WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Predicting Maternal Mortality Rate Using Data Mining Techniques: The Case of Jimma University Specialized Hospital Maternity Wards

Edosa Fekadu Olana

Wollega University,Department of Computer Science, Ethiopia

Email :edfekadu@yahoo.com,idosaf@wollegauniversity.edu.et

ABSTRACT

Recent reports from WHO and UNAIDS indicate that the number of pregnant woman died after delivery increasing. This number is dramatically increasing in sub Saharan African countries including Ethiopia. Maternal mortality is the main issues in healthcare specially in undeveloped country. The main objective of this study is to develop a predictive model for the maternal mortality rate status. The overall activity of this study is guided by a Hybrid-DM process model which is a six step knowledge discovery process. The study has used 4218 instances, with twelve predicting and one outcome variables to run the experiments. The data mining algorithms; J48 decision tree, Naïve Bayes and PART rule induction are used in all experiments due to their popularity in Data mining. Ten-fold cross validation and 70/30 split criteria test option were used to train and test the classifier models. Experimental result shows that J48 algorithms has a better performance with 98.74 % accuracy running on 10 fold cross validation test option with default parameters. Significant attributes of maternal mortality rate status, after delivery has been identified. These are Mothers BP, Address, APGAR score, Diagnosis, Age, Length of stay, Indication and Condition on Discharge. A promising result is observed by applying data mining techniques to build predictive model for maternal mortality rate using socio-demographic, clinical and biological features.This study is proved that the prediction of maternal mortality rate can be applicable with the help of data mining application in the maternity ward and predicting model for the life status of mothers after delivery has been already identified. Future works can be done by applying the above selected attributes to improve the prediction of maternal mortality rate accuracy with the addition of more data to the database.

Keywords: classification ,Hybrid DM Process, J48 Decision Tree, Maternal Mortality, Naïve Bayes,Predictive Model and PART rule Induction

1. INTRODUCTION

1.1 Data Mining

Data Mining is becoming popular in healthcare field because there is a need of efficient analytical methodology for detecting unknown and valuable information in health data. In health industry, Data Mining provides several benefits such as detection of the fraud in health insurance, availability of medical solution to the patients at lower cost, detection of causes of diseases and identification of medical treatment methods. Data that contains details regarding hospitals patients, medical claims, treatment cost etc. So, there is a need to generate a powerful tool for analyzing and extracting important information from this complex data.The analysis of health data improves the healthcare by enhancing the performance of patient management tasks [4]. Health care industry today generates large amounts of complex data about patients, hospital resources, disease diagnosis, electronic patient records, medical devices, drugs and human resources.Hospital is the one among the health station that give the service of health. Larger amounts of data are a key resource to be processed and analyzed for knowledge extraction that enables support for cost-savings and decision making that can be achieved through different types of techniques [38].

Women's are more vulnerable for death more than men's due different types of health related problems. This might be due to lack of treatment in the health station or level of life.in developing country the life status and cultural related staff can be a reason of women's death too. From this we could understand that maternal death is the big percentage in the developing country. The Jimma university specialized hospital is one of the health organization that provide a health service for the community. Jimma university Hospital has different types of wards which gives services for the patient depending on the cases of the patient. There are wards in the hospital related with treatment cases like female ward, male ward, pediatric ward, isolation room and maternity ward. Maternity wards are wards that give service of lab our and deliver for women's. Pregnancy women needs special care and the new baby should be physically and mentally health. Maternal mortality is the death of women during pregnancy, childbirth, or in the 42 days after delivery remains a major challenge to health systems worldwide. Global initiatives to intensify policy intervention for maternal mortality began with the Safe Motherhood Initiative in (1987) [29].

