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Research paper

Ambient Agent Model for Supporting Volunteers during Stress

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Abstract

Stress during natural disaster has been reported everywhere. 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 within the population. It is the most common factor which contributes to high level of stress and other psychological problems of individuals. This article proposed an ambient agent model to support volunteers who experienced stress during flooding event. Set of properties and variables are identified through past literatures and series of interview to construct the model. A number of well-known relations between events and the courses of stress are summarized and it is shown that the model exhibits their patterns. Differential equations have been used in formalizing the model. Set of equations reflecting relations involved in the proposed model are presented. From the developed models, a variety of simulation experiments was conducted. The proposed model is essential and can be encapsulated within an intelligent agent or robots that can be used to support volunteers who experienced stress during flood.

Keywords: Ambient agent model, computational modeling, stress management, flood

1. Introduction

Natural disaster is a specific form of stressor that brought various implications in the population through the sense of loss and shock which will subsequently affect the emotion and psychological of the victims;both children and adults [1].In Malaysia, the most devastating natural disaster is flood. Malaysia often experienced serious flooding,resulting negative impact particularly on the economy and the society. This prompted the government to take proactive measures in facing the disaster, such as the establishment of supervisory bodies, implementation of flood mitigation programs especially in high-risk river, implementing non-structural measures with establishment of weather and flood forecasting center and early warning systems. However, most importantly is for the government to provide thousands of competent and trained volunteers to face the demanding situations and deal with the victims either at the scene or at the evacuation or disaster relief centers. It is also crucial to ensure a more systematic and structured disaster management.
As published in The Star in 2011, there are 5,156 flood evacuation centers (EC) across the country which are managed by the Department of Social Welfare (*JabatanKebajikanMasyarakat*) and monitored by National Security Council which can accommodate up to 1.4 million people and having 28,000 disaster relief personnel from various agencies as well as 12,500 volunteers from NGOs at bay.

Being a volunteer requires a strong mental strength and high skills in coping with unexpected and desperate, demanding situations. It is common for volunteers to face extreme situations without adequate rest, heavy workload, lack of support from peers or the organization. Moreover, they have to deal with victims' negative psychological, physical and behavioral reactions due to loss and destructions of properties and life. Without a proper preparation and training to equipped the volunteers with knowledge and skills to cope with stress, anxiety as well as other psychological problems; this situation could lead towards negative emotional affects to those volunteers such as stress, frustration, extreme anxiety and physical condition suffering such as chronic fatigue. All these affects if not handled properly can cause long-term stress.
Most of the literatures on occupational stress emphasize its effect on human health either physically or mentally (for example, see [2] and [3]. Therefore, job stress-related to relief personnel can be considered as a silent killer as theymusthelp the victims to undergo stressful situation while battling their own stress.
Department of Social Welfare with supports from numbers of governmental and non-governmental agencies has been responsible for managing evacuation centers. Often, the responsibilities will be carried out by officers and volunteers, regardless of either they are trained or not. Although immediate actions have been taken by the authorities in managing the victims at the evacuation centers, they still fall short due to the flux of victims. Often, big numbers of victim caused problems that are difficult to resolve such as lack of supply, short of rescue equipment, not enough fundingto fulfill the long stays at the evacuation centers or lack of support from team

members as well as difficulties to get accessto the disaster area. This causes all the parties involved especially the volunteers to bestressful and depressed.

Furthermore, there are difficulties in making accurate and timely decisions despite having clear instructions on how to act due to combination of factors, including time pressures and heavy emotions. Besides that, factors such as lack of skills by volunteers, lack of peer support and exposure to severe environments operating area or various vagaries of the victim also added to the burden. According toZimbardo and colleagues[4], stress can be caused by interrupted events in work or social environment and also in life routine involving job, family and social life. The events of varying pressure can range from volunteers with time limitation and necessitate adjustments to situations of chronicle stress events that require ongoing and long-term adaptability. When the volunteers assume an imbalance between personal resources and demands, it can cause possible reactions namely physiological responses (e.g. hypertension and increased heart rate), mental responses (e.g. decrease in concentration and confused mind), emotional responses (e.g. anxiousness, irritability and frustration,) and behavioral reactions (e.g. crying and weeping or aggressive and impulse behavior). Unstable or distracted emotions, stress or physical illness among volunteers often caused volunteers to be mentally unprepared and unable to handle the situation effectively, hence resultedin poor rescue operations and EC management.

