELECTION AND**  
**SELF-DECISION**

**BY SINEDOS**  
**GEBRU**

**Names and Signature of Members of the Examining Board**

|                               |           |       |
|-------------------------------|-----------|-------|
| _____                         | _____     | _____ |
| Chair person, Examining Board | Signature | Date  |
| _____                         | _____     | ..... |
| Advisor                       | Signature | Date  |
| _____                         | _____     | _____ |
| Examiner                      | Signature | Date  |

## **DEDICATION**

I Dedicate this thesis to my beloved family and to all who gives me their support for success in my life.

## **ACKNOWLEDGMENT**

First and for most, I would like very grateful to GOD ALMIGHTY for without his graces and blessings, this study would not have been possible.

Second, I would like to express my sincere and deepest gratitude to my advisor Dr. Dereje Teferi for his continuous and full support, for his patience, motivation, enthusiasm, immense knowledge, expert guidance, understanding and encouragement throughout my study. Without his incredible patience and timely wisdom and counsel, my thesis work have been a frustrating and overwhelming pursuit.

Thirdly, I am exceptionally thankful to Sister Senait Hailemariam (midwife) for her unconditional love. You gave me huge amount of support and encouragement to the successful completion of this study. I have nothing except THANK YOU.

Fourthly, I would like to thanks my friends Habtom Gebregziabher and Yared Tewelde for your help throughout this study. I would like to give extra special thanks to all my classmates and my friends Solomon Degef and Asebe Teka for their discussions, and for all the fun, we have had in the last two years.

I am also grateful to express my thanks to Dr. Alemayehu Girma, Medical director of Adama hospital medical college and Kenesa kumera, General Manager of the Mari Stops Ethiopia, Adama branch for their continuous follow-up throughout the study period. I would like to thank all participant staffs of Adama Hospital Medical College and Mari Stops, Adama branch specially the gynecologists and midwives, who were important to the successful completion of the thesis.

Finally, I have to thank my bloved family for their affections and love and Dire-Dawa University for the financial support.

SINEDOS GEBRU

## Table of Contents

|                                                         |      |
|---------------------------------------------------------|------|
| DEDICATION .....                                        | i    |
| ACKNOWLEDGMENT .....                                    | ii   |
| LIST OF FIGURES.....                                    | vi   |
| LIST OF TABLES .....                                    | vii  |
| List of Acronyms and Abbreviations .....                | viii |
| ABSTRACT .....                                          | ix   |
| CHAPTER ONE.....                                        | 1    |
| INTRODUCTION.....                                       | 1    |
| 1.1. Background of the Study .....                      | 1    |
| 1.2. Statement of the Problem .....                     | 3    |
| 1.3. Objective of the Study .....                       | 5    |
| 3.1. General Objective.....                             | 5    |
| 3.2. Specific Objectives.....                           | 6    |
| 1.4. Scope and Limitation of The Study.....             | 6    |
| 1.5. Significance of the study .....                    | 7    |
| 1.6. Organization of the Study.....                     | 8    |
| CHAPTER TWO .....                                       | 10   |
| LITRATURE REVIEW .....                                  | 10   |
| 2.1. Overview of Knowledge Based System .....           | 10   |
| 2.1.1. Objectives of Online knowledge based system..... | 11   |
| 2.1.2. Advantages of Knowledge Based Systems.....       | 12   |
| 2.2. Architecture of Knowledge Based System .....       | 13   |
| 2.2.1. Knowledge Base.....                              | 14   |
| 2.2.2. Inference Engine .....                           | 14   |
| 2.2.3. Explanation Module.....                          | 15   |
| 2.2.4. Self-Learning .....                              | 15   |
| 2.2.5. User Interface .....                             | 16   |
| 2.3. Online Knowledge Based Systems .....               | 17   |
| 2.3.1. Development of Knowledge Based Systems .....     | 17   |
| 2.4. The Knowledge Engineering Process.....             | 17   |
| 2.5. Knowledge Acquisition .....                        | 18   |
| 2.6. Knowledge Modeling.....                            | 21   |

|                                             |                                                       |    |
|---------------------------------------------|-------------------------------------------------------|----|
| 2.7.                                        | Knowledge Representation.....                         | 22 |
| 2.7.1.                                      | Case based knowledge representation.....              | 23 |
| 2.7.1.1.                                    | Advantage of Case based representation .....          | 24 |
| 2.7.1.2.                                    | Disadvantage of Case Based Representation .....       | 24 |
| 2.7.2.                                      | Rule Based Reasoning.....                             | 24 |
| 2.7.2.1.                                    | Advantage of rule based reasoning.....                | 25 |
| 2.7.2.2.                                    | Disadvantage of Rule Based Reasoning .....            | 26 |
| 2.8.                                        | Knowledge Based System Development Tools.....         | 26 |
| 2.9.                                        | Application of Knowledge Based Systems .....          | 28 |
| 2.10.                                       | Related Research Works .....                          | 29 |
| CHAPTER THREE.....                          |                                                       | 31 |
| KNOLEDGE BASED SYSTEM METHODOLOGY .....     |                                                       | 31 |
| 3.1.                                        | Introduction.....                                     | 31 |
| 3.2.                                        | Knowledge Engineering.....                            | 31 |
| 3.3.                                        | Knowledge Engineering Tools and Techniques .....      | 32 |
| 3.3.1.                                      | Knowledge Source and Acquisition Techniques.....      | 32 |
| 3.3.1.1.                                    | Sampling Technique .....                              | 34 |
| 3.3.1.2.                                    | Data Collection Methods .....                         | 34 |
| 3.3.2.                                      | Knowledge Based System Modeling.....                  | 35 |
| 3.3.3.                                      | Knowledge Representation.....                         | 36 |
| 3.3.4.                                      | Online Knowledge Based System Development .....       | 37 |
| 3.3.5.                                      | System Testing and Evaluation .....                   | 37 |
| CHAPTER FOUR.....                           |                                                       | 39 |
| KKOWLEDGE MODELING AND REPRESENTATION ..... |                                                       | 39 |
| 4.1.                                        | Introduction.....                                     | 39 |
| 4.2.                                        | Knowledge Acquisition .....                           | 39 |
| 4.2.1.                                      | Steps in Knowledge Acquisition .....                  | 40 |
| 4.2.1.1                                     | Knowledge Elicitation.....                            | 40 |
| 4.2.1.2.                                    | Knowledge Structuring.....                            | 41 |
| 4.3.                                        | Knowledge of Family Planning Methods .....            | 41 |
| 4.3.1.                                      | The Selection Process of Family Planning Methods..... | 41 |
| 4.4.                                        | Types of Family Planning Methods .....                | 43 |
| 4.4.1.                                      | Short-Acting Family Planning Methods .....            | 44 |

|                                            |                                                                  |     |
|--------------------------------------------|------------------------------------------------------------------|-----|
| 4.4.1.1.                                   | Modern Short Acting Family Planning Methods.....                 | 44  |
| 4.4.1.2.                                   | Natural Short-Acting Family Planning Methods.....                | 47  |
| 4.4.2.                                     | Long-Acting Family Planning Methods .....                        | 49  |
| 4.4.3.                                     | Emergency Contraceptive Methods (EC) .....                       | 52  |
| 4.5.                                       | Conceptual Modeling.....                                         | 54  |
| 4.5.1.                                     | Contraceptive Methods Selection and Decision Tree Structure..... | 54  |
| 4.6.                                       | Knowledge Representation.....                                    | 66  |
| CHAPTER FIVE .....                         |                                                                  | 72  |
| KNOWLEDGE BASED SYSTEM IMPLEMENTATION..... |                                                                  | 72  |
| 5.2.                                       | Architecture of the Proposed System.....                         | 72  |
| 5.3.                                       | The Knowledge Base Editor.....                                   | 73  |
| 5.4.                                       | The Knowledge Base .....                                         | 74  |
| 5.4.1.                                     | The fact Base .....                                              | 74  |
| 5.4.2.                                     | The Rule Base.....                                               | 75  |
| 5.4.3.                                     | The Inference Engine .....                                       | 75  |
| 5.4.4.                                     | Self-Learning.....                                               | 76  |
| 5.4.5.                                     | The Database.....                                                | 78  |
| 5.4.6.                                     | The Explanation Facility .....                                   | 79  |
| 5.5.                                       | The User Interface .....                                         | 80  |
| 5.6.                                       | System Tasting and Evaluation .....                              | 82  |
| 5.6.1.                                     | User Acceptance Evaluation .....                                 | 83  |
| CHAPTER SIX .....                          |                                                                  | 88  |
| CONCULISION AND RECOMMENDATION.....        |                                                                  | 88  |
| 6.1.                                       | Conclusion .....                                                 | 88  |
| 6.2.                                       | Recommendation.....                                              | 90  |
| Reference .....                            |                                                                  | 91  |
| Appendixes .....                           |                                                                  | 97  |
| Appendix I.....                            |                                                                  | 97  |
| Appendix II .....                          |                                                                  | 98  |
| Appendix III.....                          |                                                                  | 101 |
| Declaration.....                           |                                                                  | 102 |

## LIST OF FIGURES

|           |                                                                                         |     |
|-----------|-----------------------------------------------------------------------------------------|-----|
| Figure 1  | Architecture of Knowledge based System adopted from [23].....                           | 13  |
| Figure 2  | A program that shows memorization based self-learning .....                             | 16  |
| Figure 3  | Knowledge Engineering Process Adapted from [30] .....                                   | 18  |
| Figure 4  | Rule format for rule based expert system .....                                          | 24  |
| Figure 5  | The effectiveness of a selected Contraceptive methods .....                             | 42  |
| Figure 6  | List of the different types of family planning methods .....                            | 43  |
| Figure 7  | The different types of modern short acting family planning methods.....                 | 44  |
| Figure 8  | The different types of modern short acting family planning methods.....                 | 48  |
| Figure 9  | The different types of Long-acting family planning methods .....                        | 49  |
| Figure 10 | The permanent type of family planning methods .....                                     | 52  |
| Figure 11 | Decision Tree for Combined Contraceptive Pills (COC) .....                              | 56  |
| Figure 12 | Decision Tree for Progesterone Only Pills (POP) .....                                   | 57  |
| Figure 13 | Decision Tree for Implants (Implanon, Jadelle, Sino-plant) .....                        | 58  |
| Figure 14 | Decision tree for IUCD method.....                                                      | 59  |
| Figure 15 | Decision Tree for Emergency Contraceptive Pills .....                                   | 60  |
| Figure 16 | Decision Tree for Injectable Depo Provera .....                                         | 62  |
| Figure 17 | Decision Tree for Barrier method or Condom.....                                         | 63  |
| Figure 18 | Decision Tree for Norplant family planning method .....                                 | 64  |
| Figure 19 | Decision tree for female sterilization method.....                                      | 65  |
| Figure 20 | General architecture of the proposed web based KBS .....                                | 73  |
| Figure 21 | Updating and adding of knowledge base using knowledge base editor .....                 | 74  |
| Figure 22 | A sample dialogue with the web based system .....                                       | 77  |
| Figure 23 | A sample learning by memorization in the proposed web based KBS.....                    | 78  |
| Figure 24 | Sample of "what" explanation facility.....                                              | 79  |
| Figure 25 | The Home page of the web based knowledge based system .....                             | 81  |
| Figure 26 | after user login the system it display the self-Decision page in Amharic language ..... | 82  |
| Figure 27 | The page display the self-Decision support in Amharic language .....                    | 98  |
| Figure 28 | Users detailed information for self-decision.....                                       | 98  |
| Figure 29 | The second page of the self-decision support page .....                                 | 99  |
| Figure 30 | The fourth page of the self-decision support system .....                               | 99  |
| Figure 31 | The fifth page of the self-decision support system .....                                | 100 |
| Figure 32 | The final result of the self-decision support system .....                              | 100 |

## LIST OF TABLES

|                                                                                           |            |
|-------------------------------------------------------------------------------------------|------------|
| <i>Table 1 Domain Experts Profile.....</i>                                                | <i>40</i>  |
| <i>Table 2 Effectiveness of family planning methods [57]......</i>                        | <i>42</i>  |
| <i>Table 3 Modern Short-Acting Family planning methods .....</i>                          | <i>46</i>  |
| <i>Table 4 List of Long-Acting Family planning methods.....</i>                           | <i>50</i>  |
| <i>Table 5 The Emergency Family planning methods list and recommendations.....</i>        | <i>52</i>  |
| <i>Table 6 The bilateral tubal ligation family planning method.....</i>                   | <i>53</i>  |
| <i>Table 7 User acceptance evaluation of the performance of WBKBS on FP methods .....</i> | <i>84</i>  |
| <i>Table 8 Summary of Users' feedback on WBKBS .....</i>                                  | <i>86</i>  |
| <i>Table 9 Questionnaire.....</i>                                                         | <i>101</i> |

## **List of Acronyms and Abbreviations**

|                 |                                      |
|-----------------|--------------------------------------|
| <b>AI</b>       | Artificial Intelligence              |
| <b>ASP.Net</b>  | Active Server Page dot Net           |
| <b>COC</b>      | Combined Oral Contraceptive          |
| <b>CSS</b>      | Cascading Style Sheet                |
| <b>C#</b>       | Csharp                               |
| <b>e-Health</b> | electronic health                    |
| <b>FP</b>       | Family Planning                      |
| <b>GP</b>       | General Practitioner                 |
| <b>GUI</b>      | Graphical User Interface             |
| <b>ICT</b>      | Information Communication Technology |
| <b>IMR</b>      | Infant Mortality Rate                |
| <b>IUCD</b>     | Intrauterine Contraceptive Device    |
| <b>KA</b>       | Knowledge Acquisition                |
| <b>KBS</b>      | Knowledge Based Systems              |
| <b>KE</b>       | Knowledge Engineering                |
| <b>MD</b>       | Medical Doctor                       |
| <b>PID</b>      | Pelvic Inflammatory Disease          |
| <b>POP</b>      | Progestin Only Pills                 |
| <b>SQL</b>      | Structured Query Language            |
| <b>STI</b>      | Sexual Transmitted Infections        |

## ABSTRACT

Maternal mortality is one of the leading causes of death in the developing world. Complications during pregnancy and childbirth are a leading cause of death and disability among women of reproductive age in developing countries. Over half a million women still die each year from preventable complications and childbirth in the world. Therefore, this world wide problem of our time needs a solution and it can be reduced by using an effective contraceptive methods.

However, among people in the developing countries like Ethiopia, effective use of contraceptive method based to user health preference, and selecting the correct method is difficult. This is mainly because of the norm, less previous practices and religious believes. Most users, usually decide based on the other women's choice or based on the most used contraceptive method that are previously used by other women. But, they do not choose based on their own health preference.

The objective of this study is thus to build a women contraceptive e-Health system by applying and using the knowledge engineering methodology of the knowledge-based system development. To this end, the required domain knowledge was acquired from Adama Hospital Medical Collage and Mari Stops of Ethiopia, Adama branch using structured and unstructured interviews from domain experts who are selected using purposive sampling technique.

This study aspired to develop a web based knowledge-based system by applying the knowledge engineering methodology. To develop the system, the acquired knowledge is modeled using decision tree, and presented using the production rule (IF ... Then) technique of knowledge representation. The implementation of the proposed system is developed using VB programming language with the integration of ASP.Net, JavaScript, CSS, Ajax control toolkit and SQL Server 2012. The system graphical interface is well designed and user friendly. The system supports the self-learning module to automatically learn and remember facts in the knowledge base. The performance measure was made using the user acceptance evaluation questionnaire. According to the evaluator's result, the new system has got 86% acceptance and meets the objectives of the study. However, in order to make the system more applicable for new cases additional study is needed for GUI based automatic rule updating.

**Key-words:** *Knowledge Based System, Self-learning, Family planning methods, Web based Knowledge-Based Systems, Self-decision support*

# **CHAPTER ONE**

## **INTRODUCTION**

### **1.1. Background of the Study**

Information and Communication Technologies (ICT) are currently a way to diverse set of technological tools and resources used to create, store, disseminate, and manage information. These technologies include computers, internet, broadcasting technologies (radio and television), mobiles and telephone. ICT is also setting speed for a changing, competitive and dynamic global marketplace, representing an invaluable vehicle for business and socioeconomic development and introducing new forms and structures of organizations that are not constrained by geographical or time barriers.

Due to fast improvement and growth of ICT currently it is being used in different domain areas such as education and research, military, society, business, entertainment, sport and medicine. ICT can also serve different tasks in the field of health and medicine which transformed the way people collaborate, identify potential collaborators or friends, communicate with each other, and identify information that is relevant to their practice. ICT has been identified as one measure to ensure its use in emerging trends in healthcare systems [1]. Since, an effective use of family planning method are directly related to the women health, ICT has a vital role to support family planning users, to counseling, and to transfer updated information in time.

Family planning (FP) is defined as the ability of individuals and couples to anticipate and attain their desired number of children, spacing and timing of their births. This is achieved through effective use of FP methods [2]. FP is a means of the health of women, families and part of a strategy to reduce the high levels of maternal, infant, and child mortality. People should be offered the opportunity to determine the number and spacing of their own children. Information about FP should be made available, and access to family planning services should be actively promoted for all individuals desiring them [2].

FP is a method of having a number of children you want, when a women decide to wait to have children, it is possible by selecting and using one of the methods. FP methods are also called child spacing methods, birth control methods and contraceptive methods. According to the women interest, some women want a lot of children especially in communities of the poor people, and some other women may want to limit the number of their children's. Using and counseling of FP methods helps everyone, especially for a women to protect themselves from unsafe abortions. Since the 1960s, the method of family planning programs have helped women around the world to avoid 400 million unwanted

pregnancies [3]. As a result, many women lives have been saved from risk of unsafe abortions. If all women could avoid unsafe abortions, the number of maternal deaths could fall by one quarter [3].

FP methods are have a vital advantages for children's', men, families, nations and to the earth at large by saving the lives of children, and by helping women in space of birth. According to Robert A. [3], between 13 and 15 million children under age 5 die each year. If all children were born at least 3 years apart, 3 to 4 million of these deaths would be avoided. In addition to that, if couples have fewer children in the future, the world's current population of 6.1 billion people will avoid doubling in less than 50 years [3].

No matter where a woman lives, she will be healthier if she has control over how many children she has, and when she will have the children. Deciding to use or not to use contraceptive method should be a woman choice not to the service provider. But, it is more effective if you talk together with your husband, service provider, physicians (doctor, nurse, and midwife) to get help about how to choosing and use their relevant methods.

A man may worry about his wife's health, because he has heard stories about the dangers of family planning methods [4]. However, as time goes and technology develop most women in the world are using methods of family planning for different reasons. According to world health organization (WHO, 2012) report, now a days more than 222 million women in developing countries are they need to use FP methods but they cannot use it [5].

Currently there are several types of contraceptive methods such as the short acting FP methods, long acting FP methods, barrier methods, natural methods, traditional methods, permanent methods, emergency methods [2]. Selecting and using of one FP method according to the women preference is an option to limit their children, spacing of child birth, save women from un-safe abortion, and to control sexual transmitted diseases including HIV, AIDS [5]. Since using and choosing FP methods are based on users preference, contraceptive providers do not pressure clients to make a certain choice or to use a certain method. However, they help clients to think through their decisions.

Knowledge based expert system is one of the most active and productive research in the field of artificial intelligence. After Edward F. developed the first expert system called DENDRL in 1970, the development of an expert system has developed rapidly. It simulates the experts' thinking process of solving a problem, and is widely used in medical diagnosis, treatment and decision support process,

geological exploration, the petroleum chemical industry, and so forth. Also, it brings great economic and social benefits in these fields [6].

Knowledge-based expert systems can be employed to reduce the number of unsafe abortion related deaths, and women health by giving updated information on time, counseling and correct decision of methods, without waiting for the specialist. The systems developed by imitating human intelligence could be employed to help the physicians (doctors, midwives, nurses) in making decision without consulting the specialists. The system is not meant to replace the specialist or physicians, but it is developed to help general physicians and midwives in counseling, selecting, deciding contraceptive methods and providing treatments from certain grounds or experiences [7]. Thus, using knowledge-based systems can be investigate solution to reduce cost, time, human expertise and medical error.

Knowledge based systems are one of the specialized branches of artificial intelligence functioning in a specific domain to offer wise decisions with reasoning. Tacit and explicit knowledge can acquired, the acquired knowledge can modeled using different knowledge based modeling techniques such as decision tree, and decision table, represented using several knowledge representation techniques such as semantic nets, logic, frames, rules and cases. Finally, it can be implemented the system in a format of machine understandable to meet their objectives. The main benefits provided by such system are wise decisions without the use of specialists, learning from their experience, explanation and/or reasoning, and pre solving problems [8].

In this study, the researcher intends to develop a low cost and time efficient automated, web based knowledge based system for women family planning methods choice selection and self-decision. It incorporates the skills of medical experts to help women in selection, self-decision and advising their preferable family planning methods.

## **1.2. Statement of the Problem**

Maternal mortality is one of the leading causes of death in the world. The United Nations Children's Fund (UNICEF) refers to maternal mortality as "in scale and severity the most neglected tragedy of our time" [9]. This tragedy disproportionately affects developing countries with 99 percent of maternal mortalities occurring in economically underdeveloped nations [10].

Currently, maternal mortality rates are reduced when we compare to the previous time. As reports highlight decreases in maternal mortality rates since the 1990s. However, this is not a universal reduction [9]. Particularly in Africa and south Asia maternal mortality rates remains extremely high

[11]. The United Nations Development Fund for Women (UNIFEM) estimates that over half a million women still die each year from unsafe abortion and childbirth in the world [12].

Due to the fast growth of technology, the awareness of women on using a FP methods also increase. Globally use of modern FP has risen slightly, from 54 percent in 1990 to 57 percent in 2012. Regionally, the proportion of women aged from 15 up to 49 reporting use of a modern contraceptive method has risen minimally or plateaued between 2008 and 2012. In Africa it went from 23 percent to 24 percent, in Asia it has remained at 62 percent, and in Latin America and the Caribbean it rose slightly from 64 percent to 67 percent [5].

Specifically, Ethiopia has made significant progress in family planning as well as in maternal and child health. The FP prevalence rate has doubled over the past five years (from 15 percent in 2005 to 29 percent in 2011). Ethiopia is committed to reaching its target of 66 percent FP prevalence rate by 2015 supported by increasing national funding for family planning as well as donor support. However, currently the number of women that are using the contraceptive methods are only 29 percent [2].

The global unmet need for contraception methods indicate an estimated 222 million women only in the developing countries would like to delay or stop childbearing and child spacing but they are not using any contraception method [5]. Specifically in Ethiopia, more than 25 percent of women of the reproductive age have an unmet need for contraceptive methods [2]. The main reasons are: lack of awareness in FP methods, limited access of methods, poorer segments of populations, or unmarried people, fear or experience of side effects, cultural and religious opposition, poor quality of available services, gender based barriers are the most cases.

Among the people of less-developed countries like Ethiopia, understanding the side effects, know-how about its advantages and finally selecting and deciding effective contraceptive method are difficult. Most contraceptive users are usually decided based on the other women choice or based on the most used contraceptive method that are previously used by other women. But, they do not choose based on their own health preference.

Hence, due to the shortage and workload of specialists in health centers and hospitals, the number of unmet women to use contraceptive methods are high, and it makes difficult for women to identify possible choice according to their own preference.

Currently, in Ethiopia FP methods are used by different women such as university students, unmarried girls, and married women. However, users has low awareness on identifying relevant method, its side

effects, about how to select, decide and advice of the methods. Even the experienced users are have a fear to tell every health information to the specialist. They simply use short acting FP methods or they decide according to their friends' choice. This method of decision could be dangerous and has a lot of health side effects [2]. Generally, due to shortage and high workload of physicians in health centers identifying and deciding relevant method for women according to their health states is time consuming and difficult. Therefore, implementing knowledge based expert system that help users and physicians in selection, decision support, and advice according to the user health condition are one solution.

In Ethiopia designing web based knowledge based system in the area of medicine and health is found at infant stage. Therefore, designing a web based knowledge based system would increase awareness of users in their health, reduce the repetition of task, the burden of human expert and waiting time of patient in hospitals. Users come free to answer all possible questions regarding their health states, and at the end they can decide themselves to use their choice. The knowledge based system could be used to assist human expert by providing the required knowledge at the right time for decision making.

This study seeks to design web based knowledge based expert system that can provide self-decision for choice of contraceptive method to users and physicians that are involved in contraceptive methods.

To this end, the study attempts to explore and find solutions for the following research questions:

- What suitable domain knowledge exists in an explicit and tacit form for selecting and self-deciding of contraceptive methods?
- How to implement a web based KBS that automatically advice women to make self-decision on contraceptive methods and update new facts?
- How do one integrate or imbed a knowledge-based system to user friendly web based user interface?
- How do one model, represent and implement the acquired knowledge to develop a web based KBS?

### **1.3. Objective of the Study**

#### **3.1. General Objective**

The General objective of this study is to implement a web based knowledge based system on family planning methods that provide a significant help for women and domain experts in order to select, decide and advise on using the effective contraceptive method according to women's choice, as well as current and previous health preference.

### **3.2. Specific Objectives**

With the aim of achieving the above general objective, the study also has the following specific objectives:

- Review previously proposed related works so as to understand the domain area and assess different principles of knowledge based expert systems.
- Acquire tacit and explicit knowledge from domain experts and relevant documents respectively for extracting the domain knowledge used in real life.
- Model and represent the domain knowledge using suitable knowledge representation techniques.
- Develop a system that is well-designed, user friendly, portable, error tolerant and remember knowledge from experience.
- Develop a web based knowledge based and self-decision support system that help women and physicians on family planning methods choice.
- Test and evaluate the performance of the prototype system with the help of professional experts in the field.

### **1.4. Scope and Limitation of The Study**

Even though there are a number of different approaches for designing web based knowledge based system, this study focuses only on a rule based reasoning approach. The study is limited to implement a web based knowledge based self-decision system for women contraceptive methods, to help women on choosing effective contraceptive method according to their health preference, create awareness on selecting, deciding and using the correct methods, and save users from FP method health side problems.

When a woman went to use a contraceptive method the first question of every contraceptive method users are, which contraceptive method is the best choice for me? In this study focuses to develop a web based knowledge based system that answer this and other related questions of women. Help physicians to council and train users on selection, decision and advice of the methods effectively and in time. Nevertheless, it does not provide advice and decision support for the short acting, barrier and natural contraceptive methods.

Since the human health problem are too many this study focused on the selected types of FP methods, their related disease and health side effects. According to Robert A. [3] “The Essentials of Contraceptive Technology book”, he stated that there are five types of contraceptive methods. These are, the hormonal

methods, natural methods, non-hormonal methods, barrier methods, and permanent methods. However, due to their availability, and effectiveness this study focus only on the four types of contraceptive methods. These are the long acting methods, modern short acting methods, emergency methods and permanent contraceptive methods.

Although tacit knowledge about the different contraceptive methods are acquired from books, internets, from medical doctors of Adama Hospital Medical College and Mari Stops Ethiopia, Adama branch using interviews. Interview the medical doctors is so difficult due to the high work load and high patients in the hospital. However, according to the physicians and domain experts most short acting contraceptive methods are high in their failures and not recommended for use as effective contraceptive methods. Due to this reason the researcher concerns only on modern short-acting, long acting, permanent, and emergency contraceptive methods.

In addition to the long acting contraceptive methods, the researcher also work with some of the effective types short acting family planning methods such as the barrier method (male condom), natural methods (Calendar method) and the traditional methods (abstinence) are included in this study. The proposed web based knowledge based system provide fast and correct decision regarding to contraceptive methods in only three languages (English, Amharic and Tigrigna) as we listed in (Appendix III). Due to this, users have an option to use the system in three different languages and it supports to easily understand and generate the final result.

