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AIMS: AI based Mental Healthcare System

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Abstract

In this era of information and communication technology (ICT), tremendous improvements have been witnessed in our daily lives. The impact of these technologies is subjective and negative or positive. For instance, ICT has brought a lot of ease and versatility in our lifestyles, on the other hand, its excessive use brings around issues related to physical and mental health etc. In this study, we are bridging these both aspects by proposing the idea of AI based mental healthcare (AIMS). In this regard, we aim to provide a platform where the patient can register to the system and take consultancy by providing their assessment by means of a chatbot. The chatbot will send the gathered information to the machine learning block. The machine learning model is already trained and predicts whether the patient needs a treatment by classifying him/her based on the assessment. This information is provided to the mental health practitioner (doctor, psychologist, psychiatrist, or therapist) as clinical decision support. Eventually, the practitioner will provide his/her suggestions to the patient via the proposed system. Additionally, the proposed system prioritizes care, support, privacy, and patient autonomy, all while using a friendly chatbot interface. By using technology like natural language processing and machine learning, the system can predict a patient's condition and recommend the right professional for further help, including in-person appointments if necessary. This not only raises awareness about mental health but also makes it easier for patients to start therapy.

Keywords:

Mental health, AI, chatbot, NLP, prediction, Machine Learning, Information and Communication Technology (ICT)

1. Introduction

Mental health is a complex yet critical aspect of human well-being, impacting individuals and society profoundly. The proposed study's primary goal is to gain a deeper understanding of mental illness and challenge the stigma surrounding it. We're taking a comprehensive approach, using various research methods to explore how mental health issues affect people and society. Our aim is to use this knowledge to improve mental health support and raise awareness, ensuring that mental health is as valued as physical health. In essence, the proposed study is a significant step in addressing a pressing issue and working towards a future where mental well-being is a top priority. A system that ensures patients privacy as well as a constructive use of machine learning technology to assist the clinical decision-making process.

To help the country and its people from mental illnesses this study is conducted to improve and increase awareness about the impact of mental illnesses. The goal is not limited to just increasing awareness but to help make the first step easier for those who suffer from any of those illnesses, as our findings and research showed us that one of the hardest steps and one of the most prominent problems lays in taking the first step. Four in five of people who unfortunately suffer from this illness don't seek help or treatment not only does this hurt the person but also hurts the GCC as this issue costs \$3.5 billion in productivity, the issue is bigger than just our country it effects the entire GCC, and we hope that by conducting this research and developing our system we can make a significant and positive difference [1].

Mental health stands as a complicated and difficult aspect of human beings, one which bears profound results no longer best for the individuals grappling with it but also for society as a whole. At the heart of our studies endeavors lies an utmost objective: to deliver even deeper into the intricacies of mental illness. This encompasses not only effectively an exploration of its incidence and significance but also a comprehensive understanding of its reach and enduring social results. The catalyst for this critical effort emanates from the undeniable and growing worldwide burden of mental health issues, which serves as a poignant reminder of the urgency surrounding the want to unravel the origins and multifaceted implications of these demanding situations. Moreover, the proposed research aspires to do more than just accumulate statistics; it seeks to ignite a transformation in societal attitudes towards intellectual ability by delving into the difficult internet of mental infection, we propose to break down the complicated shame that has, for a way too long, shrouded mental health problems in silence and misunderstanding. We hope to adopt a way of life of empathy and understanding, wherein mental health is viewed no longer with disgrace and misunderstanding but as a crucial part of normal proper-being. To achieve our ambitious dreams, we have charted a multidisciplinary path that seamlessly blends quantitative and qualitative research methodologies. Our studies panorama spans a numerous array of investigations, starting from meticulously performed clinical studies to the nuanced exploration of in-intensity interviews. The information accumulated from these varied sources will go through rigorous analysis, fortified via advanced statistical gear that draw upon the wealthy insights of psychology, sociology, and neuroscience. This multifaceted methodological framework is composed to yield insights, imparting a profound and complete understanding of its multifaceted nature and the huge spectrum of implications it carries.

