INTELLIGENT SUPPORT MODEL FOR FLOOD VICTIMS

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ABSTRACT. Stress is a common psychological stimulus that occurs in a person caused by stressors. Natural disaster is a specific form of stressor that can carry wide area of implications in the population. It is the most common factors which contribute to high level of stress and other psychological problems of individuals. Therefore, intervention must be introduced to help victims who have stress during natural disasters. In order to provide an effective intervention for victims in an evacuation center, a supporting software agent could be helpful. Focusing on providing support to flood victims, this paper presents a development of an intelligent support model of victims' stress in flood disaster based on the existing computational model. The research methodology deploys four phases; identification of properties, formalization, simulation, and performance evaluation. The computational support model is tested by using simulation in two different conditions; person without therapy and person following the therapy intervention. Results suggest that the resilience level is high due to person's capability of enhancing one's problem focus coping skills rather than relying on emotional focus coping skills.

Keywords: intelligent support model, computational model, stress management, flood

INTRODUCTION

Stress is an omnipresent part of life. It is a common psychological stimulus that disturbs our physical or mental equilibrium caused by stressors. It became a popular phenomenon in modern society and took an important role in human life, either physical or mental perspective and became a growing concern in the behavioral and health sciences. It is mental or physical phenomena which are formed due to people stimulation cognitive with environment (Lazarus & Folkman, 1984). In addition, stress can be generalized as an emotional reaction to someone who gets more pressure or excessive demand (taxing its ability to fulfill the demand) (Palmer et al., 2004) and it may cause by physical or mental tension for those individuals (Kai-Wen, 2010; Yen et al., 2013).

Natural disaster is a specific form of stressor that can carry wide area of stress implications in the population, through the sense of loss and shock subsequently will impact to the emotion and psychological to the victims, both children and adults (Tuicomepee & Romano, 2012). Some natural disasters such as Hurricane Katrina caused big destruction in the New Orleans, United States. In 2010, the violence earthquake crashed coastal areas along the Bay

of Port-au-Prince and the southern coast of the island of Hispaniola in Haiti. In 2013, Typhoon Haiyan has been paralyzed some parts of Philippine regions. Recently, a 7.8 magnitude earthquake has hit Nepal which costs deaths and destruction.

Although Malaysia is safe from natural disasters such as volcanic eruptions, typhoons, and earthquake because it is located far from the Pacific Rim of Fire, it has potential to landslides, severe haze and floods. The most experienced flood in Malaysia is the monsoon flood. Continent location and sea water level are most factors of monsoon flood (Liu et al., 2005). Many findings showed that a frequent flooding in Malaysia causes a large number of psychological problems such as stress and other implications (Liu et al., 2005).

As numbers of natural disaster are increasing and the wreck is potentially devastating, intervention must be introduced to help victims who are suffering from stress. Moreover, an intelligent supports software agent should be developed to provide aid for victims' stress. Through this software agent, therapist can predict the level of victims' stress on current situations and based on the obtained results a set of suggested activities will be provided.

To date, many researchers have developed model of human behaviors and psychology into computational models in order to improve the quality of model (Both et al., 2010; Ab Aziz et al., 2011; Naze & Treur, 2012; Bosse et al., 2013; Bu & Wang, 2013). While these models are useful in formulating and identifying the fundamentals principles of human behaviour, intervention properties are yet to be incorporated. This paper highlights the development of an intelligent support model and agent systems for analysing victim's stress during one of natural disasters, which is flood. In order to develop an intelligent agent system in supporting flood victims, the underlying model concepts and mathematical notation have been studied to translate the model into programming language.

COMPUTATIONAL MODELING

Despite of skeptical views in the development stage, computational model has a number of advantages such as to formulate ideas and identify underlying assumptions with well-defined principles for manipulations purposes. It has been successfully stimulated interesting behaviors in a particular domain and offered the accuracy of the datasets pattern. Accuracy of data can be achieved when verification process of original model properties and behavior of the system in the implementation phase are correct and using a complete test set (Stamatopoulou et al., 2012). Therefore, for this work it needs a specific computational model with appropriate properties factors that related directly or indirectly to victim's stress during natural disaster.

