

# Developing An Expert System Framework for Supporting Diagnosis and Treatment of Dyspepsia and Gastric Cancer Disease Using Local Language

Oljira Ragasa Bayana

College of Engineering and Technology, Mettu University, Ethiopia

## Abstract

Dyspepsia is a pain of the upper abdominal and it has the problem of impaired digestion like abdominal disease or other abdominal disease, which has the symptoms of heartburn, nausea, and belching, upper abdominal fullness [1]. It also related to the problem of indigestion for a group of symptoms that cause pain in the abdomen, which affects at least 25% of the world population every year [2]. From related disease of dyspepsia, Gastric cancer is the stomach cancer that develops from the lining of the stomach that affects the cell of digestive system and it is the third leading cause of death worldwide [3]. Both dyspepsia and gastric cancer is diseases that affect gastrointestinal part of human body. Therefore, this type of disease requires timely diagnosis and treatment; otherwise it can cause death and other chronic diseases. In developing countries like Ethiopia, treatment option for dyspepsia and gastric cancer is not readily available which support medical professional and also there is a scarcity of medical professional, to address such medical problems a medical expert system can play a significant role, consequently, the main objective of this research study is to develop an expert system framework for supporting diagnosis and treatment of dyspepsia and gastric cancer using local language (Amharic language). To develop this medical expert system, knowledge was acquired using both structured and unstructured interview from domain expert which are selected using purposive sampling techniques from Arba Minch General Hospital, and from document analysis. Domain knowledge is modeled using decision tree and rule-based knowledge representation was used. This medical expert system is developed by using backward chaining to infer the rule and provide an appropriate diagnosis. Finally, the performance of the system was evaluated by preparing 15 test cases by provided to domain experts and for user acceptance test, users evaluate the system through nine criteria prepared by the researcher and the system has scored 80% system performance and 85.2% user acceptance this result shows that the study has a promising result that achieves the objective of the study. The researchers recommended that to apply data mining techniques and to extract the hidden knowledge.

**Keywords:** Expert System, Dyspepsia and Gastric Cancer, Diagnosis, and Treatment.

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## I. INTRODUCTION

Dyspepsia is of upper abdominal pain or chronic indigestion disease the affect digestion system of human body and it is a most frequent condition that can occur in gastrointestinal tract [4]. Gastrointestinal tract is the sequence of the organs that play an important role in the digestion system and this common clinical problem seen by both gastroenterologists (internist). The prevalence of dyspepsia the most common in the community, which is the leading cause for other gastrointestinal disease like gastric cancer, liver cancer, gastritis, acute liver failure, gallstone and other related disease to appear [3]. Dyspepsia burden and its associated factors vary from country to country and the world prevalence of dyspepsia is 25% of the world population every year but mostly occurs as gastrointestinal diseases or gastro esophageal reflux diseases [2]. From that gastric cancer is most common and gastric cancer can be defined as abnormal growth of the cell in the stomach in which malignant (cancer) cells form in the lining of the stomach and age, diet, stomach disease, and dyspepsia are a risk for gastric cancer. The common symptoms of gastric cancer include indigestion, abdominal pain and the most common cause is infection by the bacterium *Helicobacter pylori*, which accounts for more than 60% of cases. Most cases of stomach cancers are gastric carcinomas, which can be divided into several subtypes including gastric adenocarcinoma and other related cancer.

To handle the above dyspepsia and gastric cancer disease of human health problems or internal disease, the studies from the field of artificial intelligence have given birth to a relatively new but rapidly growing technology known as an expert system (ES). Nowadays we are living in the era of digitization and rapid technological advancements. Information and Communication Technologies (ICTs) specifically expert system is getting attention to explore its applications in salient fields of research and studies by several researchers.

Artificial intelligence aims to develop an intelligent system that used to enhance health care service and provide a better health care facility with reduced cost and time. The development of computer technology has encouraged, the researchers to develop software that aids decision support of a medical professional without consulting the specialists directly, and it minimizes medical errors [5].

