Machine Learning and Natural Language Processing Usage for Psychological Consultation

Kaneeka Vidanage and Lakshman Jayaratne

Abstract - **It`s an obvious fact to claim, that the problem of stress has become a vital issue presently. One of the main root cause of this is the escalation of human desires and complexity of those. Most of those desires would be difficult to achieve or not practical at all. When the reality is so harsh, compared with the imaginations, it will incur for stress. More the gap between reality and the perceptions, stress will escalate. As results of people are running after unrealistic or difficult to achieve greener pastures, most of them will end up with becoming a victim of stress. Stress management is a difficult skill to be developed, but in current context, it has become an essential skill to have.**

This research is based on the concept of internal self-talk. Thought stream captured in-form of text stream will be segmented, according to the cognitive behavioral therapeutic approach. This is technically implemented via POS tagging of the Stanford NLP library. Afterwards machine learning approach is used to train the WEKA engine, according to the OCEAN model, which is a prominent psychological model. Predictions derived from the trained WEKA model, will be presented inform of a report with the help of itext reporting plugin. This report will be used by the psychologist, before providing the treatment to the patient/client. It`s assumed, that this tool will be a good aiding tool, which can reduce the cognitive effort of a consultant.

Respective, problem, technical, executional and all important aspects are addressed in detail, within this paper along with required evidences.

Keywords - internal-self-talk; itext plugin; WEKA engin; CBT; OCEAN model

I. INTRODUCTION

Unlike in past, people, do have very hectic life styles presently. Most of them are extremely busy with, excessive amount of responsibilities of various types. It`s an obvious fact to mention, that, any individual is having his/her own capacity. When the demand exceeds this capacity, it will cause for stress. This idea was initially presented by Yerkes and Dodson (as cited in Cooper, Cooper & Eaker, 1988), which is referred as Yerkes-Dodson law [1].

With the complex life styles of people, they need to earn more and more money, for their personnel desire fulfillment. This nature is much more prominent among the educated population, than the less educated. Educated people, who`re also known as "professionals", owns a status and life standard to be maintained, as per the social perception. For an example, if you`re a surgeon, you should have a luxurious car, a big house and a respected social status. So to achieve these things, you need to earn more and more money. For a less educated carpenter, this is not the case. He /She doesn`t need to worry lot about the social status, as society didn`t expect as such of a surgeon from a carpenter, but for these type of people, whom referred as "blue collar" workers, have another type of stress. Their job may be insecure, their life might be at a risk, due to the type of the job they do, sometimes the wage might be inadequate to satisfy, maybe the minimal requirements of a family.

So as per the above discussions, it`s very apparent, for people belonging into different social layers, different types of problems prevail. White collar workers have a different type of a problem set which makes them stressed and for the blue collar workers, it another set of issues. These, causes of stress, are known as stressors. Various forms of stressors are much more prominent in Asian continent compared with other continents. It`s much like, individuals are heavily controlled by the society. With the intention of gaining, fame, respect from the society, people tempt to earn more cash. This will require them to operate additionally, than the normal working hours, which is also referred as doing "over-time", or to take additional jobs and responsibilities, where they can earn more cash. Adverse effects of these would be less or nor time to be spent with family, kids, no entertainment, mental pressure, eye strain, gastritis, insomnia and so much of additional issues. Constant exposure to this sort of a setting, will make yourself a victim of some form of stress. As we discussed above also, in stress, though the root causes are different, yet the end result will be the same.

The psychological base of this research will be mainly on internal self-talk, Cognitive Behavioral Therapy (CBT) and the OCEAN model. The ultimate aim will be to develop and ICT based solution, which can tie up all these three concepts together.

Internal self-talk is a self-confessing mechanism. Each human being, talks with him/herself in own. This is a silent mind talk. Before you go to deliver speech, before an exam, even if you're upset, people talk with their mind. Certainly, it`s very authentic and natural. If a psychologist requests to convert all these, internal self- discussions to a stream of words, it could be taken as the though stream derived from the internal self-talk [2]. This though stream will be the starting point of this research.