A computational model for victim's stress during natural disaster is adopted from Ab Aziz et al. (2014) as shown in Figure 1. This model has been constructed based on past literatures and empirical evidences that will be used as a baseline to develop intended support model. However, this model does not address the integration of interventions such as Cognitive Behavioral Therapy (CBT) (Hrouda, 2004; Purves, 2007; Both et. al., 2010; Lumley, 2011; Yen et al., 2013) Critical Incident Stress Debriefing (CISD) (Mitchell & Everly, 1996; Wei et al., 2010), and Mindfulness Based Therapy (MBT) (Kumar et al., 2008; Segal et. al., 2012; Ruths et al., 2013), knowing information about these therapies is extremely needed to give effective support for the victims, by using intelligent software agent.

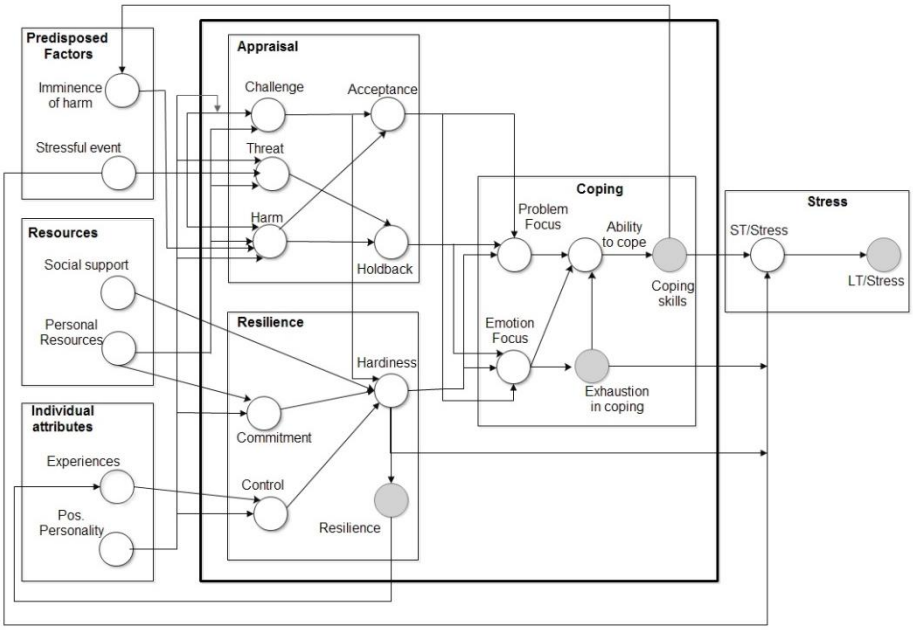

Figure 1. Conceptual Model of Flood Victims' Stress

In this model, there are three relevant categories of local dynamic properties relationships; External Relationship, Temporal Relationship, and Instantaneous Relationship. The External Relationship is a value that comes from the environment. It involves *Imminence of harm*, *Stressful Event*, *Social Support*, *Personal Resources*, *Experiences*, and *Positive personality*. Some of temporal and instantaneous factors are changeable because these two kinds of elements will be influenced by intervention therapies.

Temporal Relationship represents a cumulative value of dynamical properties. These include *Coping Skills*, *Exhaustion in Coping*, *Resilience*, and *Long term Stress*. Meanwhile, an Instantaneous Relationship is contrary from the temporal relationship; it cannot be accumulated but contains only immediate values. In this model, those instantaneous relationship attributes are *Challenge*, *Threat*, *Harm*, *Control*, *Commitment*, *Acceptance*, *Holdback*, *Hardiness*, *Short term stress*, *Problem focus*, *Emotional focus*, *Ability to cope*, and *Normal level of experiences*.

METHODOLOGY

There are four main phases involved in developing the model as illustrated in Figure 2.