Expert system is a subfield of artificial intelligence which can be used in real-world application and commonly used in the clinical domain as software that is designed to support clinical decision-support, in which the characteristics of an individual patient is matched to knowledge base of expert system and provide support the diagnosis or recommendations [6]

## **II. Related Research Study**

The purpose of paper [7] is to present the application of an expert system used for diagnosis and treatment of cancer which is the commonest cancer in women and is the second leading cause the death and it occurs in nearly one out of eight women. The majority of women do not have awareness of the importance of early diagnosis. Then, the requirement of the human expert can be reduced if its expertise can be documented into a computer system and this is a new approach used to enhance communication channels for knowledge that can be helpful for medical professionals.

Research study [3] focused on “Presenting an expert system for early diagnosis of gastrointestinal diseases” Gastrointestinal is the main part of the human body and that has direct and indirect relation with a human body, especially works on by taking food, mechanically destroying, digesting, absorbing and disposing of undigested substances in human body, so that this research study presents an expert system for diagnosing the type of gastrointestinal disease. The VP-Expert shell is used to design this expert system and knowledge is acquired from a domain expert and the designed expert system is tested with a domain expert.

## **III. Methodology of The Study**

In this research different procedure are followed in developing an expert system for diagnosis and treatment of dyspepsia and gastric cancer using local language. These are knowledge acquisition from domain expert and document analysis, knowledge modeling, knowledge representation, expert system development and finally evaluation and testing of the system.

Primary domain knowledge is acquired from Arba Minch General Hospital. Five domain experts are selected using purposive sampling techniques. The domain experts are interviewed to acquire tacit knowledge in human mind. In addition to this document analysis is used to acquire domain knowledge from journal, book, related research for disease diagnosis and treatment of human disease guidelines are used as input from expert system development.

The acquired domain knowledge from domain expert and document analysis is modeled by using decision tree. This type of knowledge of knowledge modeling is used to show the show the relationships of the problem graphically and can handle complex situations in the simplest form. Decision tree is drawn using flow chart symbols as it is easier for many to read and understand the complex problem in simplest way to help medical professional.

Based on knowledge modeling of domain knowledge and document analysis, the next step is knowledge representation by using an appropriate format for expert system development. Knowledge representation is a means of representing the human expert knowledge in an appropriate approach and it is the dedication to a vocabulary, data structures, and programs that let domain knowledge usable and knowledge is represented in the form of condition-action pairs: IF this condition (or premise or antecedent) occurs, THEN some action (or result or conclusion or consequence) will (or should) occur. The researcher used prolog programming language to develop an n expert system for supporting diagnosis and treatment of dyspepsia and gastric cancer using local language. The reasons for selecting Prolog are the features and abilities of the language that incorporate it. Prolog is a declarative language and has the capacity to describe the real world and it provides an important tool for programs that process natural language. In order to achieve the objective of the study, the expert system prototype is tested and evaluated to ensure that whether the performance of the system is accurate and to test accuracy of the system to solve the domain problem.

## **IV. Implementation**

Architecture is a blueprint showing how the components of the prototype interact and interrelates. This system was designed with the advance of conceptual design that refined the system architecture. Based on the above conceptual design and model the following system architecture is designed for this research study. Figure 1 illustrates architecture.