Next important aspect will be the CBT, which is an evidence based psychological treatment mechanism.
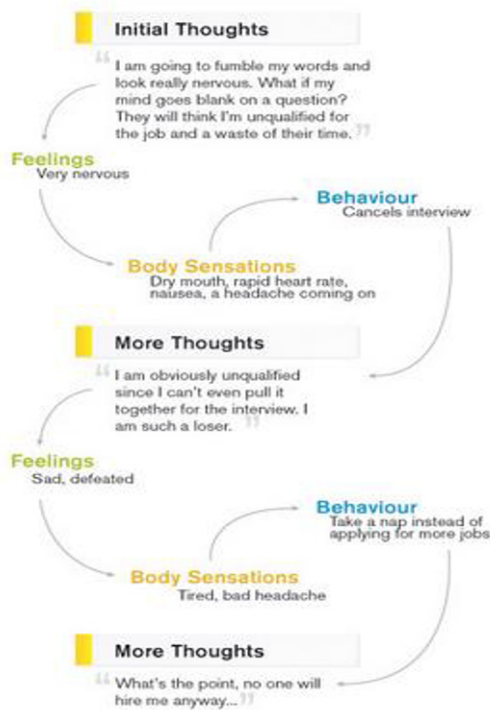

Figure 1: CBT

This is proven successful approach. What actually happen in here is, internal though streams of an individual will be segmented as thoughts, behaviors, emotions and physical reactions. Emotions could be the feelings and the thoughts could be the decisions associated with feelings and behaviors will mostly be the reactions caused by emotions and thoughts. Physical reactions which is also known as the body sensations could be headaches, tears coming of eyes and etc. [3].

With the help of the Stanford NLP (Natural Language Processing) library, a POS (Part-Of-Speech) tagging approach will be used for the segmentation of the internal thought stream into above mentioned categories of the CBT. Technical aspect of this will be discussed in detail in forth coming sections of this paper. The Figure1, above denotes, possible application of CBT into a life scenario.

The ultimate goal of this research will be, to come up with a possible decision assisting tool, which can be used to ease the work load of a clinical psychologist. The problems exists and solutions available are, evaluated in detail with evidences in the literature review section.

II.   RELATED LITERATURE

It`s mentioned, even in the introduction section, the critical and adverse impacts of stress. It`s initially, commencing as a personal, private problem, but, gradually, the adverse outcomes of it will spread across the society as well. Starting from the family unit and ultimately, it will lead to a level of a social problem. As revealed from investigations, in certain countries, like Australia, stress caused mental disorders has resulted in production losses worth 33 billion dollars per year [4].

This is mainly, due to, constant exposure to stress across a longer time periods, which will result in abnormalities such as, frequent absenteeism, higher staff turnover, loss of productivity, increased amount of sick leaves, insurance claims and etc. [5]. For people quitting from their jobs, most of the time, companies need to pay compensations, which will incur a huge loss from organizational perspectives. Also constant leaves will result in loss of effective work hours. In Canada, it`s estimated, annually $150billion worth losses will incur, as a result of the bitter impacts of the stress [6]. All these losses will negatively, impact for the GDP (Gross Domestic Production) of a country as well. So occupational or whatever types of a stress has become a problem, which has a direct negative impact for the national economic growth of any country.

In above, it`s discussed, how individual stress has advanced up to a national level problem. Let`s analyze the disastrous impact of long-term stress exposure to an individual also. The most critical attribute of the stress is, it`s fully internal. Unlike a physical disease or, wound, nothing is visible to the external world. People, who`re suffering

immensely, can pretend as to be as very happy, but that is not the reality.

Many investigations have conducted in the discipline of stress and for the causes of it. Some of the investigators claim, stress will generate as a result of the misfit between an individual and the environment. More the, misfit, generation of the stress will also escalate. It`s also identified, that the relationship between the environment and the person is, not an isolated one, it`s always a combined cause. For an example, due to inability of a person to complete an assigned official task, accurately, the boss might scold to the individual, publicly. So the staff of the office might laugh at that individual. This will make the victim feel, uneasy and humiliated. If this happens more often, it will be a stressor for the individual, making the person, a victim of stress. So as reviewed, in here, inability is the personal weakness, humiliation is caused as a result of the external social impact. So, it`s true. There will be always a combined impact [7].