Furthermore, it is anticipated to serve as a catalyst for a profound shift in public perceptions of mental health, dismantling the artificial limitations that have, for too long, separated it from the domain of physical fitness. This will lead to the creation of a greater inclusive society, one which assigns identical weight to mental and physical health, in the long run culminating well-being of all communities.

The rest of the paper is organized as follows: section 2 provides review of related literature, section 3 provides the materials and methods, section 4 is dedicated to the proposed idea while section 5 concludes the paper.

2. Literature review

Individuals with mental problems could hardly know about this illness by themselves, so thanks to many experts, psychiatric depression and anxiety tests were implemented. Also, the patient might be embarrassed to answer some unusual questions, this is enough motive to develop our machine since he or she will feel somehow comfortable which will result in answering with the highest rate of credibility. To clarify our project features and motive further, we have pointed out some vital arguments to justify our work with the following:

According to research made by the combined effort of mental health specialist and, member The Saudi National Mental Health Survey (SNMHS) [1], they conducted a comprehensive examination of mental disorders among Saudi youth aged 15 to 30. The survey involved 4004 interviews, utilizing an adapted version of the Composite International Diagnostic Interview (CIDI 3.0). Statistical analyses, including cross tabulations and logistic regression, were used to generate estimates for the SNMHS youth sample, which consisted of 1881 participants. According to a study conducted among people, in Saudi Arabia it was discovered that 40.10% of them experienced disorders. Anxiety disorders affected 26.84% of the participants followed by behavior disorders (15.44%) mood disorders (9.67%) substance use disorders (4%) and eating disorders (7.06%). The study also found that various sociodemographic factors, such as gender, education level, parental education, income, marital status, region of residence and family history of disorders were significantly associated with types of mental disorders. Alarmingly, only 14.47% of Saudi youth with any lifetime mental disorder reported receiving treatment. Age, parental education, and family history of mental disorders emerged as notable factors associated with mental health treatment utilization. These findings underscore the high prevalence of lifetime mental disorders among Saudi youth and highlight an unmet need for

culturally sensitive and age-appropriate mental health treatment in Saudi Arabia.

King Salman Center for Disability Research [2] made a technical report containing a finding and description of some disorder that could influence anyone In Saudi Arabia. After mentioning the results statistics, they explained some disorder they found. a bar chart that displays the most common mental health conditions in KSA across different age groups. The chart shows the prevalence of various mental health issues, such as depression, anxiety, and bipolar disorder, among different age groups. The data is presented in a clear and organized manner, with each mental health condition represented by a distinct bar as given in Figure 1.

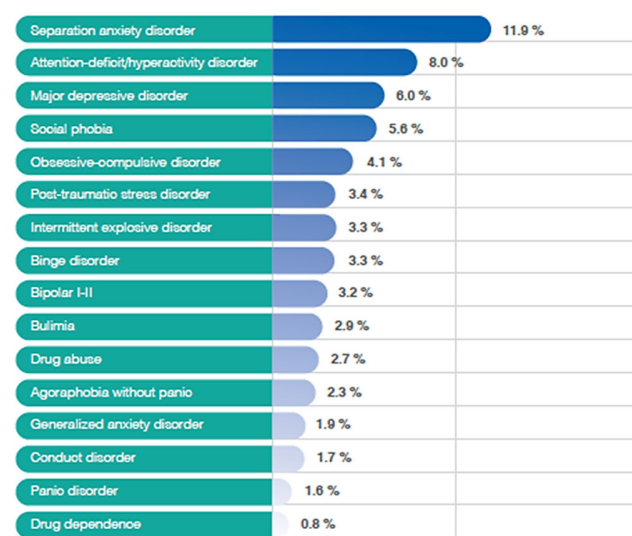


Figure 1: Common health conditions in KSA

The conclusion that can be drawn from this chart is that mental health conditions are prevalent across different age groups in KSA, and it is essential to address these issues to ensure the well-being of the community. The chart highlights the importance of raising awareness about mental health, providing support and resources for those affected, and promoting a culture of openness and understanding around mental health issues. description of various mental health disorders (as shown in Figure 2). Furthermore, an infographic is provided and split into several sections, each focusing on a specific mental health issue. The disorders are listed in a clear and organized manner, making it easy for readers to understand and identify the different types of mental health conditions.