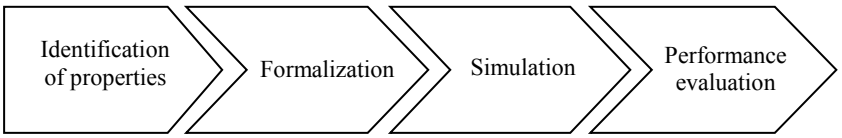

Figure 2. Research methodology

Identification of properties: In this phase, details on intervention properties from Cognitive Behavior Therapy (CBT) theories are covered. It involves some aspects in coping and appraisal skills with a number of important properties to be integrated with the model. Many researchers have applied CBT for treating many mental health disorders such as stress (Lumley, 2011; Fletcher et al., 2011), anxiety (Yen et al., 2013), addictions (Tkachuk et al., 2003), and many chronic pains (Barron, 2009). CBT has arisen as an empirically supported treatment

options by targeting symptom reduction and enhanced daily functioning. CBT is also effective and adaptable to implement in mobile platform (Fletcher et al., 2011).

An improved model which comprises of four new properties is illustrated in Figure 3. The new properties are; *Reflection (Rf)*, *Intervention (Iv)*, *Openness for intervention (Op)*, and *Openness for CBT (Oc)*. There are also two new dynamic properties have been influenced by the intervention therapies which are *Acceptance (Ac)* and *Holdback (Hb)*.

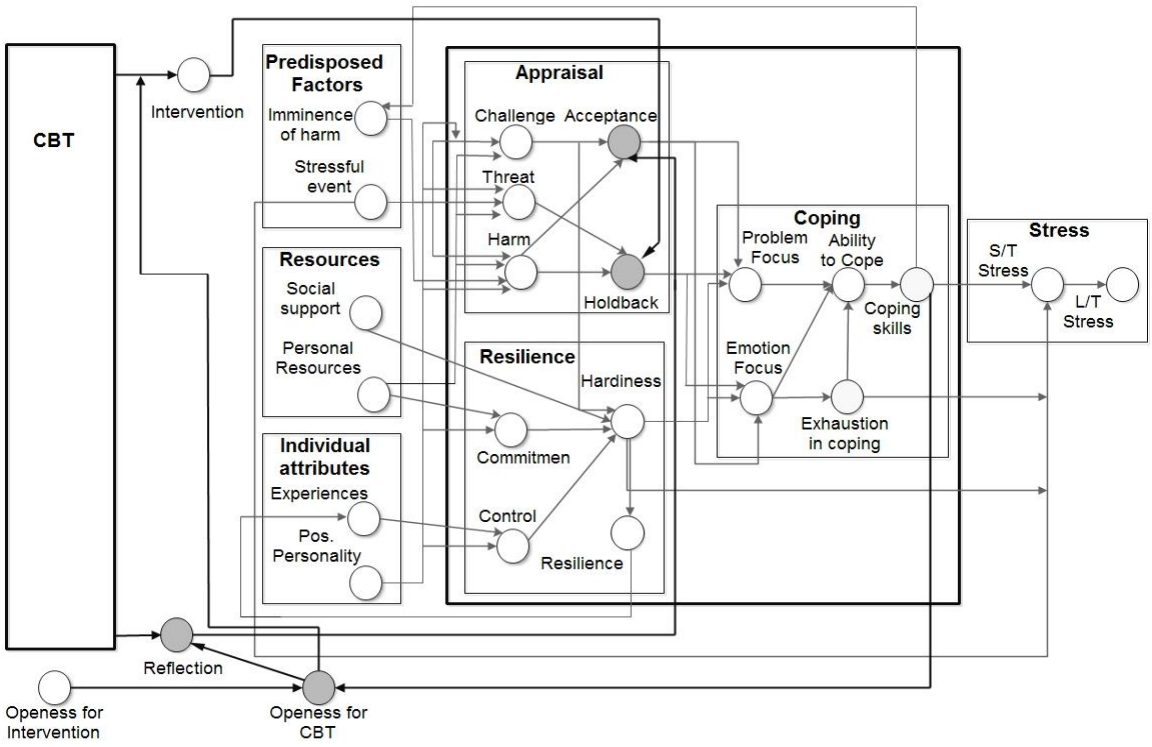

Figure 3. Support Model for Cognitive Behavioral Therapy (CBT)

Formalization: A formal model has been formulated based on the fundamental of mechanism acquired from phase I. This formal model represents CBT intervention process in victims stress during flood disasters.

