The copyright © of this thesis belongs to its rightful author and/or other copyright owner. Copies can be accessed and downloaded for non-commercial or learning purposes without any charge and permission. The thesis cannot be reproduced or quoted as a whole without the permission from its rightful owner. No alteration or changes in format is allowed without permission from its rightful owner.

# COMPUTATIONAL DYNAMIC SUPPORT MODEL FOR SOCIAL SUPPORT ASSIGNMENTS AROUND STRESSED INDIVIDUALS AMONG GRADUATE STUDENTS

ROQIA RATEB AL-SHORMAN

Universiti Utara Malaysia

DOCTOR OF PHILOSOPHY
UNIVERSITI UTARA MALAYSIA
2020

Awang Had Salleh
Graduate School
of Arts And Sciences

Universiti Utara Malaysia

**PERAKUAN KERJA TESIS / DISERTASI**
*(Certification of thesis / dissertation)*

Kami, yang bertandatangan, memperakukan bahawa
*(We, the undersigned, certify that)*

**ROQIA RATEB MOHAMMAD AL-SHORMAN**

calon untuk Ijazah **PhD**
*(candidate for the degree of)*

telah mengemukakan tesis / disertasi yang bertajuk:
*(has presented his/her thesis / dissertation of the following title):*

**"COMPUTATIONAL DYNAMIC SUPPORT MODEL FOR SOCIAL SUPPORT ASSIGNMENTS AROUND STRESSED INDIVIDUALS AMONG GRADUATE STUDENTS"**

seperti yang tercatat di muka surat tajuk dan kulit tesis / disertasi.
*(as it appears on the title page and front cover of the thesis / dissertation).*

Universiti Utara Malaysia

Bahawa tesis/disertasi tersebut boleh diterima dari segi bentuk serta kandungan dan meliputi bidang ilmu dengan memuaskan, sebagaimana yang ditunjukkan oleh calon dalam ujian lisan yang diadakan pada : ***28 January 2020.***
*That the said thesis/dissertation is acceptable in form and content and displays a satisfactory knowledge of the field of study as demonstrated by the candidate through an oral examination held on:*
***January 28, 2020.***

| | | |
|---|---|---|
| Pengerusi Viva: *(Chairman for VIVA)* | **Assoc. Prof. Dr. Yuhanis Yusof** | Tandatangan *(Signature)* |
| Pemeriksa Luar: *(External Examiner)* | **Prof. Dr. Abdul Wahab Abdul Rahman** | Tandatangan *(Signature)* |
| Pemeriksa Dalam: *(Internal Examiner)* | **Dr. Farzana Kabir Ahmad** | Tandatangan *(Signature)* |
| Nama Penyelia/Penyelia-penyelia: *(Name of Supervisor/Supervisors)* | **Dr. Azizi Ab Aziz** | Tandatangan *(Signature)* |
| Nama Penyelia/Penyelia-penyelia: *(Name of Supervisor/Supervisors)* | **Dr. Rahayu Ahmad** | Tandatangan *(Signature)* |

Tarikh:
*(Date)* ***January 28, 2020***

## Permission to Use

In presenting this thesis in partial fulfilment of the requirements for a doctorate degree from Universiti Utara Malaysia, I agree that the Universiti Library may make it freely available for inspection. I further agree that permission for the copying of this dissertation in any manner, in whole or in part, for the scholarly purpose may be granted by my supervisor(s) or, in their absence, by the Dean of Awang Had Salleh Graduate School of Arts and Sciences. It is understood that any copying or publication or use of this thesis or parts thereof for financial gain shall not be allowed without my written permission. It is also understood that due recognition shall be given to me and to Universiti Utara Malaysia for any scholarly use which may be made of any material from this thesis.

Requests for permission to copy or to make other use of materials on this project thesis, in whole or in part should be addressed to:

Universiti Utara Malaysia

Dean of Awang Had Salleh Graduate School of Arts and Sciences
UUM College of Arts and Sciences
Universiti Utara Malaysia
06010 UUM Sintok