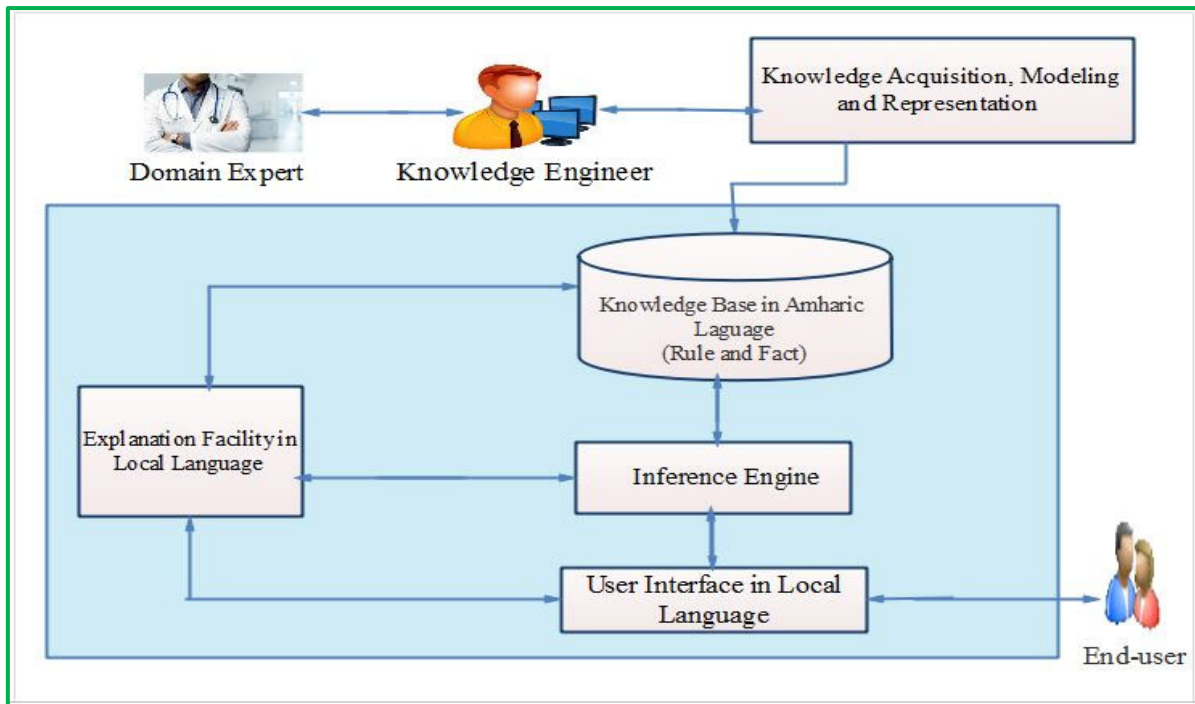


Figure 1. Architecture of Expert System.