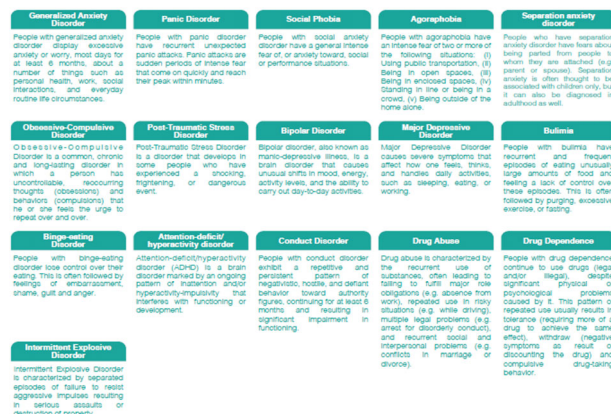


Figure 2: Disorder description

To conclude, an infographic serves as a valuable resource for individuals seeking information about mental health disorders, their symptoms, and potential treatments. It can help raise awareness and promote understanding of these conditions, which is crucial for promoting mental health and well-being in society. The most concerning consequence that could occur due to mental health issues would not only be one's mental status, but his life and other lives is suicide, which we want to avoid [3].

As suggested by Saudi National Mental Health Survey (SNMHS) about an overview in mental health in KSA [4], they conclude a decrease in the suicide rate in Dammam, Saudi Arabia, between 2003 and 2007, with most suicides occurring among non-Saudis. However, official statistics from the Ministry of the Interior show that the number of suicide deaths in the country as a whole increased by 185% between 1994 and 2006, with a similar increase for men and women (Al-Hakim, 2010). These inconsistencies are further highlighted by the World Health Organization (WHO), which reported an age-standardized suicide rate of 0.4 per 100,000 population in Saudi Arabia in 2012, but 3.4 per 100,000 in 2016. Both estimates are well below the worldwide average of 10.5 per 100,000 [4]. The literature on suicide trends in Saudi Arabia is inconsistent. Some studies have found a decrease in the suicide rate, while others have found an increase. It is possible that the inconsistencies are due to differences in methodology, data quality, or cultural factors. More research is needed to better understand the prevalence and trends of suicide in Saudi Arabia. In addition to the inconsistencies in the data, it is important to note that suicide is a complex phenomenon with multiple risk factors. These risk factors can vary from person to person and from

culture to culture. It is therefore important to consider a range of factors when interpreting suicide trends in Saudi Arabia [5].

Alqarni & Rahman [6] proposed a deep learning approach to Arabic sentiment analysis of tweets duly collected for the major cities of Saudi Arabia. Idea was to gauge the mental health of the people during and after the pandemic. Convolutional neural networks (CNN) [7] and bi-directional long short memory (BiLSTM) deep learning algorithms were applied for classifying the sentiment of Arabic tweets. This experiment showed that the performance of CNN achieved 92.80% accuracy. The performance of BiLSTM was scored at 91.99% in terms of accuracy. The scheme was promising and applicable in real-life situations.

Rahman et al. [7] proposed a user behavior prediction approach based on the hybrid intelligent systems. In this regard, a Gaussian radial basis function – neural network (GRBF-NN) [8-10] in combination with Differential Evolutionary (DE) Algorithm [11-13] was investigated over the dataset comprising of logs duly collected from a proxy server. The logs were segregated as machine logs, network logs and web logs. Based on the frequency and weightage, a fuzzy rule-based system [14-15] was designed to express the severity of the user action based on the organizational rules. Together with their 360 feedback, the proposed approach was able adequately classify the user as safe and suspicious on the temporal basis.