This paper discusses an ambient agent model to support volunteers who experienced stress during flood. Section two discusses computational modeling in general followed by the methodology used. The concept and formalization will be explained in section four. The simulation results are covered in section five and the paper ends with a concluding remark in section six.

2 Computational models

Computational modeling or known as a mathematical model is used to simulate a set of processes observed in the natural world in order to gain an understanding of these processes and to predict the yield of natural processes given a specific set of input parameters. It is intended to mimic some essential features of the studied system while leaving inessentials and review the differences in the experimental results. Operational theories of the model can be obtained or inferred from these computational experiments. Computational model are invaluable because it allows scientists to investigate the detailed relationships that cannot be solved by purely experimental methods, and to make estimate that cannot be made easily by extrapolating the available data. This model provides a mean of risk-free exploration in complex, critical, costly, time-consuming, or rare situations.

On the other hand, ambient agent may provide the way to support people in demanding tasks. In realizing these potentials, it is useful if such agent system has some awareness on how human task runswith the special awareness enabling continuous support by the ambient agent system. It is often used in environments that are highly dynamic in nature. Therefore, in many applications of agent systems, it is different from robotic contexts to virtual world contexts whereas some form of world model plays a significant role; e.g., environmental phenomena, military conflicts, intelligent support for unipolar depression patients, disease, electronic learning and criminology [5].

Normally, in such applications; a world model is represented using various types of inputs and updated with some frequency. One of the challenges for ambient intelligent agent is the need to obtain information about a human progress which could be done by analyzing the workflow model and empirical information. Example of challenges addressed are: (i) organization ofcollected data and processed signals from different types of sensor, (ii) production of local and global world models using the multi-sensor information of the environment, and (iii) integration of information from the various sensors into a continuous updated model. Coupled with the virtual training simulation concept, these software agents will be able to understand human ability hence provide detailed analysis pertaining to the particular situations.

3 Human Agent Support Model

Modelling the human support agent involved four main phases which include theoretical study, requirement gathering, development of human agent-based model and model evaluation.

Theoretical study: a conceptualframework has been constructed based on content analysis fromextensive literature review and data collected from a series of interview with domain experts (clinical psychologist and JabatanKebajikanMasyarakat officers). The demographics factors, external stressors and the personality type (as independent variables) and their relationship to the level of occupational stress among volunteer during highly-demanding situation have been thoroughly studied. External stressors which focused on the seven major potential causes of stress at work as perceived by the employees namely work overload, the nature of the job, time management, work under load, relationship, feeling of inadequacy and reward system were identified and adjusted based on Baskaran [6].

Requirement gathering:requirements of an EC virtual environment and an ambient-agent model were gathered. Requirement analysis and depth interviewing with domain experts were used in defining both requirements and information from the relevant organization has been used to identify and validate these problems.

Development of human agent-based model:based on the identified requirements and important attributes of stress, the human agent-based model was designed and developed. Those interrelated ideas were encapsulated to simulate the how fragile is a person towards stressors, and the possibility towards development of a chronic stress condition. In this model, there are seven major components representing dynamic interactions of human agent abilities involved in recurrence namely; *personal attribute, condition and care, task, reward, focus and energy, strain and burnout, and motivation and reward.* By combining these characteristics together, it allows a hypothesis or expected behavior for the human agent to be monitored. The concepts are encapsulated in Figure 1.

Model Evaluation: the proposed model was evaluated via simulation results in two main scenarios:(i) volunteerswith high risk of stress and (ii) volunteers with low risk of stress. Evaluation results will be explained further in Section 5.

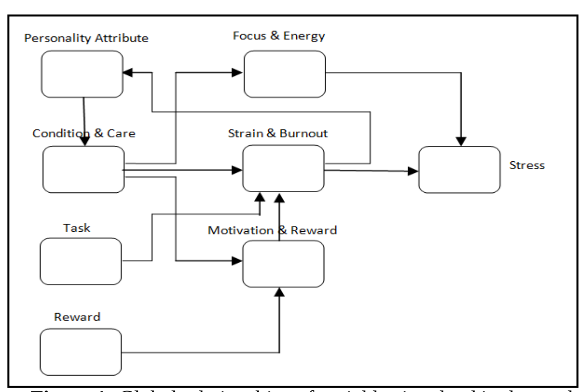

Figure 1: Global relationships of variables involved in the model.