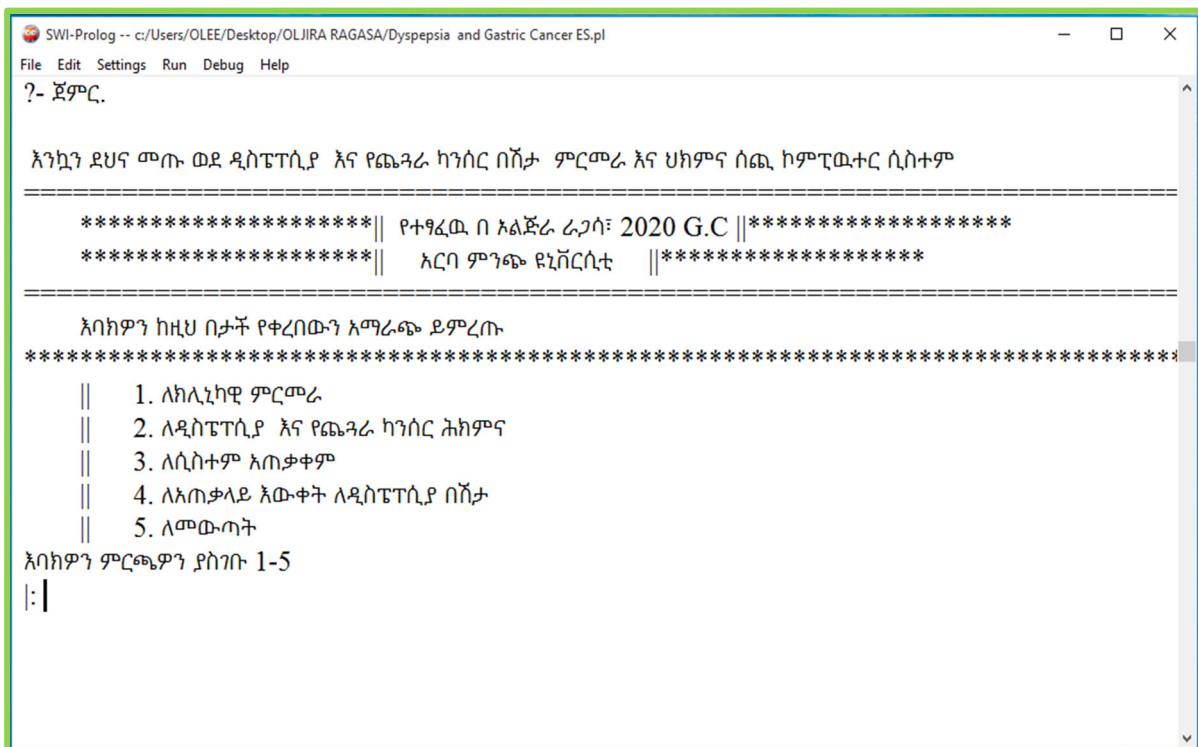


Figure 2: User Interface of an expert system prototype in local language

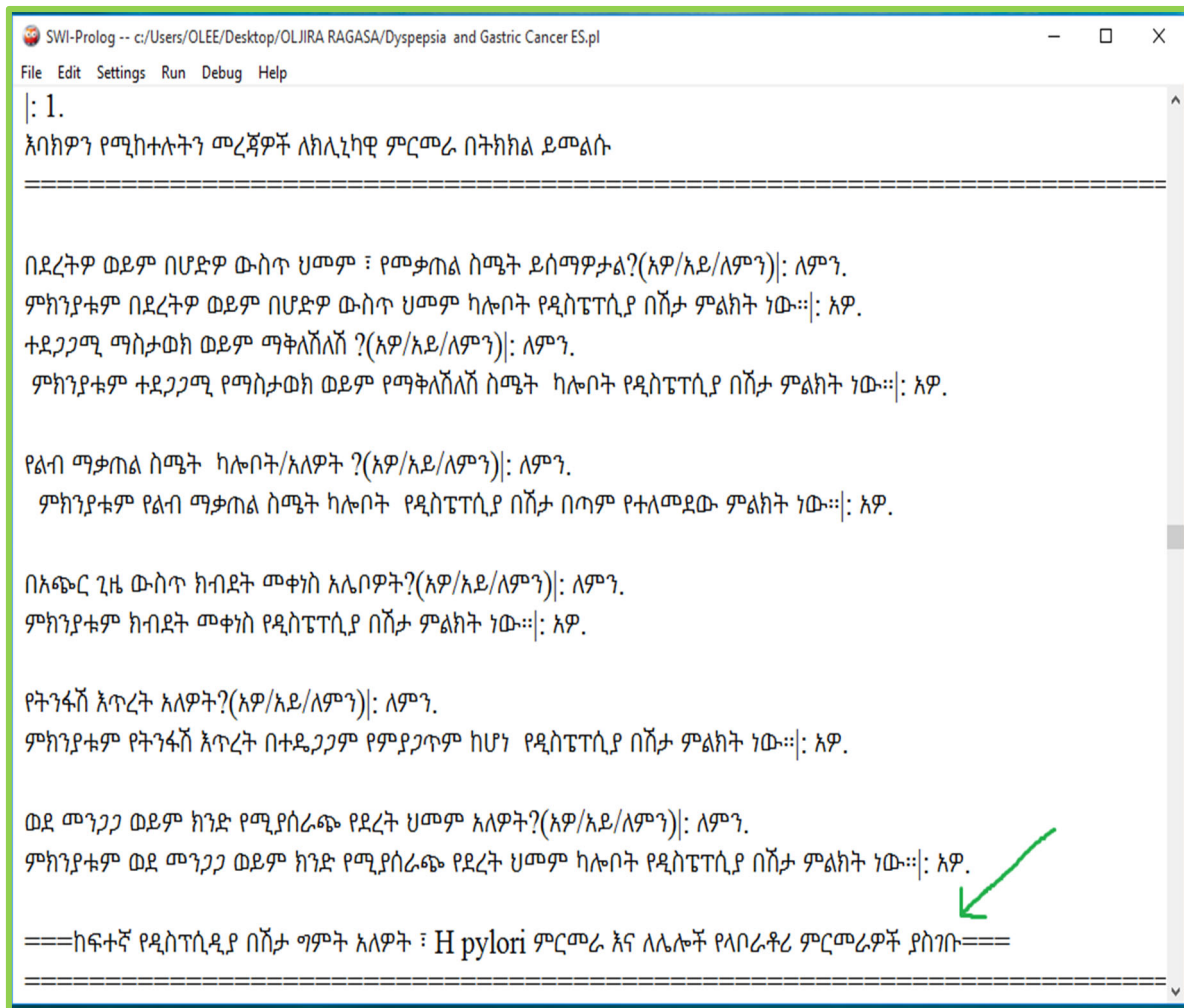


Figure 3: Sample window when dyspepsia is clinically diagnosed

## V. System Testing and Evaluation

### Validation by using Test Case

This research study focuses on the validation approaches using test cases to check whether the objective of research is achieved or not. To measure the accuracy of the system, the researcher was selected 15 test cases as a representative of the domain in which the expert system to perform and the researcher categorized those cases into three categories based on the type of dyspepsia and gastric cancer.

Naturally, evaluation of the expert system using test case needs experts as evaluators. So, in this study, to evaluate an expert system framework using local language, five domain experts from Arba Minch General Hospital were selected as system evaluators and the experts were selected purposively. To do test case the procedure is, the selected system evaluators grouped into three categories for performing test cases based on their types like functional dyspepsia, non-functional dyspepsia, and gastric cancer. For each type, five test cases are assigned to domain experts to check the accuracy of the system. The expert system testing procedure is carried out by the system evaluator to classify the test cases into correct or incorrect classes. The evaluation was done by comparing the system test result with the physician's answers (as the human expert). Therefore, system evaluators