The implemented web based knowledge based system protects user privacy information, and it asks first to authenticate the system to select, to make decision and advice. The knowledge engineer also authorized to see and update all facts of the system. Generally, the system provide information such as the list of recommended methods, list of not recommended methods according to users health states, detail information, and procedures on how to use.

### **1.5. Significance of the study**

The study give fast service both to the user and to health service providers. Knowledge-based systems are artificial intelligent tools functioning in a specific domain to provide advice and consultation in decision making. With the proper utilization of knowledge, this knowledge-based systems increase productivity, and enhance problem solving capacity in a flexible manner. It is also advantageous for remote and rural areas that have scarcity of medical professionals and health consulting. Hence, the result of this study will be used as an input for the development of a full-fledged knowledge based

system that can be used for recommendation, selection, and self-decision of women family planning methods.

Thus, this study attempts to establish a platform that enables women to select, decide and advise themselves on a relevant contraceptive methods using computers wherever they are, without the need to go to a particular physician, with the availability of Internet. This reduces the cost for the users to go to a healthcare centers and to decide freely. Apart from saving users' time while they are in medical centers, it also solves the natural habit of most people to see physicians unless problems get worst as it enables to check the medical status without any time limitation.

The service providers also has workload in counselling, giving medication, and advising of contraceptive users in each health condition. So that, if users have awareness and know-how about the self-decision of FP methods based on the health preference then service providers can save their time and minimize their workload.

In addition to the above maternal mortality is one of the leading causes of death in the world. The developed web based knowledge based system also helps to solve pregnancy related mortality of women and prevent unsafe abortion by creating an awareness of a women on using the relevant and effective type of contraceptive methods.

## **1.6. Organization of the Study**

Basically, this study is intended to develop a Web based knowledge based system for women choice of family planning methods selection and self-decision. The main body of this thesis is organized in six chapters. The first chapter introduces the background of the study and statement of the problem and its justification. It also presents the basic objectives of the study, scope and limitations of the study, and the significance of the study.

The second chapter presents review of related literatures. It provides an overview of web based knowledge-based system, architecture of knowledge based system, software engineering processes and techniques, advantages and limitations of the knowledge based systems, knowledge acquisition, knowledge modeling, knowledge representation, tools used in KBS development, applications of knowledge-based system, and review of related works.

The third chapter outlines the methodology of the study to deploy while conducting this work. It briefly discusses the knowledge engineering methodology. It briefly describes knowledge acquisition process

and techniques in the development of knowledge based systems, intelligent systems, knowledge verification, validation, and evaluation.

The fourth chapter discusses the acquisition of knowledge from different sources, and conceptual modeling of the acquired knowledge using decision tree. It also discusses the representation of the validated acquired knowledge using production rules for developing the web based knowledge based system.

The fifth chapter presents implementation of the web based knowledge-based system, and its proposed architectures. It also presents the testing process and discusses the evaluation result on the performance of the prototype system. Besides, it shows analysis and interpretation as a basis for discussing the findings of the study.

Finally, chapter six puts the major findings, based on which it provides concluding remarks and recommendations for further research in the domain area.

## **CHAPTER TWO**

### **LITRATURE REVIEW**

Currently, due to the fast growing of technology and computer based system applications, users and patients can play a distinct role in protecting their health, choosing appropriate treatments for episodes of ill health and managing chronic disease their self.

Computer based applications are increasingly becoming implemented in the healthcare centers to facilitate the work of the healthcare center. Patient record keeping systems are one to these computer applications in the healthcare service centers. However, in recent times, advanced computer applications are becoming implemented alongside other health information systems. Knowledge based computer applications are attracting greater attention in many healthcare organizations in doing of different activities. One of the activities are patients can decide and advise themselves about their health with the support of computers applications.

Self-decision and advice about patients' health care is one of the most common sources of patient satisfaction in feeling properly informed about their treatment. Self-decision making mechanism are involved as active partners with clinician in treatment decisions and advices users are fell free and treat their self about their health.

#### **2.1. Overview of Knowledge Based System**

Knowledge based system (KBS) is a software or computer program that uses artificial intelligence (AI) or expert system techniques in problem solving processes. KBS can act as an expert on demand without wasting time, anytime and anywhere. The systematic aim of AI is understanding intelligence by developing computer programs that show intelligent behavior. It deals with methods of inferring mechanisms using computer and the way of different knowledge representation techniques [13]. The existing expert system architecture supports only knowledge base for standalone systems [14].

Expert systems have provided solutions to different problems in companies, from strategic planning of marketing to consulting in process re-engineering [15]. According to Engelmores and Feigenbaum [13], "intelligence deals with many cognitive skills, comprising the capability to find solution of problems, learn, and understand language. However, developments up to the present time in AI have been made in the area of problem solving - concepts and methods for constructing program that reason about problems instead of finding the solution".

The area of human intellectual endeavor to be captured in a knowledge-based system is called the task domain [16]. Task denotes to certain goal-directed, problem-solving endeavors. Domain denotes to the area within which the task is being performed. Typical tasks are diagnosis, planning, scheduling, configuration, and designing [16].

The Internet offers an ever expanding set of capabilities and web-based expert system is capable of offering much more than traditional expert system or the standalone expert systems [17]. The web-based knowledge based system provide in industry, medicine, science, education, and government. Now a days there are a large number of knowledge based systems available on the Internet and there are several factors that make the Internet, by contrast to stand-alone platforms, an ideal base for Knowledge Based System (KBS) delivery [17].

Web based expert systems (WBES) have several factors that make the platforms, by contrast to standalone platforms, an ideal base for KBS delivery. These factors include [18], the Internet is readily accessible, web-browsers provide a common multimedia interface, several Internet compatible tools for KBS development are available, Internet-based applications are inherently portable, and emerging protocols support co-operation among KBS. The architecture of WBES is based on the traditional expert of system technology with an integration of web technology at various modules of the system [19]. The organic design of traditional expert system architecture has been adapted to Internet use by incorporating client-server architecture and web browser-based interfaces [20].

Web based expert systems have several factors that make the platforms, by contrast to standalone platforms, an ideal base for KBS delivery. These factors include [21].

- ☛ The Internet is readily accessible
- ☛ Web-browsers provide a common multimedia interface
- ☛ Communication between distributed applications are simple using a common protocols for knowledge transfer and dynamic information sharing.
- ☛ Several Internet compatible tools for KBS development are available
- ☛ Internet-based applications are inherently portable, and
- ☛ Emerging protocols support co-operation among KBS

#### **2.1.1. Objectives of Online knowledge based system**

Online expert system is an expert system that is accessed by users over a network such as the Internet. The term also mean a knowledge based computer system that is coded in a browser using a web

supported programming language such as Visual prolog, C#, VB, JavaScript, CSS and JQuery combined with a browser rendered markup language like HTML and reliant on a common web browser to render the system executable. Web applications are popular due to the ubiquitous of web browsers, and the convenience of using web.

As Turban [22] noted, one example of the specialized branches of artificial intelligence is knowledge based system (KBS). Some of the objectives of KBS are listed as follows:

- ☛ Supports individuals in finding out and constructing new fields
- ☛ Provides a huge amount of knowledge in several domain areas
- ☛ Assists in knowledge management that is deposited in the knowledge base
- ☛ Finds solution for social problems in a well manner than the traditional computer-based information systems.
- ☛ Gains new observations by imitating new circumstances
- ☛ Provides important software development productiveness
- ☛ Importantly decreases time and money to construct automated systems

### **2.1.2. Advantages of Knowledge Based Systems**

Typical information systems deal with data while knowledge-based systems automate expertise and deal with knowledge. Knowledge based systems offer several advantages over humans. Some of the major advantages of Knowledge based system are descried as follows [23].

- ☛ Knowledge Documentation: Knowledge-based systems provide efficient documentation of the important knowledge in a secured and reliable way for a long period of time.
- ☛ Effectiveness and efficiency: Knowledge-based systems offer more than one expert knowledge in an integrated fashion.
- ☛ Easy availability of knowledge: Knowledge based systems solve unstructured, large and complex problems in a quick and intelligent fashion and provides justification for the decision suggested.
- ☛ Self-learning:- Knowledge-based systems are able to infer (create) new knowledge and learn from cases or data instead of just referring the stored content.
- ☛ Easy knowledge distribution: It is easy to clone and spread knowledge.
- ☛ Justification for better understanding: The reliability of the domain experts relies on the capability to explain their decisions. This can be offered by using the reasoning and justification component of the KBS to the end-users.

### 2.1.3. Limitations of Knowledge Based Systems

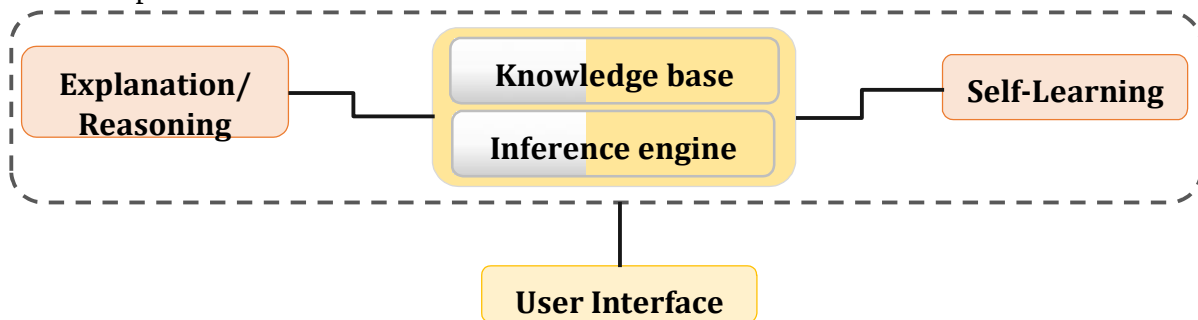
In spite of plenty of obvious advantages, the knowledge base system development and usage are difficult. According to Akerkar and Sajja [23], the following are some of the major drawbacks of using the knowledge based systems.

- ☛ Representation and manipulation of the large volume of the data/information/knowledge.
- ☛ Abstract nature of the knowledge.
- ☛ Limitations of cognitive science and there is no common development model that helps knowledge engineers to develop a KBS.
- ☛ Knowledge acquisition: since knowledge is a personal property in its nature, it is very challenging to extract the embedded knowledge from human mind.
- ☛ Lack of standard testing and evaluation techniques: quality standards such as verification, validation and quality metrics are required for ensuring the quality of the KBS.

## 2.2. Architecture of Knowledge Based System

The architecture of online knowledge based system [19] is based on the traditional expert of system technology with an integration of web technology at various modules of the system. The societies and industries are getting knowledge-based and dependent on various decision making capabilities of experts. KBS can act like an expert available when needed without wasting any time. KBS can be seen as an effective tool since it comprises knowledge from several domain experts in a specific area for a long time.

According Akerkar and Sajja [23], the architecture of KBS are listed in the figure 1, and it have at least five main components.



*Figure 1 Architecture of Knowledge based System adopted from [23]*

All knowledge based expert systems are composed of several basic components, such as a user interface, a database, a knowledge base, and an inference mechanism. Moreover, expert system development usually proceeds through several phases including problem selection, knowledge acquisition,

knowledge representation, programming, testing and evaluation. Expert systems have a number of major system components and interface with individuals in various roles. As figured above the architecture [23], of knowledge based system consists of five different components including of such as Knowledge Base, inference engine, explanation module, self-learning, and user interface.

### **2.2.1. Knowledge Base**

The knowledge base is one of the basic component of a knowledge based expert system and it contains all of the relevant knowledge of the domain that are acquired from domain experts, and relevant documents. In knowledge base there are different representation techniques such as rules and cases. In a rule based knowledge representation each rule has two sections: these are the condition and the action or conclusion pattern. These rules are consist of a condition or premise followed by an action or conclusion (IF condition ... THEN action)

For example: IF pregnancy result is Positive Then

☛ A client is not recommended to use any contraceptive method

Condition: from the above knowledge base we have one condition, pregnancy result is positive

Conclusion: due to pregnancy result is positive do not use any contraceptive method.

### **2.2.2. Inference Engine**

The inference engines formulate questions and assert the answers provided by the user in a natural language form. It provides a mechanism for conveying recommendations to the end user. An inference engine is a code at the core of the system which derives recommendations from the knowledge base and problem specific data in working storage [24]. Inference is a design of software to allow the computer to make inferences based on the knowledge and the specifics of the problem.

In an inference engine if the rule from the stored knowledge base is satisfied then it displays the final result to the end user. The inference engine has two mechanisms these are the forward and backward chaining. In a forward mechanism it checks every rules of the knowledge base until the correct hypotheses is achieved. [25].

A Forward chaining is use a forward direction that check for every rules of the knowledge base until it meet its goal. In case of the backward chaining also it starts from the conclusion then it checks back the rules that are relevant to the class or the final goal. When the knowledge base uses a complex rules it might be used both the forward and backward chaining.

### 2.2.3. Explanation Module

Explanation module is another unique feature of a knowledge base system to explain its advice or recommendations and even to justify why a certain action was recommended. The explanation module enables the knowledge base system to examine its own reasoning and explain its operations [25].

The explanation module provides a brief description to the user when the system arrived at a certain conclusion or before the conclusion is made [26]. The design and programming of an explanation capability of this module is a program that allows the system to answer questions and briefly describe about a specific piece of information or it is used to give a step by step description for how a certain conclusion was derived.

For example: in user authentication based secured systems in order to identify the correct user, it asks the system to the user like this:

*“Please enter your username and password to login”*

From the above explanation the system explains to the user to write their correct username and password in order to login, the user also understands what to do first to log the system.

### 2.2.4. Self-Learning

Self-learning is one of the important elements of KBS which tries to imitate the learning capability of human beings. It is possible to update the knowledge base of the KBS either manually or automatically using machine learning algorithms [27] [28].

According to Akerkar and Sajja [23] “Self-learning is a scientific task that enables the knowledge-based system to learn automatically from the inference process, cases executed, and environment. One of the key characteristics of KBS is the capability to learn.

According to Castillo et al. [28], there are three methods of learning. These are structural learning, parametric learning and learning by memorization. Structural learning is focused on finding of a new rules in the knowledge base and focus in formulation of rules for a specified domain problem. The parametric learning is another type of learning it deal with updating of the certain futures of the knowledge based rule. The last type of learning by memorization is denotes the capability of KBS to learn from experience based on the existing data. Using learning by memorization the KBS can perform different activities such as storing or memorizing knowledge, and update facts. For the purpose of this study we used memorization learning to update every user’s information and the fact base in different time.

Learn by memorization are used to update facts in the KBS. Let us see the following example program that shows to update the previous fact base using learning by memorization method [28] in figure 2 as follows:

[Home](#) [Self\\_Decision](#) [English](#) [Logout](#)

### Learn from experience

Please enter the name of a dam? **Nurek Dam**  
Nurek Dam is found in Tajikistan, currently worlds tallest dam

Please enter the name of a dam? **Grande Dixence Dam**  
Grande Dixence Dam is found in Switzerland, height is 285 M

Please enter the name of a dam? **Hidase Dam**  
I do not know this dam, Please tell me where is found?  
Hidase dam is found in Ethiopia, and the largest dam in Africa

Please enter the name of a dam? **Mica Dam**  
Mica Dam is found in Canada and its height is 243 M.

Please enter the name of a dam? **Ertan Dam**  
Ertan Dam is found Chaina and its height is 240 M.

Please enter the name of a dam? **Hidase Dam**  
Hidase dam is found in Ethiopia, and the largest dam in Africa

Please enter the name of a dam? **Stop**  
Thank you

**Save facts**

Figure 2 A program that shows memorization based self-learning

In figure 2, when we run the program it asks to enter name of a dam. Then the user write name of the dam and the system automatically retrieve name of the dam and the country found. However, if user enter new fact the system learn from the user. At the end the program has learned where the hdase dam is found and when a user asks again for where the dam is found then the system automatically replays the answer from the updated fact base.

#### 2.2.5. User Interface

User interface is a medium to the user in order to interact with the software. This interface has been designed keeping in mind the user and the aim of the software. It has been designed to accept the inputs

from the user pertaining to the details of the application and study [29]. The user interface is one of the most important part of a knowledge based system. A powerful program with a poorly designed user interface has little value. User interface is a part which is common for user friendliness and it supports communication between a user and the system. User interface is a channel for communication between the KBS and the end-user. Therefore, the KBS to be an interactive tool, it should include a means to show and retrieve information in a user friendly manner.

## **2.3. Online Knowledge Based Systems**

Currently, Internet is a basic need for a fast accessing and transferring of information, Due to wide accessibility of internet computer applications are given high service to users. The KBS also like any other computer applications it offers a greater potential for the delivery of information. In this essence, then, online KBS are being adopted for Internet use by integrating client-server architectures and Web-based interfaces. Thus, web based knowledge-based systems are online or internet based application software primarily designed to help clients or users get important information as well as providing expert advice in a given problem domain so as to enable the users make reasonable decisions in their careers.

### **2.3.1. Development of Knowledge Based Systems**

Unlike any conventional computer information systems, intelligent systems such as knowledge based or expert systems are not widely utilized by every individual computer users as they are expensive and difficult to develop as compared to the traditional computer applications. Hence, developing intelligent systems, knowledge-based systems in particular is not an easy task to accomplish.

Knowledge-based systems are complex artifacts that are expensive to build and difficult to validate, especially when the components of the system exhibit a variety of situations, including: sequential execution, conflict, concurrency, synchronization, merging, confusion, or prioritization [29].

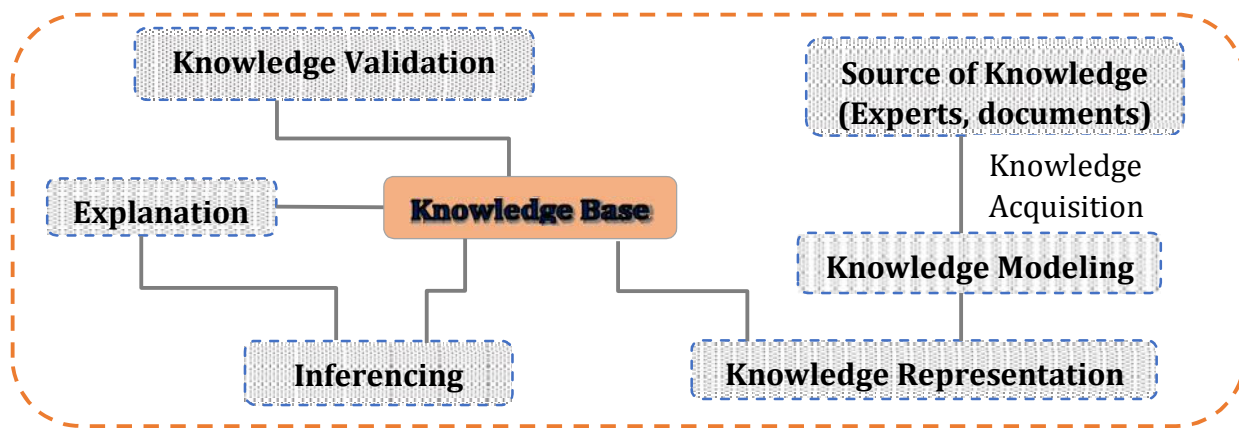
## **2.4. The Knowledge Engineering Process**

Knowledge Engineering is a process of acquiring knowledge from domain experts and building a knowledge based systems according to the acquired knowledge. Knowledge engineering involves the cooperation of human experts in the domain working with the knowledge engineer to codify and make explicit the rules that a human expert uses to solve real problems [30].

The development of a knowledge based system is a wide process and work with an integration of different components and it needs a series of activities that include gathering and organizing relevant

information, structuring and transforming the acquired information from human understandable to a computer understandable format. In the development of knowledge based system this whole process represents the knowledge engineering (KE) discipline which it needs a series of tasks from the knowledge acquisition process up to the final transformation of the acquired knowledge.

There are many different factors that make KE essential. Due to the reasons that there exist numerous kinds of knowledge, many domain experts with different backgrounds, different knowledge representation methods, etc., there must be standardized procedures to address those issues. KE provides structured methods to facilitate the development of knowledge based systems. According to Ranjan A. [30], the knowledge engineering process includes at least six major components as in figure 3 below.



*Figure 3 Knowledge Engineering Process Adapted from [30]*

Knowledge can be used in a knowledge-based system to solve new problems via machine inference and to explain the generated recommendation.

## 2.5. Knowledge Acquisition

Knowledge Engineering plays a vital role in the development of various technologies. These different types of technologies are expert systems, neural network, artificial intelligence, intelligent systems, data mining, decision support systems, knowledge based systems etc. These technologies are used in hybrid fashion that is combining of them with their strengths and weaknesses to develop Hybrid Knowledge based medical information system [31].

Knowledge acquisition involves the acquisition of knowledge from human experts, books, documents, sensors, or computer files. The knowledge may be specific to the problem domain or to the problem solving procedures, it may be general knowledge, or it may be Meta knowledge means that information about how experts use their knowledge to solve problems and about problem solving procedures [30].

Knowledge acquisition is the way to identifying of a relevant information sources and transformation of the identified information into a knowledge by developing new knowledge (research), adding value to information to create knowledge and converting implicit to explicit [32].

Usually, the process of knowledge acquisition has been considered as the process of extracting and transcribing the knowledge of domain experts into a format usable to a computer. However, current trends consider knowledge acquisition as an integral part of the designing process, centered on the idea of a model [33].

Knowledge acquisition implements various methods and techniques to accomplish the required task. It is a complex process of acquiring expert knowledge by utilizing a number of techniques to obtain the desired knowledge. Thus, in this process, the knowledge engineer focuses on the essential knowledge and uses suitable techniques to capture various types of knowledge, such as goals, decisions, relationships and attributes from different experts. The knowledge acquisition process incorporates different methods such as interviews, questionnaires, document analysis and observation to acquire factual and explicit knowledge [34]. The performance of the developed expert systems depends upon the reliability, validity and accuracy of the elicited knowledge. The process of a knowledge elicitation is affected by different contributing factors such as communication between the expert and ability of knowledge engineer [35].

Knowledge acquisition is the process in which knowledge engineers acquire knowledge from human experts, group of experts, documentation, manuals, which helps in building complete, accurate and well organized knowledge based systems.

Here are the commonly used and effective techniques of to acquire relevant knowledge are discusses as follows [36]

#### **A. Interview**

Interview is a last step of the hiring process, the opportunity to meet one another, the exchange of information and come to tentative conclusion with the domain expert. Interviewing involves asking questions and getting answers from participants in a study. Basically there are three common types of interviews. These are Structured, semi-structured and unstructured types of interviews [36].

- ❖ **Structured Interview:** it is a preplanned type of interview and also called Patterned, Directed or Guided interviews. Structured interview is a way of asking questions directly to the domain expert.

During this type of interview it requires a clear topical focus guide or questionnaire and every single detail of the interview is decided in advance. The questions to be asked, the order in which the questions will be asked, the time given to each candidate, and the information to be collected from each candidate are all decided in advance. In this type of interview all questions are uniform, accurate and precise. Therefore, there will be consistency and minimum bias in structured interviews. Characteristics of structured interview are: [36].

- Questions are created prior to the interview
- Asks each respondent the same series of questions.
- Questioning is standardized, ordering and phrasing of the questions are kept consistent from interview to interview.

✎ **Semi-Structured Interview:** it provides a clear set of instructions for interviewers and can provide reliable, comparable qualitative data. Semi-structured interviews are often preceded by observation, informal and unstructured interviewing in order to allow the researchers to develop a keen understanding of the topic of interest necessary for developing relevant and meaningful semi-structured questions. The knowledge engineer has a chance to change the order of questions and expand the dimension of questions based on the participants' responses [36].

✎ **Unstructured Interviews:** - This interview is not planned in detail and more flexible. Hence it is also called as Non-Directed interview. The question to be asked, the information to be collected from the candidates are not decided in advance. Candidates are more relaxed in such interviews. They are encouraged to express themselves about different subjects, based on their expectations, motivations, background, interests, etc. in these kind of interview the knowledge engineer can make a better judgement of the candidates' personality, potentials, strengths and weaknesses [36].

Therefore, effective interview techniques are depend on the ability of the knowledge engineer to articulate their implicit knowledge. Because every interview is different in very specific ways and it is difficult to provide comprehensive guidelines for the entire interview process. Therefore, interpersonal communication and analytic skills of knowledge engineer is very important [37].

## **B. Observation**

Observation is the most obvious and straightforward approach to knowledge acquisition. Through this technique knowledge engineer directly observe how problems are solved by domain expert. Observation was particularly fruitful in seeing what the expert physically does when solving problems. It was useful

in determining what types of knowledge the human expert used to solve problems and the forms in which the knowledge were stored. Observations are used primarily as a way of supporting verbal protocols, and it is an expensive and time-consuming task [38].

### **C. Document Analysis**

The final form of knowledge acquisition method is concerned with a detailed analysis of the existing document. This technique is used to collect relevant knowledge from the existed documents of different format. These documents include professional literature, brochures, manuals, guidelines, employee handbooks, reports, glossaries, course texts, and other relevant materials [38].

## **2.6. Knowledge Modeling**

In the development process of a knowledge-based system it is evident that many tools will be utilized in order to encode the knowledge extracted from domain experts. Among the different knowledge based tools using of the knowledge modeling tools are one issue. Knowledge modeling are help to the knowledge engineer to convert the acquired information of the knowledge acquisition process in to simple way and easy understandable manner.

Models are used to capture the essential features of real systems by breaking them down into more manageable parts that are easy to understand and to manipulate. Models are very much associated with the domain they represent [39]. That domain will define their practicing communities, modelling languages and the associated tools used. Models help people to appreciate and understand such complexity by enabling them to look at each particular area of the system in turn. Models are used in systems development activities to draw the blueprints of the system and to facilitate communication between different people in the team at different levels of abstraction. People have different views of the system and models can help them understand these views in a unified manner [39].

There are a number of knowledge modeling approaches such as structured English, decision tree structure and decision table structure. However, for the purpose of this study we are used the decision tree structure modeling. A decision tree are tools that uses a graphic approach to compare competing alternatives and assign values to those alternatives by combining uncertainties, costs, and payoffs into specific numerical values. Decision tree are tools that are used for building knowledge-based systems and they provide useful solution for many problems of classification where large datasets are used and the information contained is complex [40]. Furthermore, decision tables and decision trees are practical tools that enhance clarity, conciseness and comprehensibility.

In knowledge based system development decision tree have various advantages. The following are the most advantages of a decision tree [40]

- **Graphic:** a decision tree can be used to represent decision alternatives, possible outcomes, and chance events schematically. The visual approach is particularly helpful in comprehending sequential decisions and outcome dependencies.
- **Efficient:** it quickly express complex alternatives clearly, easy to modify as new information becomes available, and set up a decision tree to compare how changing input values affect various decision alternatives. Standard decision tree notation is easy to adopt.
- **Powerful:** a decision tree are powerful in determining conditions and actions, to transforming conditions and actions into sequences, for checking consistency and completeness, in making decisions, and to portraying simple and complex problems
- **Complementary:** it can be used in conjunction with other modeling management tools.

A decision tree is also easy to use in the development of the knowledge based system, since it is easy to convert into knowledge representation of the production rules, by deriving a rule for each path in the tree that starts at the root and ends at the leaf. Therefore in this study we are used the decision tree for the knowledge modeling tools.

## 2.7. Knowledge Representation

Now a days we use information for our day to day activities mostly by using computers, tablets and other electronic devices in its electronic format. So that, in order to store, retrieve and use the information or knowledge from the electronic devices we must be need a proper method of information and knowledge structuring. When we use information from computers and an electronic devices for a specific task information should be stored, organized and retrieved in the way of computerized format for the case of easy and fast information access.

Knowledge representation (KR) is a process of transforming the acquired information and knowledge into a computer readable model [41]. It is at the very core of a radical idea about how to understand intelligence: instead of trying to understand or build brains from the bottom up, we try to understand or build intelligent behavior from the top down [41]. We ask, in particular, what an agent would need to know in order to behave intelligently, what computational mechanisms could allow this Knowledge to be made available to the agent as required. Knowledge is a progression from data to information, from information to knowledge and from knowledge to wisdom while representation is a combination of

syntax, semantics and reasoning [42]. Hence, KR is an area of research in AI which aims at representing knowledge in symbols to facilitate inference from those knowledge elements, creating new elements of knowledge [42].