Social media sites like Facebook and Twitter are regarded as sources of datasets that are frequently employed in applications of sentiment analysis. The Tweets present usually updated information on users' interests, feelings, behaviors, and opinions about global events [16]. During the Covid-19 epidemic, most individuals attentively used social media to keep fully informed and share their feelings about this epidemic. As a result, researchers were able to conduct studies on Covid-19 datasets collected from social networking sites for studying sentiment analysis during the pandemic. Many studies on sentiment analysis in English and Arabic have been published. Arabic sentiment analysis remains a major challenge, especially regarding the Covid-19 outbreak [17-18]. However, traditional machine learning and deep learning methods are usually used for classifying sentiment analysis. Therefore, this chapter, the literature review is organized into three sections,

which are Arabic Sentiment Analysis using the Traditional Machine Learning Approaches, Arabic Sentiment Analysis using the Deep Learning Approaches, and Sentiment Analysis Related Covid-19 [19-21].

Several works in Arabic sentiment analysis used the machine learning method to study the sentiment analysis. In [22-24], studied Arabic sentiment analysis related to depression among Arabic tweeters. The data was gathered from Arabic tweeters who responded to a questionnaire from the Center for Epidemiologic Studies Depression Scale (CES-D). There are 4542 tweets in total. To extract the required features for this research, different N-gram ranges and TF-IDF methods were used. Furthermore, the dataset was manually annotated into three classes: depressed, non-depressed, and neutral. They used six machine learning techniques for Arabic tweets classification, which are SVM, AdaBoost, Random Forest (RF), Logistic Regression (LR), AdaBoost, and KNN algorithms. The findings demonstrate that the RF classification algorithm performed the best accuracy with 82.39 % compared to the rest of the algorithms, In [25-26], the researchers applied machine learning algorithms for classifying the sentiment of Arabic reviews related to cafes and restaurants in the Qassim province of Saudi Arabia. The dataset was gathered by a Microsoft form survey from different customers. They collected 1,785 reviews, which became 1,507 after cleaning the reviews. They used the KNN, RF, SVM, LR, and NB algorithms with TF-IDF feature extraction for classifying the sentiment of reviews into positive and negative classes. The outcomes revealed that the SVM algorithm has the best accuracy with 89.0% among other algorithms.

The authors in [27-28], studied the SVM model for Arabic sentiment classification into two polarities, which are negative and positive. There were 4,200 tweets in the collected dataset, which covers multiple social issues in Saudi Arabia. Three extracted feature types used in this study are N-grams, emoji features, and the tweet topic feature. The results revealed that the SVM algorithm achieved satisfactory performance with an accuracy of 89.83%.

The authors in [29], studied Facebook comments written in MSA and Moroccan dialectal. They evaluated and contrasted two Arabic SA strategies. The first strategy is the traditional approach, which recognizes all Arabic texts as homogeneous. However, the second strategy required classifying the text prior

to sentiment classification, which is based on language forms: standard and dialectal Arabic. Also, the SVM and NB machine learning algorithms were applied in this study. The feature extraction approaches used in this research are TF/Unigram, TF/Unigram with Bigram, TF-IDF/Unigram, and TF-IDF/Unigram with Bigram. The experiment obtained that the NB algorithm has better accuracy than SVM with 84.56% for MSA sentiment classification [30]. Based on the comprehensive literature review, it can be concluded that Artificial Intelligence based mental healthcare is among the hottest areas of the research. There are several studies around the world but in Saudi Arabia still there is a need for such studies and systems to help assist the people with mental healthcare needs.