Today data mining is a tool which is good for investigation of problems that occur in health sector. The Healthcare industry is among the most information intensive industries. Medical information, knowledge and data keep growing on a daily basis. It has been estimated that an acute care hospital may generate five terabytes of data a year. The ability to use these data to extract useful information for quality healthcare is crucial. Maternal

mortality can be applicable by the new modern techniques of data mining. Data mining is one among the most important steps in the knowledge discovery process. It can be considered the heart of the KDD process [12].

1.2 Tools

For this specified study the WEKA version 3.7.5 is the major tool to drive the study forward. WEKA is a good tool for the hybrid model since the model has different types of steps to pre-processes the data. There is also other tool of data mining like Rapid miner and TANAGRA, but due to the researcher's familiarity with WEKA tool it will more preferable. Also so many researchers have been used this tool before, for the purpose of mining hidden knowledge in the stored data. Additionally, MS-Excel, MS power point, MS word is the primary tool which the researcher will use for the purpose of data cleaning and preprocessing situation.

2.Literature review

2. 1 Maternal Mortality

Maternal mortality is defined as the death of a woman while pregnant or within 42 days of termination of pregnancy, regardless of the site or duration of pregnancy, from any cause related to or aggravated by the pregnancy or its management. Female literacy Rates Area Strong Predictor of Maternal Mortality Rates; The more literate a Female population, The lower The Maternal Mortality Rate. A woman's chance of dying or becoming disabled during pregnancy and childbirth is closely connected to her social and economic status, the norms and values of her culture, and the geographic remoteness of her home. That means if women live in the comfortable environment the chance of their death is very rare. Generally speaking, the poorer and more marginalized a woman is, the greater her risk of death. In fact, maternal mortality rates reflect disparities between wealthy and poor countries more than any other measure of health. A woman's lifetime risk of dying as a result of pregnancy or childbirth is 1 in 39 in Sub-Saharan Africa, as compared to 1 in 4,700 in industrialized countries. Globally, at least 585, 000 women die each year by complications of pregnancy and child birth More than 70% of all maternal deaths are due to five major complications: hemorrhage, infection, unsafe abortion, hypertensive disorders of pregnancy, and obstructed labor. The majority of maternal deaths (61%) occur in the postpartum period, and more than half of these take place within a day of delivery. Worldwide an estimated 500,000 women die as a result of pregnancy each year [3].

2.2 Mortality Rate

Mortality rate, or death rateis a measure of the number of deaths (in general, or due to a specific cause) in a particular population, scaled to the size of that population, per unit of time. Mortality rate is typically expressed in units of deaths per 1,000 individuals per year; thus, a mortality rate of 9.5 (out of 1,000) in a population of 1,000 would mean 9.5 deaths per year in that entire population, or 0.95% out of the total. It is distinct from "morbidity", a term used to refer to either the prevalence or incidence of a disease, and also from the incidence rate (the number of newly appearing cases of the disease per unit of time) [42].

2.3 Maternal Mortality Rate And Causes Of Death

Maternal mortality is a serious problem for under developing country. Maternal mortality is the leading in Africa and Asia. Since the launching of the Safe Motherhood Initiative in1987, there has been a worldwide effort to reduce maternal mortality and to identify its determinants. The declaration of the Millennium Development Goals (MDGs) aiming at reducing by three-quarters the maternal mortality ratio between 1990 and 2015 has also increased the demand for measuring maternal mortality at national and subnational levels [5][6][7].Maternal mortality is notoriously difficult to measure..Every year, more than 289,000 women die during pregnancy or childbirth. Most of these deaths are preventable.At least 12 million women suffer severe maternal complications.The chance of dying is much greater in poor countries; developing countries account for 99 percent of the global maternal deaths, the majority of which are in sub-Saharan Africa and southern Asia [1].

2.4 Causes Of Maternal Mortality In Ethiopia

There are so many cuases for maternal mortality in ethiopia.As an example listing some points will be psossible like awwerness about health,early marriage,remotnes from health station,lack of food,transport and cost of service for pre checking during the pregnency.Globally, at least 585, 000 women die each year bycomplications of pregnancy and child birth .More than 70% of all maternal deaths are due to five major complications:hemorrhage, infection, unsafe abortion, hypertensive disorders of pregnancy, and obstructed labor. The majority of maternal deaths (61%) occur in the postpartum period, and more than half of these take place within a day of delivery [8].