and knowledge engineer made decisions by comparing the system test result with the physician's answers. The result of the comparison shows that an expert system framework using local language just has made a close decision in the diagnosing process of patients as the human expert did in the diagnosis process. The following table1 shows measuring the accuracy of the system.

Table 1, Test case for assessment to accuracy measuring

No	Selected case	Total Number of cases	Correctly classified	incorrectly classified	Accuracy in percent
1	Functional dyspepsia	5	4	1	80%
2	Non-functional dyspepsia	5	5	0	100%
3	Gastric cancer	5	3	2	60%
4	Total Average	15	12	3	80%

From the above table 1, the total of 15 diagnosed patients test cases, in the first row shows that out of 5 diagnosed patient's test cases of functional dyspepsia, 4 test cases are classified as correct and 1 as incorrectly and on the second-row show that of the total 5 diagnosed patient's test cases of non-functional dyspepsia, 5 taste cases are classified as correctly classified and no test cases as incorrectly classified. Also, the third rows show that of the total 5 diagnosed patients test cases for gastric cancer, 3 diagnosed patient's test cases are classified as correctly classified and 2 as incorrectly classified. Generally, from 15 diagnosed patient's test cases 12 diagnosed patient's test cases are classified correctly and 3 diagnosed patient's cases are classified incorrectly. The test case result that provided by system evaluators show that the expert system is about 80.0% correct and 20.0% incorrect.