3. Methodology

3.1 Theoretical aspects

Explained by in articles about the impact of covid-19 among high-school students in Saudi Arabia. The PHQ-9 survey, utilized for the assessment of depression, comprises nine items aimed at gauging depressive symptoms. Scores on the PHQ-9 can vary from 0 to 27, and they delineate different levels of depression: minimal depression (0-4 score), mild depression (5-9 score), moderate depression (10-14 score), moderately severe depression (15-19 score), and severe depression (20-27 score) [31]. Designed in accordance with the Diagnostic and Statistical Manual of Mental Disorders, the PHQ-9 stands as a dependable tool for evaluating depression within a given population. On the other hand, the GAD-7 survey is employed to assess anxiety symptoms. Comprising seven items, it aligns with the criteria outlined in the full Diagnostic and Statistical Manual of Mental Disorders. Respondents provide answers using a scoring system where 0 signifies "Not at all," 1 represents "Several days," 2 denotes "More than half the days," and 3 indicates "Nearly every day." GAD-7 scores span from 0 to 21 and are categorized into four groups to determine the severity of anxiety. Scoring between 0-4 indicates a minimal level of anxiety, 5-9 corresponds to mild anxiety, 10-14 reflects moderate anxiety, and 15-21 indicates severe anxiety [32]. By using both stated tests, that will be the corner stone of the chatbot mind and knowledge. Using different tools, the knowledge and logic will be transformed into a

language which will be understood by the expert system.

3.2 Technically aspects

To establish our chatbot the following software and tools will be used to accomplish the objective of the study:

- Python, Flatter, HTML, CSS, JS, NodeJS frameworks: Targeted for the web and mobile applications, for full stack development. These languages and frameworks are the base of building an environment.
- Anyword: Used for Natural languages processing (NLP) in which the normal vocabulary is transformed into a recognized manner for the expert system.
- Android studio: integrated development environment (IDE) by google, used to create an android application with various features.
- Visual studio: integrated development environment (IDE), that offers tools and friendly environments for work on coding or creating applications in different languages.
- React native: Framework Intended to allow cross-platform development including code sharing via IOS and android with maintain a native like experience.
- Figma: Cloud-based platform used to create an interface prototype whether it's a mobile application or website interface.
- Tensor flow: Open-source framework aimed for machine learning. It manages the creation of an AI model in several platforms since it has the ability of deep learning.

Combining the stated software, tools, and frameworks will largely cover the entire aspect of creating a chatbot that is fully functional and friendly.

Figure 1 shows the overall system architecture. It is a three-tier architecture. Where first tier is presentation where the user will interact with the system. Followed by the chatbot layer that will be used to collect and analyze the textual information and send it the last layer which is the data layer.

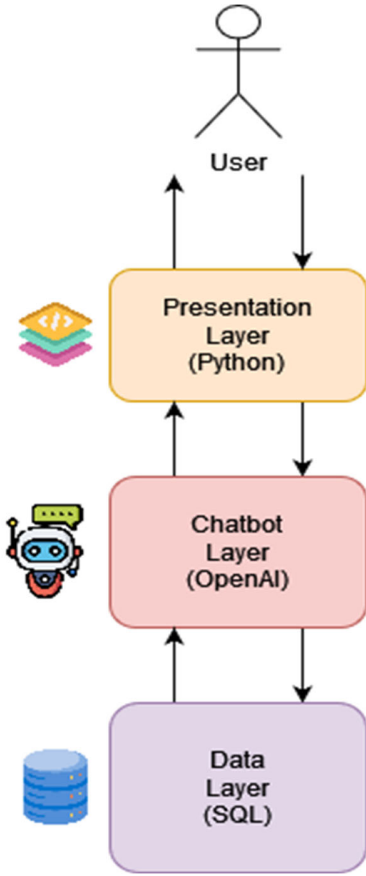


Figure 1 Overall system architecture.