The number of maternal deaths is highest in countries where women are least likely to have skilled attendance at delivery, such as a midwife, doctor or other trained health professional. Likewise, within countries, it is the poorest and least educated women who are most vulnerable to maternal death and disability.High maternal mortality rates are an indication not only ofpoorly functioning health systems, but also of deep-seated gender inequalities that leave women with limited control over decision-making and that restrict their access to social support, economic opportunities and health care.These gender inequalities manifest early in life; girls born into poverty are more vulnerable to child marriage and exploitation, such as sex trafficking or forced labor. Adolescent girls frequently lack the power to decide whether contraception is used during sex, or whether sex takes places at all. This places them at high risk for early pregnancy and its resulting complications [35].

According to Ahmed [8] Lack of information and adequate knowledge about danger signals during pregnancy and labor; cultural traditional practices that restrict women from seeking health care; lack of money,Out of reach of health facilities; poor road,communication network,community support Mechanisms Delay,Inadequate skilled attendants, poorly motivated staff,inadequate equipment and supplies weak referral system, procedural guides and the like are the causes for the mortality of maternal.

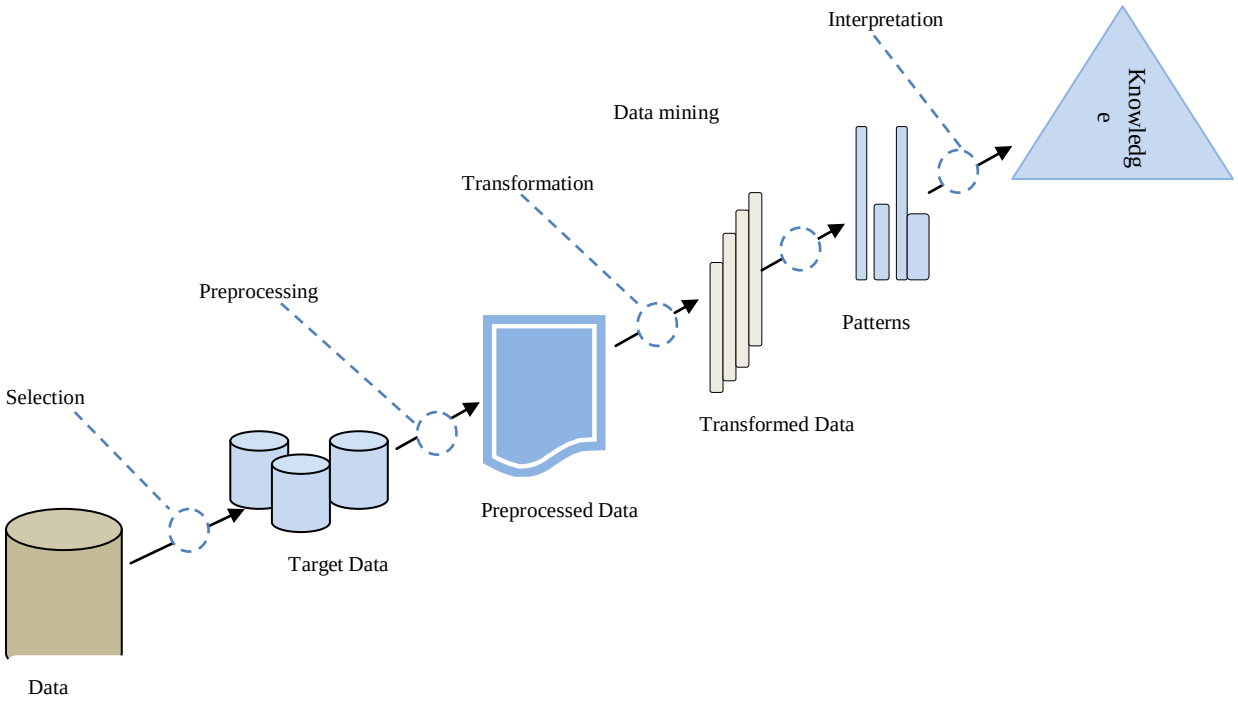

Figure :Data Preprocesses cycle

3.RELATED WORKS

[5][42] explains the art of data mining tool in predicting the Chances of Liver Disease in Ectopic Pregnant Groups, they used the regression method and K fold cross validation to subgroup the data of the for liver disease. On here they used the data mining with the statistical method. Medical data mining techniques like Association Rule Mining, Clustering, Classification Algorithms such as Decision tree, C4.5 Algorithm are implemented to analyze the different kinds of heart based problems. C4.5 Algorithm and Clustering Algorithm like K-Means are the data mining techniques used in medical field. With the help of this technique, the accuracy of disease can be validated. Classification is one of the supervised learning methods to extract models describing important classes of data. Three classifiers Decision Tree, Naïve Bayes and Classification via clustering have been used to diagnose the Presence of heart disease in patients [35][39].

[45], PART pruned rule induction model, J48 unpruned tree and Navies Bayes are appeared with good predictive performance for nutritional status of under-five children. From all the scenarios experimented, all models reveal the better performance in predicting True positive cases or sensitivity; than predictive performance of True negative case or specificity. As sensitivity and specificity has greater importance than general accuracy of the classifier in clinical and medical fields, models are better compared based on WROC area. The model created using PART pruned rule induction classifier registers good performance (i.e. 97.8% WROC area) and hence selected for further analysis/rule tracing. PART is a good algorithm to predict the under five-year nutrient ion