Main step in the development of a model to represent potential stress level during highly-demanding situation is to understand how this condition may occur by describing several theoretical concepts. The model has number of factors. First, the personal attributes such as *performance personality*, *individual skills*, and *adequate rests* are often related to reported cases in stress inoculation training [7]. Human performance under stress condition depends on multiple factors related to the individual performer and to specific attributes of the situation in which they must perform [8]. Performance personality and individual skill are two factors that are closely related to each other, whereby individual with good personality and high skills usually focus more on the job hence resulting a better performance [9]. *Focus* is also important in fulfilling job demands. In many cases, focus plays significant role when facing critical situations. Loss of concentration can have an adverse effect on the individual or their related tasks[10]. However, effects of stress on human performance in general and on cognition in particular can be very difficult to predict at individual level. Inadequate rest from multi-tasking for a long period can caused an individual to become less focus due to debilitation hence leading towards short-terms stress [11]. It should also be noted that *Energy levels* will increase with adequate rest. Furthermore, *quality of victims'care*, ability to cope with victims' anxiety and the level of volunteer composure are among the important factors in determining the satisfaction in completing the given tasks or the services provided. All these reactions towards human performance factors will tend to produce additional condition known as cognitive effectiveness [12].

Additionally, *Physical environment* and *assign task* could influence *job demands* [13, 14] . Severe physical environment could become circumstances beyond individual control which can seriously affect work performance. When the job demands cannot be achieved as expected, it will cause*job strain* hence lead towards *burnout syndrome*. Bakker and colleagues [15] suggest that every job has its own specific risk factors associated with job stress and these factors can be classified in two general categories namely job demands and job resources; constituting an overarching model that may be applied to various occupational settings irrespective of the particular demands and resources involved.

Other factors that will lead towards job strain are*time pressure*, *lack of job support* and *job satisfaction*[16, 17]. The time pressure to complete an assigned work within the stipulated time job will cause some strain. It goes up when the job was not unable to be completed on time and at the same time, other job increases. Lack of support from peers or supervisor can also cause job strain [18] that lead towards unsatisfactory job achievement. And conversely, getting full support from peers and supervisor can increase employee motivation. Another motivating factor is *reward*ing the employee for their effort, idea and improvements[19]. When the characteristics of job strain is known but not addressed properly, this will lead to the occurrence of either mental or physical exhaustion and will exacerbate the risk of chronic *stress*. Critical *exhaustion* and long-term stress will increase normal depression that reduce focus on work, and later increase the risk of burnout syndrome[20]. Figure 2 shows the detailed interactions within human agent-based model for volunteers' stress.

4. Concepts and Formalization

Once the structural relationships in the model have been determined as discussed in the previous sections, the model was formalized into instantaneous and temporal relationships. In the formalization, all nodes were designed in a way to have values ranging from 0 (low) to 1 (high). This model involves a number of instantaneous and temporal relations.

4.1 instantaneous Relations

The instantaneous relations were derived based on several formula, such as; focus (*Fc*), energy level (*Ey*), job demands (*Jd*), adequate rest (*Ar*), job control (*Jc*), job satisfaction (*Jf*), motivation (*Mv*), job strain (*Jg*), short-term exhaustion (*Sx*), and burnout (*Bn*). These relations were formulated as follows: Focus (*Fc*) on the job will increase while a human have good performance personality (*Pf*), skillful (individual skills,(*Is*)), job satisfaction (*Jf*) and adequate rest (*Ar*), otherwise will later influence the burnout.