3.3 Dataset

For the proposed study, we are interested in the dataset available at [33] as benchmark. The dataset is in raw format and yet needs to be preprocessed. There are various approaches to be applied to make it qualified for the machine learning model building. Small inconsistencies in dataset records could result in misleading classification or classification error [34-36]. Furthermore, inconsistent data input leads to incorrect and misleading outcomes. Hence, an important step before performing ML is to handle noisy data through preliminary data pre-processing steps. The following approaches are used to preprocess the dataset other than fixing missing values.

- Normalization: it is usually applied to bring the data elements in a certain range such as between -1 and 1 etc.
- Discretization: it helps to bring the diverse data elements into intervals or buckets.

3.4 Machine learning algorithms.

First, the study is supposed to employ experimenting with five frequently used classifiers Naïve Bayes [37], Neural Network [38], Support Vector Machine [39], J48 [40], and Regression [41] to identify the most suitable classification technique. The study is further extended at training the most suitable classifier to correlate relationships between different features [42-45] using Weka data mining software as well as the Python Programming language. Figure 2 describes the type of neural network being used. It is known as multilayer perceptron. It consists of three types of layers such as input layer, output layer and several hidden layers. The number of hidden layers can be adjusted depending on the nature of the problem at hand [46].

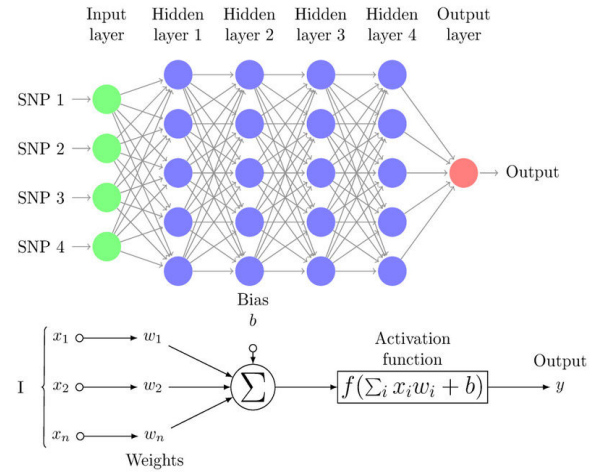


Figure 2. Multi-layer perceptron network

3.5 Evaluation Metrics

To evaluate the proposed system's performance, well-known criteria have been suggested. That are accuracy, precision, recall and F-score as given in equation 1-4, respectively [47-53].

$$Accuracy = \frac{TP + TN}{TP + TN + FP + FN} \quad (1)$$

$$Precision = \frac{TP}{TP + FP} \quad (2)$$

$$Recall = \frac{TP}{TP + FN} \quad (3)$$

$$F - measure = 2 * \frac{Precision * Recall}{Precision + Recall} \quad (4)$$

True Positive (TP) represents the number of correct predictions that an instance is positive, whereas True Negative (TN) is the number of correct predictions that an instance is negative. False Positive (FP) represents the number of incorrect predictions that an instance is positive, whereas False Negative (FN) represents the number of incorrect predictions that an instance is negative.

4. Experiments and Results

As stated earlier, the system is yet to be implemented. However, a complete plan has been established. Based on the plan, Figure 3 shows the first screen of the system that allows user to sign in and sign up. This is for both patients as well as the practitioners who want to register with the system for the first time. Upon successful completion, they will be able to utilize the other functionalities, as described further.

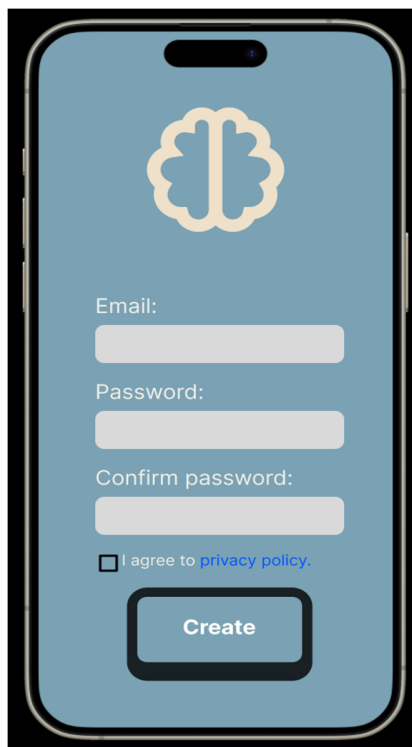


Figure 3: Signup screen

Figure 4 shows the main screen for the patient where there are several controls given to proceed. Such as booking the appointment and viewing the history and notes of the practitioner.