[6]) also used (artificial neural networks and decision trees) to predict breast cancer survivability. Additionally, they used 10-fold cross-validation methods to measure the unbiased estimate of the three prediction models for performance comparison purposes. In order to perform the research reported in this manuscript, we used the data contained in the SEER Cancer Incidence Public-Use Database for the years 1973-2000. After the data preprocesses data cleansing and data preparation strategies, the final dataset, which consisted of 17 variables (16 predictor variables and 1 dependent variable) and 202,932 records, was constructed. The c=accuracy measurement was measured by stratified 10-fold cross validation and the result also obtained by the result testing on the data set. the result shows the ANN model achieved a classification accuracy of 0.9121 with a sensitivity of 0.9437 and a specificity of 0.8748. The logistic regression model achieved a classification accuracy of 0.8920 with a sensitivity of 0.9017 and a specificity of 0.8786. However, the decision tree (C5) preformed the best of the three models evaluated. The decision tree (C5) achieved a classification accuracy of 0.9362 with a sensitivity of 0.9602 and a specificity of 0.9066. For each fold of each model type, the detailed prediction results of the validation datasets are presented in form of confusion matrixes. A confusion matrix is a matrix representation of the classification results.

[36] also stated that encouraging results were obtained by employing both neural networks and decision tree approaches. Although both neural network and decision trees showed comparable accuracy and performance in predicting the risk of child mortality, the decision tree approach seems

more applicable and appropriate to the problem domain since it provides additional features such as simple and easily understandable rules that can be used by non-technical health care professionals as well as health care planners and policy maker.

[26][29] used the popular data mining techniques include Bayesian analysis, neural networks, genetic algorithms, decision trees and logistic regression. The propose to use a hybrid method that combines the strength of both logistic regression and decision trees in the paper. The proposed hybrid method includes three steps.The first step is to identify the importance of the risk factors in determining the advanced age mortality distribution. We fit a logistic regression model using only age and square term of age as the depend variables because it is well knowing that mortality rate is grow exponentially with age.