$$Fc(t) = [w_{f1}.Pf(t) + w_{f2}.Is(t) + w_{f3}.Jf(t) + w_{f4}.Ar(t)] - \gamma_f.Bn(t) \quad \textbf{(1)}$$

$$Ey(t) = \alpha_e.\ Ar(t) + (1-\alpha_e).[w_{e1}.\ Is(t) + w_{e2}.Jf(t)] \quad \textbf{(2)}$$

$$Jd(t)=[w_{j1}.\ Pe(t) + w_{j2}.\ As(t) + w_{j3}.Tp(t)]- \partial_j.[\beta_j.Jc(t) + (1-\beta_j).Fc(t)] \quad \textbf{(3)}$$

$$Jc(t) = \gamma_j.Pf(t) + (1-\gamma_j).Is(t) \quad \textbf{(4)}$$

$$Jf(t) = Qv(t).Js(t) \quad \textbf{(5)}$$

Energy level (*Ey*) is influenced by individual skill (*Is*), adequate rest (*Ar*) and job satisfaction. The stated job demands (*Jd*) is used to express what a person feels when facing uncomfortable environment (physical environment,(*Pe*)), fulfill assign task (*As*), pursued by time pressure (*Tp*), more focus (*Fc*) and unable to prioritize job control (*Jc*). Job control depends on the interaction between performance personality and individual skills whereas job satisfaction (*Jf*) covers on the connection between quality of victims care (*Qv*) and job support (*Js*).

$$Mv(t) = w_{m1}.Js(t) + w_{m2}.Jf(t) + w_{m3}.Rw(t) \quad \textbf{(6)}$$

$$Jn(t) = Jd(t).[1- (\eta_j.Jf(t) + (1-\eta_j).Mv(t)] \quad \textbf{(7)}$$

$$Bn(t) = w_{b1}.Lx(t) + w_{b2}.Jn(t) + w_{b3}.Ls(t) \quad \textbf{(8)}$$

$$Sx(t) = \varphi_e.Ly(t) + (1-\varphi_e.Jn(t)) \quad \textbf{(9)}$$

$$Ss(t) = (1-Ey(t)).Sx(t) \quad \textbf{(10)}$$

Other important condition being considered is motivation (*Mv*) that relates to the job satisfaction, job support and reward (*Rw*). The combination of job demands, job satisfaction and motivation will lead to job strain (*Jn*) hence influence burnout (*Bn*); added with long-term exhaustion (*Lx*) and long-term stress (*Ls*) condition. The effect on short-term exhaustion (*Sx*) is determined by a combination between job strain and long-term energy level (*Ly*). The interaction between energy level and short-term exhaustion determines the level of short-term stress (*Ss*). For all instantaneous relations, parametersw_{f1}, w_{f2}, w_{f3}, w_{f4}, γ_f, α_e, w_{e1}, w_{e2}, w_{j1}, w_{j2}, w_{j3}, ∂_j, β_j, γ_j, w_{m1}, w_{m2}, w_{m3}, η_j, w_{b1}, w_{b2}, w_{b3} andφ_e provide a proportional contribution in respective relations.

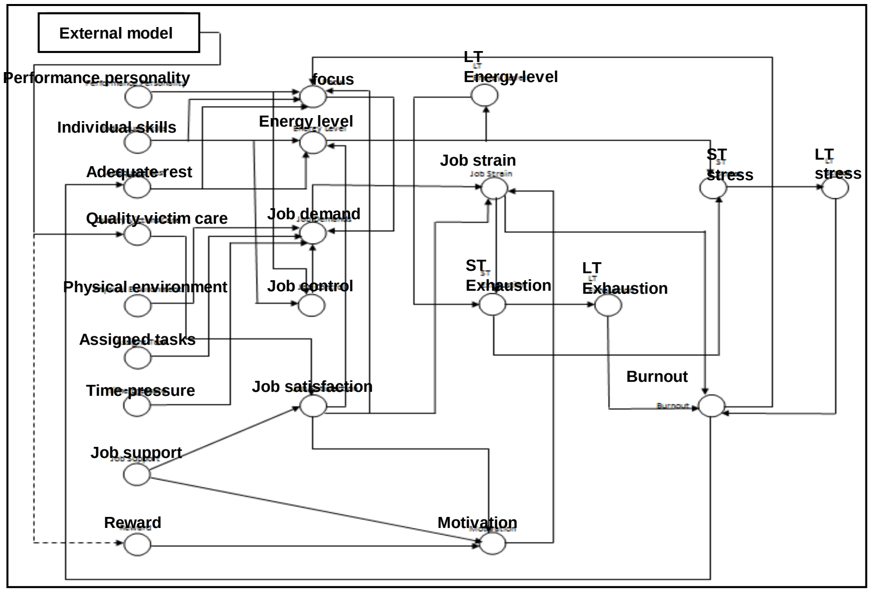

Figure 2:. The Interactions of Human Agent-Based Model for Volunteer Stress.

