

Developing A Fuzzy Expert System to Analyze Risk of Physical and Psychological Disorder of Khat Addiction

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Abstract:- Khat is discovered in the giant shrub, which consists of cathinone. Khat dependency will become the growing public fitness situation in Ethiopia. It is consequently vital for humans to have adequate understanding of physical and psychological disease associated to Khat dependency to keep away from the risk. Fuzzy common sense is one of the methods used for bettering non-public fitness care transport in the fitness sector. Since there is scarcity of specialists in the area, we improve fuzzy specialist gadget to diagnose the danger of physical and psychological disease associated to Khat addicted addiction. A java library walking on android running system was once used to develop the inference engine and knowledge base. The supply of records to construct fuzzy expert system had been collected from literatures, interview with experts and clinical statistics extracted from Khat addicted patients with physical and psychological disease from Assosa General Hospital, Assosa City in Ethiopia. The designed fuzzy expert system is used for sufferers and doctors to look at the risk degree of the disease. The experimental end result confirmed that the designed professional device performs 95% accuracy, precision 94% and sensitivity of 100%. This fuzzy expert system was once evaluated and furnishes tremendous end result for diagnosing physical and psychological sickness associated to Khat addiction.

Keywords:- Khat, Fuzzy Expert system, Android, physical, psychology, Membership.

I. INTRODUCTION

Khat (*Catha edulis*) is evergreen plant to East Africa and Arabian Peninsula which is the most widely used psychoactive herb in the world. Ethiopia is the biggest producer of Khat. Fresh leaves of Khat are used with the aid of tens of millions of peoples as a leisure drug on day by day bases for its euphoric and psycho stimulant outcomes (Engida work, 2017)). Khat leaves incorporate psychoactive substance recognized as Cathinone which have impact on individual's consciousness, behavior, temper and questioning processes. Besides adverse health, Khat chewing has additionally effect on socio monetary elements of youth's each day life. High doses and chronic use of Khat can motive extra serious negative on lengthy time period

Khat chewers neurological, psychiatric, cardiovascular, dental, gastrointestinal, and genitourinary results (Michael Odenwald, n.d.; Musonda, 2018)

Ethiopian Demographic and Health Survey (EDHS) 2011 noted the incidence of Khat use in the populace of Ethiopia was once 27.3% amongst men and 11.0% amongst ladies of 15-49 years (FDREMOH, 2015)). Different research carried out in distinctive section of the U.S.A. Indicates that psychological influences of Khat chewing are hazardous to the community. There is additionally importance affiliation psychological Khat dependence and frequency of Khat use (Dessie et al., 2013). Impaired concentration, insomnia, headache, impaired motor coordination and nice tremors are additionally central fearful gadget deficits associated with Khat use (El-Setouhy et al., 2016). A find out about was once carried out to verify the impact of Khat chewing in Assosa City, West Ethiopia (Birhane, 2014)). The end result shows, frequently chewing Khat have big impact on fitness effect of Khat addicted patients.

Fuzzy expert system has been recognized as one of the devices that is used to mannequin human selection making of expert in a computer software such that the application can work like human professional to remedy problem (Samuel et al., 2013)). Due to imprecision and uncertainty in clinical exercise the benefits supplied by fuzzy common sense for dealing with imprecise and uncertainty scenario make it appropriate strategy for solving complicated clinical records (Kunhimangalam et al., 2013)). Fuzzy professional is a series of fuzzy rules and membership functions.

A. Statement of the problem

The incidence of Khat use and its physiological, social and psychological trouble has been studied in numerous populace and specific section of Ethiopia (Wondemagegn et al., 2017). Khat dependency is currently the essential hassle that impacts people's everyday life. There is shortage of lookup on knowledge based totally gadget in physical and psychological interventions that tackle Khat associated health problems. In order to minimize the danger of Khat associated fitness issues remedy equipment for a number of extreme person corporations as nicely as expertise base structures are wished (Michael Odenwald,

n.d.; Musonda, 2018)). Clinicians deal with and screen the fitness fame of Khat addicted sufferers with physical and psychological ailment manually and this leads to wastage of time and resources. Most of the time prognosis and fitness monitory offerings are solely supplied in hospitals due to integral scarcity of man electricity in the vicinity of intellectual health.

The results of Khat dependency are drowsing disorder, hallucination; enamel staining, anxiety, loss of appetite, depression, constipation, gastritis, hypertension, psychosis, cardiovascular, respiratory and central worried gadget (Garumma Tolu & Wolfgang Krah, 2015). Khat additionally motives instant enlarge in blood strain and coronary heart rate. World Health Organization mentioned that Khat use is additionally associated to Cardiovascular, respiratory, reproductive and central anxious machine problems. Khat dependency hassle is the contemporary difficulty of our neighborhood by using affecting their initiation to work, behavioral changes, decreasing social lifestyles and leads to unintentional death. West Ethiopia used neighborhood based and pass sectional find out about to decide the incidence of Khat chewing and its related unstable sexual behaviors. The find out about individuals have been chosen based totally on sex, age, residence, occupation, education, faith and marital status. Among learn about members the existence time and incidence of Khat chewers have been 25.7% and 19.5% (Abate et al., 2018). The addiction of Khat chewing influences massive element of the populace specifically the productive age group and its bad have an effect on fitness was once mentioned by means of distinct find out about findings. Khat chewing practice additionally reinforces different habits like cigarette smoking, alcohol consumption and narcotics.

According to Federal minister of fitness (FDREMOH, 2015) a National Mental Health Strategy (NMHS) was once developed to tackle the intellectual fitness problems. The evaluation supplied records suggests 1.2 intellectual fitness specialists per 100,000 human beings and most of these people primarily based in the capital city. It shows how the intellectual fitness gadget in Ethiopia ought to be accelerated thru coaching increased quantity of intellectual fitness employees in areas where they are wanted most. Early identification of the disorder chance degree can assist in making sure applicable interventions are put in vicinity to enhance the fitness fame of Khat addicted sufferers ((Kunhimangalam et al., 2013).

Developing fuzzy expert system would minimize the burden of human specialist and ready time of sufferers in hospitals. It is additionally beneficial to help human specialist by using presenting splendid expertise at the proper time for choice making motive in diagnosing the threat of Khat addicted sufferers with physical and psychological disorder. Basically, this lookup addresses the following questions: -

- What kind of understanding is treated by using the proposed model?

- How to assemble a fuzzy specialist gadget to diagnose the danger of physical and psychological disorder associated to Khat addiction?
- How the proposed professional machine diagnoses the threat of physical and psychological disorder related to Khat addiction?

B. Objective of the Study

a) General objective

The general objective of this paper study is to develop a fuzzy expert system to Analyze Risk to Physical and Psychological Disorder of Khat Addiction.

b) Specific objectives

- To extract the necessary knowledge from domain experts for physical and psychological disorder related to Khat addiction
- To identify the appropriate model for physical and psychological disorder related to Khat addiction
- To develop fuzzy expert system using the acquired knowledge
- To evaluate and validate the new system.