## 2. User Acceptance Testing

User acceptance testing is the most important issue for expert system development and it is a process of testing whether the system satisfies the requirements or not There are many criteria used for testing the accuracy of the prototype is described briefly as follows. those are: easy to use, the attractiveness of the prototype, efficiency in response time, the accuracy of the prototype in clinical decision support, the result of the system in the domain area, the ability of the prototype in making the right recommendations, and the importance of the prototype in the domain area. The questionnaires are prepared to test the performance of an expert system and the evaluators fill the questionnaire after they have used an expert system prototype. The researcher customized the questionnaires from local researchers used to test user acceptance of the system based on the above-listed criteria. Table 2 represents the questionnaires to test user acceptance of the system.

Table 2: Questionnaires for user acceptance testing

No	Criteria of Evaluation
1	Do you think that the system is simple for the interaction between end user and prototype?
2	Is the prototype of the system being attractive and user-friendly manner?
3	Do you think that the system is efficient in terms of the response time?
4	Is the system being accurate for diagnosis and treatment of dyspepsia and gastric cancer?
5	Do you think that the system can replace the domain expert when he/she not present?
6	Do you think that the system is significant for improving health care service?
7	Is additional domain knowledge is required for diagnosis of dyspepsia and gastric cancer?
8	Are you confident for using the system in terms of medical professionals?
9	Do you think that localization of the prototype used for simplicity to the end-user?

Different researchers [8], [9] and [10] are used different types of user acceptance testing and evaluation criteria was used and customized. The researcher assigned the values for each attributes of the questionnaires as listed in above which used to evaluate the performance of the prototype of the system on the side of the end-users. The values of all attribute are assigned as follows Excellent =5, Very good=4, Good=3, Fair=2 and Poor=1. This value allows the domain expert to put their values for each criteria of evaluation and eight domain experts are participated in the system evaluation. Table 3 show outcomes generated by a domain expert.

Table 3: Results of Test Evaluation

Question number	Excellent	Very good	Good	Fair	Poor	Average
Q1	5	3	0	0	0	4.62
Q2	4	3	1	0	0	4.37
Q3	4	2	2	0	0	4.25
Q4	3	3	2	0	0	4.12
Q5	5	2	0	1	0	4.37
Q6	3	3	1	1	0	4.00
Q7	4	3	0	1	0	4.25
Q8	3	3	1	1	0	4.00
Q9	5	1	2	0	0	4.37
Total Average						4.26(85.2%)

Table 3 briefly explains that, the evaluators scored simplicity for the interaction between end user and prototype of the system, criteria of evaluation as 62.5% scored as excellent, 37.5 % as very good. Similarly, attractiveness and user-friendly manner of the system is evaluated as 50.0% of the respondents as excellent, 37.5% as very good and 12.5% as good with the system. For evaluation criteria 3, the efficiency in terms of the response



time generated by the system, criteria of the evaluation as 50.0% scored as excellent, 25.0 % as very good and 25.0 as good with the system.

## VI. CONCLUSION AND RECOMMENDATIONS

Medical diagnosis is one of the first expert system that used for diagnosis and treatment of human disease. In this research study focused on same domain area. To develop an expert system for supporting diagnosis and treatment of dyspepsia and gastric cancer using local language (Amharic language) follow many process, first the knowledge engineer assessed the problem area and the problem is considered feasible, then a statement of requirements is created and the development process continued as follows, knowledge was acquired by both structured and unstructured interviews from domain experts. In addition to that, documents analysis methods also used to acquire relevant domain knowledge to achieve objective of the study. Therefore, to address objective of the study knowledge engineering research design is used in order to acquire the important domain knowledge form domain expert and by document analysis. Then, the acquired domain knowledge and concepts was modeled using decision tree and the model has been converted into productive rules of knowledge representation techniques and codified using SWI-Prolog tool for designing an expert system for diagnosis and treatment of dyspepsia and gastric cancer. Lastly, as the evaluating and testing result shows that, the overall performance of the prototype system registered 82.6% as accurate result.

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