Different definition and description had been given about KR by different researchers and expert system developers regarding the concepts of what it is, the methods and the tools involved in KR, its requirements, etc. Among the various researches [43] had put the definition KR from the perspective that involves five different roles that KR plays. First, KR is most fundamentally a surrogate or a substitute for a thing or an entity enabling the entity to determine consequences by thinking rather than acting or by reasoning about the world rather than taking action in it.

Secondly, it is a set of ontological commitments, presenting an answer to the question regarding in what terms we should think about the world. Third, it is a fragmentary theory of intelligent reasoning expressed in terms of the representation's fundamental conception of intelligent reasoning, the set of inferences that the representation sanctions and the set of inferences that it recommends. Fourthly, it is a medium for pragmatically efficient computation, that is, the computational environment in which thinking is accomplished. And finally, KR is a medium of human expression, that is, a language in which we say things about the world.

There are numerous ways of knowledge representation techniques, such of the common knowledge representation techniques are: production rules, semantic networks, frames, cases, objects and logical expressions are available to provide a high-level abstraction of a system [44]. For the purpose of this study the researcher discusses the two representation techniques namely the case and the rule based representation technique as follows.

### **2.7.1. Case based knowledge representation**

A case can be defined as previously experienced situation which has been captured and learnt, is referred to as a past case, previous case, stored case or retained case. Note that the term problem solving is used with common practice in the area of knowledge-based systems. This means that problem solving is not necessarily the finding of a concrete solution to an application problem, it may be any problem put forth by the user [45]. Therefore, cases have three different aspects this can be described as follows.

- Situation/ problem description: describes specific circumstances, and the state of a situation
- Solution: provide how the problem described was solved or treated in a particular instance.
- Outcome: describe the final result, consequence and feedback of the proposed solution.

### 2.7.1.1. Advantage of Case based representation

A case based reasoning approach has tremendous advantages in the development of knowledge based system. The following are the main advantages of case-based reasoning [46] [47].

- Ability to express specialized knowledge.
- Naturalness of representation
- Modularity
- Easy to knowledge acquisition
- Self-updatability
- Handling unexpected or missing values
- Inference efficiency.

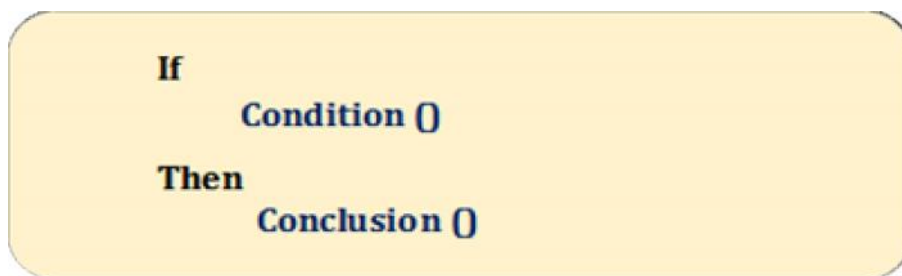
### 2.7.1.2. Disadvantage of Case Based Representation

Even though case based reasoning approaches have a numbers advantage. However, due to lack of sufficient cases, the construction and inference mechanism of a case-based system loss the required objective. Some of the limitation issues in case based representation are [48]:

- Inability to express general knowledge
- Knowledge acquisition problems
- Inference efficiency problems and Provision of explanations

### 2.7.2. Rule Based Reasoning

Rule based reasoning is a particular type of reasoning whose knowledge representation is a set of rules and facts which uses a way of "If ... Then" rule statements. Rules are one of the most popular knowledge representation and reasoning methods. This popularity is mainly due their naturalness, which facilitates comprehension of the represented knowledge. The rule based reasoning has an "If ... Then" type structure which links a certain identified information in the IF (condition) part with the concluded information in the THEN part.



*Figure 4 Rule format for rule based expert system*

Using the rule, one can construct a comprehensive knowledge base for diagnosing different domain problems. Each conditions of the rules are connected between each other with logical connectives such as, AND, OR, NOT, etc., thus forming a logical function. When sufficient conditions of a rule are satisfied (true) then the conclusion is derived. Rule based expert systems have a significant role in many different domain areas such as medical diagnosis, electronic troubleshooting and data interpretations. A typical rule based system consists of a list of rules, a cluster of facts and an interpreter [48]. One example of rules are listed below:-

**Rule1:**

**If** Client age is above 35, and heavy Smoker And/ Or  
 Have problem of varicose vein And/ Or  
 Had history of have (Hypertension, or Diabetes) And/ Or  
 Current problem of Hypertension And/ Or  
 Current problem of Diabetes **Then**

- ☛ Not-recommended methods: COC, Implants
- ☛ Recommended methods: POP, Condom, and IUCD

According to the above rule based reasoning, the “IF” side of the rule is referred to the conditions and the “Then” side of the rules referred to the conclusions. The given conditions are evaluated based on what is currently known about the problem being solved. This mean if all the premises of the rule evaluated are true, the actions in the conclusion part is executed.

### **2.7.2.1. Advantage of rule based reasoning**

Rule based reasoning approach have a numbers of advantages. According to [48] the major advantages of rule based reasoning in the development of knowledge based system are:

- They can easily represent general knowledge about the given problem domain.
- Each rule has a uniform syntax. Hence, each rule can be easy to understand and to analyze.
- Independent: without affecting the existing rules add a new additional rules.
- Rules are a very natural knowledge representation method with a high level of comprehensibility.
- Each rule is a discrete knowledge unit that can be inserted into or removed from the knowledge base without taking care of any other technical detail.
- The ability to provide explanations for the derived conclusions are a straightforward manner. This feature of symbolic rules is a direct consequence of their naturalness and modularity.

### **2.7.2.2. Disadvantage of Rule Based Reasoning**

As rule based knowledge representation system has many advantages, it has the following some limitations [49].

- The standard way of acquiring knowledge through interviews with domain experts is bulky and time consuming.
- It is not possible to draw conclusions from rules when there are missing values in the input data.
- Inference efficiency problems: In certain cases the performance of the inference engine are not the desired one especially when the rules are too large.
- Difficulty in maintenance of large rules

In the comparison above both case based and rule based knowledge representation have advantages and dis-advantages. The rule based knowledge representation technique has limitation of maintenance and inference efficiency in some cases when the number of rules are too large. However, since human health is sensitive by its nature every input values, conditions, and parameters of these study must checked to meet the final conclusion or goal. Therefore, due to this reason and the objectives of the study by minimizing and solving the problems of a rule based knowledge representation technique, the researcher uses the rule based representation technique.

## **2.8. Knowledge Based System Development Tools**

A KBS tool is a set of software instructions and utilities taken to be a software package designed to assist the development of knowledge-based systems. Personal computers, typical programming languages like java and dot Net framework (VB and C#) can used in KBS development. These programming languages are general purpose and also being used to develop other application than AI applications [23].

A programming tool or software development tool is a computer program that software developers use to create, debug, maintain, or otherwise support other programs and applications [50]. Since a research programming is a form of programming, modern day tools that help all programmers also help research programmers. However, research programmers often do not take full advantage of these tools since the target audience of these tools is people engaging in software engineering, an activity with vastly different characteristics than research programming [50]. The main goal of software engineering is to create robust, well-tested, maintainable pieces of production quality software. In contrast, the research programming is to obtain insights about a topic [50].

Currently there is a huge number of programming tools available for programmers that exist in different forms and purposes. Some tools are used for writing and editing program source codes while others are used for compilation, source code analysis and many more tasks.

A KBS tool is a set of software instructions and utilities taken to be a software package designed to assist the development of knowledge-based systems. According to John [51], up to 200 KBS tools were commercially available. Many are still available but no longer described as KBS tools for marketing reasons. The KBS tools have another name like intelligent decision support tools, enterprise support tools or knowledge management tools.

There are more development tools that are used to develop KBS such as the general purpose programming tools such as Java, Asp.net, software packages like Matrix Laboratory (MATLAB), Java Neural Network Simulator (Java NNS), E2gRuleEngine, Java Expert System Shell (JESS), Prolog Expert System Shell (PESS), List Processing (LISP), Artificial Intelligence Markup Language (AIML) are useful tools in developing the KBS.

**LISP:** John McCarthy (1960) published a remarkable paper showing a handful of simple operators and a notation for functions, one can build a whole programming language. He called this language Lisp, for "List Processing," because one of his key ideas was to use a simple data structure called a list for both code and data. There are various versions of Lisp available namely KLISP and C Language Integrated Production System (CLIPS) [23].

**Prolog:** is a logic programming general purpose fifth generation (AI) language. It has a purely logical subset, called "pure Prolog", as well as a number of extra logical features. Prolog has its roots in formal logic, and unlike many other programming languages, Prolog is declarative. The program logic is expressed in terms of relations, and execution is triggered by running queries over these relations [23].

**The dot Net Framework:** - the dot net framework is a library for writing and executing written programs. It exposes numerous classes to the developer. These classes allow the development of rich client systems and Web based systems alike. Since the dot net framework has more classes it provide web based infrastructures for GUI based system development and web services for programming interface development. The framework dot Net also has an integration with the ADO. Net and XML to provide the functionality for the data access. Most of the KBS tools like SWIG prolog are weak in their GUI design and difficult to design a user friendly knowledge based system. Therefore, using the dot net

framework tools for the development of the web based knowledge based system it solves the problem and make the KBS more interactive to the user and make it easy for potential users.

Most of the KBS development tools are case sensitive and has a limitation to develop user friendly, portable, and well-designed user interface. Among the different KBS development tools the dot net framework programming tool are used to develop a web based knowledge based systems with an integration of the different web readable languages like HTML, CSS, JQuery, JavaScript.

Therefore, for the purpose of this study, the ASP.Net framework programming language with an integration to the web readable languages (HTML, CSS, JavaScript, Ajax control toolkit) and VB programming are used to implement the proposed web based knowledge based system.

## **2.9. Application of Knowledge Based Systems**

The knowledge based systems offer several advantages over humans. Due to their advantages they are applicable in different area of studies. Knowledge-based systems can be used in a number of applications, some of the applicable areas are listed below [23]:-

Physical development: the KBS are applicable in the area of physical development such as:

- knowledge based system for infrastructure planning
- E-Governance and administration
- Communication and transportation

Economic Development: the KBS are applicable in the area of economic development such as:

- Employment exchange services
- Market reforms/information systems
- New product development advisory
- Business selection advisory

Social Development: the KBS are applicable in the area of social development such as:

- Cultural information, Tourism portal
- Voters identification and election related systems
- Social Awareness systems and programs

Health Improvement: the KBS are applicable in the area of health improvement such as:

- Government schemes information system
- Disease diagnostic system
- Health treatment, and decision support system

## 2.10. Related Research Works

More researchers are work various knowledge based systems in different times. Some of related works conducted by different researchers in the area of medicine and health, and web based expert systems discussed below:-

**Redit (2006)** conducted a study to investigate KBS for HIV pre-testing counseling. The main objective of her work is to look into the feasibility of employing the expert system in the area of pre-test counseling by the knowledge based system technology. She used rule based reasoning techniques and pro gold expert system shell in the developing of the system. The implemented system is able to show the applicability of the technology to the area at a satisfactory level.

**Dada (2011)** developed a knowledge based system for classification of industrial and commercial waste products for the classification of wastes to overcome the difficulty, The main objective of the system is to join the expert system intelligent knowledge and the capability of the Web to put the knowledge of experts anywhere the expert system cannot go, and also to obtain facts and rules from the experts that will allow the system to draw expert level conclusions. The method used production rule for the representation of the knowledge and object oriented approach using Universal Modeling Language (UML) to modeling and it uses Java programming language to implement the system.

**Solomon (2013)** developed a standalone self-learning knowledge-based system that can provide advice for physicians and patients to facilitate the diagnosis and treatment of diabetic patients. The researcher uses both structured and unstructured interviews from domain experts which are selected using purposive sampling technique to acquire knowledge on the area. The acquired knowledge is modeled using decision tree and represent using production IF --- THEN rules. It uses the SWI prolog to implement the system. The developed prototype uses backward chaining to infer the rules. Finally, the developed system is tested and evaluated by the domain experts and encouraging result is obtained.

**Tagel (2013):** developed a standalone knowledge-based system for pre-medical triage treatment. The main objective of the system is to investigate the applicability of rule-based reasoning approach in the development of knowledge based system for hospital triage service. The researcher uses semi-structured interviews from domain experts which are selected using purposive sampling technique to acquire knowledge on the area. The acquired knowledge is modeled using decision tree structure and represented using the production rule. The system is developed using the LPA WIN prolog. The

prototype developed uses backward chaining to infer the rules and provide recommendations. The developed system is tested and evaluated by domain experts and encouraging result is obtained.

A numbers of local researches have been done research in the medical domain. All of the researchers are developed a standalone KBS. The main intension of all researchers is to investigate the applicability of knowledge based system in the medical domain area. The researcher employ similar knowledge representation approaches called the rule based techniques to develop the knowledge based system. In addition all of the researchers are implemented a standalone system that support one language (English), not user friendly (input sensitive) system.

Similarly, the proposed web based KBS of this study is conducted to explore the applicability of rule based KBS for women family planning methods choice and self-decision. The objective of the study is to select, decide and advice women for contraceptive methods based on their health preference and to put the knowledge of experts anywhere in the web. Furthermore, in this research the attempt is to implement rule based system using both back ward and forward inferencing mechanisms. Since, the KBS is implemented using ASP.Net programming language it accessible from everywhere, support three languages, user friendly, easy to explain and error tolerant. Therefore, the proposed web based knowledge based systems can assist family planning method users and physicians during the selection, decision-support process and recommend an appropriate advice.

## **CHAPTER THREE**

### **KNOLEDGE BASED SYSTEM METHODOLOGY**

#### **3.1. Introduction**

In order to develop a KBS the world view is typically related to the general approach of knowledge engineering. In doing this study, we used different types of methods and techniques to achieve the general and specific objectives. As stated previously in chapter one, this study aspires to implement a web based knowledge-based system that intended to select, decide and advice for family planning method users using a knowledge-based system that utilizes the web as an interface. Designing such a system requires adequate human expertise from domain experts, medical professionals, to be exploited by applying knowledge engineering methodology.

The acquisition of knowledge from domain experts is an important process in the construction of any knowledge-based system since such a system is primarily developed to emulate human experts. This process involves data collection, organization, modeling and representation of the acquired knowledge that used for further processes in the development of these KBS.

After the process of knowledge acquisition and modeling, the next most important process in the transformation of the acquired knowledge of domain experts. Obviously, any knowledge that is acquired from human experts are easy and simple to understand by humans, but it is not directly accesses and used by computer. Hence, this knowledge should be converted or transformed into a format that is understandable and ready to act up on by computer by using appropriate knowledge representation tools.

Therefore, this portion of the study is dedicated to present knowledge engineering and the most important process that has been employed throughout the process of this study in the effort to design a web based knowledge-based system for selection and self-decision support to users of the different family planning methods.

#### **3.2. Knowledge Engineering**

The process of building artificially intelligent systems, such as knowledge based systems is summarized under a broader phrase of Knowledge Engineering (KE) which represents different key sub methods and processes. The different methods and techniques that are utilized in this study are described in the following sections where knowledge engineering takes the greater part as the study is intended to build a knowledge-based system.

### **3.3. Knowledge Engineering Tools and Techniques**

There are certain important stages or steps that will be utilized while using the knowledge engineering methodology. Those steps include problem identification, knowledge acquisition, knowledge modeling, knowledge representation, system implementation, testing and evaluation of the system are utilized in this study.

Problem identification represents to the first stage of the study in the development process of this web based knowledge-based system to understand the domain problem. For this study, the problem identified is on self-advice and decision support of women family planning methods according to the users' health preference, current and history of their health condition.

#### **3.3.1. Knowledge Source and Acquisition Techniques**

Knowledge acquisition is the extraction and formulation of knowledge derived from various sources, especially from experts and other sources of knowledge. Knowledge acquisition in knowledge based systems development involves elicitation and representation of the appropriate knowledge from its sources such as human experts, textbooks, multimedia documents, databases, different research papers, yellow pages and from the web in general. This is a process by which KBS developers use to determine where in the organization the knowledge exists, how to capture and use it in the system development phase [52].

Relevant knowledge should be acquired from domain experts, and document analysis to develop the web based knowledge-based system. Developing a knowledge based system of any kind involves extensive extraction of expert knowledge to explore useful knowledge from experts and present the derived knowledge in an appropriate format.

According to this study, knowledge acquisition represents one of the major tasks that plays vital role to get useful information about the domain area in the process of developing an integrated information in family planning methods of the system. Collecting useful information from health center professionals such as physicians (doctors, midwives, nurses) enables to acquire useful knowledge that will be used for the development of the online knowledge based systems. In this study, different valuable information was explored in the knowledge acquisition process. Such as: information about different types of family planning methods, the recommended and not-recommended users' to take the method according to their health condition, its side effects after a user takes the method, and method of action are among the major tasks to be gathered so as to build the knowledge based system.

Various sources of information and knowledge that are required for this study were utilized to collect the relevant expert knowledge. Hence, both the primary and secondary sources of information were utilized to acquire the required knowledge. For this study, medical professionals are the primary sources of knowledge to develop the knowledge based system (Appendix I). In addition, the secondary knowledge sources, various publications such as books, journals and the Internet supplemented a huge amount of knowledge relevant for the study. Thus, the different data collection methods and techniques have been utilized to obtain useful knowledge in conducting this study.

The primary sources of knowledge used in this study are the medical doctors who are currently working in Adama Hospital Medical College and Mari Stops Ethiopia, Adama branch. Adama Hospital Medical College is one of the oldest hospitals which was established in 1943 E.C. The hospital gives different health related services. Currently the hospital has 210 medical staffs who are involved in diagnosing and treatment of patients, and it serves for more than 900 people per a day in different services. Among the different services of the hospital, using and counseling of the family planning method is one of them. Out of the total 210 medical staffs, 55 of them are general practitioner or general doctors (MD) with 27 of them are specialist doctors, 6 health-officers, 17 midwives, 51 nurses with bachelor degree and 23 clinical nurses, 20 pharmacists, 20 laboratory technicians, 4 X-ray and 2 physiotherapy technicians.

In this study, only the medical doctors (gynecologists, Midwives, nurses) were utilized to acquire the medical knowledge regarding family planning methods. Due to high workload, shortage of specialists and health professionals, specialist doctors does not give counseling and service to family planning methods. Hence, among the total of 55 doctors were available to gather the required medical knowledge by selecting sample of doctors in gynecologists and some midwives are selected.

The Mari Stops Ethiopia, Adama branch is one of the non-governmental organization that help people in different health care problems, especially for women. In Mari Stops more women take service of FP counseling, child delivery, pregnancy examination and abortion. This non-governmental organization after it was established in 1982 E.C worldwide it opened a branch in Adama in 1988 E.C to help women in the area. In Mari Stops of Adama branch more than 190 women come to get different service per a day. Out of the 190 women, more than 45 get services on counseling on FP, choose FP, pregnancy checkup and abortion. Most women are choose Mari Stops, because it is free and give service only for women. Currently the Adama branch Mari Stops has 35 medical staffs, 16 of them are midwife, 9 nurse, 2 gynecologist, 2 laboratory technicians, and 2 pharmacists. For the purpose of this research only selected medical doctors (gynecologists) and midwives are taken.

### **3.3.1.1. Sampling Technique**

Due to various constraints, it was difficult to personally contact and communicate each medical expert to gather the required knowledge. Hence, certain sample domain experts from Adama Hospital medical college and the Mari Stops of Ethiopia Adama branch are selected. In doing so, sample medical experts (doctors) and midwives were selected from Adama Hospital Medical College and Mari Stops of Ethiopia, Adama branch out of a total professionals based on the researchers personal judgment using a non-probabilistic sampling technique.

The purposive or judgment sampling is considered desirable when the universe happens to be small and a known characteristic of it is to be studied intensively. In this method of sampling, items for the sample will be selected deliberately by the researcher provided that the choice relating to the items remains supreme. Hence, purposive sampling technique was employed as it best suits the selection of sample domain experts for the study. To select the domain experts by using the purposive sampling technique the researcher uses different parameters such as their field of study, qualification, medical experience and the area where they work.

Since the proposed system is not intended to include all the FP methods and utilize the knowledge of all medical staff of both organizations (Mari Stops Ethiopia and the Adama Hospital medical college), only sample of selected family planning methods that recommended to women and medical professionals to provide the required knowledge about the domain area are selected. The professionals were selected from the staff that involved in gynecology and family planning method counseling.

After deciding and selecting the appropriate methods for the acquisition of knowledge and selecting the sample domain experts from Adama Hospital medical college and Mari Stops Ethiopia, Adama branch staffs, two medical doctors (gynecologists) and one midwives from Adama Hospital Medical College and one medical doctors and one midwives, generally five professionals are selected to acquire the required knowledge.

### **3.3.1.2. Data Collection Methods**

In data collection methods the interview method was chosen as a major method to gather useful information and knowledge. Interviewing different experts on the same problem domain, provides a wider view and knowledge about the particular domain area. The selected five medical professionals (Doctors (gynecologists), and Midwives) from Adama Hospital Medical Collage and Mari Stops Ethiopia, Adama branch were interviewed so far using both the structured and unstructured methods of interviewing.

The interview of the medical professionals had been used for two most important purposes. First, the physicians were interviewed in order to acquire and collect detail information of domain area of the study. Regarding to the FP methods of the study, out of the different types of FP methods, we gather the most effective, available method here in Ethiopia, common and relevant types of family planning methods, the health contradictions of the methods, disease that conflict with the type of methods, the most frequently used type of method, and the most preferable type of FP method that are observed and diagnosed in Adama General Hospital and Mari Stops of Ethiopia, Adama branch are identified.

The physicians were questioned about the most frequent signs, health side effects after users used the method, the recommended and non-recommended method, method of action, more advantageous type of users and a more preferable type of f methods that are observed in the hospital as well as in Mari Stops of Ethiopia. In this regard, the researcher identified the most relevant and effective type of methods, methods that are recommended and not recommended to the user regarding to some conditions such as current and history of user health, age, user method experience are identified during the interview and data collection method.

The interview has also been used to get the knowledge about the selected FP methods, the user pre-checkup diseases, pregnancy related disease, and STI. Therefore, physicians were thoroughly interviewed to extract knowledge required to build the proposed web based KBS.

Besides the interview technique of knowledge acquisition, additional methods of data collection such as document analysis and field observation were also chosen to be utilized. Combined with the knowledge obtained from the secondary sources of knowledge for the study, important knowledge is extracted from the interview of the medical professionals. For the purpose of this study, the most effective methods are the long action FP methods. They are more effective and highly recommended for uses to select instead of the short acting FP methods.

### **3.3.2. Knowledge Based System Modeling**

Knowledge Based System (KBS) construction methods typically provide tools for knowledge analysis in the form of conceptual models of knowledge or simply knowledge models [53]. A knowledge model provides knowledge formats for writing down both static domain knowledge (rules, classes, relations) as well as reasoning strategies in which this domain knowledge is used to solve a problem.

Different type of knowledge modeling tools are available that can used in the construction of knowledge based systems such as structured English, decision table and decision tree. Decision tree structure is a

widely used tool for modeling sequential decision problems under uncertainty and graphically describes the decisions to be made, the events that may occur, and the outcomes associated with combinations of decisions and events [53].

Decision tree structures are very important and powerful to model the knowledge in the development of KBS. When we compare decision tree to decision tables, the decision tree structure has many advantages than the decision tables especially to determining conditions and actions, to transforming conditions and actions into sequences, for checking consistency and completeness, in making decisions, and to portraying simple and complex problems.

This study follows the knowledge engineering methodology to implement the proposed web based knowledge based system. The main objective of these study is to select, decide and advice the relevant and recommended contraceptive method to users based on their health condition. In this process, since decision tree are powerful in decision making medical knowledge should collected and modeled using the decision tree structure. Therefore, for the proposed web based knowledge based system, decision trees structure is used to model the knowledge.

### **3.3.3. Knowledge Representation**

As discussed in chapter two to implement the proposed system, the knowledge obtained from the medical experts should be converted into a format that a computer can understand. To do so, there are different knowledge representation techniques there are numerous ways of knowledge representation techniques, such as production rules, semantic networks, frames, cases, objects and logical expressions are available to provide a high-level abstraction of a system [44]. For the purpose of this study the researcher uses the rule based representation technique.

Rule based knowledge representation has limitation of maintenance and inference efficiency in some cases when the number of rules are too large. However, rules are powerful in their compact representation of general knowledge, homogeneity, independent (adding new rule), its modularity and powerful to check every input values. Since human health is sensitive by its nature every input values, conditions, and parameters of these study (area of medicine) are checked to meet their objective or its goal. Therefore, due to this reason and the objectives of the study by minimizing and solving the problems of a rule based knowledge representation technique, the “IF ... THEN” method of knowledge representation has been utilized to represent the family planning methods knowledge. Therefore, rule based knowledge representation with the “IF ... THEN” method were used to represent the knowledge.

In rule based reasoning mechanism there are two inference mechanisms called the backward chaining and forward chaining. The backward inference mechanism is guided by the goals or final conclusions then check the rules later. But, the forward inference mechanism is guided by the given facts in the knowledge base, check every rules until it satisfies their goal [48].

According to this study users can choose their relevant method before they checked the current and history of their health condition. In the other case users first check all conditions of the system to meet on the final recommended contraceptive method. Therefore, the proposed web based system used both backward and forward inference mechanisms.

#### **3.3.4. Online Knowledge Based System Development**

The KBS development primarily represents the set of software packages that are designed to assist the development of knowledge-based systems. In addition to the software packages, the hardware components, such as computers, that are involved directly or indirectly in the development process also facilitate the development of the proposed web based knowledge based system.

The proposed online knowledge based system incorporates a knowledge base and a web interfaces. The system integrates ASP.Net framework with VB programming language behind code, to implement the web based KBS. ASP.Net is powerful to implement web based systems and easily integrated with other web supported languages such as JavaScript, CSS, HTML and Ajax control toolkit. Therefore, for the purpose of this study ASP.Net framework has been chosen and utilized to implement the proposed system. In addition to that the proposed system supports self-learning. So, to store knowledge, to learn from previous experience and for automatic fact update it uses the Microsoft SQL Server 2012.

Generally the proposed WBKBS is designed with the integration of various programming languages in the dot net framework and it has attractive graphical user interface (GUI). The system it supports three languages (English, Amharic, Tigrigna). Most of the knowledge base is stored using the visual basic programming language and in the SQL server 2012 database. The graphical user interface also designed using the integration of Asp.net, CSS, JavaScript, and Ajax control toolkit version 15.1 programming languages.

#### **3.3.5. System Testing and Evaluation**

Knowledge based system evaluation is the process of determining the quality of the proposed system and advice it provides by using some evaluation criteria. After the implementation phase of software is

completed, it is important to test and evaluate the newly developed system. Therefore, the sets of test cases must be built very carefully.

According to Meseguer, [54], KBS evaluation is a process of checking the system against the predetermined formal requirements. In a knowledge based systems, complete translation and representing of all the requirements is very difficult due to the subjective nature of knowledge and new research outputs.

System evaluation is important in order to measure the quality of the system (including system performance) which helps for further improvement tasks and it helps to measure the performance of a system by utilizing different criteria. It involves user evaluation in order to estimate the degree of acceptance of the system by the users.

In this study the proposed web based knowledge-based system, evaluation is one of the key issues to measure the performance of the system. For medical knowledge-based systems including of this proposed system, the system should be of high quality and performance because users should get quality healthcare services, which includes advising, decisions, and treatment. A statistical methods of system evaluation will be used in order to taste and evaluate the performance of the proposed system.