C. Methodology of the study

The fuzzy expert system was developed with fuzzy set of rules. Fuzzy units are synthetic Genius strategies that grant suitable prognosis to specific problems. Fuzzy expert system is primarily based on reasoning. Fuzzy expert system affords effective reasoning method for dealing with imprecise and uncertainty in records to diagnose the danger degree of physical and psychological sickness associated to Khat addiction. Fuzziness takes place in physical and psychological sickness considering that signs and symptoms and chance elements may additionally be exaggerated, eliminated by means of sufferers and adequate facts may additionally now not grant with the aid of sufferers for figuring out the risk.

a) Method of Data Collection

In order to gather information for fuzzy expert system, five sufferers' facts have been accrued purposely from documented Khat addicted sufferers with physical and psychological disease from Assosa City Assosa General Hospital. Structured and unstructured interview was once carried out in order to acquire the required know-how from area specialists (psychotherapist). The obtained understanding has been validated through area experts. They evaluated primarily based on its importance and widely wide-spread incidence in diagnosing physical and psychological disease associated to Khat addiction.

b) Software Tools

Android Studio together with JfuzzyLogic and WampServer was used to develop fuzzy expert system. Software development tools are; Android SDK Tools 26.1.1, Android API 26, Java Development Kit Java (JfuzzyLogic) for storing the knowledge of experts, MYSQL database engine used

for storing facts about physical and psychological disorder related to Khat addiction.

c) Scope of the study

This find out about focuses on growing fuzzy expert system for diagnosing the threat degree of physical and psychological sickness associated to Khat dependency to reveal the fitness fame of patients by means of identifying the danger degree of sickness based totally on signs to get better from disorder in case of Assosa City. It covers physical and psychological disease associated to Khat dependency and doesn't encompass different form of diseases.

d) Significance of the Study

The full-size of the find out about would be for Khat users, researchers, clinicians and for the neighborhood as a whole. It helps clinicians to discover the severity of physical and psychological sickness in Khat addicted patients. The developed expert system would additionally assist clinicians to enhance their talent in diagnosing the hazard degree of physical and psychological disease associated to Khat dependency for supplying suitable analysis to their patients. It additionally lets in academicians and researchers to strengthen new mannequin and device to prognosis Khat dependency associated fitness issues primarily based on the developed fuzzy expert system. It is additionally necessary for self-monitoring of sufferers with physical and psychological ailment associated to Khat addiction. The developed fuzzy professional device is beneficial for diagnosing the chance stage of physical and psychological ailment associated to Khat addiction. Expert system requires massive information base to technique and challenges on occasion exist to work effectively.

II. LITERATURE REVIEW

Chronic consumption of Khat influences the physical and psychological health of the chewers and leads to more than a few fitness disturbances. In latest years transportable gadgets like cell phones and laptops make bigger the availability of cell functions to commercial enterprise centers, hospitals and domestic users. Medical functions trade the way people assume and they are well-known with the aid of the society. This section presents fundamental records on theoretical heritage associated to this work, it additionally includes signs and threat elements of physical and psychological ailment that used to be used to diagram cell based totally fuzzy specialist gadget for diagnosing the hazard degree of Khat addicted sufferers with physical and psychological disorder.

A. Concepts of Khat Addiction

The chewing of Khat leaves which is broadly chewed in jap Africa and southern Arabian Peninsula, is a psychoactive substance with tiers of problematical fitness outcomes. According to Ethiopian demographic Health Survey the occurrence of Khat chewing in the population of Ethiopia used to be 27.3% amongst guys and 11.0% amongst ladies

between a while of 15-49 years. The said psychiatric outcomes of Khat dependency are depression, insomnia, feeling anxious and irritability, free of appetites, nausea and vomiting, problem of seeing at night, headache, quickly coronary heart rate, depression, challenging with stability and coordination, blurred vision, difficulty in attention etc. Khat dependency can have an impact on the physical and psychological health of the neighborhood and can motive extra serious unfavorable psychiatric, cardiovascular, dental and gastrointestinal effects. Khat use and its related outcome in individuals with intellectual sickness have been performed in West Ethiopia which suggests that the occurrence of Khat use reaches 64.4% (Garumma Tolu & Wolfgang Krahel, 2015)

Another learn about was once conducted, about the consequences of Khat dependency behaviors on fitness results among male Khat chewers in Assosa City, West Ethiopia and the end result of the find out about indicates that Khat chewing has a massive affect in oral fitness popularity and blood strain of chewers (Birhane, 2014). Based on the information about Khat addiction, the want for growing cell based totally fuzzy specialist device to prognosis the danger degree of Khat addicted sufferers with physical and psychological disease would be person friendly, price fine and assist choice making in the fitness sector.

B. Related Works

Diagnosing the threat of physical and psychological ailment associated to Khat dependency consists of several layers of ambiguity and imprecision that makes regular strategies unsuitable. The result confirmed that the system performs as human professional in diagnosing cattle with endometritis and performs one hundred percent accuracy. It used to be found that detection and remedy of endometritis in cattle the usage of cell software used to be extra environment friendly and relaxed (Suharjito et al., 2017). However, the authors use solely 12 samples to take a look at the accuracy of the system.

In this paper the authors use fuzzy inference method to formulate membership functions. Mamdani strategy used to be used for the gadget design. The recommended fuzzy specialist device was once implemented in MATLAB software. The device accommodates imprecision, tolerance and uncertainty to reap tolerance and low cost. The end result of the learn about shows that the developed fuzzy professional device recorded greater accuracy and the gadget was once successful of detecting early Gastric Cancer danger stages (Safdari et al., 2018). Strong policies had been now not built in this paper for inference expertise of experts.

(Ature et al., 2016). Developed a fuzzy primarily based expert system for tuberculosis analysis and treatment. The authors used java (JFuzzy logic), membership functions, enter variables, output variables and rule base for designing the professional system. They used the symptom of the sufferers as enter for finding out the danger stage of the ailment and the gadget used to be efficient in diagnosing sufferers with tuberculosis with in brief length of time.

Mobile primarily based expertsystem for febrile ailment analysis used to be developed (E. S et al., 2017). The machine was once applied the use of android SDK programming language and SQLite as database which incorporates experts' knowledge. The machine was once quicker and much less susceptible to error in analysis the ailment of patients. The end result of this lookup shows that the usage of expert system for analysis and cure of fevers helps clinical professional, sufferers and these who desire to comprehend short information about a number of sorts of fevers, their treatment, prevention and advice.