4.2 Temporal relations

Long-term energy level (*Ly*) primarily contributes the accumulation exposure towards short term energy level, while the accumulated short-term exhaustion produces long-term exhaustion (*Lx*). And the final relation is long-term stress (*Ls*) that contributesto the accumulation of exposure towards short-term stress.

$$Ly(t+\Delta t) = Ly(t) + \lambda_y[Ey(t)-Ly(t)].\ \Delta t \quad \textbf{(11)}$$

$$Lx(t+\Delta t) = Lx(t) + \phi_e.[Ex(t)-Lx(t)].\ \Delta t \quad \textbf{(12)}$$

$$Ls(t+\Delta t) = Ls(t) + \eta_s.[Ss(t)-Ls(t)].\ \Delta t \quad \textbf{(13)}$$

In the calculation of long-term energy level, exhaustion and stress, a continuous logistic function was used. The change process was measured in a time interval between t +Δt. The rates of changes for all temporal specifications were determined by flexibility rates λ_y, ϕ_e andη_s.

5. Simulation Results

Once the stress conditionshave been determined using the formula, simulations traceswere performed using Matlab software. Some patterns on human attributes have been explored with several personality factors and some similaritieswere found. This paper discussesresults of the simulation runs based on possible persons:(i) individual with high risk of stress and (ii) individual with low risk of stress. The results of the simulations are shown in Figure 3 and 4.
Figure 3 shows the variable of individuals with high risk of stress. In the first half of the simulation trace, the effect on the Long-term stress (*Ls*) was determined by decreased of job satisfaction (*Jf*) and tend to be stable on motivation (M*v*). In addition, long-term exhaustion (*Lx*) can be seen to increase rapidly after long-term energy (*Ly*) level was performed.

In other case showed in Figure 4, an individual with high motivation lead higher than long-term stress while job satisfaction was moderate. Another result from this simulation trace showed that long-term exhaustion is lower than long-term energy level found in stress condition. The simulation traces also show that volunteers with a positive personality (high motivation and skill), high job satisfaction, and capable to manage and cope demanding situation are less stress compared to those who are not.

6. Conclusion

This paper presented a human agent-based model for supporting volunteers during flood. This model has been simulated to investigate the effect of different level of volunteer's stress in facing demanding situation. The mathematical analysis from the simulation traces give evidence for the appropriateness of the model. The proposed model provides an underlying principle towards the development of a software agent to support volunteers hence promote a better theoretical understanding and recognition of the complexities and effect of occupational stress due to physically and mentally challenging tasks. Future work of this model could focus on formulating effective therapies related to the occupational stress model. This computational support model can be further explored and implemented into another type of intelligent software system for example, in a virtual avatar and intervention activities based on the volunteers' personality. In addition it could also assist other researcher in formulating other effective occupational stress model to help volunteers in coping stressful events.