Differential equation technique was used to show the formalization of dynamic properties. The states are related, as connected by the arrows. These connections have been modeled mathematically. First state to deliberate is *Acceptance (Ap)*. *Acceptance (Ap)* is determined by *Challenge (Ch)* and *Harm (Hm)*. In addition, direct intervention of *Reflection (Rf)* combine with *Openness for CBT (Oc)* will increase the value of *Acceptance* and change the value for *Problem focus (Pf)* and *Emotion focus (Ef)*.

The *Reflection (Rf)* will be determined as:

$$Rf\,(t+\Delta t) = Rf(t) + \beta_r.[Oc(t) - Rf(t)].\Delta t \qquad \textbf{(1)}$$

Openness for CBT (Oc) will be calculated as:

$$Oc\,(t+\Delta t) = Oc(t) + \phi_c\,[Cs(t) - Oc(t)].Op(t).\Delta t \qquad \textbf{(2)}$$

Therefore, a new value of *Acceptance (Ac)* will be calculated as:

$$Ap^{*}(t) = Ch(t).[(1 - [(1 - Rf(t)).Oc(t).Hm(t)])] \quad \textbf{(3)}$$

Furthermore, the values for *Holdback (Hb)* influence by the *Harm (Hm)* and *Threat (Th)*. The *Interventions (Iv)* in combination with *Openness for x (Oc)* and *Openness for intervention (Op)* was taken a place to new values of *Holdback (Hb)*, which is calculated as follows:

$$Hb^{*}(t) = [\mu\, hb.Th(t) + (1-\mu hb).Hm(t)].(1- Iv(t).Oc(t)) \quad \textbf{(4)}$$

Finally, those interventions of therapy play roles in *Acceptance (Ac)* and *Holdback (Hb)*. More over *Short term stress (Ss)* and *Long term stress (Ls)* equation after intervention with therapy will still remain as follows:

$$Ss(t) = \rho ss\,[Se(t).(1- Cs(t))] + (1-\rho ss).[Ex(t).(1- Hd(t))] \quad \textbf{(5)}$$

$$Ls(t+\Delta t) = Ls(t) + \zeta\, ls.(1-Ls(t)).[Ss(t)-Ls(t)].Ls(t).\Delta t \quad \textbf{(6)}$$

Note that the change process is measured in a time interval between t and $t+\Delta t$. In addition, the rate of change for all temporal specifications is determined by flexibility rates ϕ_c and β_r.

Simulation: the computational support model was simulated using Matlab in order to generate simulation traces. This study used simulation instead of conducting experiment in a real situation due to duration of the experiment in real time is impracticable. Simulation of computational model offers process insight in the series of events over time in details. Simulation used the same condition of high level of stress but has two different scenarios; person without therapy and another one is person following the selected therapy as an intervention.

RESULTS AND VERIFICATION

The initial values run into simulation software and obtained result of pre and post CBT as shown in Figure 4. The level of victims stress without therapy shown from time steps 0 to 250 and victims stress with CBT shown from time steps 251 to 500. These time steps are represented within a week.