A fuzzy expert systemfor analysis of cystic Fibrosis used to be designed and developed the use ofMATLAB environment. It was once designed primarily based specialists understanding and preceding literature. Foreliminating uncertainty in the disorder fuzzy common-sense method was once used for making choice based totallyon patients' threat thing and symptoms. The expert used to be successful of storing the understanding of experts in the location and used as education device for new physicians. The device was once used as diagnostic help to the experts for supplying sufferers with appropriate treatment. The end result indicates that the gadget was once

environment friendly in diagnosing cystic fibrosis sickness with 93.02% precision, 89.29% specificity, 95.24% sensitivity and 92.86% accuracy (Hassanzad et al., 2017)

III. METHODOLOGY OF THE RESEARCH

Research methodology consists of planning the universal strategy to the lookup technique in accordance to lookup questions and objectives. This chapter gives an element description of the methodology that was once used to plan fuzzy expert system for Khat addicted sufferers with physical and psychological disease as properly as statistics series strategies used in designing the system. The values for formula of membership features used to be used in the sketch of fuzzy expert system.

A. Design of the Proposed Fuzzy Expert System

In order to diagnose the chance stage of physical and psychological disease associated to Khat addiction, cellular primarily based fuzzy expert system used to be developed. Fuzzy expert systemis information based totally structures the usage of Fuzzy IF-THEN guidelines and membership functions. The structure of the proposed cell based totally fuzzy expert system is introduced in Figure 3.1.

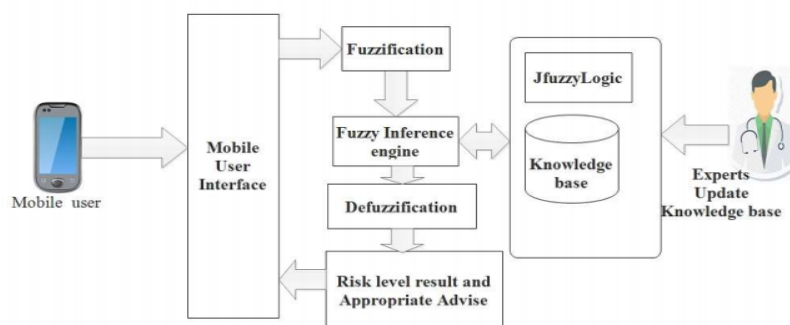


Fig. 1: Architecture of the Proposed Fuzzy Expert System

B. Knowledge Representation the usage of JfuzzyLogic

DevelopedJfuzzyLogic is an open supply Fuzzy good judgment libraryimplementing enterprise requirements to simplify fuzzy machine developments. It lets in us to layoutfuzzy good judgment controllers. It helps the improvement of rule primarily based expert machine functions which can be tightly coupled to code written in portable, effective and platform unbiased java language. It is desired built-in improvement surroundings (IDE) for java and android development.

C. Process of the Designed Fuzzy Expert System

In the first step we collect facts about physical and psychological sickness signs and symptoms and threat elements associated to Khatdependency from three) doctors, affected person archives and literature studies. After gathering information, the chance elements and signs of physical and psychological disease associated to Khatdependency gathered from literature research used to be introduced to area experts. The entered and output variables of the proposed mannequin used to be bought from experts

opinion with the aid ofconsidering their diploma of significance. Eight signs and chance elements have been chosen asinfluencing elements that leads to physical and psychological disorder. These signs and symptoms and dangerfactors had been viewed as enter variables of fuzzy professional machine with single output that mirror the hazard status, which similarly divided into “very low risk”, “low risk”, “medium risk”, “high risk” and “very excessive risk”. Then put together a varying of values and fuzzify them the usage of membership feature for every signs and danger factors. After getting ready vary of values assemble fuzzy rule with the assist of experts, generate fuzzy inference and practice defuzzification. Finally sketch person interface for interplay and the output is the hazard of physical and psychological ailment associated to Khat addiction.

The five elements used for designing cellular based totally fuzzy expert system to prognosis the threat stage of physical and psychological sickness for Khataddicted sufferers are: consumer interface, fuzzification, inference

engine, expertise base and defuzzification. The enter variables are signs and threat elements of the patient such as headache, depression, Being Absent minded, blurred vision, sleep disturbance, quickly coronary heart rate. The output variable is chance degree of Khatdependency sufferers with physical and psychological disease as very low, low, medium, excessive and very high.

- **Step 1-User Interface:** -It is the way of verbal exchange for the user. The fuzzy expert system to prognosis physical and psychological sickness associated to Khatdependency makes use of the information of specialists to apprehend patients' signs and symptoms and grant correct selection in accordance to fuzzy policies constructed.
- **Step 2 –Fuzzification:** -It is a procedure that determines the diploma of membership to the fuzzy set primarily based on membership function. Methods used for fuzzification are Singleton, Triangular, Trapezoidal and Gaussian. Triangular membership characteristic is distinctive by using three parameters. These parameters are a_1 , a_2 and a_3 the place a_1 and a_3 are triangular stop points. The equation for triangular membership characteristic is represented by means of equation 3.1. In this membership feature the three variables a_1 , a_2 , a_3 are in the x-axis the place a_1 and a_3 are recognized as 'feet values' which has membership diploma zero and a_2 is acknowledged as 'peak' fee with membership diploma one.

$$\mu(x) = \begin{cases} 0 & \text{if } x < a_1 \\ \frac{x - a_1}{a_2 - a_1} & \text{if } a_1 \leq x < a_2 \\ \frac{a_3 - x}{a_3 - a_2} & \text{if } a_2 \leq x < a_3 \\ 0 & \text{if } x \geq a_3 \end{cases} \quad 3.1$$

Fuzzy logic input variables and their acronym used to generate fuzzy logic model to diagnosis Khat addicted patients with physical and psychological disorder are:

- Feeling depressed (DP), (low, moderate, severe)
- Dizziness (DZ), (low, moderate, severe)
- Headache (HD), (low, moderate, severe)
- Being absent minded (BAM), (low, moderate, and severe)

- Fast heart rate (FHR), (low, moderate, severe)
- Blurred vision (BV), (low, Moderate, severe)
- Sleep disturbance (SD) (low, moderate, severe)
- Chewing frequency (CF) (low, moderate, severe)

The output parameter of physical and psychological disorder related to Khat addiction are risk level of the disease such as very low, low, medium, high and very high.

- **Step 3- Knowledge Base:** -Knowledge base includes rule base and database. The rule base section consists of if then-rules and the database consist of membership characteristic of fuzzy units used in the rule base. Knowledge base is the aggregate of expertise of human experts. The guidelines use enters membership values to decide their effect on fuzzy output for ultimate conclusion.
- **Step 4- Fuzzy Inference Engine:** -Fuzzy inference engine is guided by way of fuzzy rules. It tests all the person inputs and all corresponding regulations in understanding base. It indicates how a specialist gadget applies the guidelines to attain conclusion. The policies have IF (condition) and THEN (action) structure. When the IF section of the rule is satisfied, the rule is fired and its motion section is executed. The designed fuzzy specialist gadget inference engine hyperlinks the policies given in the rule base to the statistics saved in the database. The trouble precise records which are referred to as database are series of records used to healthy IF (condition) phase of the guidelines saved in the information base. Figure 3.2 Adopted inference engine showing match-fire procedure Aggregation of the outputs rule. The input of aggregation process is a list of consequent membership functions and the output is a single fuzzy set for individual risk of physical and psychological disorder. It unifies the output of all fuzzy rules. The membership function of each symptoms and a set of functions for every rule were obtained.
- **Step 5-Defuzzification:** -It is one component of fuzzy expert system which used to obtain one single value that shows the best output of aggregate fuzzy set result. It involves converting a fuzzy set in to crisp output. The input to the defuzzification process is a single fuzzy set (aggregated output fuzzy set) and the output is a single value. The center of gravity is the most widely used method because the defuzzified values move smoothly around the output fuzzy region, thus giving more accurate representation of the output fuzzy set for any shape. The mathematical equation for this method is represented below (3.2).

$$COG = \frac{\sum_{X=a}^b \mu_A(X) / X}{\sum_{X=a}^n \mu_A(X)} \quad 3.2$$

Where (X)=membership value in the membership function and X is center of membership .