Stress management is a difficult skill to be developed. Also, it has become an essential skill to be developed, to survive in the current society and work places. As mentioned by, Fisher, more you try to reduce the gap between the perception and the reality, you will become success in stress management. Most of the perceptional goals, you have might not be realistic. Hence, more you keep on day dreaming, your stress will increase [8].

Long term, constant high stress exposure is identified as chronic stress. Being a victim of chronic stress is very bad to your health. As mentioned by the greatest scientist Hans Selye, "stress is the rate of all wear and tear caused by life" [9]. This statement will suggest that, stress is a silent killer within you. Though how healthier you`re, though how fit you`re via doing exercises and taking good meals, yet stress can make you a victim of cardio vascular disease. Though a person is not smoking, not drinking, yet if your mind is not calm, you`re not escaped. This situation will cause for, severe heart attacks. Other complications like, impotency, fear towards having sex, fear towards women, lack of sexual satisfaction, domestic violence will also result in if the victim is married [10].

So it`s obvious, as discussed above, stress is a worst problem, than we think of it. It will ruin your life personally, socially and also economically.

Specially, in counties like Sri Lanka, still we are at developing state. Though we have very high percentage of literacy in almost all the aspects, still there are ample of problems, which `re not yet solved, in different scales. Hence majority of the people in Sri Lanka, including Asian counties have lots of problems in their minds. So no doubt, ample of them are already victims of various types of stress forms. It`s a significant fact, that the suicidal attempts in Sri Lanka, prevails at a considerably higher level [11]. So it will also be a good evidence to prove, lots of mental suffering exists.

This is the actual setting which exists in Sri Lanka, but again from the other side, we do have very limited amount of psychologists or psychiatrists. This causes for higher, patient ratio for one consultant. As per the statistics, we have about 30 psychiatrists operating is Sri Lanka, which is foremost inadequate. Also there are about 12 clinical psychologists operating across the island. So this will be a notable evidence to prove the amount of patient load per a consultant [12]. As claimed by psychologists, it`s rather difficult to identify a feasible point to commence an effective discussion with a patient, in order to pin point the actual problem. As mentioned previously as well, treating to psychological disorders are comparatively different, than treating to ordinary ailments. Hence, in a mental disorder, symptoms are mostly internal, pain is internal, and the critical fact is, all those will be expressed to the consultant via, words, gestures and postures. There `re lots of people who`re not capable enough to verbally express an idea in an unambiguous manner to an external party. Some tempt to feel shy, become tensed; hence, they will be getting a feeling as that they're going to express some personal problem of them to an unknown external person.

As a result of may be one, or many of above facts, it will not be easy to grasp the actual problem of the patient with quick small chat. As mentioned earlier, with the limited amount of consultants, lots of patients will be there. Hence amount of time to be utilized per a patient also needs to be controlled, but mostly, mental disorder related root causes are lengthy stories, which might actually require at least 30 minutes for proper understanding As a composition of all those problems, psychologists will become emotionally overloaded, via listening to numerous of stories of patients one after another.

Hence, this ICT based aiding tool will be, effectively contributing to a psychologist in managing his/her limited time effectively, to the best to their patients and, without making themselves emotionally overloaded as well. Operational advantages of this tool will be discussed in detail, under results and discussions section.

Next important section to be reviewed is the rule base, operating behind this aiding tool. Technical aspect of this will be discussed in detail, under the methodology section, but the conceptual theory behind this will be the OCEAN model. This is also known as the five factor theory.

This is a popular model, which is familiar with most of the psychologists, and mainly used for the purpose of determining the personnel temperament of a patient. Before doing treatment, it would be very much beneficial to understand the temperament of a particular patient. It would assist the consultant to choose the ideal treatment methodology. This ICT based tool will help to achieve that goal, with a limited time via integrating all dispersed information together.