Consequently, the predicted power for each segment logistic regression model is different. Detail description of each segment's logistic regression model is given in the section of the paper. Generally, from these literatures review the researcher will gain one useful information to solve the stated problem, these literature review will cover the rough starting for the stated problem. From the reviewed literature different types researcher will prove the techniques and algorithm that the researcher will use in the future. Without any doubt the listed algorithm and techniques that the researcher raises under chapter one of this proposal PART tree, J48 and naïve Bayesian will solve the problem stated under chapter one.

As a general according to the above cited researchers, the evaluation of best performed algorithms compared based on accuracy, sensitivity, specificity, false prediction rate and time taken to build model. They also used the 10-fold cross validation to evaluate their performance of the model. Additionally, the used the J48 decision tree, Naïve Bayes and PART and they got the encouraging result on the prediction and model creation. according to the researcher understanding J48 decision tree and Naïve Bayes algorithm used at one place sometimes and adding one algorithm beside J48 decision tree and Naïve Bayes will produce a good result for the purpose of prediction techniques around health area. adding one algorithm and above on the J48 decision tree and Naïve Bayes is the gap and recommendation that many researchers left in their paper and WEKA tool is used as primary.

But they used the old version of WEKA, for this reason the advanced version of WEKA and other un used algorithm will be one of the gap that the researcher understands. Also applying the data mining techniques will provide a good model and result. Therefore, decision tree, Naïve Bayesian and PART are used for the purpose of classification and prediction of events in the future with useful knowledge. Using those algorithms and adding hybrid model approach will be success the work of maternal mortality rate prediction. additionally, using the advanced version of WEKA with modified algorithm will produce a good result for the maternal mortality in maternity ward.

4.Methodology

Methodology is the way that the stated problem that raised on the chapter one of this research solved procedurally. Data mining techniques and architecture is the essential tool in the environment of health for the purpose of prediction and clustering. It is known that data mining techniques contain different types of models to predict and classify the problem of maternal mortality rate that occurs during lab our and delivery. There are models which could solve the problem of predicting and creating a model which we discussed on the literature review parts of the chapter two sections. Therefore, the researcher should depend on the model which is highly useful for the purpose predicting using the more applicable and recent model of Hybrid model.Hybrid means a thing made by combining two different elements. In this paper, hybrid classification model refers to a combination of two data mining tasks, which are clustering and classification in effort to obtain higher accuracy result [32].

This research is designed by starting the data exploration and applying the data mining techniques procedurally. The KDP processes is one of the important and Necessary one before we apply the data mining model [13].The Hybrid model is not far from the KDP processes due to the difference between them is not a lot.The development of academic and industrial models has led to the development of hybrid models, i.e., models that combine aspects of both it was developed based on the CRISP-DM model by adopting it to academic research, but Hybrid model a more general than CRISP DM. As a general the hybrid model providing more general, research-oriented description of the steps and introducing a data mining step instead of the modeling step. Due to this Hybrid is becoming more preferred one [9]. Therefore, Hybrid model known by the following descriptive steps.

1) Understanding of the problem domain: -This initial step involves working closely with domain experts to define the problem and determine the project goals, identifying key people, and learning about current solutions to the problem. It also involves learning domain-specific terminology. A description of the problem, including its restrictions, is prepared. Finally, project goals are translated into DM goals, and the initial selection of DM tools to be used later in the process is performed.

2) Understanding of the data: -This step includes collecting sample data and deciding which data, including format and size, will be needed. Background knowledge can be used to guide these efforts. Data are checked for completeness, redundancy, missing values, plausibility of attribute values, etc. Finally, the step includes verification of the usefulness of the data with respect to the DM goals.

3) Preparation of the data. This step concerns deciding which data will be used as input for DM methods in the subsequent step. It involves sampling, running correlation and significance tests, and data cleaning, which includes checking the completeness of data records, removing or correcting for noise and missing values, etc. The cleaned data may be further processed by feature selection and extraction algorithms (to reduce dimensionality), by derivation of new attributes (say, by discretization), and by summarization of data (data granularization). The end results are data that meet the specific input requirements for the DM tools selected in Step 1.