Function.Center of gravity (COG) method takes the centroid of total area represented by membership function curve in the aggregate final result of membership function.

D. Data Collection

Symptoms and risk factors of physical and psychological disorder related to khat addiction were collected from literature studies and interview with domain experts. Questionnaires, structured and unstructured interview was conducted to gather knowledge from experts. The criteria for selecting specialized experts was based on profession, educational background, experience, role and position in diagnosis of khat addicted patients with physical and psychological disorder. For constructing membership functions, the response of three medical experts was aggregated to determine the range of final MF formulation and fuzzy rules.

The lowest and highest values were considered to formulate membership function for each symptom and risk factors. For collecting data about symptoms and their risk level, fifty patients' data were collected purposely from their psychiatric diagnosis in Assosa General Hospital (Assosa City, Ethiopia). The data was presented to medical specialists and asked them to rate the range of each symptoms based on the risk level of the disease.

In this research work data is also obtained from twenty khat addicted individuals with physical and psychological disorder based on their experience of using khat and other personal characteristics using interview. The data was collected from those already diagnosed in the disease. During interview from khat addicted individuals, it was similar with symptoms collected from hospitals and severe symptoms related to physical and psychological disorder were identified with the help of domain experts.

IV. DATA ANALYSIS, RESULTS AND DISCUSSION OF FINDINGS

Fuzzy expert system for diagnosing the risk level of khat addicted patients with physical and psychological disorder has been developed. The developed fuzzy expert system supports khat addicted patients with physical and psychological disorder to improve their health status and helps clinicians to diagnosis their patients. Since khat addiction is currently the main problem of our society, this fuzzy expert system is used to diagnosis the risk level of physical and psychological disorder for patients.

A. Design of Fuzzy Expert System Specification

Software tool that used for developing the expert system was Android version 3.0 with Android SDK tools and JfuzzyLogic. Android is widely used platform due to its computing power and performance. Android version 3.0 is used to develop this fuzzy expert system. The minimum requirement for the expert system to run in android device is the android version 4.4 KitKat and it is capable of running 95% of the devices. This fuzzy expert system software would be installed in android devices. The system can easily integrate and portable to all mobile phones which run on android platform.

B. Physical and Psychological Disorder Risk Factors and Symptoms

Specification related to Khat Addiction: -In real world, physicians take the risk factors and symptoms of a patient based on their experience as input for providing the appropriate diagnosis to the patients. Physical and psychological disorder related to khat addiction is associated with risk factors such as frequency of khat chewing and symptoms like feeling depressed, headache, dizziness, absentminded, fast heart rate, blurred vision and sleep disturbance. A list of different symptoms and risk factors was found in literature studies and physical examination of patients' data. Questionnaires were organized for domain experts based on their experience to assign suitable weight between 1(non-significant) and five (very significant) to the symptoms based on their significance of diagnosing physical and psychological disorder related to khat addiction. According to the completed questionnaires highest weight were selected. This research consists of the following eight input variables for designing fuzzy expert system to diagnosis the risk of physical and psychological disorder related to khat addiction according to interviewed medical experts and literature. These are: Feeling depressed, Dizziness, Headache, being absent minded, fast heart rate, Blurred vision, Sleep disturbance and Chewing frequency.

The above parameters are identified with the help of domain experts and literature studies. These parameters were used to include all possible range values for a given membership function selection. The model classifies the symptoms and risk factors of khat addicted patients with physical and psychological disorder into five categories. These are very low, low, medium, high and very high. The expert system would recommend the patients for further physical examination if the risk is very high. If risk is medium proper treatment would be provided in order to reduce the risk level of physical and psychological disorder related to khat addiction.

Type	No	Variable Name	Linguistic set Actual range of variables	Linguistic set Actual range of variables
Inputs	1.	Feeling depressed (age of symptom in days)	Low	<3
			Moderate	2-6
			Severe	5-10
	2.	Dizziness (age of symptom in days)	Low	<8
			Moderate	7-14
			Severe	13-20
	3.	Headache (age of symptom in days)	Low	<4
			Moderate	3-6
			Severe	5-10
	4.	Being absent minded (age of symptom in days)	Low	<4
			Moderate	3-6
			Severe	5-10
	5.	Fast heart rate (age of symptom in days)	Low	<4
			Moderate	2-6
			Severe	5-10
	6.	Blurred vision (age of symptom in days)	Low	<5
			Moderate	4-10
			Severe	7-15
	7.	Sleep disturbance (age of symptom in days)	Low	<6
			Medium	5-12
			High	11-20
	8.	Chewing frequency (in days)	Low	<5
			Medium	4-10
			High	8-15

Table 1: Description of input variables and their range based on experts rating

C. Description of Input Variables

Fuzzy expert system to diagnosis physical and psychological disorder related to khat addiction based on expert's knowledge the following symptoms:

- Feeling depressed (DP): -It is one of the symptoms of khat addicted patients with physical and psychological disorder which have high health effect among longterm khat chewers. The input variables for feeling depressed are classified in to three (3) fuzzy sets as below; Age of the symptom in days: <3 low, 2-6 moderate, 5-10 severe
- Dizziness (DZ): -It leads to high risk level among khat addicted patients with physical and psychological disorder when they use it in their daily life. The input variable for Dizziness are classified in to three (3) fuzzy sets as described below; Age of the symptom in days: <=8 low, 7-14, moderate, 13-20 severe
- Headache (HD): -It is common symptoms of khat addicted patients which increase the risk level of physical and psychological disorder when used frequently for a long session. The input variable for headache are classified in to three (3) fuzzy sets as described below; Age of the symptom in days: <4 low, 3-6 moderate, 5-10 severe
- Being absent minded (BAM): -It is frequently seen in patients with physical and psychological disorder related to khataddictions which have high effect on khat dependent chewers. The input variable for being absent minded are classified in to three (3) fuzzy sets

as described below; Age of the symptom in days: <4 low, 3-6 moderate, 5-10 severe