Figure 4: Main menu screen

Figure 5 shows the chatbot window/screen shown as the patient chooses to conduct a test or conversation.

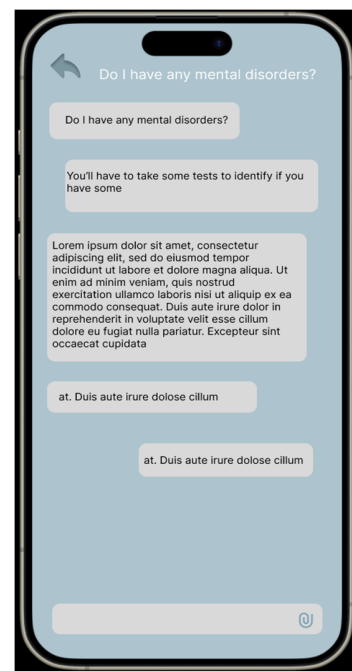


Figure 5: Chatbot window/screen

From the software engineering perspective, the software must be tested before deployment. In this regard, Figure 6 shows the complete test plan for the proposed system.

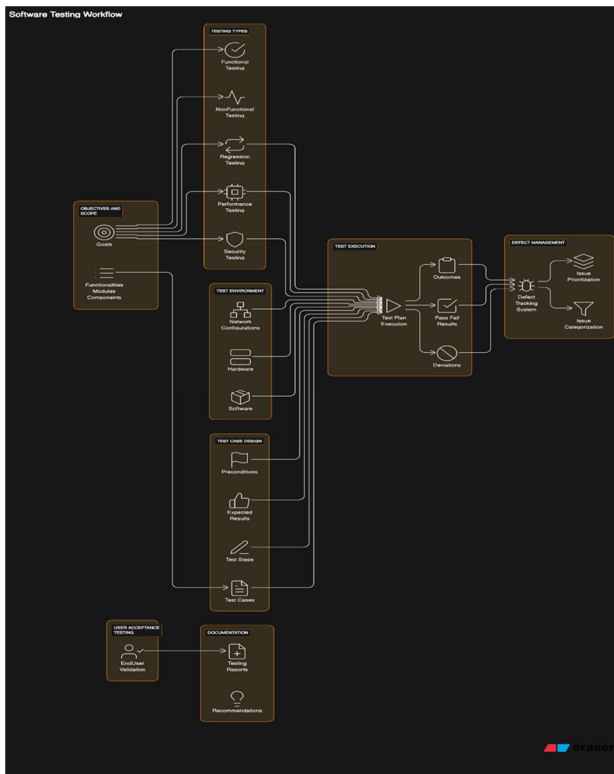


Figure 6: Testing plan for the entire system.

5. Conclusion.

The study proposed the idea of intelligent mental healthcare system that ensures privacy, anonymity, and timely assistance to people with mental health conditions. The paper also discussed the motives in which is stated in statistical manner. Chatting with them is meant to be easy and flexible with no complexity or ambiguity. Moreover, the mental health tests work on diagnosing the type of mental issue he/she has and providing the rightful treatments. Without a doubt, the mental status of a person is critical for one's family and self, and it is hard to ignore, with no one wanting it to grow in which the undesirable outcome occurs. Hopefully the awareness of such matter spreads among our society and the world. It will be a great contribution in the field. In future, authors intend to implement the proposed system with full functionality in web and smartphone.

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