4) Data mining. Here the data miner uses various DM methods to derive knowledge from preprocessed data.

5) Evaluation of the discovered knowledge. Evaluation includes understanding the results, checking whether the discovered knowledge is novel and interesting, interpretation of the results by domain experts, and checking the impact of the discovered knowledge. Only approved models are retained, and the entire process is revisited to identify which alternative actions could have been taken to improve the results. A list of errors made in the process is prepared.

6) **Use of the discovered knowledge.** This final step consists of planning where and how to use the discovered knowledge. The application area in the current domain may be extended to other domains. A plan to monitor the implementation of the discovered knowledge is created and the entire project documented. Finally, the discovered knowledge is deployed.

5. Conclusion

Data mining techniques can be applied to maternity ward database to predict the maternal mortality rate and helps to discover links or patterns in a store of data. It can help to discover interesting associations between data items of pregnant mother's records and enable to predict missing or unknown values based on rules mined through the process of Decision tree rules with classification mining.

In order to achieve the objective of the study the researcher used three popular classification algorithms (J48, Naïve Bayes and PART rule induction) and long process of data cleansing, data and dimensionality reduction and transformation used it to build the prediction models on 4218 instances and 14 attribute of maternity ward dataset from Jimma university specialized Hospital.

The result from the three applied classification algorithm of the experiment the J48 un pruned decision tree had scored the pretty good results for the prediction of maternal mortality rate by classifying the attribute which could predict mothers future life status. This is already proved by classifying the last result as normal and Medium which means as Normal conditions pregnant mothers life could not fail under risk whereas under medium class the life of woman's will fail under risk, so additional counseling and other important advice should be given by the physicians.

The study has shown the necessity to experiment as many classification algorithms as possible before selecting and using a single algorithm for prediction. Eight attribute is selected from fourteen to predict the maternal mortality rate. The un pruned J48 algorithm is a good model for the prediction of maternal mortality rate.

6. Recommendation

In this research work, efforts have been made to apply data mining technology to predict maternal mortality rate using J48, Naïve Bayes and PART rule induction tree algorithms.

Thus, based on the result of these research future works are lined. This would more enhance applicability of data mining technology in maternal mortality status so the death of maternal is determined by the developed prototype and attributes. This is in lined in health prevention and control activities with advocacy efforts of maternal mortality reduction policy in rural communities of the country. The following recommendation is lined:

- Beside this instead of developing the model by using and testing three algorithms adding the algorithms more than three would provide a more accurate result like Neural network, since neural network is used in many health related research.
- In both the decision tree and Naive Bayes approaches the result is an encouraging output, still performance improvement is expected.
- Other classification algorithms such as Neural networks and Bayesian network (Belief network) which have also been proved to be important techniques in the health care sector could be applied by using the entire dataset.
- It is appropriate to predict the survival years of the individual in the area corresponding to sample data available through data mining technology and it is also possible to guess the life expectancy of the pregnant woman would live after she served from maternity ward.
- The decision tree and Naïve Bayes reported promising results and hence they could be applied in the area of maternal mortality rate predictive modeling, decision tree tends to perform better.
- Thus, it would be more optimal for the Jimma University Specialized hospital maternity ward to employ the developed model with this technique.

References

[1] Abdella, A. (2010). Maternal Mortality Trend In Ethiopia. *Health Dev,Special Issue 1*, 116-119.

[2] Abraham, T. (2005). Application of Data Mining Techniques To Discover Cause of Under-Five Children Admission To Pediatric Ward:The Case of Nigist Eleni Mohammed Memorial Zonal Hospital.Masters Thesis.Addis Abeba Unversity:Addis Ababa,Ethiopia.