- Fast heart rate (FHR): -Those who frequently use khat as daily base are affected by fast heart rate as a result of using khat for a long period of time. The input variable for Fast heart rate are classified in to three (3) fuzzy sets as described below; Age of the symptom in days: <4 low, 2-6 moderate, 5-10 severe
- Blurred vision (BV): -Regular khat chewing has a huge factor for increasing the risk level of physical and psychological disorder related to khat addiction. The input variable for blurred vision are classified in to three (3) fuzzy sets as described below; Age of the symptom in days: <5 low, 4-10 moderate, 7-15 severe
- Sleeping disturbance: - It is one of the factors which increases the risk of physical and psychological problems among khat addicted patients. The clinical finding of chewing sides of addicted patients varied according to the duration of khat chewing habit. The input variables for sleeping disturbance are classified into three (3) fuzzy sets. Sleeping disturbance duration in days : <6 low, 5-12 moderate, 11-20 severe
- Chewing frequency: -The frequency of khat chewing is the risk factor of khat addicted patients with physical and psychological disorder. Khat dependent patients which use khat frequently are more vulnerable to physical and psychological disorder. The input variables for chewing frequency are classified into three (3) fuzzy sets. Chewing frequency in days: <5 low, 4-10 moderate, 8-15 severe.

Fuzzy set	Interval	Fuzzy set	Interval
Very low symptoms	[0-3]		
Low symptoms	[2-5]		
medium symptoms	[4-8]		
high symptoms	[7-11]		
Very high symptoms	[10-20]		

Table 2: Linguistic terms and output variable classification for physical and psychological problems of khat addicted patients

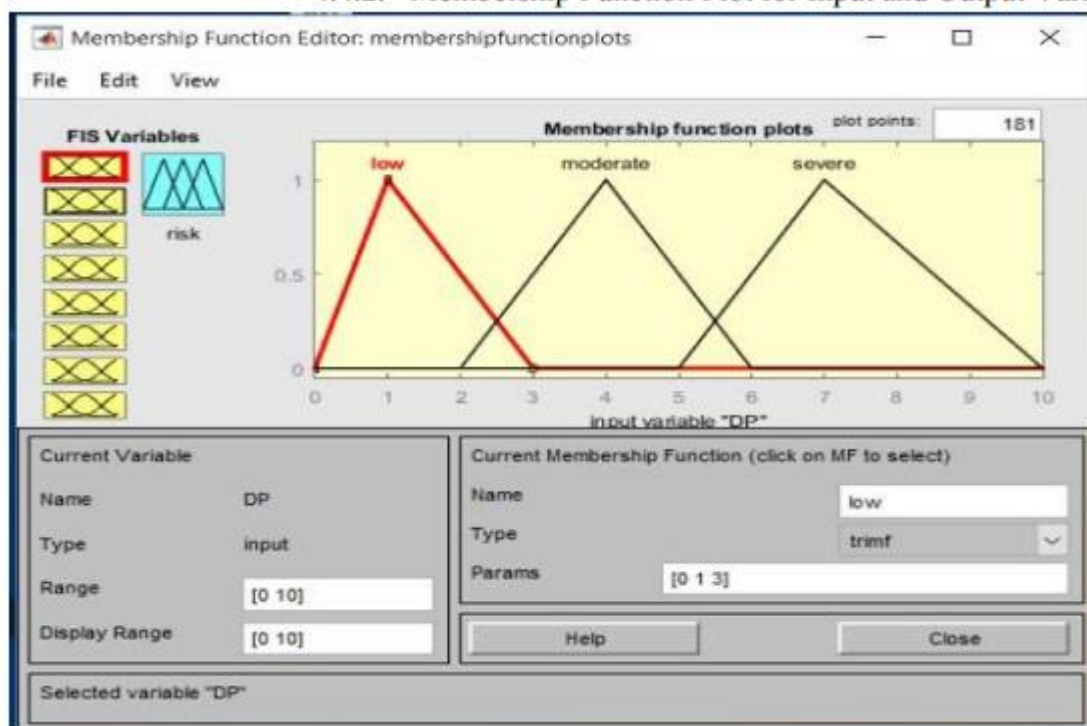


Fig. 2: Membership function plot for input variable feeling depressed

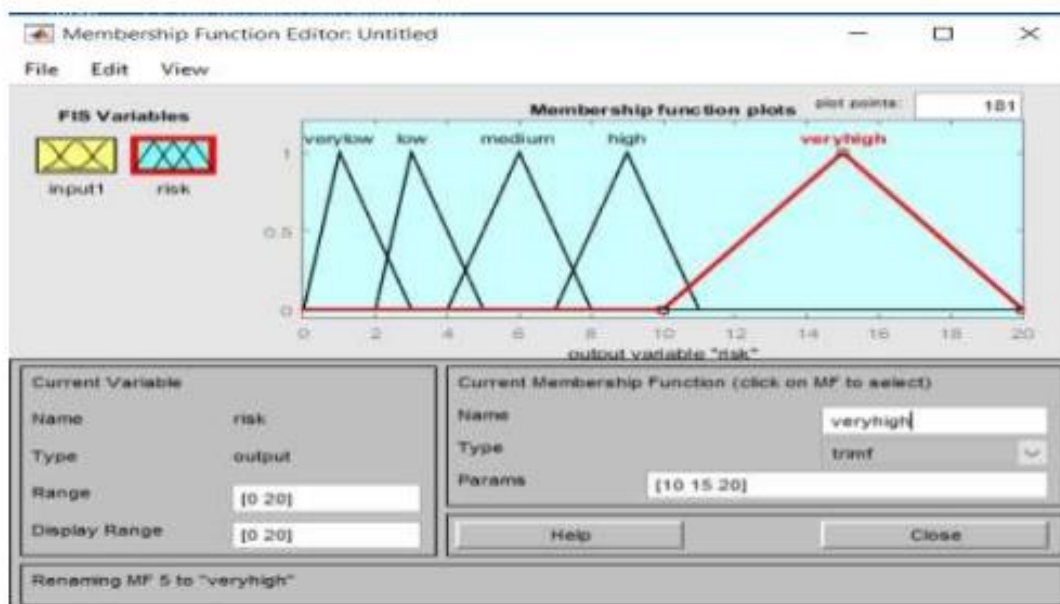


Fig. 3: Membership function plot for output variable riskSystem Implementation

D. Experimental Result

As the design model is accomplished, fuzzy expert system software to diagnosis the risk level of khat addicted patients with physical and psychological disorder was developed. The users select the age of symptoms in days and click Submit Button. After clicking Submit button, membership degrees for all inputs are calculated with the designed fuzzy expert system and all fuzzy rules formulated were checked. As a result, the risk level of khat addicted patients with physical and psychological disorder is displayed in interface as low, medium, high and very high with recommended advisory message to take measures.

For testing the performance of the system in diagnosing physical and psychological disorder related to khat addiction, data was collected and processed using the

designed fuzzy expert system. The dataset is divided into training and testing sets. Thirty (30) samples were used to derive membership functions and fuzzy rules. Twenty (20) samples were used for testing fuzzy model. The designed fuzzy expert system is tested by matching the system output and expert's analysis. The input symptoms and risk factors feeling depressed, dizziness, headache, absent minded, fast heart rate, blurred vision, sleeping disturbance and chewing frequency are filled and the result shows, better performance of the system in diagnosing khat addicted patients with physical and psychological disorder. Table 4.3 shows; the result of testing dataset after filling the age of symptoms in days, the system output was compared with expert output to test the performance of the system.