## **CHAPTER FOUR**

### **KNOWLEDGE MODELING AND REPRESENTATION**

#### **4.1. Introduction**

To solve a problem using any methods, useful knowledge has to be extracted from experts of the problem domain and organized. However, initially the extracted knowledge might not be in a format that a computer can understand and act upon. Hence, after the required knowledge has been acquired and organized, the acquired knowledge must be transformed from a human understandable to a computer understandable format using knowledge representation.

In this chapter, the knowledge engineer collected the different type of contraceptive methods and model it by using decision tree structure. The major features concerning to selecting, deciding of a relevant contraceptive method and their essential concepts are identified. The study explores the applicability of rule-based reasoning in health and medicine particularly for selecting and deciding of a relevant contraceptive method according to users' preference. The knowledge for this study is acquired from domain experts by using interviewing and critiquing knowledge elicitation methods, and from relevant documents by using document analysis technique which have been employed to purify the acquired knowledge. Generally, this chapter covers the knowledge acquisition, conceptual modeling and knowledge representation process.

#### **4.2. Knowledge Acquisition**

Knowledge acquisition (KA) is the process of acquiring relevant knowledge from domain experts and other sources such as books, databases, guidelines, manuals, journal articles etc.

KA is the process of eliciting, structuring and representing (formalizing) domain knowledge acquired from different sources. The term knowledge acquisition and knowledge elicitation have been used interchangeably in the field of artificial intelligence (AI) literature. The acquired knowledge can be specific to the problem domain, it can be general or it is meta-knowledge (knowledge about knowledge). Knowledge acquisition is the first step and time consuming task in the development of knowledge based system [55]. Knowledge acquisition is the most important and decisive phase in building knowledge based systems. However, it is an extremely hard task that knowledge engineer does while developing a knowledge-based system. As a result of the challenges and difficulties confronted in the transfer of

expertise knowledge, knowledge acquisition has been depicted as the obstruction of knowledge based systems development [33].

#### **4.2.1. Steps in Knowledge Acquisition**

According to Jones [56], there are two main steps in knowledge acquisition process that are accomplished by the knowledge engineer so as to develop knowledge-based system. These are knowledge elicitation and knowledge structuring.

##### **4.2.1.1 Knowledge Elicitation**

It involves extracting knowledge from human experts, and/or written documents to build a knowledge-based system. In this study, the knowledge required to build a web based knowledge based system was elicited from both tacit and explicit sources of knowledge. Tacit knowledge is collected from five domain experts in the area from Adama Hospital Medical Collage and Mari Stops Ethiopia, Adama branch by using structured and unstructured interviews (the sample interview questions used for this study are found in Appendix I).

During the face to face communication, the acquired knowledge from domain experts has been recorded manually by using pen and paper sheet. Profiles of the domain experts participated in the interview process are presented in the Table 1 below.

*Table 1 Domain Experts Profile*

| <b>No</b> | <b>Educational Level</b> | <b>Specialization</b> | <b>Area Interviewed</b> | <b>Role</b>  | <b>Year of experience</b> |
|-----------|--------------------------|-----------------------|-------------------------|--------------|---------------------------|
| 1         | MD                       | Medicine              | Adama Hospital          | Gynecologist | 7                         |
| 2         | MD                       | Medicine              | Adama Hospital          | GP           | 3                         |
| 3         | MD                       | Medicine              | Mari Stops/Adama        | Gynecologist | 4                         |
| 4         | BSc Midwife              | Midwifery             | Mari Stops/Adama        | Midwifery    | 3                         |
| 5         | BSc Midwife              | Midwifery             | Adama Hospital          | Midwifery    | 4                         |

As indicated in Table 1, the health professionals are devoted to providing health care services in the institutions. According to the domain experts, the investigation of client health problem starts by collecting some relevant information such as current and history of client health condition, age, and user contraceptive choice. Especially current and previous health history of the user is an important attribute to determine users recommended contraceptive methods.

#### **4.2.1.2. Knowledge Structuring**

It involves using concepts discovered during the knowledge elicitation session to build a model or representation of the domain experts' knowledge. It is a process where knowledge engineer uses concepts discovered during the knowledge elicitation phase to build a model of the domain. The knowledge used for building of the knowledge based system in this study focused on knowledge regarding to selection and self-decision of family planning methods.

### **4.3. Knowledge of Family Planning Methods**

Family planning is defined as the ability of individuals and couples to anticipate and attain their desired number of children and the spacing and timing of their births. It is achieved through the use of family planning methods [2] [57]. It is also described as a means of promoting the health of women and families. It is part of a strategy to reduce the high levels of maternal, infant, and child mortality. Any reproductive-age person male or female, regardless of marital status is eligible for FP services, including information, education, and counseling [58].

#### **4.3.1. The Selection Process of Family Planning Methods**

Due to fast technology development and medical improvement, currently there are different types of FP methods available throughout the world to protect women from, risk of sexual intercourse, unsafe abortion and pregnancy related death by selecting the most preferable and recommended contraceptive methods.

All over the world to enhance women health, different health service providers are giving education, training and counseling about contraceptive methods. However, it is not enough to increase the awareness of users, and to decrease unsafe abortion. Except condom almost all methods do not protect against STIs, and HIV-AIDS. Therefore, condoms are the best way to control STIs all the time [59].

When considering the preferable contraceptive method, and to select the relevant method, first one we should understand the method effectiveness, its health risk, partner involvement, its permanence, ability to prevent HIV and STIs, and its availability [60] [58].

**Effectiveness:** Using effective FP methods correctly and consistently can reduce the risk of unintended pregnancy. The effectiveness of a birth control method is measured by how effective it is in preventing pregnancies with typical use and perfect use of the method. Table 2, shows the effectiveness of each family planning methods.

Table 2 Effectiveness of family planning methods [57].

| No | Name of FP Method      | Effectiveness (%) |             |
|----|------------------------|-------------------|-------------|
|    |                        | Typical Use       | Perfect use |
| 1  | COC                    | 92                | 99.7        |
| 2  | POP                    | 92                | 99.7        |
| 3  | Depo-Provera           | 97                | 99.7        |
| 4  | IUCD                   | 99.2              | 99.8        |
| 5  | Male Condom            | 85                | 98          |
| 6  | Implanon, Sino-plant   | 99                | 99          |
| 7  | Abstinence             | 100               | 100         |
| 8  | Sterilization          | 99.5              | 99.5        |
| 9  | Vasectomy              | 99.8              | 99.9        |
| 10 | Calendar Method        | 75                | 96          |
| 11 | Norplant               | 99                | 99          |
| 12 | Jadelle                | 99                | 99.5        |
| 13 | Lactational Amenorrhea | 98                | 99          |
| 14 | No method              | 15                | 15          |

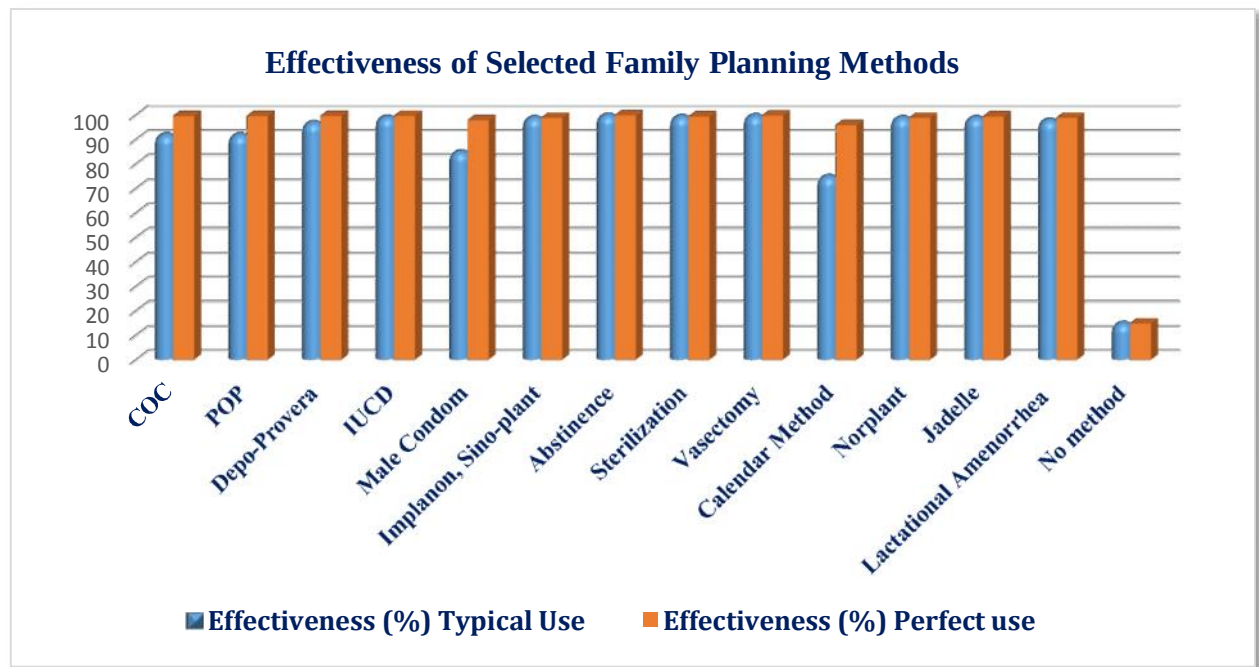


Figure 5 The effectiveness of a selected Contraceptive methods

**Health Risk:** After using the FP methods, they may have some health risks. According to the domain experts and the documents we analyzed there are different type of disease that affect FP method users.

Therefore, to take any type of FP method first a user must check and understand the type of disease that conflict with the method they went to use.

**Partner Involvement:** The willingness of a partner to accept and support a given method may affect your choice of birth control. However, you also may want to reconsider a sexual relationship with a partner unwilling to take an active and supportive role.

**Permanence:** when we choose a method we must consider the long-acting term, short acting term and the permanent methods. Usually short acting methods are less effective than the long-acting methods.

**Preventing HIV and Sexually Transmitted Infections (STI):** Many methods offer no protection against STIs except condoms.

**Availability:** when we choose a contraceptive methods we must understand the availability of the method.

#### 4.4. Types of Family Planning Methods

The most widely used and available methods of family planning are identified during the knowledge acquisition process. As indicated in following figure 5, the family planning methods are it includes four main categories. These are Short-Acting FP methods, Long-Acting FP methods, Emergency FP methods and the Permanent FP methods. The Short-Acting Family planning methods also classified in to Modern methods and Natural methods. The following figure 6, show the overall categories of FP methods.

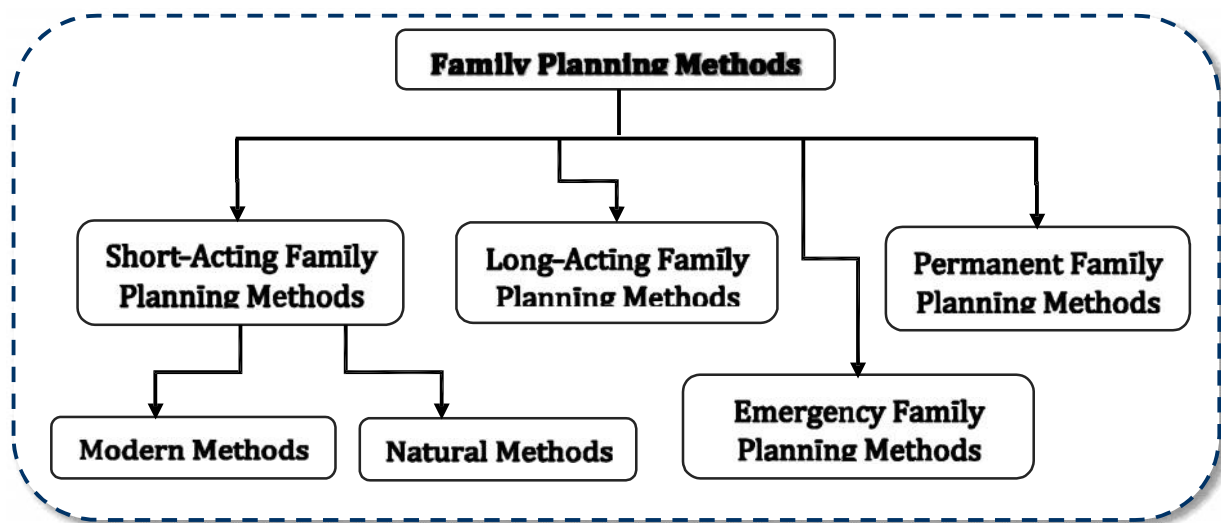


Figure 6 List of the different types of family planning methods

Figure 6 above indicates, the current FP method classifications and its sub-categories. For the purpose of this study sample of family planning methods with their recommended and non-recommended side-effects are selected in each category. Therefore, in this section we discuss the type of each FP method, characteristics and their recommended and non-recommended methods are listed based on the selected disease in each FP method.

#### 4.4.1. Short-Acting Family Planning Methods

Short-Acting FP methods are used for a short period of time to protect women from pregnancy. Due to their low effectiveness and high rate of failing, short-acting FP methods are usually not recommended for use. Some of the short-acting FP methods are hormonal and the others are non-hormonal methods. Hormonal methods are systemic in nature and contain either a progesterone combined with estrogen or progesterone alone [5]. These short acting FP methods are classified into two categories. These are the Modern short-acting methods and the Natural short-acting methods.

##### 4.4.1.1. Modern Short Acting Family Planning Methods

These type of methods are used for a short period of time to prevent unwanted pregnancy. There are different types of modern short acting family planning methods, such as:- Cervical caps, female condoms, male condoms, diaphragms, Depo-Provera, COCs, POPs, and vaginal spermicides. However, for this study due to their availability and their low effectiveness on protecting only the Depo-Provera, COCs, POPs, and Male Condoms are used as indicated in the figure 7.

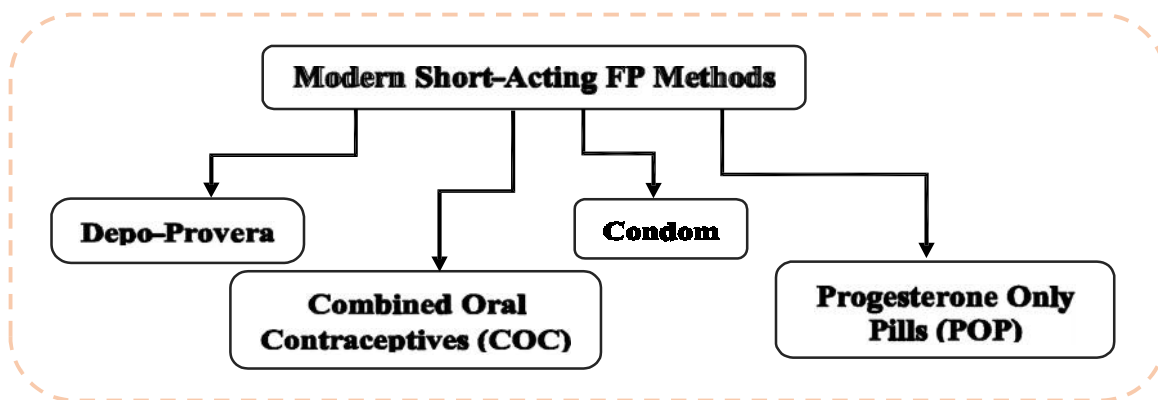


Figure 7 The different types of modern short acting family planning methods

#### A. Combined Oral Contraceptive (COC)

COCs are pills which are preparations of synthetic estrogen and progesterone. They are highly effective in preventing pregnancy. These pills work by preventing the ovary from releasing an egg,

thickening the cervical mucus making it difficult for the sperm to reach the egg, and changing the lining of the uterus making implantation difficult. These pills are taken once a day to prevent pregnancy, and they are controlled by the women any time, can be stopped at any time without a provider's help and do not interfere with sex. Taking these methods are help to protect ovary cancer, and symptomatic of pelvic inflammatory disease.

### **B. Progestin Only Pills (POPs)**

Progestin only pills are taken once a day to prevent pregnancy. As the name indicates the pill only contains progestin, no estrogen and are also called minipills. It works by thickening the cervical mucus making it difficult for the sperm to reach the egg, changing the lining of the uterus making implantation difficult. These pills may be used during the breast-feeding period, as they do not reduce milk flow and must be taken at the same time each day without interruption. As there is no estrogen in the pills there is an increased chance of spotting when used by menstruating women. These pills are relevant for breastfeeding, have varicose veins, have anemia, and smoker women. However, it is not-recommended to take for a women who have a current or history of breast cancer, liver tumor or blood clot.

### **C. Depo-Provera**

Depo-Provera is a type of progesterone-only injections type of modern short acting FP method that a shot is given in to the muscle every two or three month to prevent pregnancy. These methods are systemic progestin preparations that contains synthetic progesterone. It stops ovulation, and/or thickens of the cervical mucus to prevent sperm from passing through.

There are two types of injectable FP methods, namely Depo-Provera which given for every three months, and Net-En which is given every two months, But the most common type of injectable contraceptive is Depo-Provera. Depo-Provera is most used type of FP method in Ethiopia. A women who have Active liver disease, history of diabetes, kidneys, or nervous system caused by diabetes, history of heart attack, breast feeding a baby less than six weeks old, unexplained vaginal bleeding and current or history of breast cancer are not recommended to take Depo-Provera or Net-En method.

### **D. Condom**

Condom is a part of modern short-acting FP method that protect women from pregnancy. Basically there are two types of condoms. These are the male condom and the female condom. Female condom has recently become available in many health centers. However, but for this study due to the traditional know how and law awareness on using of female condom, we discussed only about the male condom.

The effectiveness of this method depends on the user. Risk of pregnancy is greatest when condoms are not used with every act of intercourse. Condoms are it does not have any health side effect. However, it needs effective use all the time. This method is used at any time and preferred by more users because:

- No hormonal side effects,
- It can be used as a temporary backup method and
- Can be used without seeing a health care provider.

The following tables (Table 3) shows the selected type of modern short-acting FP method and their recommended user.

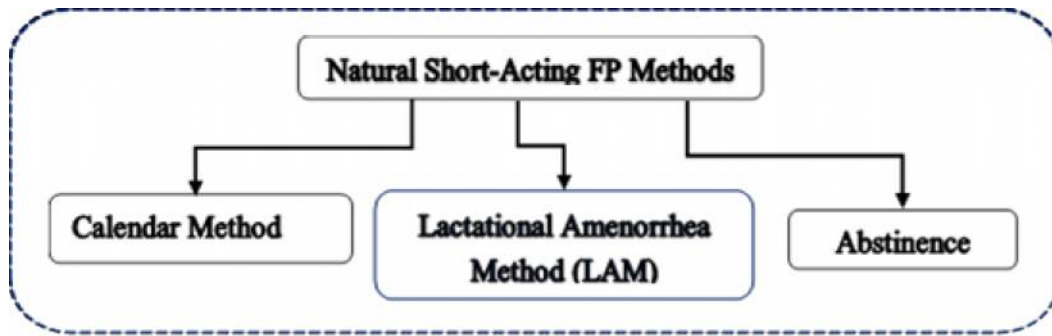
*Table 3 Modern Short-Acting Family planning methods*

| No | FP Method Name | Not Recommended for                                                                                                                                                                                                                                                                                                                                                                                                                     | Most recommended if                                                                                                                                                                                                                                                                                                                                                                                                            |
|----|----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1  | COC            | <ul style="list-style-type: none"> <li>• Liver diseases</li> <li>• Breast feeding below six month</li> <li>• Heavy smoker and age more than 35 years old</li> <li>• Current or history of breast cancer</li> <li>• Current or history of high blood pressure</li> <li>• History of stock or heart disease</li> <li>• History of diabetes</li> <li>• Thrombosis or History of Thrombosis</li> <li>• History of sever-headache</li> </ul> | <ul style="list-style-type: none"> <li>• Unexplained vaginal bleeding</li> <li>• Irregular and painful menses</li> <li>• Diabetes, tuberculosis</li> <li>• Varicose veins</li> <li>• Pelvic inflammatory disease</li> <li>• Past ectopic pregnancy</li> <li>• Smoker and age below 35</li> <li>• Malaria, Anemia</li> <li>• Endometriosis</li> <li>• Cervical, endometrial, and ovarian cancer</li> <li>• HIV, AIDS</li> </ul> |
| 2  | Condom         | <ul style="list-style-type: none"> <li>• Any below age of 18 year</li> </ul>                                                                                                                                                                                                                                                                                                                                                            | <ul style="list-style-type: none"> <li>• Current STIs</li> <li>• HIV, AIDS</li> <li>• Multiple sexual partner</li> <li>• Hepatitis</li> <li>• Diabetes</li> <li>• High blood pressure</li> <li>• Cervical cancer</li> <li>• Any disease</li> </ul>                                                                                                                                                                             |

|   |              |                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                     |
|---|--------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3 | POP          | <ul style="list-style-type: none"> <li>• Current or history of breast Cancer</li> <li>• Jaundice</li> <li>• Liver infection</li> <li>• Serious problem blood vessel</li> <li>• Tuberculosis</li> </ul>                                                                                                                                                             | <ul style="list-style-type: none"> <li>• Severe headache</li> <li>• Ectopic pregnancy</li> <li>• Unexplained vaginal bleeding</li> <li>• Irregular and painful menses</li> <li>• Diabetes,</li> <li>• Epilepsy</li> <li>• Anemia,</li> <li>• Malaria</li> <li>• Heavy smoker and any age</li> <li>• Breast disease</li> <li>• Infected with HIV</li> <li>• High blood pressure</li> <li>• Varicose veins</li> </ul> |
| 4 | Depo-Provera | <ul style="list-style-type: none"> <li>• Liver disease</li> <li>• Current or history of breast cancer</li> <li>• Hepatitis</li> <li>• Breast feeding below six month</li> <li>• Heavy smoker</li> <li>• Un-explained vaginal bleeding</li> <li>• Thrombosis, over weight</li> <li>• Current or history of heart diseases</li> <li>• History of diabetes</li> </ul> | <ul style="list-style-type: none"> <li>• Irregular and painful menses</li> <li>• Tuberculosis</li> <li>• Current diabetes</li> <li>• Epilepsy</li> <li>• Breast feeding a baby above six month</li> <li>• Infected with HIV</li> <li>• AIDS</li> <li>• Varicose veins</li> <li>• Have just had abortion</li> </ul>                                                                                                  |

#### 4.4.1.2. Natural Short-Acting Family Planning Methods

Before the advent of modern contraceptives and up until the present time natural FP methods are used worldwide to control pregnancy. These types of family planning methods include the barrier and traditional type of FP methods, and used for a short period of time to protect women from unexpected pregnancy. There are different types of natural short acting family planning methods. However, for the case of this research we used only the three types of methods: - these are the LAM, Calendar method, and the Abstinence method. The following figure 8, shows the brief categories of a natural short acting family planning methods.



*Figure 8 The different types of modern short acting family planning methods*

### **A. Abstinence**

Abstinence is a method of protecting yourself from having sex. It is a very effective and acceptable method of birth control. Its major problem is that it is only effective if followed without exception. It is important that the user knows the dangers of unprotected sex which include HIV/AIDS, unwanted pregnancy, unsafe abortion, pelvic infection and cultural isolation. Effectively using this method without any exception is 100% effective.

### **B. Lactational Amenorrhea Method (LAM)**

Lactational amenorrhea is the use of breast-feeding as a contraceptive method. It is based on the physiologic effect of suckling to suppress ovulation. To use breast-feeding effectively as a contraceptive for 6 months after delivery requires that the mother feed the baby nothing but breast milk (exclusive breast feeding).

### **C. Calendar Method**

A woman must keep a monthly record of the days she menstruates, with the help of a qualified natural FP counsel or she can estimate when she is most likely to get pregnant if she has sexual intercourse. To use the calendar method as a family planning method, she has to use the following to calculate her fertile period.

- Monitor the length of at least 6 menstrual cycles while abstaining or using another family planning methods. Then calculate the fertile days period by the following method:-
  - From the number of days in the longest cycle, subtract 11. This identifies the last fertile day of the cycle.
  - From the number of days in the shortest cycle, subtract 18. This identifies the first fertile day of the cycle.

For example: Longest cycle: 30 days minus 11 = 19, Shortest cycle: 26 days minus 18 = 8

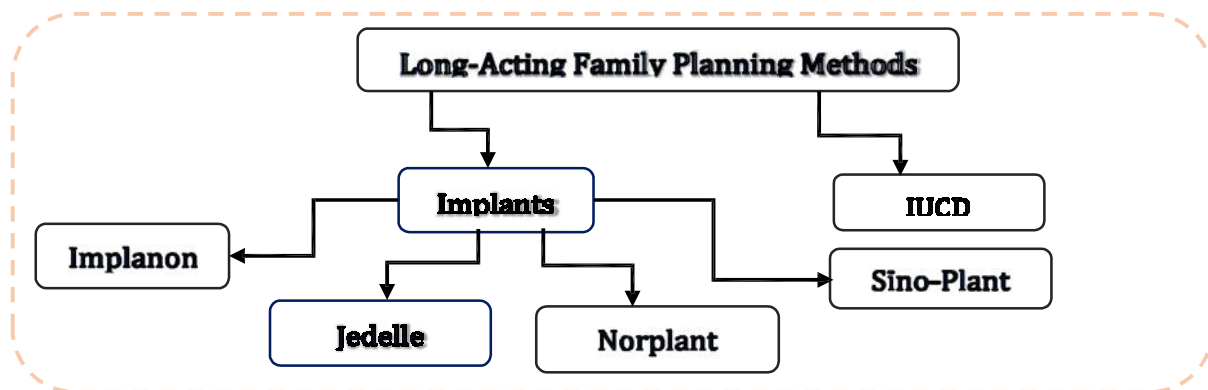
Therefore, the fertile period is calculated to be days 8 through 19 of your cycle. The women must abstain from sexual intercourse during the fertile period.

- Day 1 is the first day of menstrual flow.

Generally the calendar method is not effective type of family planning method. It is high in their failure with a simple step of mistake. Most of the time, it is not relevant method for a women that has irregular menstrual cycle. However, with high care it is good to protect pregnancy and better for women who live with HIV and AIDS.

#### 4.4.2. Long-Acting Family Planning Methods

Long acting contraceptive methods are used for a long period of time to save women from pregnancy. Long acting methods are more effective than the short acting contraceptive methods. There are different types of long-acting family planning methods. The most known and available methods are: - Implanon, Jadelle, Norplant, IUCD, and Sino-plant As indicated in the figure (figure 9) the common types of long acting family planning methods are listed.



*Figure 9 The different types of Long-acting family planning methods*

##### A. Implants - (Implanon, Jadelle, Sino-plant)

Implanon is one part of a hormonal and long-acting FP method with the size of a matchstick. It is a single rod implant that is inserted under the skin in the forearm. It is a progesterone containing long acting FP method with a duration of action of three years. Works primarily by, thickening cervical mucus and disrupting the menstrual cycle, including preventing the release of eggs from the ovaries. They are nearly hundred percent effective or less than one pregnancy per 100 women using of this method. Once this method is used there is no worry about pregnancy and after the Implanon is removed there is no delay, but it cannot protect you from STIs. The Implanon method is may not work as well for women who are overweight.

## **B. Implants - Norplant**

It is one part of a hormonal and long-acting FP method with the size of a six roads of matchstick. It is inserted under the skin in the forearm. It is a progesterone containing long acting FP method with a duration of action of five years, but currently it is effective for up to seven years. Works primarily by, thickening cervical mucus and disrupting the menstrual cycle, including preventing the release of eggs from the ovaries. They are nearly hundred percent effective or less than one pregnancy per 100 women using of this method. Once this method is used there is no worry about pregnancy and after the Implanon is removed there is no delay. Implants-Norplant is relevant to a women who have tuberculosis, epilepsy, heavy smoker, high blood pressure. However, it cannot protect you from STIs and may not work as well for women who are overweight.