[3] Admasu, K. (2014, April). Supporting Evidence-Based Decision Making:To Wards The Achievement of The Health Millennium Development Goals. *Policy And Practice Information For Action.*, 3-4.

[4] Agarwal, D. T. (2013). A Survey On Data Mining Approaches For Healthcare. *International Journal of Bio-Science And Bio-Technology Vol.5, No.5* , 241-266.

[5] Ana P Betrán, D. W. (2005). National Estimates For Maternal Mortality: An Analysis Based On The Who Systematic Review of Maternal Mortality And Morbidity. *Bmc Public Health*, 2-6.

[6] Anagaw, S. (2002). Application of Data Mining Technology To Predictchild Mortality Patterns.The Case Of Butajira Rural Health Project:Masters Thesis,Addis Ababa Unvesrity,Addis Abeba,Ethiopia.

[7] Assamnew, S. (2011). Predicting The Occurrence of Measles Outbreak In Ethiopia Using Data Mining Technology:Un Published Masters Thesis.Addis Abeba.Addis Abeba Unversity.

[8] Ayale, D. (2013). Predicting Maternal Health Care Seeking Pattern.Masters Thesis.Addis Ababa Univesity,Addis Ababa,Ethiopia. 69-71.

[9] Chaudhary, P. (2015). Data Mining System, Functionalities And Applications,A Radical Review . *International Journal of Innovations In Engineering And Technology (Ijiet),Volume 5*, 449.

[10] Danso, S. O. (2006). An Exploration of Classification Prediction Techniques In Data Mining:The Insurance Domain. 6-29.

[11] Delen, D. O. (2008). *Advanced Data Mining Techniques.* Heidelberg: Springer.

[12] Dharani Shree, K. (2014). Application of Data Mining Techniques In Health Care Industry. *International Journal Of Computer Science And Information Technology Research*, 23-25.

[13] Getachew, D. (2013). Application Of Data Mining Techniques To Predict Antiretroviral Therapy Initation Time The Case of Adama And Ambo Hospitals, Oromia Regional State.Masters Thesis.:Addis Abeba Unversity:Addis Abeba.Ethiopia.

[14] Gheware, A. K. (2014). Data Mining: Task, Tools, Techniques And Applications. *International Journalo of Advanced Research In Computer And Communication Engineering*, 8095.

[15] Goel, M. G. (2015). Data Mining - Techniques, Methods And Algorithms: A Review On Tools And Their Validity. *International Journal of*

Computer Applications,Volume 113 – No. 18, 1-8.

[16] Hailemariam, T. (2012). Application Of Data Mining For Predicting Adult Mortality.Masters Thesis.Addis Abeba,Addis Abeba Unversity:Ethiopia.

[17] Han, J. (2006). *Data Mining Concepts And Techniques.* Singapore,Sydne: Morgan Kaufmann Publisher.

[18] Ian.H.Witten, E. F. (2011). *Data Mining : Practical Machine Learning Tools And Techniques.* Newyork: Morgan Kaufmann .

[19] Jackson, J. (2002). Data Mining: A Conceptual Overview. *Communications Of The Association For Information Systems (Volume 8*, 267-296).

[20] Jyoti Soni, U. A. (2011). Predictive Data Mining For Medical Diagnosis: An Overview Of Heart Disease Prediction. *International Journal Of Computer Applications (0975 – 8887) Volume 17– No.8*,, 5-47.

[21] Kale, T. D. (2015, Dece). *Application Of Data Mining Techniques To Discover Cause Of Underfive Children Admission To Pediatric Ward: The Case Of Nigist Eleni*. Retrieved From Http://Dx.Doi.Org/10.4172/2157-7420.1000178.

[22] Kale, T. D. (2015). Application Of Data Mining Techniques To Discover Cause Of Underfive Children Admission To Pediatric Ward: The Case Of Nigist Eleni . *J Health Med Inform*, 10-14.