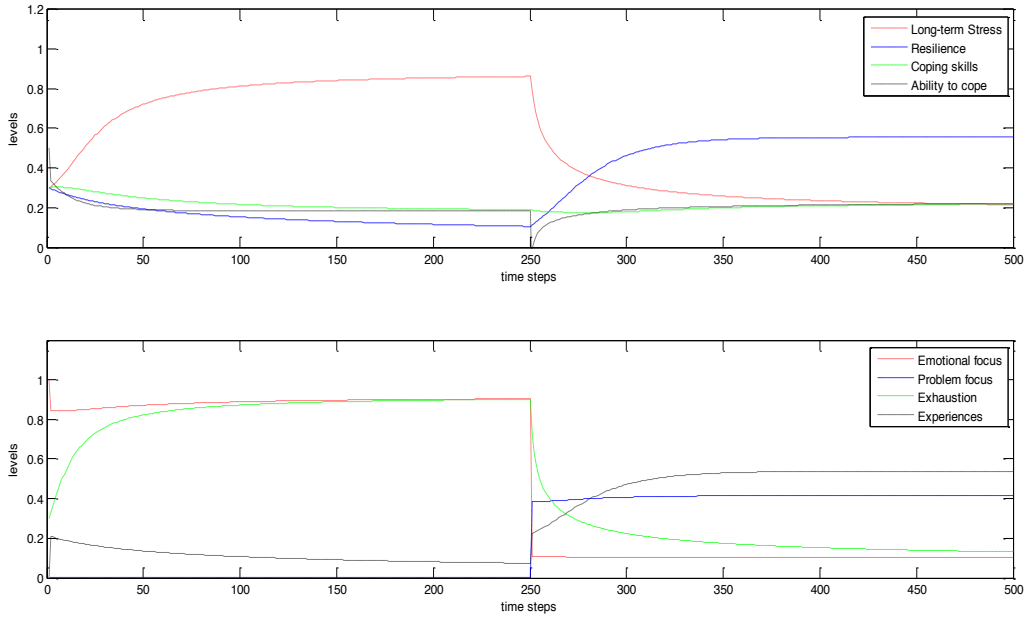

Figure 4. Simulated Results (Pre and Post CBT)

Based on Figure 4, x axis represents the time steps is initialized in [0, 500] interval values and *y* axis is levels in [0, 1] interval values. The level of victims stress without therapy is shown from time steps 0 to 250, which increased gradually. This is happened when the presence of negative factors is higher than positive factors. For example, the high level of exhaustion (i.e; unhappy with the results), is resulted from the outcomes of individuals when using the emotional focus coping rather than problem focus coping. Later, it reflects the low level of victim's resilience and experiences facing the difficulties to cope with stressful event.

However, level of victim's stress when following CBT programmes (shown in time steps 251 to 500) is decreasing slowly. This condition shows an effect that the resilience level is going up due to the victim's capability to enhance his/ her problem focus coping skills rather than relying only to the emotional focus coping approach. This means a positive individual reflections is pulling negative factors on the exhaustion and emotional focus. The openness of individuals towards the CBT programmes has made them more rational to face the stressful event and affect to the improvement of individuals' experience levels.

CONCLUSION

A computational support model has been extended from the one developed by Ab Aziz et al. (2014). It is structured sequentially based on physiology and cognitive theories. The mobile intelligent support system is designed form combination of integration existing model and supporting model. This intelligent support system has been developed in android operating system with XML code and JAVA code. The results of an intelligent agent system are expected to be helpful for individual and society in general. This study provides a working mechanic process to simulate various conditions during real situations. Furthermore, the computational support model may serves as a foundation to be used in an intelligent software agent that can determine activities intervention based on the victim's personality. Moreover, by implementing this support model into intelligent software agent in evacuation center, it is expected to be helpful in reducing victim's stress. In addition, officers and volunteers of flood evacuation centers would have a better understanding with internal and external processes of victims' stress by the mean of simulation process deduced from the proposed intelligent software agent.

In order to develop computational support model, this study only focuses on Cognitive Behavioral Therapy (CBT). Future works should explore on using the Mindfulness Based Therapy (MBT), Critical Incident Stress Debriefing (CISD) and other psychological therapies to make a comparison of effectiveness interventions therapy. This computational supporting model can be further explored and implemented into another type of intelligent software system such as in virtual avatar and the intervention activities based on the victim's personality.

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