No	Input age symptom in days								Output by the System	Output by the users	Result
	Feeling depressed	Dizziness	Headache	Absent Minded	Fast Heart Rate	Blurred Vision	Sleeping Disturbance	Chewing Frequency			
1.	7	5	4	5	7	6	6	8	veryhigh	veryhigh	True
2.	5	8	4	6	5	2	4	6	High	High	True
3.	2	3	5	7	6	5	5	4	veryhigh	veryhigh	True
4.	3	2	2	2	3	4	3	6	medium	medium	True
5.	2	4	3	4	7	5	8	7	High	High	True
6.	4	3	3	2	3	2	2	4	Low	Low	True
7.	3	2	7	5	3	7	5	8	High	High	True
8.	6	3	4	2	9	5	5	6	veryhigh	veryhigh	True
9.	4	3	2	2	2	3	3	4	verylow	verylow	True
10.	7	5	4	4	3	6	2	7	High	High	True
11.	4	2	2	3	4	8	5	8	medium	medium	True
12.	3	7	2	6	3	8	8	7	veryhigh	veryhigh	True
13.	7	5	4	3	7	3	5	6	veryhigh	veryhigh	True
14.	6	2	5	4	7	7	3	6	veryhigh	veryhigh	True
15.	1	3	2	4	2	4	3	5	Low	Low	True
16.	5	7	5	9	4	5	9	13	veryhigh	veryhigh	True
17.	1	2	4	4	3	2	6	4	medium	low	False
18.	1	2	1	2	4	3	3	6	medium	medium	True
19.	2	7	5	8	4	3	3	6	High	High	True
20.	1	7	3	5	4	3	3	7	Medium	medium	True

Table 3: Sample test results of the designed fuzzy expert system

Based on analyzed data (Table 4.3), the designed fuzzy expert system was evaluated using performance measures such as accuracy, precision and sensitivity have been used.

N=20	Incorrectly Diagnosed	Correctly Diagnosed	
Actually Incorrect	TN=1	FP=1	2
Actually correct	FN=0	TP=18	18
	1	19	

Table 4: Confusion matrix used to calculate the accuracy of the designed system

Where, True Negative (TN) - In this case, we have predicated no risk of physical and psychological disorder.

False Positive (FP) – In this case, we have predicated physical and psychological disorder and they have no disease.

True positive (TP) – In this case, we have predicated physical and psychological disorder according to the data and it was actual.

False Negative (FN) – In this case, we have predicated no risk of physical and psychological disorder and they have physical and psychological disorder.

$FP+TP=1+18=19$ indicates the actual instances classified. $TN+FN=1+0=1$ shows the incorrect instances classified.

$$\text{Accuracy value} = \frac{TP + TN}{\text{Total}} \quad \text{or} \quad \frac{19}{20} = 0.95 \text{ (95\%)}$$

$$\text{Precision value} = \frac{TP}{\text{Correctly diagnosed}} \quad \text{or} \quad \frac{18}{19} = 0.94 \text{ (94\%)}$$

$$\text{Sensitive value} = \frac{TP}{TP + TN} \quad \text{or} \quad \frac{18}{10} = 1 \text{ (100\%)}$$

The confusion matrix of the expert system in Table 4.4 shows twenty (20) samples of data used to test the system. It is observed that the developed system performance was effective in all performance metrics for diagnosing khat addicted patients with physical and psychological disorder with accuracy of 95%, precision 94% and sensitivity of 100%. Accuracy indicates agreement of the system and approved diagnosis by expert physicians, which showed the proposed system was 95% equal to medical experts' diagnosis. Precision metric 94% shows the developed system is consistent when repeatedly tested. Sensitivity value calculated shows the correctness of the proposed system to predicate the percentage of the patients with

disease having positive test. Higher sensitivity (100%) indicates the system can respond to even smallest input.

Triangular membership function was employed to evaluate the degree of participation of each symptoms and risk factors to diagnose khat addicted patients with physical and psychological disorder. The designed fuzzy expert system provide relevant feedback for the users to take appropriate measure according to the risk level of physical and psychological disorder. Figure 4.3, 4.4 and 4.5 shows symptoms degree of participation in diagnosing the risk level of khat addicted patients with physical and psychological disorder. The degree of membership shows the degree of truth in diagnosing the risk level of the disease.

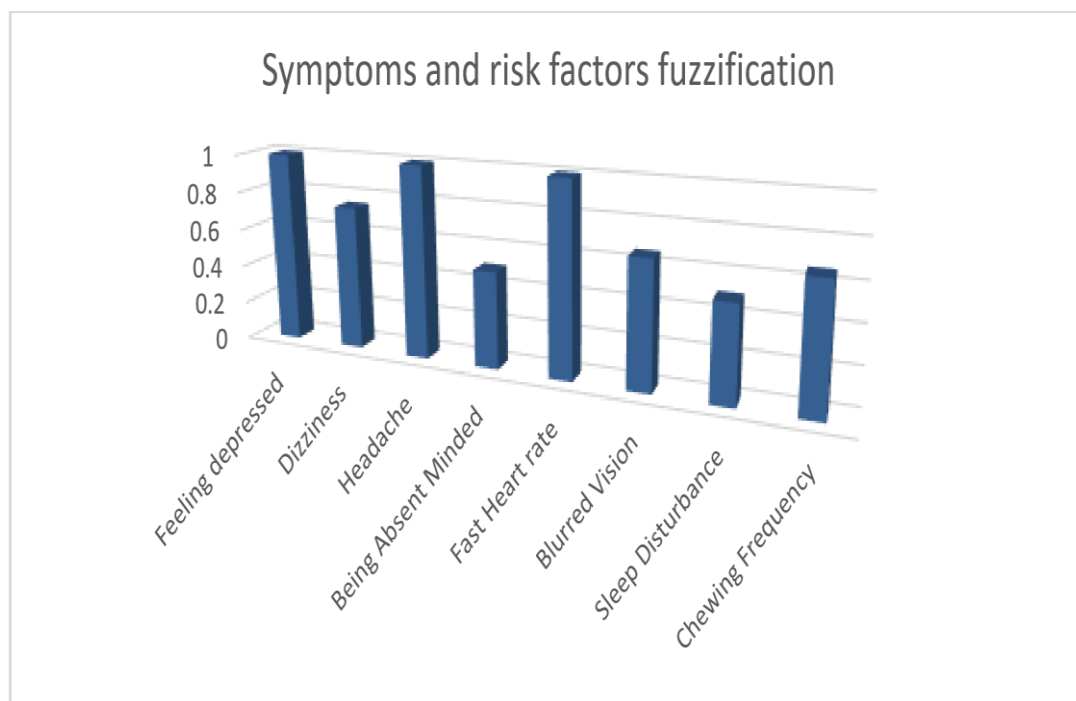


Fig. 4: Symptoms and risk factor fuzzification showing each level of membership degree (first data in Table 4.3)