Figure 2: OCEAN Model

As in above Figure 2, this is a sketch of the OCEAN model. The letters, OCEAN will stnads for 5 different personal traits of an individual. Those will be Openess, Conscientiouness, Extraversion, Agreebleness and Neuroticism, respectively [13].

A WEKA based machine learning model/s will be developed for the decision aiding purpose. Training sets for the learning model will be selected via keeping the OCEAN model as the base theorm [14].
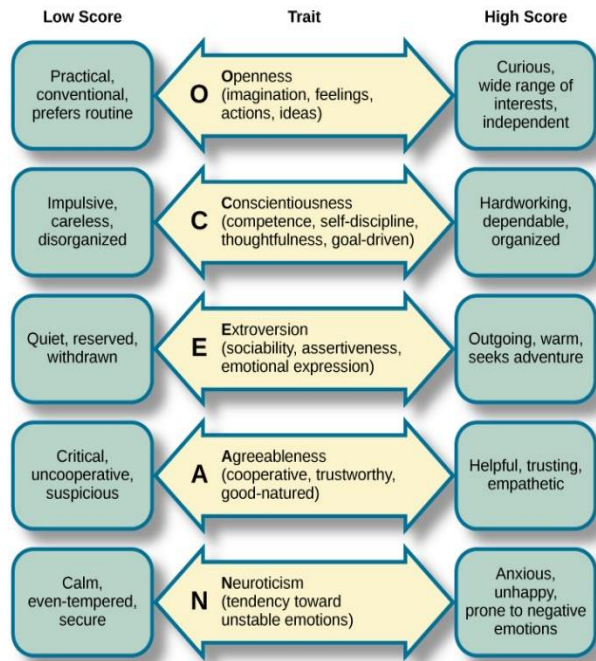
III. METHODOLOGY

As discussed in above context also, the main intension of this research is to propose an aiding tool, which can be used to ease the emotional work load of a clinical psychologists or a psychiatrist.

The first goal is to segment the inserted internal thought stream based text into behaviors, thoughts, emotions, physical reactions as well as automatic negative thoughts, which is also known as "ANTS. In achieving this goal of appropriate segmentation, Stanford NLP (Natural Language Processing) library is used. In Stanford NLP library, POS tagging (Part-Of-Speech) tagging technique is used to achieve the intended requirement.

Once user entered the internal self-talk based thought stream, it`s provided to "Maxenttagger" derived from the Stanford NLP library. It will perform the required POS tagging for the inserted thought stream.

```
run:

Reading POS tagger model from taggers/wsj-0-18-left3words-nodistsim.tagger ... done [0.3 sec].
Input: I met Sam on my way to home. I smiled with him. He ignored me. I was thinking why he did like
Output: I_PRP met_VBD Sam_NNP on_IN my_PRP$ way_NN to_TO home_NN ._. I_PRP smiled_VBD with_IN him_PRP
```

Figure 3: Use of "Maxenttagger"

Output derived after POS tagging will be as in below Figure 4.

```
MaxentTagger tagger = new MaxentTagger("taggers/wsj-0-18-left3words-nodistsim.tagger");
String sample=this.txtSelfTalk.getText();
String tagged = tagger.tagString(sample);
```

Figure 4: Output after POS-tagging

Entered thought stream will be labeled, as _PRP,_VBD, _IN and etc after pos tagging. These labels denote pronouns,prepositions, verbs of varous tenses, articles and etc. From this label based segmentation, a simple set of rules can be defined, for the seperation of thoughts, behaviors, emotions and physical reactions mainly. This rule set is defined after disucssing with a clinical psychologist. As claimed, for a behavior it`s not practical to have adjectives, models (eg:- like, should, would) and posesive pronouns. So programetically, after pos taggine, if there is an adjective, model or a preposition labels present in a sentence, there could be a higher potential, that it could not be a behavior. For emotions, again, there should not be an article, posesive pronounes, or 3rd person singular verbs. Likewise combination of rule sets are defined, based on the nature of the possible values for emotions, thoughts, behaviors, physical reactions, as well as ANTs. Identification of ANTs are much easy, hence, there could be phrases, such as "I don`t , I can`t , I`am a losser ……", which are totally negative from tone.