## **C. Intrauterine Contraceptive Device (IUCD)**

IUCD is a small piece of flexible plastic device with or without copper wound around it. The copper increases effectiveness of the method. Modern IUCDs are highly effective, easily inserted and removed. The IUCD is inserted into the uterus through the vagina and cervix by a trained family planning provider and is left in place with the strings hanging down through the cervix into the vagina. There are different types of IUCDs which are: - MLCu-375, Nova T which are used for five years and TCU-380A IUCD which are effective for up to twelve years.

The most commonly used and available type IUCD in FP programs is the copper-bearing TCU-380A-IUCD, which are available and widely used in Ethiopia, and the first usable method in Addis-Abeba (capital city of Ethiopia). It works primarily by causing a chemical change that damages sperm and egg before they can meet. However, Depo-Provera is the top usable FP method in Ethiopia, and female sterilization is the top useable FP method around the world respectively.

*Table 4 List of Long-Acting Family planning methods*

| No | FP Method Name                                       | Not Recommended for                                                                                                   | Most recommended if                                                                                |
|----|------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|
| 1  | Implants -<br>(Implanon,<br>Jadelle, Sino-<br>plant) | Thrombosis<br>Jaundice or liver disease<br>Current or history of breast<br>cancer<br>Un-explained vaginal<br>bleeding | Women who need FP method<br>up to 3, 4, and 5 years<br>respectively<br>Miscarriage<br>Heavy smoker |

|   |          |                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                  |
|---|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|   |          | Diabetes<br>Over weight<br>Hepatitis<br>Epilepsy<br>Tuberculosis<br>High blood pressure                                                                                                                                                                    | Breast feeding above six month<br>Varicose veins<br>Current or history of Anemia<br>Have HIV infected                                                                                                                                            |
| 2 | IUCD     | History of PID<br>Uterine abnormality<br>History of ectopic pregnancy<br>Un-explained vaginal bleeding<br>Irregular and painful menses<br>Multiple partner<br>Current STI<br>Pelvic tuberculosis<br>HIV, AIDS<br>Cervical, endometrial, and ovarian cancer | Any reproductive age<br>Breastfeeding<br>Diabetes<br>Epilepsy<br>Heart disease<br>Genital treat infection<br>Breast Cancer<br>Heavy smoker<br>Pelvic Inflammatory Disease<br>Do hard physical work<br>Past pelvic surgery<br>High blood pressure |
| 3 | Norplant | Weight over 75kg<br>Jaundice<br>Breast cancer<br>Sever Chest pain and shortness of breath<br>Serious problem of blood vessels<br>Un-explained vaginal bleeding<br>Hepatitis, Over-weight<br>Tuberculosis                                                   | Epilepsy<br>Heavy smoker<br>Pelvic Inflammatory disease<br>High blood pressure<br>Women need FP method up to 7 years<br>Varicose veins<br>Current or history of Anemia<br>Have HIV infected                                                      |

#### 4.4.3. Emergency Contraceptive Methods (EC)

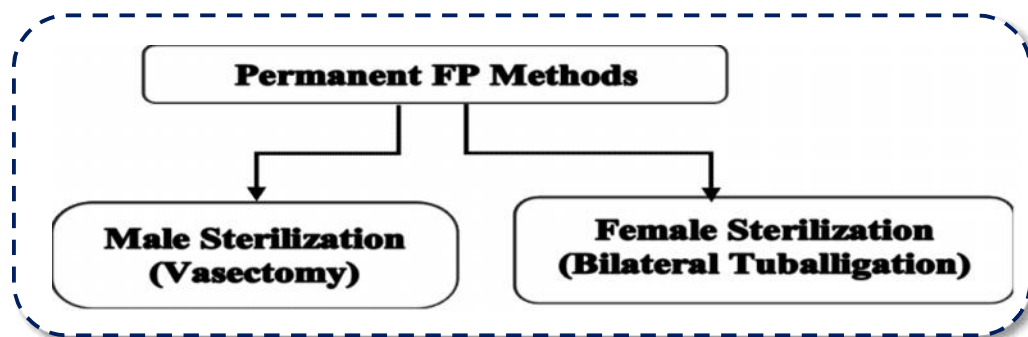
EC methods are one part of FP methods that contain a progesterone alone, or a progesterone and estrogen hormones together like the natural hormones. It is also called the morning after pill. This type of FP method is used to protect pregnancy when taken up to five days (120 hours) after unprotected sex, if pregnancy is not planned or desired to prevent pregnancy. But, when the number of hours after unprotected sex increase, its effectiveness can be decrease. This method is not work when the women is already pregnant. EC should not be used in place of contraceptive method, it should be used only in an emergency case by any women. Basically COCs, POPs, and IUCDs (copper-releasing) can be used as emergency contraceptives.

*Table 5 The Emergency Family planning methods list and recommendations*

| No | FP Method Name                | Not Recommended for                                                                                                       | Most recommended if                                                                                                                                                                                                        |
|----|-------------------------------|---------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1  | Emergency Contraceptive Pills | <ul style="list-style-type: none"><li>Do not use after five days</li><li>Do not taken as a continuous FP method</li></ul> | <ul style="list-style-type: none"><li>In cases of rape</li><li>When condom has broken</li><li>IUCD has come out of place</li><li>When pills are lost or forgotten</li><li>When sex took place without FP method.</li></ul> |

#### 4.4.4. Permanent Family Planning Methods

Permanent methods of FP are methods that are used to completely stop child birth forever. A women who used a permanent family planning method cannot be pregnant even if she wants. Therefore, this type of family planning is only recommended for women or man who will not want more children. Generally this method is a surgical approach and an irreversible type of family planning method. As indicated in figure 10, there are two types of permanent FP methods



*Figure 10 The permanent type of family planning methods*

### A. Bilateral Tubal ligation

Bilateral tubal ligation is a permanent and non-hormonal type of FP method for women who do not want more children. It involves blocking both fallopian tubes (by tying or cutting or applying rings or clips) and preventing the sperm from reaching the ovary. It is intended to be an irreversible method. Therefore, repeated and thorough counseling is essential to minimize regret in the future. There is no medical condition that prevent from using female sterilizations, but it might be delay, caution the procedure or make special arrangements. This method is suitable for:-

- Clients who have all the children they want and need reliable contraceptive
- Clients who have serious medical problems and cannot use other reliable methods E.g. Cardiac disease

### B. Male Sterilization (Vasectomy)

Vasectomy is a permanent and non-hormonal FP method for men involving a minor surgical procedure. Where by both tubes are cut and tied. This type of family planning method is highly effective, does not affect sexual performance, does not have any known associated health risk, simple and save. But the disadvantage of vasectomy is that it not reversible family planning method.

In this research, due to the law awareness of men in family planning method only the Bilateral Tubal ligation method of family planning are used as shown in table 6.

*Table 6 The bilateral tubal ligation family planning method*

| No | FP Method Name | Not Recommended If                                                                                                                                                                                                                                          | Most Recommended If                                                                       |
|----|----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|
| 1  | Sterilization  | <ul style="list-style-type: none"><li>• Pregnant</li><li>• Past abortion infection</li><li>• Unexplained vaginal bleeding</li><li>• Pelvic Inflammatory Disease (PID) with in past 3 months</li><li>• Current STI and HIV</li><li>• Pelvic cancer</li></ul> | <ul style="list-style-type: none"><li>• Breast Cancer</li><li>• Cardiac disease</li></ul> |

## 4.5. Conceptual Modeling

As stated in the literature review section, conceptual modelling is the heart of knowledge acquisition phase. It is the basic step to know and to understand well the problem domain and to prepare for the knowledge representation phase.

Knowledge modeling is a cross disciplinary approach to capture and model knowledge into a reusable format for the purpose of preserving, improving, sharing, aggregating and processing knowledge to simulate intelligence [61]. Knowledge is modeled after it is captured from its sources, Knowledge modeling for family planning methods has been done after the core concepts are extracted from domain experts and secondary source of data (document) analysis. Mainly family planning methods are done in taking consideration on each of the attributes such as user current health condition, user family history, Age, breast feeding, and current pregnancy condition. In this study, the concept laddering modeling technique is used to show how a user can choose and decide a relevant type of Family planning method.

Decision tree are now used effectively and widely in practical application areas, due to its interpretability and ease of use. Decision tree is a schematic tree-shaped diagram used to determine a course of action and models the possible consequences of a series of decisions in some situation. Decision trees are modelling tools that are used in a variety of different settings to organize and break down clusters of data [62].

Conceptual Modeling of domain knowledge implies capturing the static structure of information and knowledge types [63]. Currently, decision trees are used in many disciplines such as medical diagnosis, cognitive science and artificial intelligence [64].

### 4.5.1. Contraceptive Methods Selection and Decision Tree Structure

Family planning method selection and self-decision process involves laboratory examination, and physician estimates in order to recommend the possible and relevant method.

To summarize, during the method selection process the physician performs the following specific activities. Such as:-

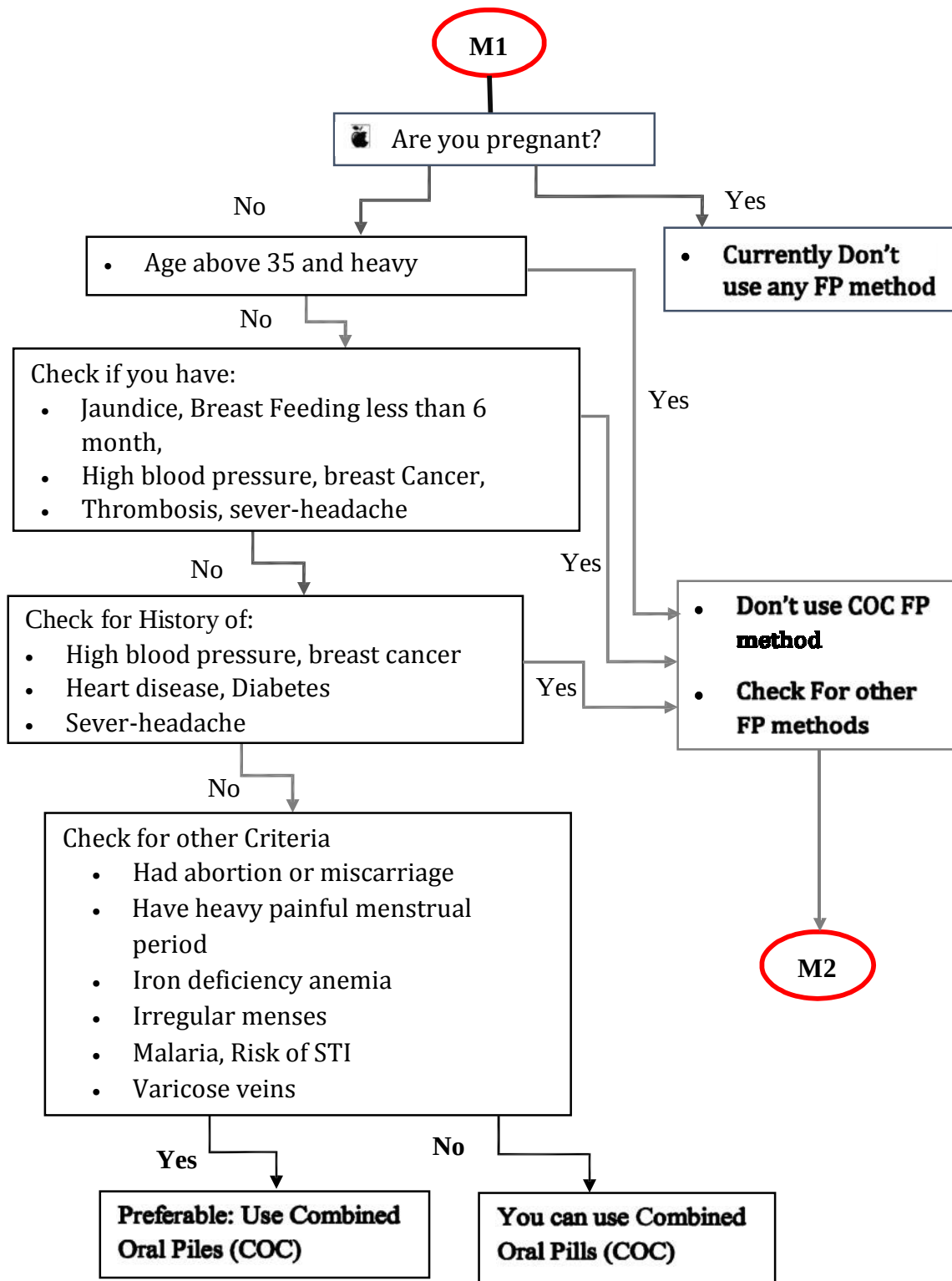
- History taking (gather information from the family planning method user).
- The correct age of the family planning user
- Breast feeding below six month after child birth
- Checking the current pregnancy laboratory result.

- The method she needs firstly, regarding of the users preference.
- Check if the choice of the FP method user is match with the users health condition or not
- Recommend the possible type of family planning method that match to the user.
- Inform the type of family planning method that are not recommended to use by the user regarding of the users health states.

Additionally, users' response may be ambiguous when describing symptoms and even can not specify the details of their feeling clearly. Therefore, to complete the diagnosis successfully and reach at certain conclusion further assessment on physical examination and laboratory test for pregnancy and medical checkup has a great value.

Decision tree structures are the bases for the development of KBS. The system follows the same procedures as presented in the decision tree structure below to decide the recommended and not recommended type of family planning methods during the self-decision support process.

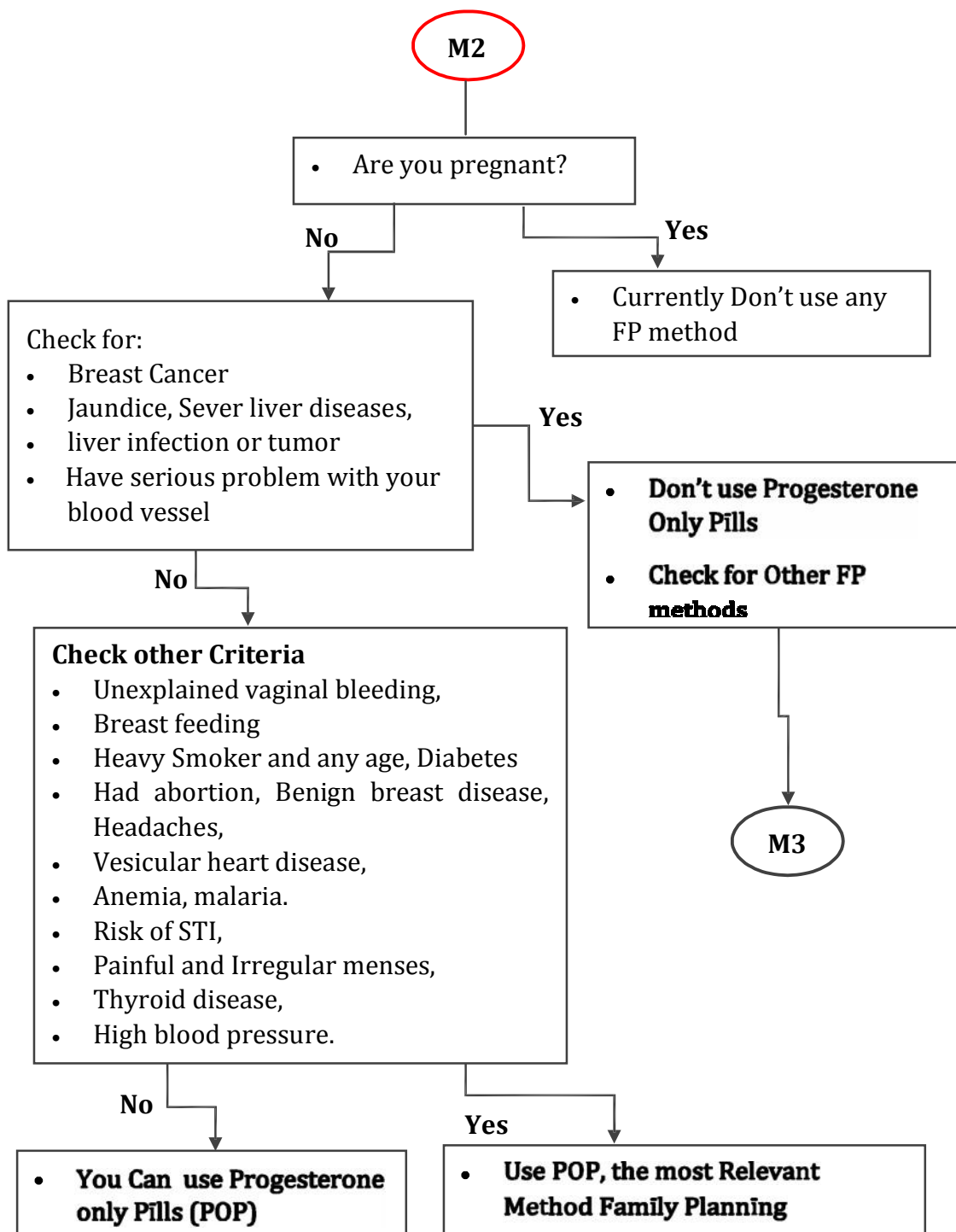
Finally, the acquired knowledge of different FP methods from Adama Hospital Medical Collage and Mari Stops Ethiopia, Adama branch are modeled using the decision tree structures below from Figure 11 up to Figure 19.



**Note:**

**M1** = Family planning method category

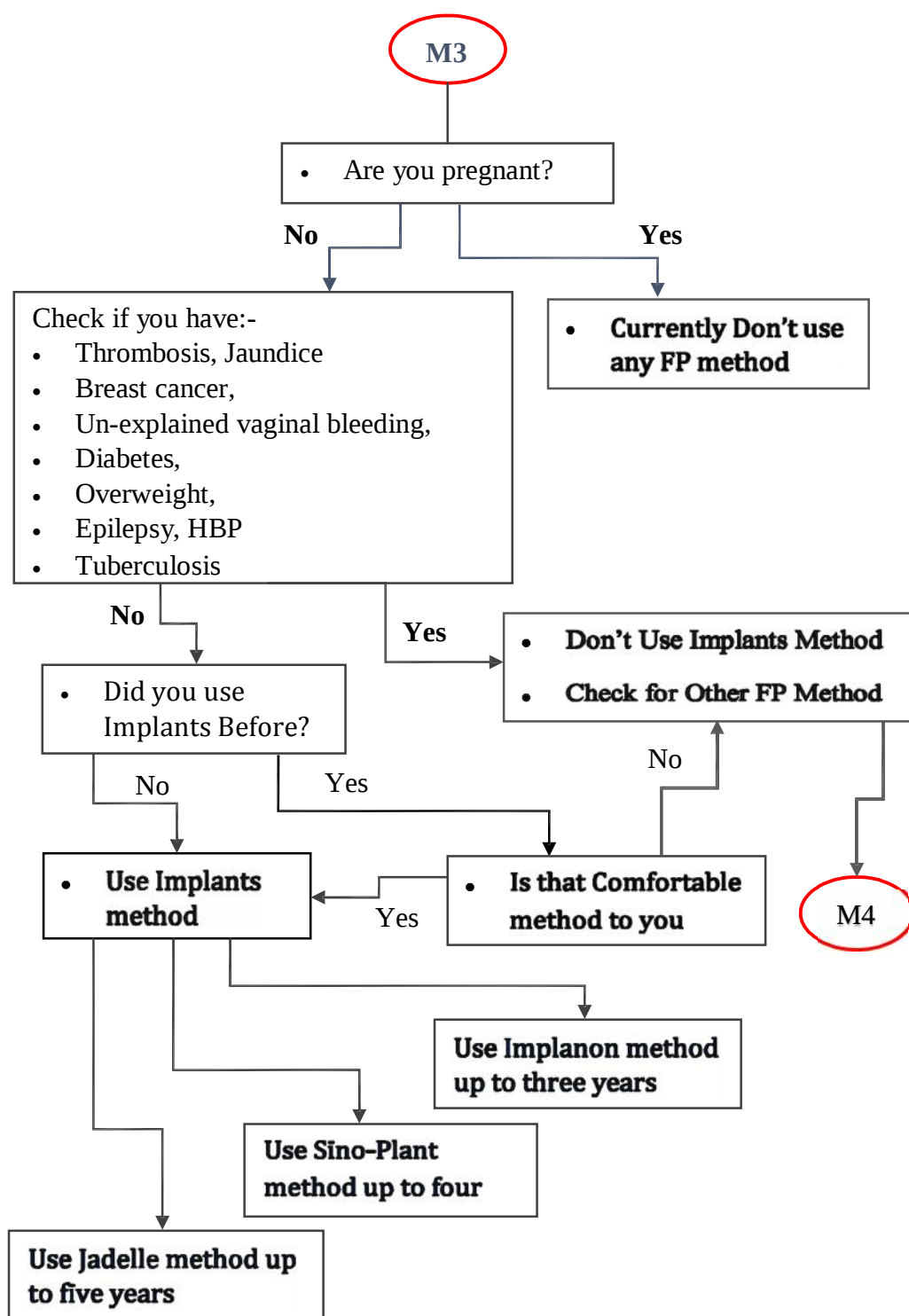
*Figure 11 Decision Tree for Combined Contraceptive Pills (COC)*



**Note:**

**M2** = Family planning method category

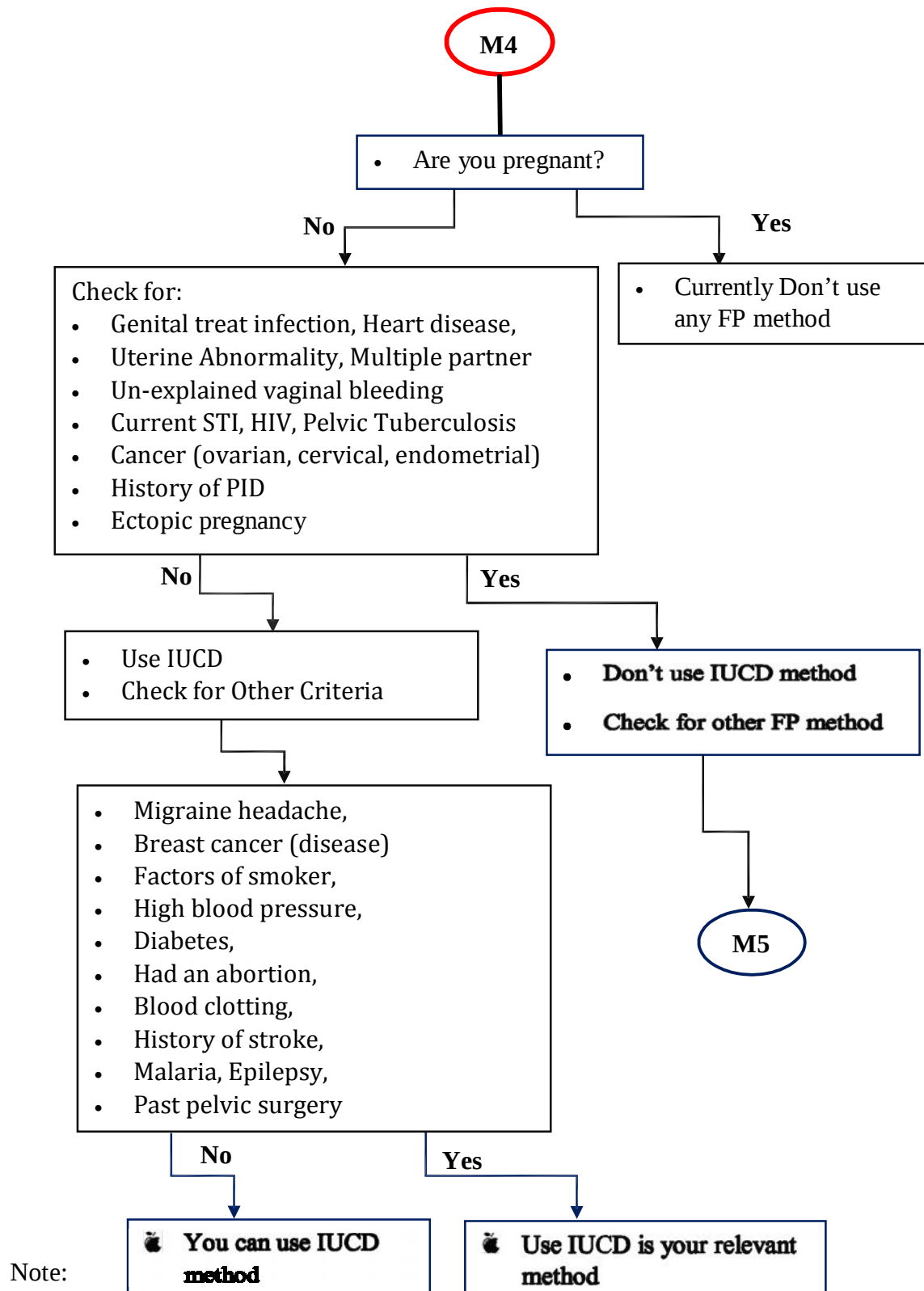
*Figure 12 Decision Tree for Progesterone Only Pills (POP)*



Note:

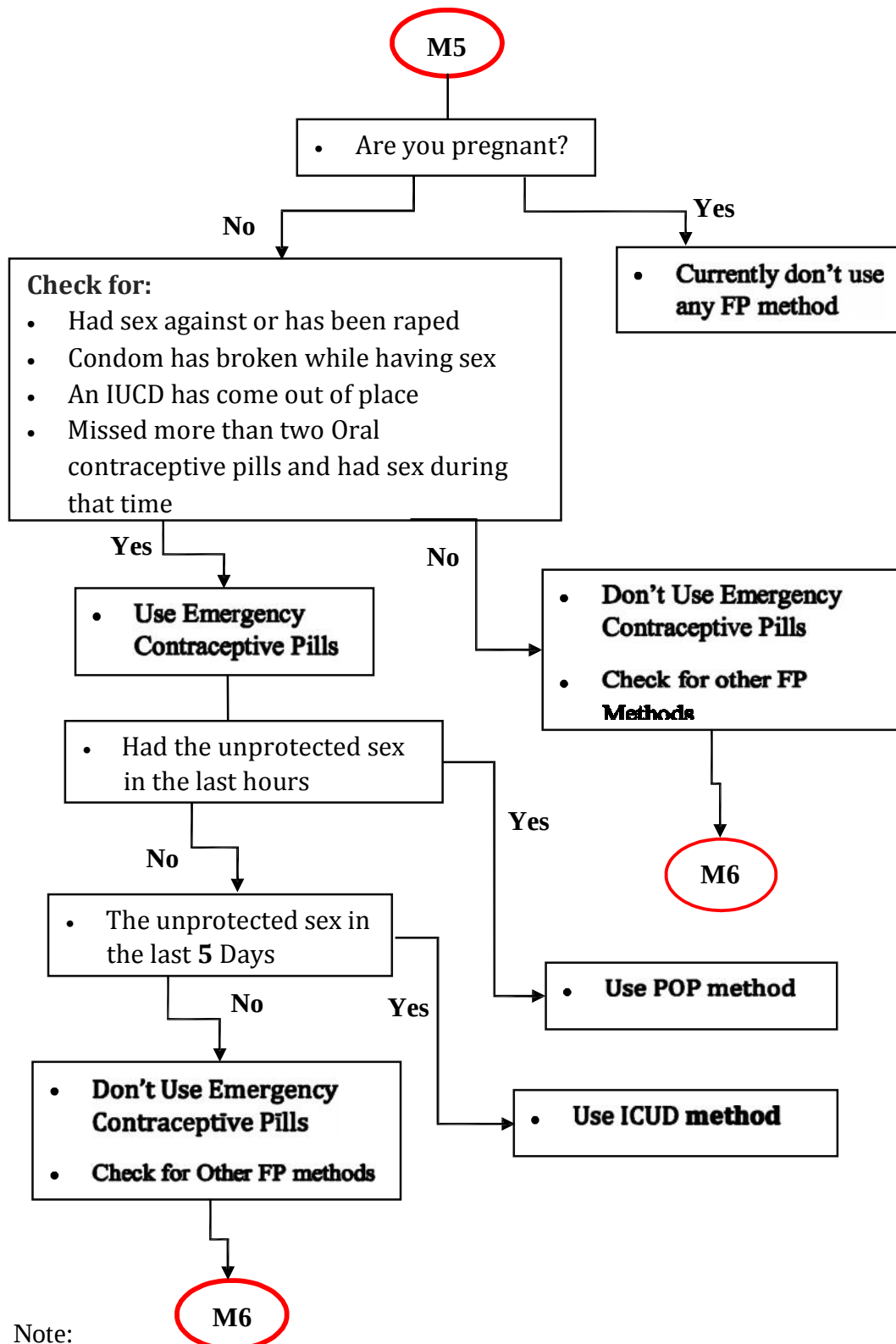
**M3** = Family planning method category