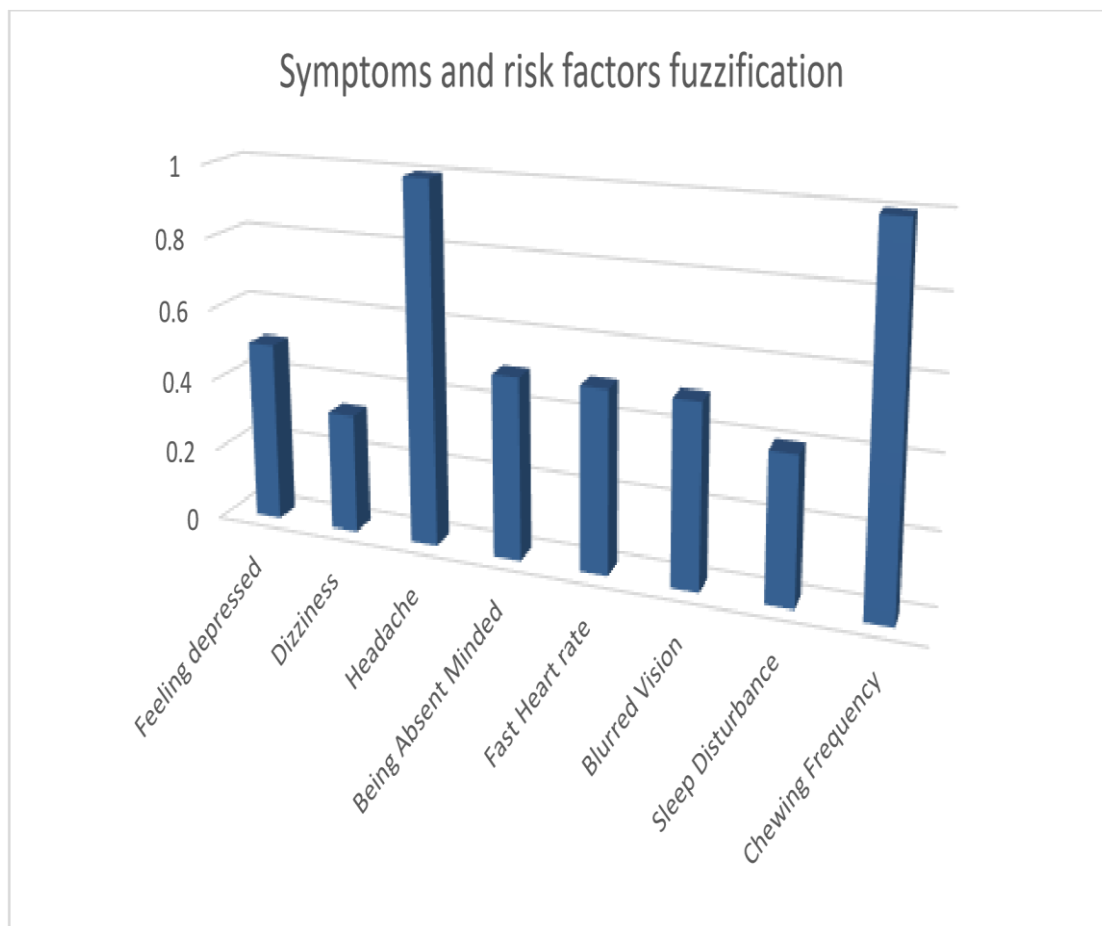


Fig. 5: Symptoms and risk factor fuzzification showing each level of membership degree (Second data in Table 4.3)

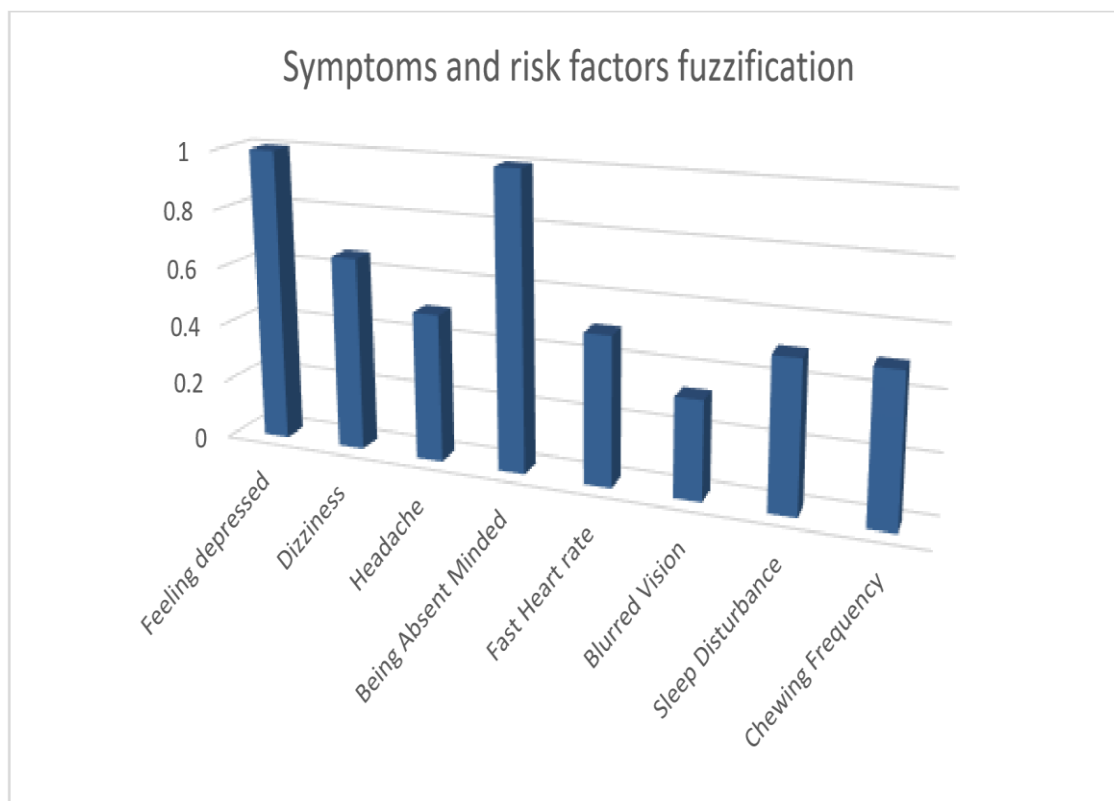


Fig. 6: Symptoms and risk factor fuzzification showing each level of membership degree (Third data in Table 4.3)

E. Discussion

In this research work, a fuzzy expert system was designed and implemented to diagnose the risk level of individuals with physical and psychological disorder related to khat addiction. The system contains eight (8) input variables: feeling depressed, dizziness, headache, absentminded, fast heart rate, blurred vision, sleep disturbance and chewing frequency. It uses five output parameter values: very low, low, medium, high and very high. Triangular fuzzifier was used for membership function evaluation. The fuzzified data were used to infer diagnosis with the knowledge stored in the knowledge base. The rule base was designed based on knowledge of domain experts. The system has 6587 fuzzy rules building strong rule base, since quality of the results in fuzzy system depends on rule base of the system.