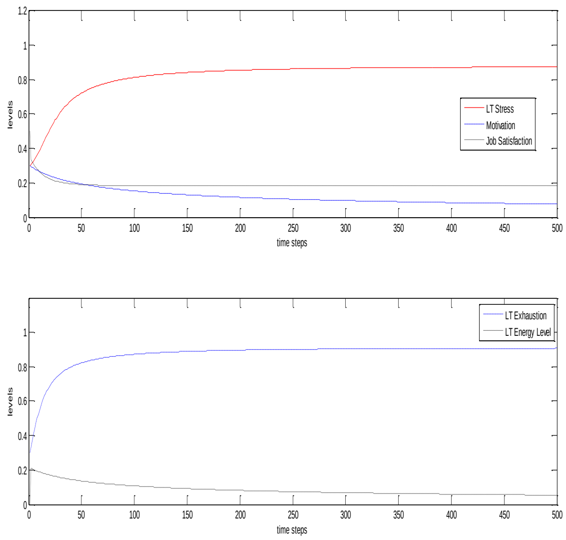

Figure 3: Case #1: Individuals with High Risk of Stress

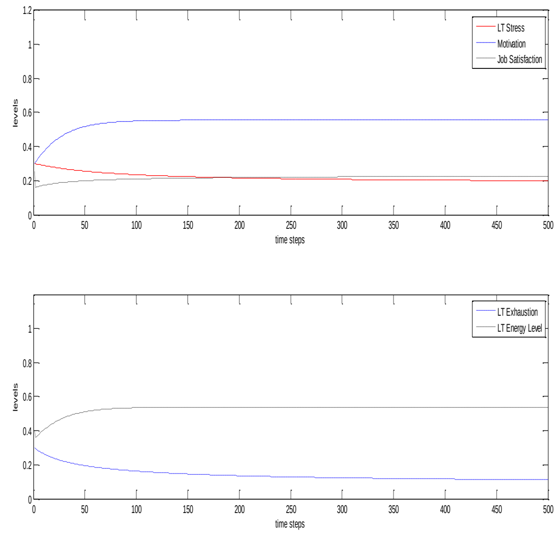

Figure 4: Case #2: Individuals with Low Risk of Stress

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References

[1] Tuicomepee, A., & Romano, J. L. 2012. Children and adolescents in natural disasters: psychological implications for Thai youth affected by the 2004 tsunami. วารสารสุขภาพจิตแห่งประเทศไทย, 14(2), 134-141.

[2] Saunders, T., Driskell, J. E., Johnston, J. H., & Salas, E. 1996. The effect of stress inoculation training on anxiety and performance. Journal of occupational health psychology, 1(2), 170.

[3] Noblet, A., & LaMontagne, A. D. 2006. The role of workplace health promotion in addressing job stress. Health promotion international, 21(4), 346-353.

[4] Zimbardo, P.G., et al.2006. Psychology: core concepts.

[5] Ab Aziz, A., Treur, J., & Van Der Wal, C. N., 2011. An agent-based model for integrated contagion and regulation of negative mood. In Agents in Principle, Agents in Practice, 83-96. Springer Berlin Heidelberg

[6] Baskaran, S. 2004. A Study On Occupational Stress Experienced By Lecturers Of The Higher Learning Institutions. Universiti Utara Malaysia

[7] Meichenbaum, D. 2007. Stress inoculation training: A preventative and treatment approach. Principles and practice of stress management. 3: p. 497-518.

[8] Bourne, L.E. & Yaroush R.A. 2003.Stress and cognition: A cognitive psychological perspective. Unpublished manuscript, NASA grant NAG2-1561.

[9] Chatman, J.A., Caldwell D.F.& O'Reilly C.A. 1999.Managerial personality and performance: A semi-idiographic approach. Journal of Research in Personality, 33(4): p. 514-545.

[10] Hajek, A. 2013.Life satisfaction and unemployment: The role of voluntariness and job prospects. SOEPpapers on Multidisciplinary Panel Data Research.

[11] Lane, A.M. & Terry P.C. 2000.The nature of mood: Development of a conceptual model with a focus on depression. Journal of Applied Sport Psychology, 12(1): p. 16-33.

[12] Carroll, J.B. 1993.Human cognitive abilities: A survey of factor-analytic studies. Cambridge University Press.

[13] Ford, J.K., et al. 1992.Factors affecting the opportunity to perform trained tasks on the job. Personnel psychology, 45(3): p. 511-527.

[14] Vischer, J.C. 2007. The effects of the physical environment on job performance: towards a theoretical model of workspace stress. Stress and Health, 23(3): p. 175-184.

[15] Bakker, A.B., et al. 2003.Job demands and job resources as predictors of absence duration and frequency. Journal of Vocational Behavior, 62(2): p. 341-356.

[16] Brewer, E. &McMaha-Landers J. 2003.The Relationship Between Job Stress and Job Satisfaction of Industrial and Technical Teacher Educators.

[17] Brewer, E.W. & Shapard L. 2004.Employee burnout: A meta-analysis of the relationship between age or years of experience. Human Resource Development Review, 3(2): p. 102-123.

[18] Bickford, M. 2005. Stress in the Workplace: A General Overview of the Causes, the Effects, and the Solutions. Canadian Mental Health Association Newfoundland and Labrador Division, p. 1-3.

[19] Kotter, J.P. 1995.Leading change: Why transformation efforts fail. Harvard business review, 73(2): p. 59-67.

[20] Adams, R.E., Boscarino J.A. &Figley C.R. 2006. Compassion fatigue and psychological distress among social workers: A validation study. American Journal of Orthopsychiatry, 76(1): p. 103-108.