*Figure 13 Decision Tree for Implants (Implanon, Jadelle, Sino-plant)*



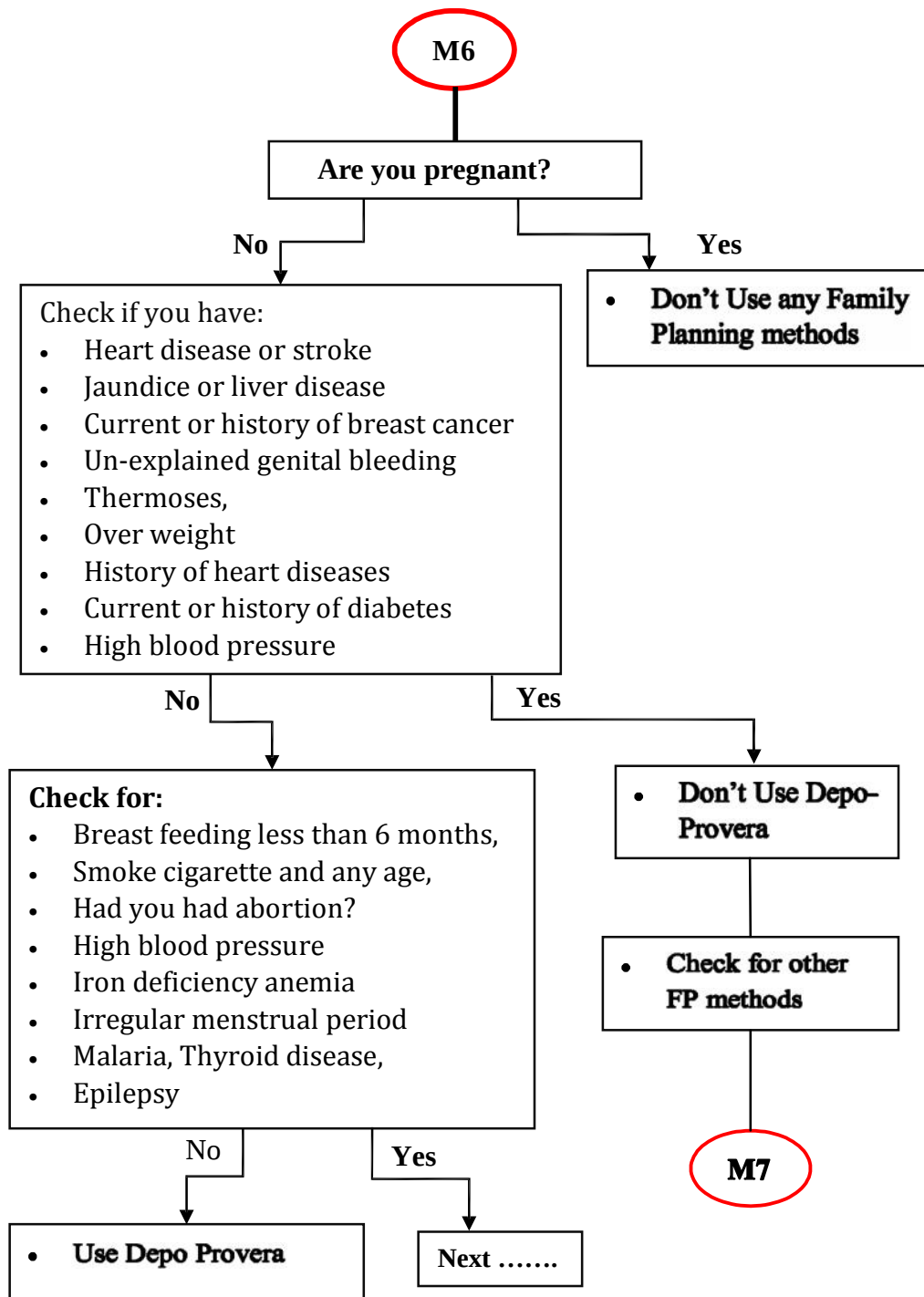
**M4** = Family planning method category

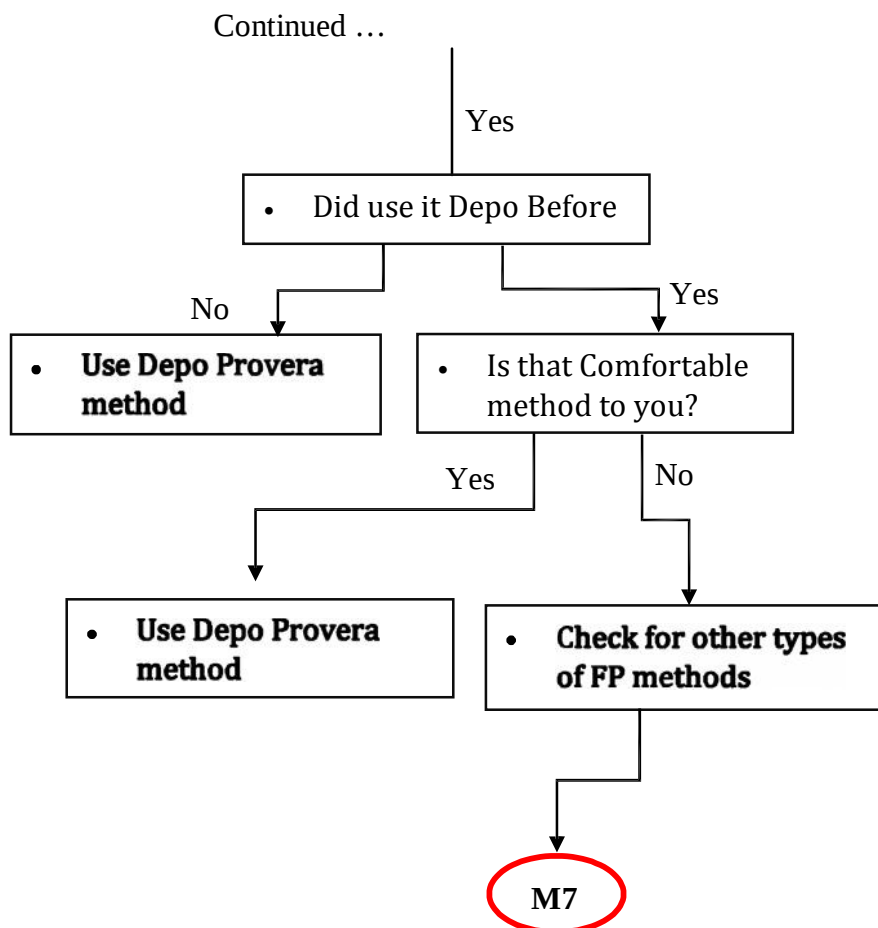
*Figure 14 Decision tree for IUCD method*



M5 = Family planning method category

Figure 15 Decision Tree for Emergency Contraceptive Pills

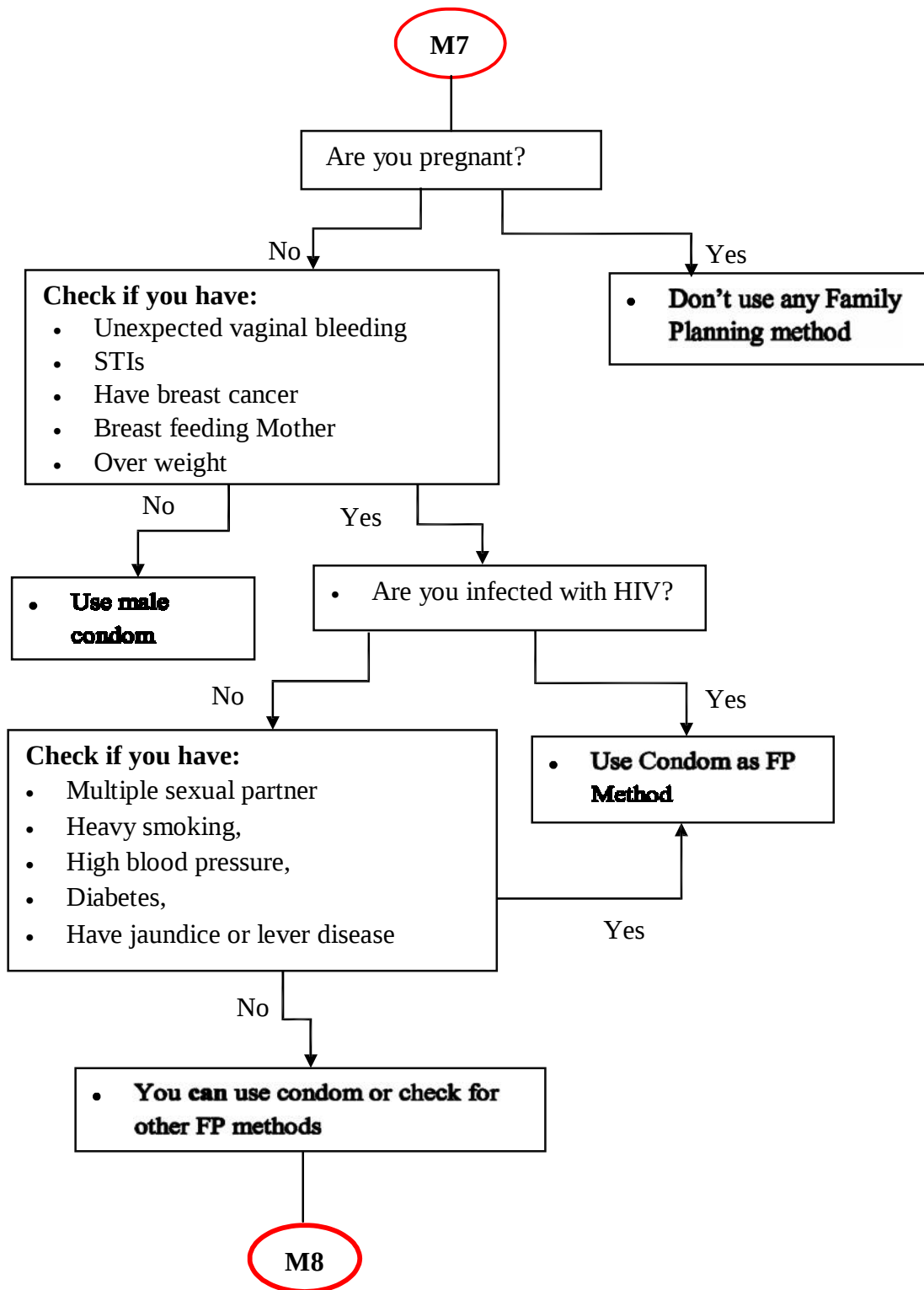




Note:

**M6** = Family planning method category

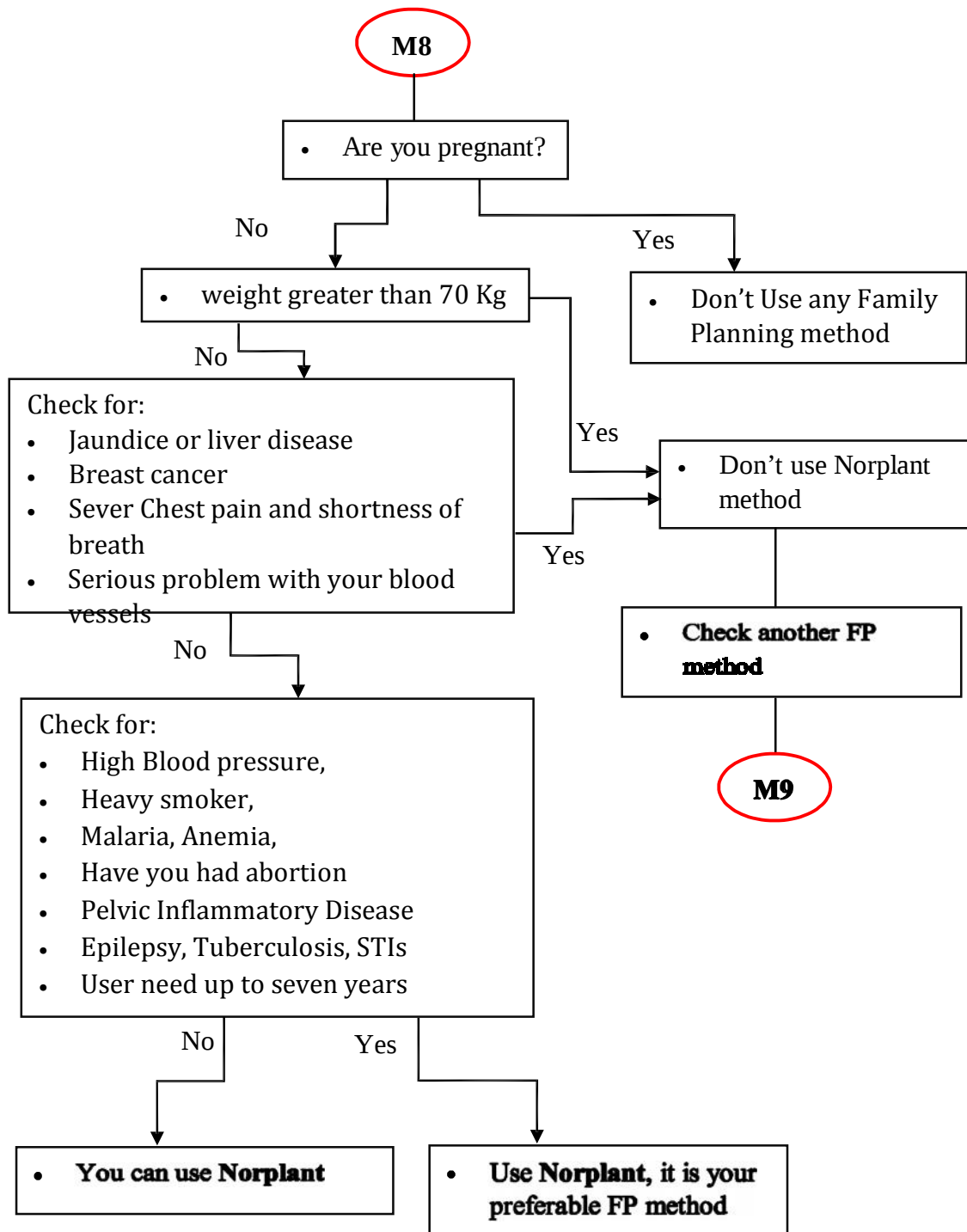
*Figure 16 Decision Tree for Injectable Depo Provera*



Note:

**M7** = Family planning method category

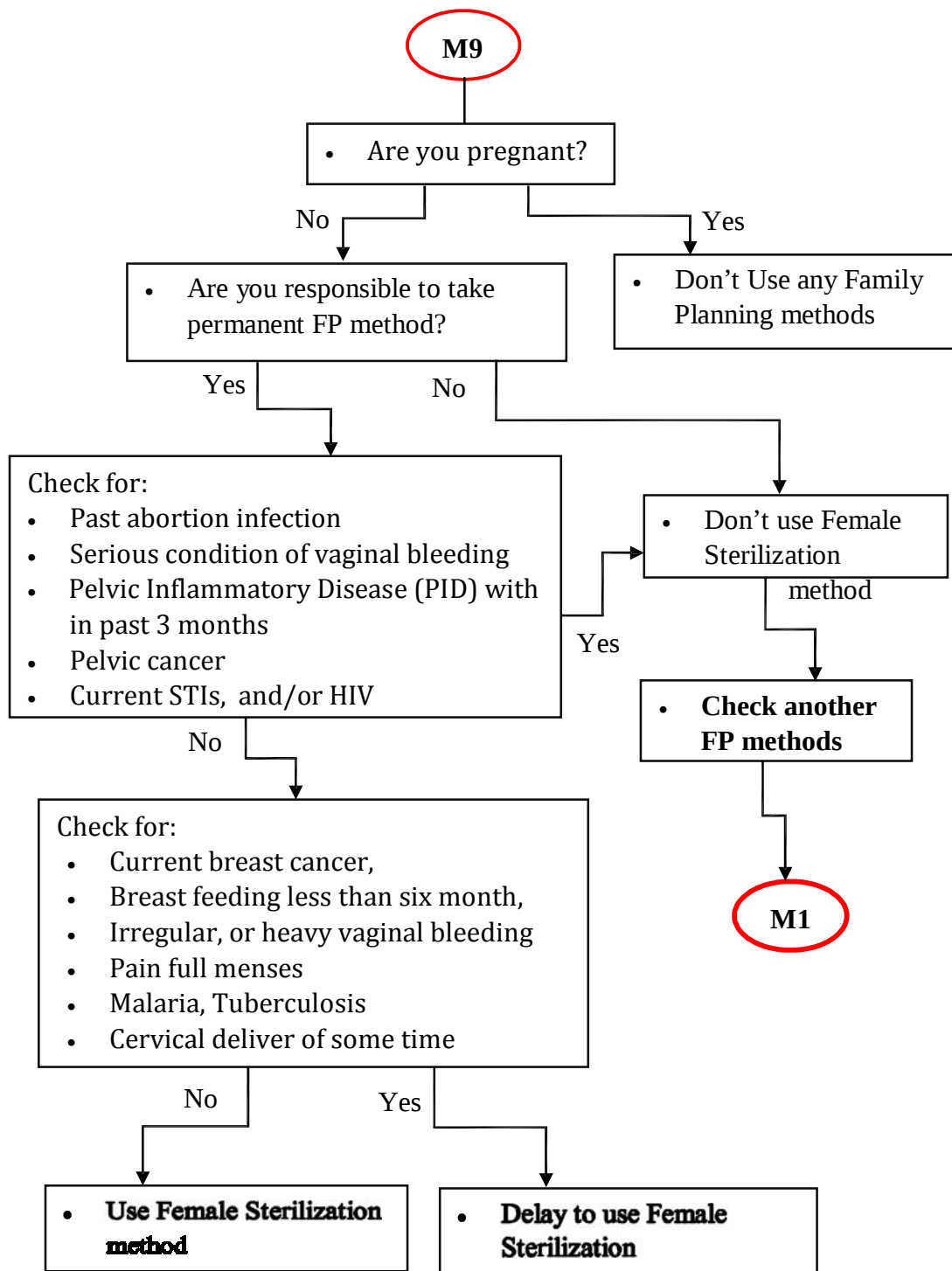
*Figure 17 Decision Tree for Barrier method or Condom*



Note:

**M8** = Family planning method category

*Figure 18 Decision Tree for Norplant family planning method*



Note:

**M9** = Family planning method category

Figure 19 Decision tree for female sterilization method

## 4.6. Knowledge Representation

Knowledge representation (KR) is one of the basic steps in the process of knowledge based system development. In AI system implementation, efficiency, speed and maintenance are the major things affected by the knowledge representation. KR is the process of interpreting domain knowledge into computer understandable form using knowledge representation methods. The acquired domain knowledge is represented as a set of “IF – THEN” rules.

The “IF” side (the left hand side) of the equation which states the conditions(s) that must be true in order to satisfy the rule and the “**THEN**” side of the equation specifies the appropriate action to be taken. The inference engine evaluates the “**IF**” portion of a statement and concludes whether a goal is satisfied or not. If the goal is not satisfied then the inference engines proceed to the next rule until the conditions are satisfied.

A rule is a conditional statement that links the given conditions to actions. Rules in the knowledge base are constructed based on the decision tree structure on conceptual model we have discussed above.

To make easy and understandable the ASP.Net framework system implementation of the knowledge base, the acquired knowledge from the domain expert is represented using the “IF ... THEN” form. The rules are the base for the construction of knowledge base system. The following are sample rules which are incorporated in the web based knowledge base system.

---

### Rule1:

**If** patient has vomiting

And/or patient has morning sickness

And/or patient has missed period

And/or patient has sexual contact

And/or patient has nausea, **then**

☛ Patient is suspected for pregnancy checkup

☛ **Recommendation:** Please don't take any type of FP methods

---

The above rule represents that, any FP method user of a reproductive age that have any of the above signs must checked for pregnancy and not-recommended to take any of the family planning methods before pregnancy laboratory checkup.

### Rule2:

**If a women check pregnancy and found positive **then****

☞ **A women is not-recommended to use any FP method to protect pregnancy.**

**If a women check pregnancy and found Negative **then****

☞ **A woman is recommended to check for other health condition to use FP method.**

---

The above rule show that before using any FP method, any reproductive age women first must take a laboratory checkup for pregnancy and have two options:- the first one if pregnancy is positive, she cannot use any type of FP method. Second if pregnancy checkup is negative (no pregnancy) then she must check for other medical laboratory before she can choose and decide the relevant type of FP method.

**Rule3:**

**If Age is above 35 years old and heavy smoker,**

**And/or Have a jaundice or liver diseases,**

**And/or Breast feeding less than six month,**

**And/or Current or history of high blood pressure,**

**And/or current or history of breast cancer,**

**And/or History of heart disease,**

**And/or History of diabetes,**

**And/or History of sever-headache and blurring of vision,**

**And/or Thrombosis (blood clot in a vein) **then****

☞ **A user cannot recommended to use COC, and Depo-Provera method**

---

The Rule 3, above indicates that, if a FP method user has all or any one of the above listed disease it does not recommended to use the Contraceptive Oral Pills (COC) and Depo-Provera method. In the other case if a user does not have any of the above disease it is recommended to use the FP Contraceptive Oral Pills (COC) and Depo-Provera method as a relevant method.

**Rule4:**

**If user is smoking cigarette and age under 35 year,**

**And/or have just had abortion, past ectopic pregnancy**

**And/or have heavy, painful and irregular menses,**

**And/or iron deficiency anemia,**

**And/or malaria, endometriosis**

---

And/or pelvic inflammatory disease,  
And/or tuberculosis,  
And/or have un-explained vaginal bleeding,  
And/or breast feeding less than six month after child birth **then**  
☞ User can highly recommended to use COC Method

---

The above rule shows that a FP method user that have all or any one of the above diseases are highly recommended to use the Contraceptive Oral Pills method. Because taking this type of method is used to minimize the disease risk, in addition to its effective prevention of pregnancy.

#### **Rule5:**

**If** a user have a breast Cancer,  
And/or have Jaundice or liver disease,  
And/or sever liver diseases,  
And/or liver infection or tumor,  
And/or have serious problem with your blood vessel, **then**  
☞ User cannot be recommended to use Progesterone Only Pills (POP)

---

Rule 5, above shows that a FP method user that have all or any one of the above diseases problem it does not recommended to use the Progesterone Only Pills (POP) method, but a FP user who doesn't have any of the listed types of disease are recommended to use the FP Progesterone Only Pills (POP) method.

#### **Rule6:**

**If** user have unexplained vaginal bleeding  
And/or breast feeding and heavy smoker,  
And/or have diabetes,  
And/or have just had abortion,  
And/or benign breast disease,  
And/or iron deficiency anemia,  
And/or vesicular heart disease,  
And/or heavy, painful and irregular menses,  
And/or Have high blood pressure,

And/or Have risk of STIs,

And/or Woman who can regularly take a pill, **then**

☛ **User highly recommend to use Progesterone Only pills**

---

The above rule shows that a FP method user that have all or any one of the above diseases are highly recommended to use the Progestin Only Pills method. Because taking this type of method is used to minimize the disease risk, in addition to its effective prevention of pregnancy.

#### **Rule7:**

**If** user have a thrombosis,

And/or jaundice or liver disease,

And/or breast cancer,

And/or unexplained vaginal bleeding,

And/or diabetes,

And/or over weight,

And/or suffer from epilepsy,

And/or weight above 75 kg,

And/or tuberculosis,

And/or high blood pressure **then**

☛ **A user can not recommended to use Implants**

---

The rule 7 shows, any FP method user that have all or any one of the listed diseases are not recommended to use the Implants (Implanon, Jadelle, and Sino-plant) method. Because using this method will increase its health risk of the disease and decrease the effectiveness of the method on preventing pregnancy. However, the above rule shows that a FP method user that does not have any of the listed disease can recommended to use any of the three relevant implants. the first one is the Implanon method that prevent pregnancy up to three years, the second and third options are the contraceptive method Sino-Plant and the Jadelle method in which protects users from unwanted pregnancy up to four and five years respectively.

#### **Rule8:**

**IF** user have a genital treat infection,

And/or uterine abnormality

And/or undiagnosed vaginal bleeding  
And/or heart disease, And/or  
multiple partner And/or risk  
of STIs and HIV, And/or  
pelvic tuberculosis  
And/or prolonged menstrual bleeding  
And/or any type of cancer  
And/or history of PID,  
And/or history of ectopic pregnancy **then**

☛ **A user can not recommended to use the IUCD method**

---

Rule 8 shows, any FP method user that have all or any of the above listed diseases are not recommended to use the IUCD method. Because the listed disease are conflict with the method and have a risk after user take it. However, if a user do not have any of the above human disease user can be recommended to use the IUCD method.

#### **Rule9:**

**If** a user have migraine headache,  
And/or breast cancer  
And/or heavy smoker,  
And/or high blood pressure,  
And/or current or history of diabetes  
And/or had an abortion or miscarriage,  
And/or history of stroke,  
And/or malaria, epilepsy,  
And/or Do hard physical work  
And/or past pelvic surgery, **then**

☛ **A user highly recommended to use the IUCD method**

---

The above rule shows that a user that have all or any one of the listed diseases are highly recommended to use the IUCD method. Because taking this method is used to minimize the disease risk, and increase its effectiveness to prevent pregnancy.

#### **Rule10:**

**If** a user have Jaundice or liver disease

And/or current or history of breast cancer

And/or hepatitis

And/or breast feeding baby less than six month

And/or heavy smoker

And/or un-explained vaginal bleeding

And/or thrombosis, over weight

And/or current or history of heart diseases

And/or history of diabetes

And/or HBP when systolic above 140 and diastolic above 90 **then**

---

**☛ A user not recommended to use the Depo-Provera method**

---

The above rule shows that a user that have all or any one of the listed diseases are highly recommended to use the Depo-Provera method. Because taking this method is used to minimize the disease risk, and increase its effectiveness to prevent pregnancy.

Based on the above listed sample rules, all family planning methods are used similar procedures and they have been used for all rules incorporated in the knowledge base. To summarize the chapter, the transformation process of the acquired knowledge from human expert and document analysis is helpful to investigate the specific attributes which are significant in the process of family planning method selection and self-decision support system. Once the relevant knowledge is acquired then it is represented in human understandable manner to arrive at the expected goals. Therefore, the proposed web based knowledge based system for family planning methods is implemented based on the above sample contraceptive method representation rules.

## CHAPTER FIVE

### KNOWLEDGE BASED SYSTEM IMPLEMENTATION

#### 5.1. Introduction

In a knowledge based system development the accuracy of inference engine and robustness of the system are very important. The proposed web based knowledge based system implementation depends on the decision tree structure. As we discussed in chapter three in the development of a knowledge based systems, decision tree structures are powerful in determining conditions and actions, for checking consistency and completeness, in making decisions, and to portraying simple and complex problems.