The designed fuzzy expert system uses rules to diagnosis the risk level of khat addicted patients with physical and psychological disorder based on symptoms and risk factors. Center of gravity method was used for defuzzification of the output variable. Defuzzification was used to produce crisp value on arbitrary scale of fuzzy out variable as risk of physical and psychological disorder. The efficiency of the designed expert system was tested with data of khat addicted patients with physical and psychological disorder. The test result indicates that the symptoms and risk factors used in designing the model were responsible physical and psychological disorder related to khat addiction. The designed system has recorded 95% accuracy.

Appropriate advice is provided to minimize the risk level of khat addicted patients with physical and psychological disorder by the designed fuzzy expert system. Mobile based fuzzy expert system model for diagnosing the risk level of khat addicted patients with physical and psychological disorder as a new approach was used. The motivation for the choice of fuzzy expert system model was because of real and near accurate drawing of inference from the system, based on the nature of the disease (physical and psychological disorder). We used fuzzy logic approach for removing uncertainty, ambiguity and vagueness in physical and psychological disorder related to khat addiction. It was perceived that best result were gotten by testing mobile based fuzzy expert system using real data of individuals.

F. User Acceptance Testing

Testing was used to identify whether the developed system achieve the goal or not. Two methods are used for expert system evaluation. Functional testing approach was used in this research work for testing the basic functions of the system such as the risk level of physical and psychological disorder related to khat addiction. Real data and expert reported cases were used for testing the functionality of the designed expert system. The performance Metrix used to test the designed fuzzy expert system are efficiency, functionality, and portability following ISO 9126 software quality characteristics standard. Ten (10) respondents were selected randomly for

evaluation of the designed system. Among ten individuals two of them were medical experts and eight of them are khat addicted patients. They were asked to determine portability, functionality and efficiency and the result is presented below. The functionality of the proposed system was measured based on correctness suitability of functions in determining the risk level of the disease. The portability of the proposed system is measured in terms of efforts required to install the device in different environment. The efficiency is evaluated based on system response for input symptoms and risk factors of diagnosing the risk level.

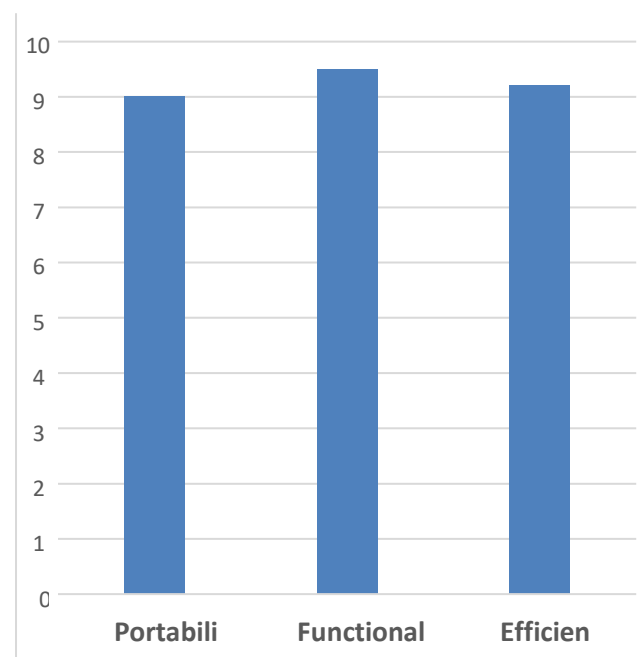


Fig. 7: Chart result for Evaluation of the Designed System

For evaluating the designed fuzzy expert system, we include users (patients and physicians) feedback based on a set of criteria. The data collected was analyzed to recognize the usefulness of the designed fuzzy expert system for patients and physicians to improve their knowledge about physical and psychological disorder related to khat addiction. The users evaluated the designed fuzzy expert system in terms of functionality, efficiency and portability. The developed fuzzy expert system was evaluated by taking respondents answer by asking serious of questions using Likert scale (Appendix II). The users give score five (Strongly Agree) as highest value and 1 as lowest value (Strongly Disagree). We summarized the evaluation result of two (2) experts and Eight (8) khat addicted patients in table 4.5 below.

Criteria	User 1	User 2	Average	Interpretation
functionality	4.8	4.7	4.75	Agree
Efficiency	4.6	4.5	4.55	Agree
portability	4.6	4.4	4.5	Agree
Mean Average			4.6	Agree

Table 5: Result of Evaluation

Where:

User1- Experts in physical and psychological disorder

User2- khat addicted patients with physical and psychological disorder

The above table 4.5 shows the result of evaluation conducted by users (khat addicted patients and physicians) and its interpretation. The Evaluation result (4.6) indicates that most of the respondents agreed which is equivalent to 92 % result of the system evaluation.

V. CONCLUSION AND RECOMMENDATION

A. Conclusion

Fuzzy expert system for diagnosing the risk level of physical and psychological disorder related to khat addiction runs on android operating system was successfully designed and implemented using symptoms and risk factors of khat addicted patients with physical and psychological disorder. The developed fuzzy system would be used by khat addicted patients with physical and psychological disorder for monitoring their health status.

The nature of physical and psychological disorder related to khat addiction created a big problem in health care centers. In developing countries like Ethiopia where insufficient specialists are in the area, the disease spreads from time to time. The use of fuzzy logic has been found important technology to model uncertainty in medical area. The designed fuzzy expert system can provide decision support platform for assisting khat addicted patients with physical and psychological disorder, clinicians and health care workers to diagnosis the risk level of physical and psychological disorder caused by khat addiction.

The fuzzy logic model used in this research work achieved the overall result by using symptoms and risk factors of physical and psychological disorder related to khat addiction. This model delivers effective solution and provide more accurate diagnose result to a problem. The designed fuzzy expert system performs 95% success. The symptoms and risk factors used in the designed fuzzy expert system was confirmed as contributing factors for increasing the risk of physical and psychological disorder related to khat addiction. Therefore, the output of fuzzy expert system provides advice which enables individuals to take the necessary measures in reducing the risk level of physical and psychological disorder related to khat addiction.

B. Recommendation

For future research direction, this research can be extended on khat addiction related health problems using different approaches. The symptoms and risk factors of physical and psychological disorder may continuously change based on different factors like health status of the patient. So future works can be done on integrating intelligent systems that has capability of self-learning using neural network adaptive systems. A major challenge is specialized experts are expensive and are not likely to sit down and write large number of rules. Wide consultation of psychiatrists is required to improve the accuracy of the system.

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