[23] Kamber, J. H. (2006). *Data Mining Concept And Techniques.* Amsterdam Boston: Morgan Kaufmann.

[24] Kenneth Hill, C. A. (2001). Estimates Of Maternal Mortality For 1995. *Bulletin Of The World Health Organization*, 79.

[25] Krzysztof J. Cios, W. P. (2007). *A Knowledge Discovery Approach.* New York: Springer Science+Business Media, Llc, 233 Spring Street.

[26] Kumar R, K. A. (2012). A Modified Tree Classification In Data Mining,Vol 12. *Global Journals Inc*, 58-63.

[27] Kumar, Y. A. (2012). Analysis Of Bayes, Neural Network And Tree Classifier Of Classification Technique In Data Mining Using Weka:. *Cs & It05*, 359– 369.

[28] Maimon, L. R. (2008). *Data Mining With Decision Trees:Theories And Application,Vol 69.* Singapore: World Scientific Publishing Co. Pte. Ltd.

[29] Margaret C Hogan, K. J. (2010, April 10). Maternal Mortality For 181 Countries, 1980–2008: . P. 1.

[30] Maurizio, M. (2011). Data Mining Concepts And Techniques. *E-Commerce Winter*, 23-34.

[31] Minale Tefera, M. M. (2014). Application Of Data Mining Techniques To Predict Urinary Fistula Surgical Repair Outcome: The Case Of Addis Ababa Fistula Hospital, Addis Ababa, Ethiopia. *Health & Medical Informatics*, 23-37.

[32] Mulugeta, T. (2013). Constructing A Predictive Model For Occurrence Of Tuberculosis: The Case Of Menelik Ii Hospital And St. Peters Tb Specialized Hospital.Masters Thesis.Adis Abeba Unversity.Addis Abeba,Ethiopia.

[33] Obenshain, M. (2004). Application Of Data Mining Techniques To Healthcare Data. *Infection Control And Hospital Epidemiology, Vol. 25*, 690-695.

[34] Parvez Ahmad, S. Q. (2015). Techniques Of Data Mining In Healthcare: A Review. *International Journal Of Computer Applications ,Volume 120 ,No.15*, (0975 – 8887).

[35] Paulraj. (2015). Prediction Of Low Birth Weight Infants And Its Risk Factors Using Data. *Proceedings Of The 2015 International Conference On Industrial Engineering And Operations Managemen*, 2.

[36] Petri, C. (2010). Decision Trees. *Journal Of Computer Enginering*, 23-56.

[37] Pradhan, M. (2014). Data Mining& Health Care: Techniques Of Application. *International Journal Of Innovative Research In Computer And Communication Engineering Vol. 2, Issue 12, December* , 235-435.

[38] Ranjani, M. D. (2013). Data Mining Applications In Healthcare Sector: A Study. *International Journal Of Scientific & Technology Research Volume 2, Issue 10, October 2013* , -.

[39] Sivanandam, S. S. (2006). *Introduction To Data And Mining And Its Applications.* Berlin: Springer.

[40] Srideivanai, C. (2014). Data Mining Techniques For Performance Evaluation Of Diagnosis In Gestational Diabetes. *International Journal Of Current Research And Reveiew,Vol 2,No 10*, 91-98.

[41] Sundar, A. (2012). Performance Analysis Of Classification Data Mining. *International Journal Of Engineering Science & Advanced Technology,Vol 2,No 2*, 471-475.

[42] Venkateswaran, A. &. (2012). An Approach of Data Mining For Predicting The Chances . *The International Conference on Communication, Computing And Information Technology (Icccmit) 2012*, 1.

[43] Wang, L. G. (nd). Data Mining Techniques For Mortality At Advanced Age. -, 3-27.

[44] Witten, I. H. (2005). *Data Mining - Practical Machine Learning Tools And Techniques With Java Implementations.* San Francisco.: Morgan Kauffmann Publishers.