The “**If .... Then**” rules of knowledge based system are generated based on the decision tree structure. However, the main challenge of implementing a knowledge based system was choosing the appropriate representation method. Too large rules may reduce the performance of the system because, as the number of rules increases the inference engine fails to infer from the complex rules. This chapter describes the development of a Web and Knowledge-based System for women family planning methods choice and self-decision support. The web and knowledge based system incorporates the knowledge base, the inference engine, user interface, knowledge base editor, self-learning, and the explanation facility components as indicated in figure 20.

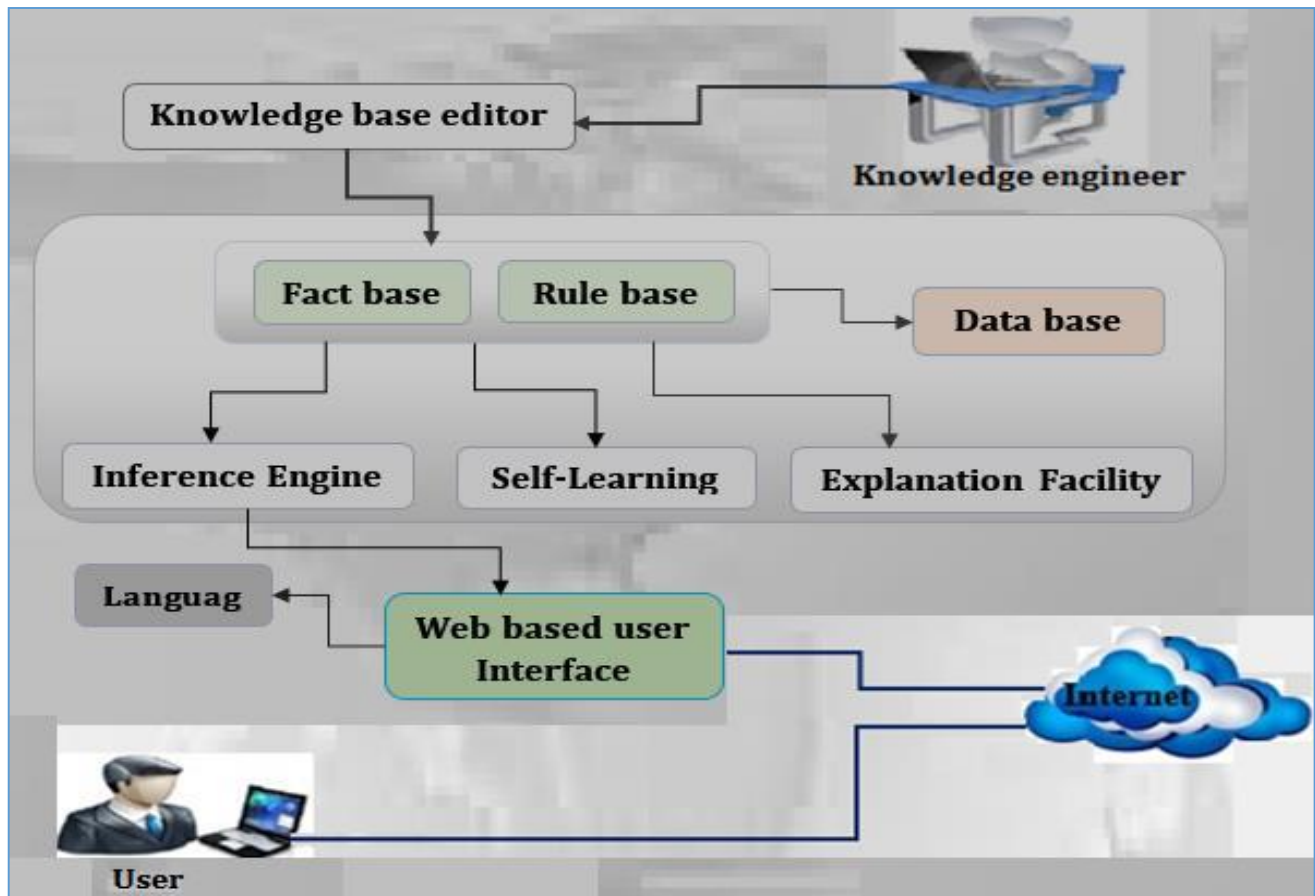
To implement a knowledge based system choosing and using an appropriate knowledge representation approach is an important issue. Due to their rule independency and complete way of condition checkup, among the various knowledge representation approaches the rule-based knowledge representation (**If ... Then**) methods are the most effective way of knowledge representation technique for the development of a medical and health related systems.

Therefore for this study, the proposed web and knowledge based system (WBKBS) has been designed using a rule-based knowledge representation in which the experts knowledge has been represented using production rule of an IF...THEN method of knowledge representation technique.

#### 5.2. Architecture of the Proposed System

A web-based tool is a tool that allows the construction and development of an expert system based on a web technology. This tool allows the creation of web-based knowledge based system using a rule-based knowledge representation. The proposed system of a web-based knowledge based system is a web based implementation of knowledge-based system designed to incorporate various components

each of which are intended to perform different tasks. The general architecture of the proposed system is presented in figure 20 below.



*Figure 20 General architecture of the proposed web based KBS*

As indicated in figure 20 at the front-end of the system, the system has a user interface through which users will have access to the knowledge base and the whole system with in the availability of an internet. The user interface is a web based interface that will serve as a link and a communication bridge between the users and the knowledge base system with in the availability of internet. The system also incorporates the main part of the proposed system, a knowledge base system. The user of the system also need a client side web browser software to interact or to view the user interface of the system using the available internet service.

### 5.3. The Knowledge Base Editor

The knowledge base editor is the first component of the proposed web-based knowledge based system which the knowledge engineer use to add and update rules and facts for the purpose of creation of the web based knowledge based system. Generally this component helps to enter the new facts and the rules as well as to update the rules and facts of the knowledge base.



Figure 21 Updating and adding of knowledge base using knowledge base editor

## 5.4. The Knowledge Base

The knowledge base of the proposed system is the main component of the whole system. It contains the facts, the rules, and the relationships that are used to reach conclusions about the recommended family planning methods and non-recommended family planning methods.

The development of a knowledge-based system involves the utilization of knowledge engineering method which comprises the problem identification, knowledge acquisition and knowledge representation processes. After acquisition, the acquired knowledge has been modeled using the decision tree structure, and also represented using the appropriate rule based knowledge representation approach so as to make the knowledge ready for the implementation phase of the proposed system.

The acquired knowledge is represented using a production rule method. The rule based representation uses the method of an **IF ... THEN** format as presented in Chapter 4. Hence, based on the representation of the knowledge, the knowledge base of the new system is developed using ASP.Net framework and the VB programming language behind code. In the proposed web based knowledge based system, the knowledge base of this system contains six components. These are the fact base, the rule base, the inference engine, the explanation facility, Self-learning and database.

### 5.4.1. The fact Base

Fact base is a first component of the knowledge base. The fact base is the one which contains facts about the family planning methods, signs and criteria's that are represented in the designed knowledge base. The fact represent the relationship between the types of family planning method, characteristics, possible diseases, and user's current health condition that have or observed. For this study, the facts are represented using the VB (visual basic) programming language behind the ASP.Net user interface to display the recommended and not-recommended methods. As we described and shown below, by identifying users current and history of disease we determine the recommended methods and non-recommended methods.

Diseases (Not-recommended method, recommended method)

The above fact states that a list of a family planning affected disease are used to identify the recommended and non-recommended contraceptive methods according to the rule.

#### **5.4.2. The Rule Base**

Rules are used to check or evaluate a condition. The proposed web based knowledge based system is designed using a rule based knowledge representation approach. The rule base of the system contains a list of rules which are used to evaluate a condition against required goal. Using the ASP.Net the rules in the rule base are represented using the **IF ... THEN** method. The rules are used to check or evaluate a condition. The system first accepts possible diseases from the user and checks against a goal using the rules in the rule base. When a condition is true, the system take action and give final decision to the contraceptive method user.

#### **5.4.3. The Inference Engine**

The inference engine is a computer program designed to produce reasoning on rules based on logic where the logic enables the inference engine to generate new information from the knowledge contained in the rule base and data to be processed [26]. Inference engine is a main component of a knowledge based system that are used to search, to generate and reason through the rule based knowledge representation. Inference engine uses two basic chaining approach, the forward chaining and the backward chaining [65].

- ❏ **Forward chaining:** Using forward chaining, the inference engine starts with some facts and searches through the rule base to find all possible conclusions. In case of this study of the forward chaining, the system first it accepts all possible disease and conditions. After it accepted each conditions from the user, it compares the possible user input with the inference rules used. Then after comparing the input with the inference rules used, the inference engine applies the rules to find all of the recommended contraceptive methods and the list of non-recommended methods. At the end the user can choose one relevant method from the listed recommended contraceptive methods.
- ❏ **Backward chaining:** In case of the backward chaining, the inference engine starts from the final conclusion, and it starts reasoning from the fact base which supports to the final result. In case of this study of the backward chaining, first the user decided their relevant contraceptive method which wants to use, then the system checks their possible disease regarding to the selected method and it give a decision whether the method is recommended or not recommended to the user.

According to the rules from the fact base when the method satisfied the conditions then the contraceptive method is recommended to the user otherwise the user choose other methods.

The proposed web based knowledge based system uses both a forward and back ward chaining reasoning mechanism. During forward reasoning process, the inference engine starts from the beginning and check for all of the possible conditions to prove the recommended and not-recommended contraceptive methods. In the case of backward reasoning process, the inference engine starts from consequents starts from user chosen method disease only (does not check for all of the classes) and checks the rules to prove whether the method is recommended method or not-recommended methods to the user.

#### **5.4.4. Self-Learning**

As we discussed in chapter two, among the three different types of self-learning methods remembering from experience is one part of self-learning [28]. Individuals can learn new facts and on certain time cannot remember the knowledge that is not in regular uses. Remembering of previous knowledge for the case of different purpose is one important future of a knowledge based system. Memorization learning is a mechanism of adding new facts or updating of previous facts into the knowledge base. After the knowledge base is updated and runs the system then system will remember the new updated facts for the next time. Thus, the web based knowledge-based system can update and modify its knowledge by integrating the self-learning module into their structure.

The system attempts to store the details of a specific contraceptive user information. The facts base is stored on a separate data base file called **“FamilyPlanningData.mdf”** and becomes updated whenever the end-user ends the program. In the case of the family planning method users may come again, to terminate the method or to change the method, then the system remembers when was used the contraceptive method, and which method was taken by the user. This is important mechanism both to the user and physicians. Because some user may come after a long period of time and they do not remember the method taken before. The following figure 22, shows a sample dialogue between end-user and the web based KBS in English language.

Home Self Decision English Logout

*Welcome — to Self-decision support system*

Hello, Merhawit Abebe

Personal Information »

Decision Mode: **Self-decision**

Consultation Date: 2/9/2016

Client Name: **Merhawit Abebe**

Age: 32

Religion: **Ortodox**

Marital Status: **Married**

Mean that you are a married women

Continue »

Additional Information

Selected FP Methods +

Selected Disease +

Self-Decisison

Continue ...

*Final result of the user*

Client Name: **Merhawit Abebe**

Age: 32

Consultation Date: 2/9/2016

Enter method: **IUCD** Save choice

»» Conculliston 1

The following methods are Not-recommended to use

Not-recommended methods:

COC

Depo-Provera

Implants

Norplant

»» Conculsion 2

The following methods are Recommended to Use

Recommended methods:

IUCD

POP

Male Condom

Additional Information

Selected FP Methods +

Selected Disease +

Self-Decisison

*Figure 22 A sample dialogue with the web based system*

In figure 22, the system requests to the user to enter her name and all of the possible information regarding to the contraceptive method up to the final decision. After accepting all of the required information the system it displayed name and Age of the user, current date, list of non-recommended methods, and recommended methods. At the end the system waiting to choose relevant method from the list of recommended methods. Finally the user choose IUCD and the system saves all of the user information and it closes the system. Another time when a user come to the system it requests first to authenticate the system and it remembers you when was used the system, your final decision as we can show in figure 23 below.

[Home](#)
[Self\\_Decision](#)
[English](#)
[Logout](#)

## Self-Learning of family planning method

Client Name: Merhawit Abebe

Current Date: 2/9/2016

===== HELLO Ms. Merhawit Abebe =====

Last time you used the Self\_decision support system to select and decide your relevant contraceptive method based on your health condition on date 2/9/2016

At the decision time, you had different contraceptive method options that are recommended to you.

Finally, you decided to use the contraceptive method: IUCD

---

Now, do you want to use the system?

Select one:

Select one:
Yes
No

### 5.4.5. The Database

Since, a web based system are available everywhere and used by different users, the system asks to login the system or to register for a new users. Therefore, in the proposed system the database are used to store secured information, specific knowledge, and new facts.

#### 5.4.6. The Explanation Facility

Another features of the knowledge based systems is their ability to explain themselves. Given that the system knows which rules were used during the inference process, it is possible for the system to provide those rules to the user as a means for explaining the results.

Knowledge based system development uses different types of explanation facilities such as the WHAT, HOW, WHY, WHY-Not are the most used ones. The explanation facility WHAT and WHY are mostly used to give a brief explanation before conclusion or decision is made. In this study, only the “What” and “How” explanation facilities are incorporated.

**What explanation facility:** - The “What” explanation facility is used to create a brief description to the user before conclusion is made to explain the given question that are not clear to the user.

*Wellcome — to Self-decision support system*

Hello, Masho gebre

Personal Information >>

Decision Mode: Self-decision

Consultation Date: Select One: Self-decision

Client Name: Education / Training

Age: Servie provider

Religion: Choose religion:

Marital Status: Select Status:

Mean that you are now using this system to decide your relevent family planning method your self with out the need of any service provider

Continue >>

Figure 24 Sample of "what" explanation facility

The “what” explanation facility that is used to make the results easily to understand the end-users and to build good communication between the end-users and the system. The “what” explanation is displayed when the mouse is over or when the user selects one option from the dropdown list the system will automatically displays an explanation facility at the bottom side of the GUI. As we shown in the above figure 24, there is a sample dialogue between the end-user and the system. The system first it requests to choose one value of decision mode, from the drop down list. Then, when the user choose **“Self-decision”** item from the given items, the system also displays its explanation of the self-decision mode automatically without the need to write the word **“what”**.

**How explanation facility:** -The how explanation facility create a better explanation to the user. This type of explanation facility is used after decision is made to explain how the final conclusion decided or not decided the specific method from the list of different methods.

**For example:** a user input all the possible commands on the user interface, at the end the system recommend to use the Implanon method, but not-recommend to use the FP method COC. However, if the user does not understand the reason it asks “HOW” explanation facility. Then the system will be reason out for the recommended Implanon FP method and for the non-recommended COC FP method.

## 5.5. The User Interface

The usefulness of the proposed system is dependent upon the ease with which users can access its information [66]. User interface includes a sophisticated graphical user interface (GUI) which is a user-friendly interface that allows secure and confidential access to information. It has a short response time (timely information) and is accessible from many places which includes a reliable access procedure [29].

The user interface of the proposed web based knowledge based system is built by considering of the user attractiveness, fault tolerance and its user friendly. The system is easy to use and it correct and supports users when they make a mistake. It is designed to offer a quick graphical warning scheme that is easily accessible yet offers additional detailed information if the user is interested.

The designed user interface of the web based knowledge based system is a web page that will function as a gateway of the users to the KBS. Mainly, the contents of the web interface have been developed using CSS, HTML, JavaScript and Ajax control toolkit together in the ASP.Net web server which has been integrated with the VB programming language to embed the knowledge base to the web interface. The SQL database server 2012 also used in the proposed knowledge based system for the purpose of self-learning and automatic knowledge updating. After the integration of the ASP.Net framework, the whole contents of the pages with the knowledge base will be accessed using the web browsers that put in in the ASP.Net web server.

The proposed web based knowledge based system, incorporates six main parts or modules. Each modules it serves different tasks. The first part of the system displays the Home, which show the welcoming home page of the whole system. The home page contains general information and information about an e-health, as indicated in figure 25, the Home page of the proposed web based knowledge based system.

In the proposed web based knowledge based system, the home page of the given interface will be displayed from the local Asp.Net server on the browser using the address:

<http://localhost:19909/Family%20Planning/Home.aspx>

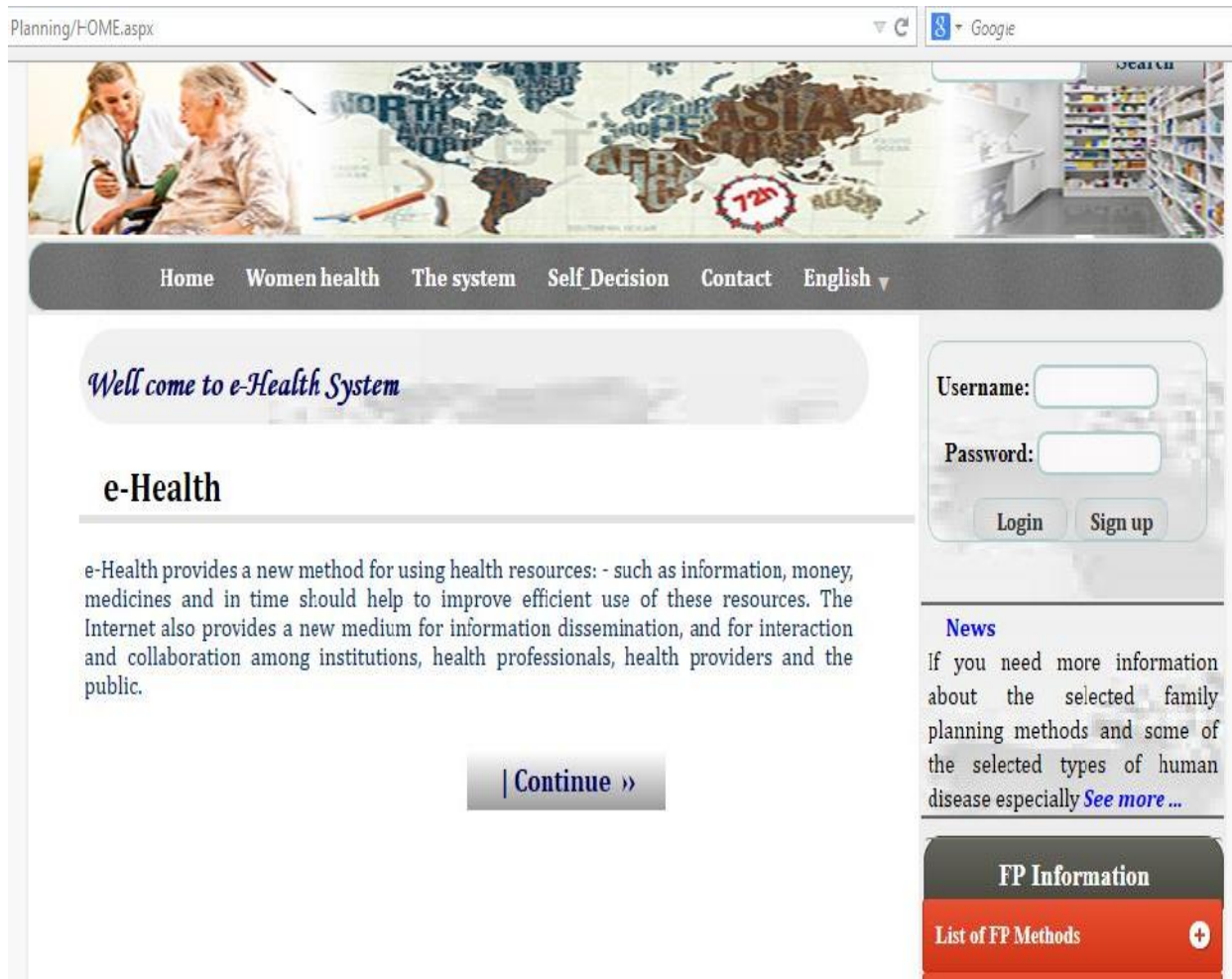


Figure 25 The Home page of the web based knowledge based system

The second page contains information about women health. The page describes the overall health of women and how they can protect themselves are briefly described. The third page of the system also describes about the proposed web based knowledge based system. The page contains a description of the system and how it works with its procedures and brief descriptions. The page it describes how a new user can use the system and run it without the need of service providers. To run the system, latest version of visual studio 2010 and later versions like visual studio 2013 are required. However, since the proposed system is a web based system users can use the system at anytime and anywhere with an availability of the internet. While developing this system, visual studio 2010 is used. It is possible to download and use the ISO version of the Microsoft visual studio software which freely found in the Microsoft website.

The fourth module of the system describes the self-decision support, which is the main part of the web based knowledge based system. The system need an authentication when a user clicks the self-decision module then the system directly asks to login the system. Since the web based knowledge based system are available everywhere, the system need to identify users. So that, in order to protect user's private information the system asks a correct username and password or to registered as a new user in order to use the system. In addition to that, the proposed system supports three languages (English, Amharic, Tigrigna), to help local users in multiple languages.

The screenshot displays the self-decision support interface in Amharic. At the top, there is a navigation bar with links for 'Home', 'About Us', 'Contact Us', and 'Help'. Below this, a banner image shows a doctor consulting with a patient. The main content area contains a login form with the following fields: 'Username' (with a dropdown menu), 'Password' (with a date input field showing '2/9/2016'), 'Email' (with a text input field), 'Phone Number' (with a dropdown menu), 'Gender' (with a dropdown menu), 'Age' (with a dropdown menu), and 'City' (with a dropdown menu). A 'Login' button is located at the bottom of the form. To the right of the login form, there is a sidebar with a 'Logout' button and a 'Forgot Password' link. The sidebar also features a 'Forgot Password' link and a 'Forgot Password' link.

Figure 26 after user login the system it display the self-Decision page in Amharic language

## 5.6. System Tasting and Evaluation

After implementing knowledge based system the final step is measuring the performance of the system whether it achieve the objective of the system or not. Testing and evaluation of the knowledge based system is the final step that are used to measure the knowledge engineer if the system achieves its objectives or not.

For the purpose of this research, web based knowledge based system for family planning method users self-decision is tested and evaluated based on the objective of the system. This is to measure the accuracy of the system during the self-decision support processes. Measurement is from the point of

whether the system achieved its objective or not. In this study the performance of the system is measured against human expert decision using predictive validation method. The user acceptance of the system is carried out during system user interaction.

The knowledge based system user acceptance is measured by using open and closed ended questions. The system evaluators directly interact with the system to measure its performance from the points of its correctness in assigning the patient case in the correct category. In addition, the validation test was done by comparing solved cases against the system conclusions on the similar issues. By comparing the result obtained from the system conclusion, the evaluators determine the performance of the system. Therefore, knowledge based system performance is measured first by using open and close ended question, and second by using the test case validation method.

#### **5.6.1. User Acceptance Evaluation**

The visual interaction evaluation method for the knowledge based system allow the users, and the domain experts to directly interact with the system. This direct interaction with the system is also used to evaluate the performance of the knowledge based system from the system users' point of view. In addition, this method helps to ensure the performance of the system by assessing the feedback acquired from the domain expert towards the developed system. Structure questions are developed to assess and evaluate the appropriateness and applicability of KBS for family planning methods in the domain area.

Different local researchers have adapted evaluation questionnaires that are used to evaluate their model. Therefore, for the purpose of this research the evaluation questionnaires were converted and adapted as into the context of the family planning methods self-decision support in order to test the performance of the prototype system by domain experts is found in appendix IV.

In this way, eight users were selected and had been given the chance to use and interact with the system. The users selected were five medical professionals (two medical doctor and one midwifery) from Adama hospital medical college and another one medical doctor and one midwife from Mari Stops Ethiopia, Adama branch) and three midwife university students that have apparent practiced (trainers) in Adama hospital medical college. All of the three midwife students have a knowhow in Information technology. During the web based knowledge based system development these five domain experts were actively involved in different stages of the study such as in knowledge acquisition, system development process, and consulting on the content of knowledge. The informal discussion with domain experts has significant role to understand the dimension of the problem. Before the actual evaluation

process is conducted, some guideline and brief explanation is given to the system evaluators on how the system works and the system based self-decision support and service delivery.

Finally, all the system evaluators are requested to evaluate the performance of the system using questionnaires. The evaluators had been given a questionnaire to fill by giving the values **Excellent**, **Very Good**, **Good**, **Fair**, and **Poor**. In those questionnaires, the evaluators had given their judgment as shown in Table 5 below. For the purpose of the analysis, the researcher assign values in numbers for each scale as Excellent = 5, Very Good = 4, Good = 3, Fair = 2, and Poor = 1. Based on the given scale, the system evaluators provide a value for each questions. Thus, this method helps the researcher to manually examine the user acceptance based on evaluator's response. The user acceptance of the system is measured manually as follows:

$$\text{Average (av)} = \frac{v1(ne) + v2(ne) + v3(ne) + \dots + vn(ne)}{n} \quad (1)$$

Where, AV refer it average, SV refer to the scale value, NE refer to the number of evaluators, and TNE refer to the total number of evaluators. As shown in the table below the total number of evaluators are eight. To get the result of user acceptance average performance is calculated out 100%.

$$\text{Average performance (avp)} = \frac{av(100)}{n} \quad (2)$$

Where, TNS refer to the total number of scale, and avp refer to the average performance or performance in percentage. In this system we used five scale evaluation (from excellent up to poor). Table 7 shows the overall user acceptance evaluation result that obtained from the evaluators.

*Table 7 User acceptance evaluation of the performance of WBKBS on FP methods*

| No | WKBS Evaluation Criteria                               | Excellent | Very Good | Good | Fair | Poor | Average | Percentage (%) |
|----|--------------------------------------------------------|-----------|-----------|------|------|------|---------|----------------|
| 1  | Is the system easy to use and interact with?           | 3         | 4         | 1    |      |      | 4.25    | 85             |
| 2  | How do you rate the user attractiveness of the system? | 5         | 1         | 2    |      |      | 4.38    | 87.6           |

|                      |                                                                    |   |   |   |   |  |      |      |
|----------------------|--------------------------------------------------------------------|---|---|---|---|--|------|------|
| 3                    | How do you rate the accuracy of WBKBS in FP methods self-decision? | 4 | 3 |   | 1 |  | 4.25 | 85   |
| 4                    | How do you rate time efficiency of the system to respond?          | 3 | 4 | 1 |   |  | 4.25 | 85   |
| 5                    | Does the system incorporate adequate knowledge on FP?              | 3 | 3 | 2 |   |  | 4.13 | 82.6 |
| 6                    | Does the system provide appropriate Decision for FP users?         | 5 | 2 |   | 1 |  | 4.38 | 87.6 |
| 7                    | Does the system have contribution in the domain area?              | 4 | 4 |   |   |  | 4.5  | 90   |
| <b>Total Average</b> |                                                                    |   |   |   |   |  | 4.31 | 86.2 |

Based on the data indicated in table 5.1 above, to the first evaluation criteria of the system which is easy to use and interactive it gives one of the evaluators (12.5%) as a good, three of the evaluators (37.5%) as excellent, and the rest four evaluators (50%) also rated the system as very good. To the second evaluation criteria, regarding to the attractiveness of the new proposed system also the evaluators gives: two evaluators (25%) rated as good, one evaluators (12.5%) rated as very good and the rest five evaluators (62.5%) rated the system user attractiveness as excellent. Regarding to the third evaluation criteria of a system accuracy, one evaluator (12.5%) said that the system is fair in their accuracy, three evaluators (37.5%) rated as very good, and the rest four evaluators (50%) are rated accuracy of the system as excellent.