For proper sementation of thoughts, as per CBT, analysis should occur in a sequential order. That sequence has to be initially commenced with assesing of physical reactions, then, behaviors, emotions, ANTs and thoughts respectively. If a particular sentence captured as physical reaction, it should not be tested for belonging into other categories.
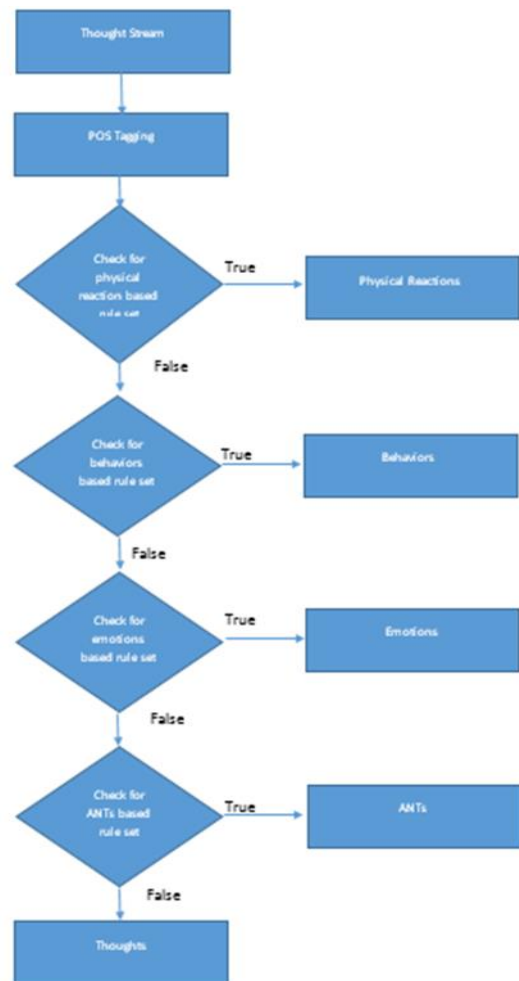

Figure 5: Logic used for the Segmentation of CBT Components

As represented in above flow chart, the decision symbols denote the pos tagged label based, restriction rule sets defined, for the separation of the thought stream. In addition to these rule sets, to improve the accuracy, acception lists and rejection lists are also introduced. Acception lists are mainly introduced for the physical reactions, and ANTs. The refined sentences from the pos-

tagged rules set will be further cross checked with a possible set of keywords. This mechanism is implemented to enhance the accuracy of the overall result. Similarly, for behaviors and emotions, rejection lists are proposed. The set of keywords to be included in these lists are captured after doing extensive amount of testing and as per the advices taken from a clinical psychologist. Once the sets of sentences are identified for the categories of the CBT, all those sentences will be inserted into five different hash maps. From those hash maps, refined information set will be used for the generation of the itext based pdf reports.

The second section of the methodology is to train the WEKA engine. This is done via user response collected via interviewing nearly 25 professionals, belonging into various occupational domains, covering engineering, lecturing, medical, construction and etc. Didn`t implement the questionnaire approach for the fact collection, hence the active involvement would have been less in that. This might adversely affect to the accuracy of the final results. Hence people are interviewed informally, via putting prior appointments with them. Contents of the interviews are mainly based on the aspects of the OCEAN model discussed above. Mostly, perceptions related with various occupational atmospheres, which they have come across was interviewed. No personnel or sensitive data are collected. Collected sets of data are analyzed via putting them into to similar categories based on the similarity of the responses provided. MS Excel based open-ended questionnaire analysis mechanism is used for this.

Subsequently, a refined set of information is provided for the analysis of a clinical psychologist. Requested to categorize them under the five components of the OCEAN model. For an example, as openness related, emotions, physical reactions, ANTs, thoughts and behaviors. Likewise, for the other remaining four sections of the OCEAN model also, same practice is implemented. Also, requested to rate the user responses provided as mild, moderate and severe. After doing this post processing with the psychologist for the collected data set, it is used for the training of the WEKA engine.