According to the fourth evaluation criteria for time efficiency of the system 37.5% of the evaluators rated as excellent, 50% of evaluators rated as very good, and the rest 12.5% of the evaluators said that the time efficiency of the system is good. For the fifth evaluation criteria of does system incorporate adequate knowledge 37.5% of evaluators rated as excellent, 37.5% evaluators rated as very good and the rest of 25% rated as good. For the evaluation criteria of the capability of the system in appropriate decision, 62.5% of the evaluators rated as excellent, 25% of the evaluators as very good and the rest 12.5% of the evaluators rated the appropriate decision support of the system as fair. To the last evaluation criteria of the system does the system have contribution in the domain area, 50% of the

evaluators are rated as excellent, and the rest of 50% the evaluators said that the contribution of the system in domain area is very good.

To summarize table 7 above based on the responses of eight system evaluators, the average performance obtained is 4.31 on a scale of 5. This value is the result obtained from the values assigned questionnaires. The result indicates that about 86% of users are satisfied by the performance of the proposed web based knowledge based system. It means that the proposed knowledge based system gain about 86% of user acceptance.

When we categorize the user acceptance evaluation of the web based KBS according to each evaluation name, its general feedback will summarized as follows.

$$\text{Percentage (pr)} = \frac{n_{\text{e}}(100)}{n_{\text{e}}} \text{-----} (3)$$

Where, PR refer it percentage, NSE refer to the number of evaluators in individual scale, TNSE refer to the Total number of evaluators in each evaluation criteria. From the above user acceptance table the total number of evaluators in each criteria are 56.

*Table 8 Summary of Users' feedback on WBKBS*

| Evaluation Name | Value | Number of evaluators | Percentage |
|-----------------|-------|----------------------|------------|
| Excellent       | 5     | 27                   | 48.21      |
| Very good       | 4     | 21                   | 37.5       |
| Good            | 3     | 6                    | 10.71      |
| Fair            | 2     | 2                    | 3.57       |
| Poor            | 1     | 0                    | 0          |

From the above table 8, when we analyze the user acceptance evaluation response, the users responded that the web based KBS is excellent by responding twenty seven times in the whole evaluation criteria which represents 48.21%. The system ranked very good by responding twenty one times which represents 37.5% and ranked good by responding six times which represent 10.71%. Finally, the web based KBS is ranked as fair two times which represents 3.6%.

In general, the proposed web based knowledge-based system has got an excellent acceptance from the users by getting 48.21% from the above evaluation result, it is evident that the proposed web based

disease KBS will be a greater significance in selecting, self-decision and advice to women in order to choose their relevant contraceptive method and to prevent unsafe abortion

### **Findings of the Study**

In the effort to establish this study, a web based knowledge-based system had been developed and achieved 86% user acceptance while evaluating the performance of the system. According to the results obtained during the system evaluation, the proposed system has an encouraging acceptance of the users both from the domain area and family planning method users. This indicates that there is a high demand for instant decision support service and information delivery over the Internet.

On the other hand, the result obtained during system evaluation (86%) shows another limitation that the new system has. It indicates that there are some gaps in the system that prevented it from achieving high accuracy. However, the system is not at its final implementation stage, in that, there are certain tasks to be done in order to avoid those limitations that prevented the system from getting high accuracy. In addition to when we coding the in the system implementation the researcher is get difficulties of rule updating. But, since human disease are too many new cases and disease are come from time to time regarding to this domain. So to update the incoming new cases in the rule based knowledge representation, a graphical user interface or system based rule updating is needed to make the system powerful.

## CHAPTER SIX

### CONCLUSION AND RECOMMENDATION

#### 6.1. Conclusion

Knowledge based system development is widely used in the area of medicine and health science especially for in case of decision support and advice. In this study a web based knowledge based system is developed basically for advising and self-decision of the different types of a family planning methods.

Currently throughout the world death of women and children especially pregnancy related death of women is one of the major issue. Women pregnancy related death is found all over the world, but it is high in developing countries including Ethiopia.

To address the above problems web based knowledge base system is developed, the system aims to help general users in the processes of family planning method selection and decision. The relevant knowledge is acquired from domain expert and document analysis. Different challenges also identified during acquisition phases such as willingness and confidence of domain expert to share their knowledge. The developed knowledge based system is conceptually modeled using decision tree structure to the logical relationships between the selected and effective types of family planning methods and their respective non recommended and recommended diseases.

The proposed system was designed aiming at establishing a computer based self-decision support for family planning users. In the effort to conduct this study, a number of healthcare professionals have been contacted in order to extract useful medical expertise. The data collection (the knowledge acquisition) process was conducted by selecting sample domain experts from the healthcare centers based on purposive sampling method. During the knowledge acquisition process, a huge amount of knowledge relevant for the construction of the proposed system was obtained and it was organized in a structured format so as to make the data ready for the next phase, knowledge representation. The acquired knowledge was represented using the production rule, **IF...THEN**, knowledge representation method in order to implement the proposed system. Finally, the proposed system which has a knowledge base that is connected to a web interface was implemented by employing different development tools.

The knowledge base was developed using ASP.Net framework with an integration of the JavaScript, Ajax control toolkit and CSS with VB programming language code behind to the knowledge base and to design user friendly GUI.

The system integrates the knowledge based system with a user friendly web supported graphical interface. In addition to that the system supports three languages (English, Amharic and Tigrigna) to help user's self-decision process in different language.

The system it remembers, new facts and user information from previous experience. When a user change or update new facts the system remembers and update the new facts. In addition to that the system is input insensitive, error tolerant and supports an automatic explanation facility for every activity and support users in every explanations without the need to write the word "what" and "How". This explanatory mechanism also support users to easily use the system as well as to minimizes the typing errors of the end-user.

Generally the positive side of the system shows, it have an attractive and user friendly user interface. It is also easy to use and accessible everywhere at the availability of internet. The system can learn from its experiences and it automatically update new facts. The system also identifies the recommended and non-recommended methods accurately and efficiently, based on the contraceptive user's health states. The system supports both the backward and forward chaining in decision support, and it helps the user to use the system as they wish. However, the system is not able to update new rules automatically from the graphical user interface.

Finally, to assess the performance of the proposed system, user acceptance evaluation was done in order to measure the performance of the new system. In doing so, five medical experts and three trainers were contacted with a questionnaire to evaluate the system performance using different evaluation criteria's such as easiness, accuracy, efficiency, etc. Accordingly the new system has a wider acceptance according to the feedback from the evaluators, Accuracy of 86% is registered by the evaluators.

## 6.2. Recommendation

The study achieves its main objectives by proving the applicability of the rule based system in Family planning methods self-decision support and advice. Based on the findings of the study the following recommendations are suggested for further researchers with in the knowledge based system domain area. The recommendation can initiate interested researcher to investigate further implementation of a knowledge based system in related health domain.

- ☛ The proposed web based KBS is support users and physicians in family planning methods selecting and decision support, increase awareness of users regarding to method selection criteria, and effective type of methods. Therefore, using this system in different health organizations, hospitals, non-governmental organizations (Mari Stops), internet cafe, public services are reduce women contraceptive methods health problems, increase users knowhow and reduce physicians workload, reduce contraceptive method selection complication, unsafe abortion, and support users to choose their relevant method confidentially.
- ☛ Due to the low effectiveness of the short acting family planning methods, this study is limited on giving a self-decision support for the long-acting family planning methods by accepting client's laboratory result from physicians. To make the system more useful, further work on short acting family planning methods can be included.
- ☛ Since, human disease are too many and new cases come from time to time, the current required diseases and cases of contraceptive methods may change. When the requirements are changed the system rule will be needed to update their rule. However, manually updating the rule is not effective and flexible. Therefore, further study is needed for graphical user interface based system rule updating.
- ☛ The web based knowledge based system can be used for service providers contraceptive users to advice themselves according to their health preference when the physician is not available. Since users speak different languages, this system also designed to support three languages. However, to self-decision and advice users by using different languages, designing the user interface by using different other local language will be helpful and easy to understand for users when they interact with knowledge based system.

## Reference

- [1] I. T. Adeleke, A. A. Salami, M. Achinbee, and T. C. Anamah, "ICT knowledge, utilization and perception among healthcare providers," *American Journal of Health Research*, vol. 3, no. Health Information Technology in Developing Nations: Challenges, pp. 47-53, 31 December 2014.
- [2] Federal Democratic Republic of Ethiopia, National Guideline for Family Planning Services in Ethiopia, Ethiopia: Ministry of Health, November 2011.
- [3] Robert A. Hatcher, M.D. Ward Rinehart, Richard Blackburn, Judith S. Geller, James D. Shelton, The Essentials of Contraceptive Technology, vol. PART I, Baltimore: Population Information Program, 2003.
- [4] K. Ringheim, "Factors that Determine Prevalence of Use of Contraceptive Methods for Men," *Studies in Family Planning*, (Mar. - Apr., 1993), Vols. Vol. 24, No. 2, pp. 87-99, mar. -Apr. 1993.
- [5] W.H.O, "Family planning methods or Contraception," world health organisation, 2015. [Online]. Available: <http://www.who.int/mediacentre/factsheets/fs351/en/>. [Accessed 22 June 2015].
- [6] K. W. Chau and F. Albermani, "An Expert System on design of Liquid-retaining Structures with blackboard Architecture," *Expert Systems*, vol. 21, pp. 183-191, 2004.
- [7] W. Wan-Ishak, and F. Siraj, "Artificial Intelligence in Medical Application: An Exploration," [Online]. Available: <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.102.4631&rep=rep1&type=pdf>. [Accessed 22 October 2015].
- [8] E. Kock, "Decentralising the Codification of Rules in a Decision Support Expert Knowledge Base," in *MSc Thesis, University of Pretoria, Faculty of Engineering, Built Environment and Information Technology*, South Africa, 2003.
- [9] Geneva center for Democratic control of Armed forces (DCAF), "Womens in an insecure world violence of women's, facts figures and analysis," 2005.
- [10] Hogan, Margaret C., et al, "Maternal Mortality for 181 countries, 1980-2008," *A Systematic analysis of progress towards millennium development Goals*, vol. 375, no. The Lancet, pp. 1609-1623, 2010.

- [11] United nations, "The millennium development Goals report," *New York: United Nations Department of Economics and social Affairs*, 2010.
- [12] United Nations Fund for women (UNIFEM), "Gender Equality now: Accelerating the Achievement of the millennium development Goals," 2008.
- [13] E.A. Feigenbaum and R.S. Engelmores, "Expert System and Artificial Intelligence," *Japanese Technology Evaluation Center panel's report about Knowledge Based Systems*, 1993.
- [14] C.S. Krishnamoorthy and S. Rajeev, *Artificial Intelligence and Expert Systems for Engineers*, CRC Press, CRC Press LLC, 1996.
- [15] B. Ruiz-Mezcua, A. Garcia-Crespo, J.L. Lopez-Cuadrado, and I. Gonzalez-Carrasco, "An expert system development tool for non AI experts," *Expert Systems with Applications*, vol. 38, p. 597–609, 2011.
- [16] J. Durkin, "Expert Systems: A View of the Future," *IEEE Expert*, no. University of Akron, pp. 56-63, 1996.
- [17] D. Yanqing, "Web-Based Expert Systems," *Encyclopedia of Information Science and Technology*, vol. Second Edition, no. IGI Global, 2009.
- [18] R. Grove, "Internet-based expert systems," *Expert Systems*, vol. 17, no. 3, pp. 129-136, July 2000.
- [19] Kumar, S. and Mishra, R., "Expert systems and services," *The Knowledge Engineering Review*, vol. 2, no. 25, p. 167–198, 2010.
- [20] F. Grove, "Design and development of knowledge-based systems on the web," in *In Proceedings of ISCA 2000: 9th International Conference on Intelligence Systems, Artificial Intelligence Applications for the New*, Louisville, KY, USA, 2000.
- [21] Hogo, M. , Fouad, K. and Mousa, F., "Web-Based Expert System for Civil Service Regulations: RCSES," in *International Journal of Computer Science and Information Security, IJCSIS*, USA, December 2009.
- [22] Turban, E., "Decision Support and Expert Systems: Management Support Systems," *Macmillan Publication*, 1990.

- [23] R.A. Akerkar and P.Srinivas Sajja, "Knowledge-Based Systems for Development," *Jones and Bartlett Publishers*, vol. 1, pp. 1-11, USA, 2010.
- [24] Yasser A. Nada, H. Meshref, "Analysis, Design, and Implementation of Intelligent Expert System for Clothes Style Selection," *International Journal of Computer Applications*, vol. 105, November 2014.
- [25] Turban E., Sharda., and Delen D., "Decision Support and Business Intelligence Systems," in *Ed. 9th, Prentice Hall of India Private Limited*, Oklahoma State, India, 2010.
- [26] R. Aref, "A Knowledge based system for comfort analysis of internal environment of," 2000.
- [27] S. Gebremariam, "A Self-learning knowledge based system diagnosis and treatment of diabetes," *Addis abeba university*, no. A Thesis Submitted in information science , 2013.
- [28] E. Castillo, J.M. Gutierrez and A.S. Hadi, "Expert Systems and Probabilistic Network Models," *Springer*, USA, 1997.
- [29] Richa Goyala, T. Jayasudhaa, Prateek Pandeyb, D. Rama Devic, A. Rebeccac, M. Manju Sarmad, B. Lakshmi, "Knowledge Based System for satellite data selection," Vols. Volume XL-8, no. The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, 12 December 2014, Hyderabad, India.
- [30] A. Ranjan, J. Glassey, G. Montague, and P. Mohan, "From Process Experts to a Real-Time Knowledge-Based System," in *Expert Systems*, 2002, p. 69 –79.
- [31] Aankita Kaur, Mansaf Alam, "Role of Knowledge Engineering in the Development of a Hybrid Knowledge Based Medical Information System for Atrial Fibrillation," *American Journal of Industrial and Business Management*, vol. 3, pp. 36 -41, 2013.
- [32] O'Keefe, Daniel E. O'Leary and Robert M., "Expert system verification and validation: a survey and tutorial," *Artificial Intelligence Review*, vol. 7, pp. 3-42, 1993.
- [33] Pearson Education, " Chapter 18 - Knowledge Acquisition, Representation, and Reasoning," [Online]. Available:  
[http://wps.prenhall.com/wps/media/objects/3778/3869053/Turban\\_Online\\_Chapter\\_W18.pdf](http://wps.prenhall.com/wps/media/objects/3778/3869053/Turban_Online_Chapter_W18.pdf).  
 [Accessed 23 08 2015].

- [34] G. B., "Flexible Knowledge Acquisition Through Explicit Representation of Knowledge Roles," *Marina del Rey: USC/Information Sciences Institute*, 1999.
- [35] S. Tehrani, "A Conceptual Model of Knowledge Elicitation. College of Business, Technology and Communication," 2009.
- [36] S. Kvale, *InterViews: An Introduction to Qualitative Research Interviewing*, Thousand Oaks: CA: Sage publications, 1996.
- [37] S. Wang, "Knowledge elicitation approach in enhancing tacit knowledge sharing," *Emerald*, pp. 1039-1064, 2011.
- [38] M. Gau, *Knowledge Acquisition for a Diagnosis-Based Task*. NATO ASI Series, 1990.
- [39] Savolainen, T., Beeckmann, D., Groumpos, P, and Jagdev, H., "Positioning of modelling approaches, methods and tools," *Computers in Industry*, vol. 25, pp. 255-262, 1995.
- [40] R. Olivas, "A Primer for decision-making Professionals," in *Decision trees*, 2007.
- [41] W. Mettrey, "An Assessment of Tools for Building Large Knowledge Based Systems," *AI Magazine Number 4*, vol. 8, 1987.
- [42] S. Jimmy, "The Diagnosis of Some Lung Diseases in a Prolog Expert System," 2013, *International Journal of Computer Applications (0975 – 8887)*, vol. 78, September, 2013.
- [43] el Yu et, Belfast, "A knowledge-based decision-support system for health and safety competence assessment," *UK : Association of Researchers in Construction Management*, no. In: Boyd, D (Ed) *Procs 23rd Annual ARCOM Conference*, pp. 305-314., September 2007.
- [44] E. Kock, *Decentralising the Codification of Rules in a Decision Support Expert Knowledge Base*, MSc Thesis, University of Pretoria, Faculty of Engineering, Built Environment and Information Technology, South Africa, 2003.
- [45] P. A., "Case-Based Reasoning: Foundational Issues, Methodological Variations, and System Approaches," *AI Communications*, pp. 39-59, 1994.
- [46] S. Simon, "Case-Based Reasoning: Concepts, Features and Soft Computing," *Kluwer Academic Publisher*, no. *Manufactured in The United States*, p. 233–238, 2004.

- [47] H. Bekele, "A case based reasoning knowledge based system for hypertension managment," 2011.
- [48] J. Prentzas, "Categorizing Approaches Combining Rule-Based and Case-Based Reasoning," *Expert Systems*, vol. 24, May, 2007.
- [49] Hatzilygeroudis, Integrations of Rule-Based and Case-Based Reasoning. Greece: Research Academic Computer Technology Institute, 2007.
- [50] P. J. Guo, "Software tools to facilitate research programming," *Stanford university department of computer science* , no. A resarch study of doctor of philosophy, May, 2012.
- [51] J. K. Kingston, "Knowledge Based System Development Tools," AIAI, University of Endinburgh, Scotland, 2010.
- [52] J. Rhem, "A Framework for Knowledge Acquisition Providing today's Solutions with Tomorrow's Technology, White Paper," 2002. [Online]. Available: <http://www.ajrhem.com/framework.pdf>. [Accessed 22 May 2015].
- [53] Mettrey, William, "An Assessment of Tools for Building Large Knowledge-Based Systems," *Knowledge based systems*, vol. Volume 8, no. AI Magazine, Number 4, 1987.
- [54] a. M. P. Hope T., "Validation, verification and Testing Terminology A: proposal," *Journal of IEEE Expert*, vol. 8(3), pp. 48-55, 1993.
- [55] T. Sagheb, "A Conceptual Model of Knowledge Elicitation :College of Business, Technology and Communication," 2009.
- [56] P. Jones, "Knowledge Acquistion: Knowledge Engineering in Agriculture," [Online]. Available: <https://engineering.purdue.edu/~engelb/abe565/nowacq.htm>. [Accessed 19 10 2015].
- [57] Cotton N., Stanback J., Maidouka H., Taylor-Thomas J., and Turk T., "Early discontinuation of contraceptive use in Niger and gambia.," in *International Family planning perspectives*, vol. 18(4), 1992, pp. 145-149.
- [58] Federal Democratic Republic of Ethiopia Ministry of health, "National Adolesent and youth Reproductive Health Strategy," Addis Abeba, Ethiopia, Ministry of Health, 2006 up to 2015.

- [59] Mtawali, G., Curtis, K., Angle, M., and Pina, M., "Contraceptives side effects: Responding to clients concerns.," 1994.
- [60] World Health Organization, "The medical Eligibility Criteria for Contraceptive use," in *Contraceptive methods use and selection Criteria*, 4th Edition, 2010.
- [61] Aronson J., and Turban E., "Decision Support System and Intelligent Systems, 7th Edition," *New Delhi, Prentice-Hall of India Private Limited*, 2007.
- [62] D. Lidtke, "Fast based NP chunking with decision trees: experiment on different POS," in *International conference on computational linguistic and intelligent text processing*, kyto association for computing machinery Inc, 2003.
- [63] H. Schreiber, "Conceptual Modelling for Knowledge-Based Systems," *Encyclopedia of Computer Science and Technology*, Marce Dekker Inc., New, 1999.
- [64] J. Quintana, "Decision tree for indication of total hip replacement on patients with osteoarthritis," *Oxford journal*, pp. 1402-1409, 2009.
- [65] Saxena P., "Architecture for Medical Diagnosis Using Rule-Based Technique," in *The First International Conference on Interdisciplinary Research and Development*, Thailand. Dayalbagh Educational Institute, 2011.
- [66] ". B. H. Toby, "Experst system GUI, a graphical user interface for GSAS," *Journal of Applied Crystallography*, vol. 34, pp. 210 - 213, 2001.
- [67] R. F. Grove, "Design and development of knowledge-based systems on the Web," in *In Proceedings of ISCA 2000: Ninth International Conference on Intelligence Systems: Artificial Intelligence Applications for the New Millennium*, Louisville, KY, USA. Int. Soc, June 2000.

# Appendixes

## Appendix I

### Interview Questions

The following structured interview questions were prepared and presented for the selected medical experts, who are currently involved in family planning methods counseling and advising at Adama Hospital Medical College and Mari Stops of Ethiopia in Adama branch. After introducing the objective of the study, the medical professionals were kindly requested to provide their professional expertise by forwarding the following questions.

1. What are the different types of family planning? Which types of family planning methods are commonly used in Ethiopia? Why?
2. What are the important points that you take in to account when consulting of using family planning methods?
3. Which group of women's are excluded from using of family planning, according to their health states, and age?
4. What are the Advantages and dis-advantages of using family planning methods?
5. Among the different types of family planning methods, how can we manage and identify the most preferred one to client's during the final recommendation result?
6. In which age group are used family planning methods? How you categorized it? Why?
7. What are the major criteria's of each family planning methods when we consulting the clients?
8. .Do you have standardized guidelines for family planning methods? If yes, to what extent do you follow the guideline?
9. When consulting clients about family planning, what are their purpose and aims of family planning using?
10. In which marital states are client's mostly used family planning methods?
11. What are the fear of clients towards fertility regulation and family planning using?
12. Does the client/couple find some methods unacceptable? If yes, which method? Why?
13. What are the diseases that affect client's from using a family planning methods?
14. What are the client's family history of diseases that affect to the clients from using family planning methods?

## Appendix II

### Sample graphical user interface of the Self decision support system

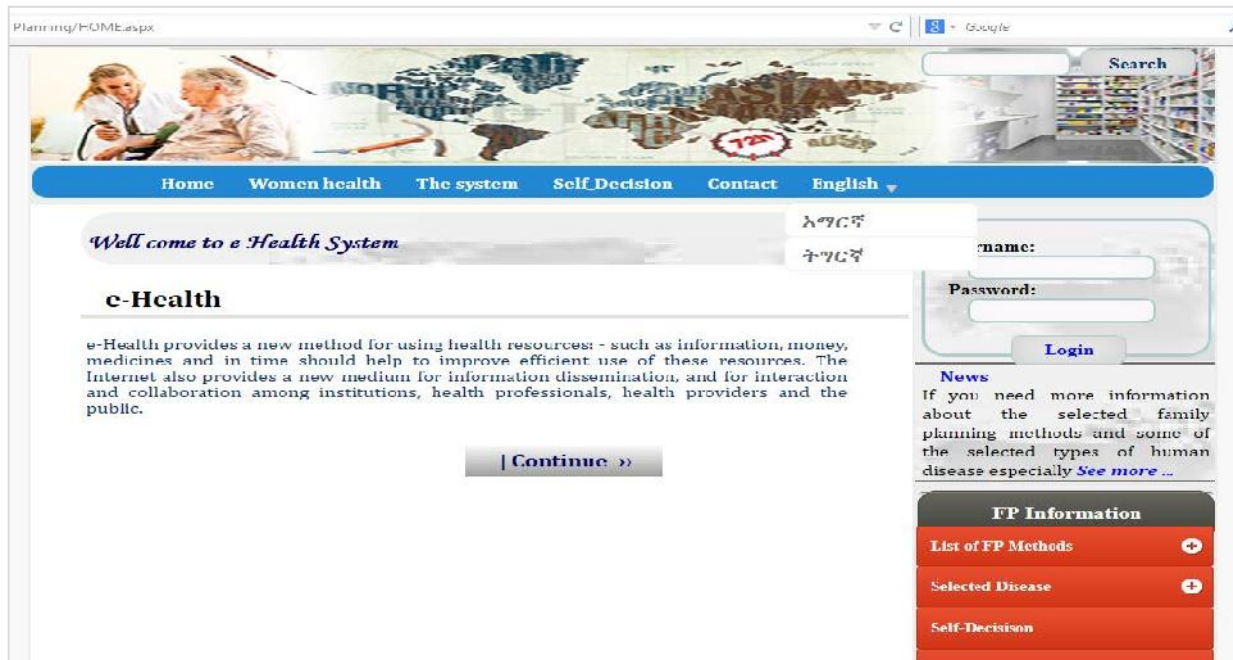


Figure 27 The page display the self-Decision support in Amharic language

This is the home page of the web based knowledge based system and it describes about the general information of the electronic health using English language.

The screenshot shows the user information form of the web-based knowledge-based system. At the top, there is a navigation bar with links: Home, Self Decision, English, and Logout. Below the navigation bar, there is a banner image showing a doctor and a patient. The main content area is titled 'Wellcome — to Self-decision support system' and 'Hello, Melawit Tesfaye'. It contains a 'Personal Information' section with fields for 'Decision Mode' (Self-decision), 'Consultation Date' (2/9/2016), 'Client Name' (Melawit Tesfaye), 'Age' (36), 'Religion' (Ortodox), and 'Marital Status' (Married). There is a 'Continue' button. On the right side, there is a sidebar with a logo 'HelloDr.net' and a list of links: 'Selected FP Methods', 'Selected Disease', and 'Self-Decision'.

Figure 28 Users detailed information for self-decision

Figure 28 shows the first page of the self-decision support module. The page first checks if the user personal information is correct, then next checks if user pregnancy result is negative or positive to proceed to the next page.

Figure 29 The second page of the self-decision support page

Continue ...

Figure 30 The fourth page of the self-decision support system

Home
Self\_Decision
English
Logout

Continue to answer Questions

Additionally select if you have any of the following disease

Select disease which are suffers you
Select

Malaria  
Do hard physical work

Remove

Mean that: in your day to day activity you are doing hadr physical work

Enter your weight: 68 Kg  
Enter your height: 178 Cm  
Your Over weight status: Normal  
Enter utrine size in cm: 7  
Your utrine size: Normal  
Do you have hepaites (history)? No

« Back
Check
Continue »

HelloDr.net

Additional Information

Selected FP Methods  
Selected Disease  
Self Decisison

Figure 31 The fifth page of the self-decision support system

Final result of the user

Client Name: Melawit Tesfaye  
Age: 36  
Consultation Date: 2/9/2016  
Enter method: IUCD Save choice

>>> Conculision 1  
The following methods are Not-recommended to use  
Not-recommended methods:  
COC  
Depo-Provera  
Implants  
Norplant

>>> Conculision 2  
The following methods are Recommended to Use  
Recommended methods:  
IUCD  
POP  
Male Condom

End ~ SD
How
Restart

HelloDr.net

Additional Information

Selected FP Methods  
Selected Disease  
Self Decisison

Figure 32 The final result of the self-decision support system

This is the final decision support page of the knowledge based system it displays the last recommended and not recommended FP methods.

## Appendix III

### Prototype Evaluation Questionnaire

*Table 9 Questionnaire*

| No                   | WKBS Evaluation Criteria                                           | Excel<br>lent | Very<br>Good | Good | Fair | Poor | Aver<br>age | Percent<br>age (%) |
|----------------------|--------------------------------------------------------------------|---------------|--------------|------|------|------|-------------|--------------------|
| 1                    | Is the system easy to use and interact with?                       |               |              |      |      |      |             |                    |
| 2                    | How do you rate the user attractiveness of the system?             |               |              |      |      |      |             |                    |
| 3                    | How do you rate the accuracy of WBKBS in FP methods self-decision? |               |              |      |      |      |             |                    |
| 4                    | How do you rate time efficiency of the system to respond?          |               |              |      |      |      |             |                    |
| 5                    | Does the system incorporate adequate knowledge on FP?              |               |              |      |      |      |             |                    |
| 6                    | Does the system provide appropriate Decision for FP users?         |               |              |      |      |      |             |                    |
| 7                    | Does the system have contribution in the domain area?              |               |              |      |      |      |             |                    |
| <b>Total Average</b> |                                                                    |               |              |      |      |      |             |                    |

**N.B:** Put “X” symbol on the available place for the corresponding attribute values of each evaluation criteria.

## **Declaration**

I declare that the thesis is my original work and has not been presented for a degree in any other university.

---

**SINEDOS GEBRU**

**FEBRUARY, 2016**

---

**Advisor: DEREJE TEFERI (PHD)**