IV. RESULTS AND DISCUSSION

WEKA explorer is used, for the preparation of the training models. Initially, arff (Attribute Relation File Format) files are created for the use of the training requirements. Following is an arff file created for the training of the physical reactions.

```
@relation PhyOCEAN

@attribute PhyReactions {lazy,sleepy,inactive,
pain,stomachache,feverish,eye-strain,vomitish,
pain,crying,tears,increased-pulse,panting}
@attribute 'severity' {0,1,2}

@data

"lazy",0
"lethargic",0
"sleepy",0
"inactive",0

"not-fit",1
"no-energy",1
"sluggish",1
"fedup",1
"fatigue",1
"overloaded",1
"thirsy",1
"hungry",1

"headache",2
"stomachache",2
"eye-strain",2
"vomitish",2
"muscle-strian",2
"back-pain",2
"faintish",2
"feverish",2
"feeble",2
"chest-pain",2
"panting",2
```

Figure 6: Sample Aattribute Relation File for Physical Reactions

In here the severity attribute which is denoted as 0, 1 and 2, corresponds to mild, moderate and severe. This gauging of the user responses are done after getting initial advices from a clinical psychologist. Similar for other sections as well, separate arff files are created and separate WEKA models are created.

As a mechanism of enchasing the accuracy, 21 WEKA models are created in total. Five models for emotions, under the 5 aspects of the OCEAN model and similarly five models of each for thoughts, behaviors, as well as ANTs.

Physical reactions can be common in most cases; hence one model is created for that.

This will not cause any inefficiencies; hence, all the models are not executed at the same time. After segmentation of the thought stream into the components of the CBT, for an example, if physical reactions hash map is not, empty, via WEKA API, identified physical reactions are sent one after another from the application program to the WEKA engine, for the purpose of determination of the severity. Within this time, all other 20 models stay inactive.

For emotions, if the emotions hash map is not empty, those sentences are sent one after another, starting from Openness emotional model, up to remaining four emotional models created as per the OCEAN concept. From each model, severity levels are determined. Same practice is followed for the other sections of the CBT as well.

Hence severity levels are determined as 0,1and 2 supervised learning approach is used. Therefore used a classification mechanism, not a clustering approach.

For the classification purposes, "NaiveBayesUpdatable" classifier is used, as it derived the highest classification rate.
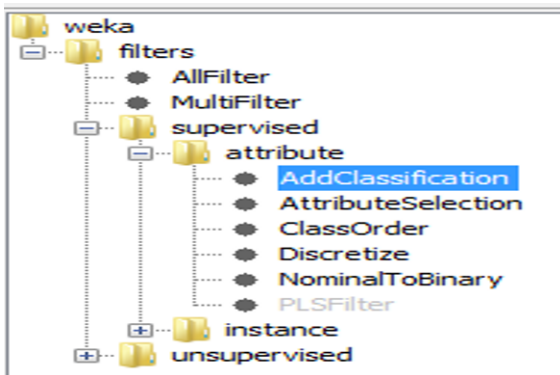

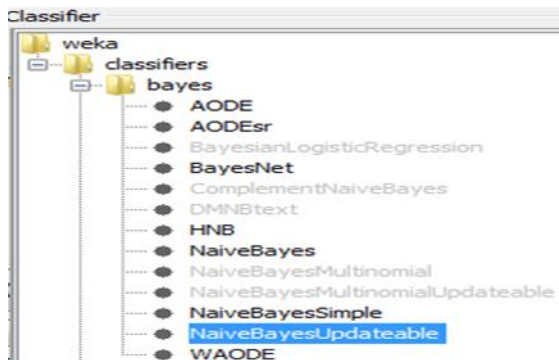**Figure 7: Supervised Learning Approach**

Figure 8: Used Classifier

As mentioned in the below figure, classification accuracy above 80% is achieved, which can be identified as a significant training outcome.

=== Evaluation on training set ===

=== Summary ===

Correctly Classified Instances	22	84.6154 %
Incorrectly Classified Instances	4	15.3846 %

Figure 9: Classification Summary

Likewise, similar approach is used in creating all the models. Once the models are ready, it`s linked with the application program created using java, with the WEKA API.

In the application, separate counters are maintained to capture the severity levels. Henceforth, following scale can be used for the determination of the overall stress impact for a particular individual.

Overall Stress	Detailed Scale
Excess	o Excess in physical reactions o Excess in emotions. o Excess in ANTs. o Excess in behaviors o Excess in thoughts
Excess	o **Moderate** in physical reactions o Excess in emotions. o Excess in ANTs. o **Moderate** in behaviors o Excess in thoughts
Excess	o **Mild** in physical reactions o Excess in emotions. o **Excess** in ANTs. o **Mild** in behaviors o Moderate in thoughts
Moderate	o **Mild** in physical reactions o Moderate in emotions. o **Moderate** in ANTs. o **Mild** in behaviors o Moderate in thoughts
Mild	o Moderate in physical reactions o Mild in emotions. o **Mild** in ANTs. o Moderate in behaviors o Mild in thoughts

Figure 10: Overall Stress Determination Scale.

Before completion, as a review of the process, initially patient enters the internal self-talk based though stream to the following interface.
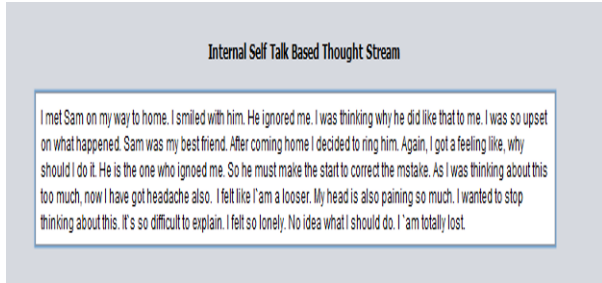

Figure 11: Interface to Capture Internal-Self Talk

Henceforth, after executing the above discussed segmentation process, with the help of the itext plugin, a report as denoted below (Figure 12) will be generated.

Figure 12: Itext Report Generated with the Processed Output of CBT

Above report will aggregate all, dispersed information of the story of the patient to one place. Along with this, OCEAN model related personal trait analysis will also be provided inform of a report with the help of the WEKA engine. With all these information, it will be much easier for the consultant to derive into a prior judgment about the mindset and the personality of the patient. This will also provide a connected, synopsis about the patients associated story. Combination of all these facts will make it easy to pin point an effective place to commence the discussion and, consultant will be starting the discussion with prior knowledge about the patient. It`s assumed, that this will lead to reduce the emotional overload of the consultant, as well as to use his/her time effectively to provide more fine-tuned treatment to the patient/client.

V. CONCLUSION

I am a strong believer of the intension, that the technological advancements must be used for the escalation of the life standards of the human beings. It`s not an arguable fact, that during past decades, technology has improved drastically. In the ICT domain also, it`s the same situation. New technologies like, GPS, RFID, RSS, Virtual Reality, Augmented Reality and so many new concepts also evolved.

Even with this enhancements, still it`s a famous comment, that ICT itself is a huge stressor. Lots of software engineers are contemplating to quit their jobs or to change the track. Most of them declare, that it`s mainly due to utmost stress associated with this job role.

Advancements in the field of networking, computer gaming, bioinformatics occur. Also those might cause to assure the materialistic quality of a life, but still, as claimed in the above literatures, there are ample of people suffering immensely, due to stress. So can`t this evolution of technology can be used to soothe the messed up mind set of an individual? People claim that computer games will solve all these problems, which is a wrong argument, because many researches have proved that, people might get addicted to gaming, and might end up in breaking their family lives as well. Kids, ruin their education.

As mentioned in the beginning also well, goal of this research is to use the advancements of ICT for consoling the mindsets of individuals. This could not be easily achieved, hence human mind is one of the utmost complex element in this universe, which cannot be understood properly and controlled as we need. Hence as discussed throughout this research, attempt is to capture the internal self-talk based thought stream, then segment them according to the CBT theory, with the use of POS tagging and finally use machine learning technique to come up with possible reasoning aspects to facilitate the cognitive assessing of the consultant.

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