## Abstrak

Mengkonfigurasi sumber terbaik untuk prestasi keseluruhan yang optimum adalah salah satu topik yang mencabar dalam domain Sains Komputer. Dalam domain aplikasi penugasan sokongan sosial pintar untuk membantu individu yang mengalami stres, ia memerlukan aspek penting dalam mengkonfigurasi set input dan parameter yang mungkin untuk mendapatkan penyelesaian optimum dari kedua-dua model komputasi penyedia sokongan dan penerima. Walau bagaimanapun, algoritma konfigurasi yang sedia ada adalah secara rawak dan statik. Oleh itu, keputusan yang diperolehi adalah berbeza secara signifikan antara beberapa larian. Dalam konteks perspektif sokongan sosial, sokongan yang diberikan mungkin tidak mencukupi atau menimbulkan beban kepada penyedia. Oleh itu, kajian ini bertujuan untuk membangunkan algoritma konfigurasi dinamik untuk memberikan tugasan sokongan yang optimum berdasarkan maklumat yang dihasilkan oleh model komputasi penerima and penyedia sokongan sosial. Model komputasi yang mensimulasikan tingkahlaku penyedia dan penerima sokongan dan tingkah laku penerima telah dibangunkan untuk menghasilkan beberapa corak simulasi. Model ini menjelaskan dinamik tingkah laku penerima dan penyedia sokongan dan penyediaan dan dinilai menggunakan analisis keseimbangan dan pendekatan pengesahan logik automatik untuk 14 kes empirikal yang dipilih. Kemudian, algoritma konfigurasi dinamik dirancang untuk menggunakan kemungkinan pengusan sokongan berdasarkan keperluan penyediaan sokongan. Analisis kekomplesan algoritma digunakan untuk mengukur masa pelaksanaan dalam keadaan terburuk. Akhirnya, prototaip dibangunkan dan disahsahihkan dengan 30 pelajar siswazah. Kajian ini meneroka kemungkinan analisis komputasi dalam pemahaman eksplisit tentang bagaimana proses mencari dan memberi sokongan dapat diperoleh pada keadaan kes yang berbeza. Juga, kajian secara eksplisit menunjukkan stres psikologi penerima sokongan dapat dikurangkan setelah proses algoritma konfigurasi dinamik menentukan penyedia sokongan sosial terpilih dari ahli rangkaian sokongan sosial. Selanjutnya, kajian ini menyediakan kaedah alternatif untuk jurutera perisian dalam sistem pengurusan stres pintar untuk mengintegrasikan konsep berasaskan sokongan sosial sebagai salah satu mekanisme dalam menangani sokongan individu dengan stres yang berkaitan dengan kognitif.

**Katakunci:** Stress kognitif, Algoritma konfigurasi Dinamik, Penerima dan penyedia sokongan, Penugasan sokongan tidak formal, Pemodelan komputasi kognitif .

Universiti Utara Malaysia

# Abstract

Configuring the best resources for optimal overall performance is one of the challenging topics in Computer Science domains. Within the domain of intelligent social support assignment applications to help individuals with stress, it requires important aspects of configuring a possible set of input and parameters to obtain optimal solutions from both computational support provider and recipient models. However, the existing configuration algorithms are often randomized and static. Thus, their results can vary significantly between multiple runs. In the context of social support perspectives, the assigned support may not sufficient or cause a burden to the providers. Hence, this study aims to develop the dynamic configuration algorithm to provide an optimal support assignment based on information generated from both social support recipient and provision computational models. The computational models that simulate support providers and recipients behaviours were developed to generate several simulated patterns. These models explain the dynamics of support seeking and provision behaviours and were evaluated using equilibria analysis and automatic logical verification approaches for 14 selected empirical cases. Later, the dynamic configuration algorithm was designed to utilize possible support assignments based on support provision requirements. The algorithm complexity analysis was used to measure the execution time in the worst case. Finally, a prototype was developed and validated with 30 graduate students. This study allows to explore computational analysis in explicit comprehension of how seeking and giving support process can be obtained at different case conditions. Also, the study explicitly shows the psychological stress of support recipient can be reduced after the dynamic configuration algorithm process assigned selected social support providers from social support network members. Furthermore, this study provides an alternative method for software engineers in intelligent stress management systems to integrate social support-based concepts as one of the mechanisms in addressing the support of an individual with cognitive related stress.



**Keywords:** Cognitive stress, Dynamic configuration algorithm, Support recipient and providers, Informal support assignment, Computational cognitive modelling .

# Acknowledgement

To God be the glory, great things He has done; I adore the name of the Almighty for lightening my way throughout the completion of this valuable and golden thesis. My sincere appreciations go to my parents scholarly and academically, Dr Azizi Ab Azizi and Dr Rahayu Ahmad, who spent their time solely to show me the correct path to follow in order to achieve my dreams. Whatever good I extend to them is nothing compared to what they have done to assist in sailing me through my career. I am proud to be identified as one of your academic children. Besides, and most importantly, I would like to thank my beloved husband, Ahmad. His support, encouragement, quiet patience and unwavering love were undeniably the bedrock upon which the past four years of my life have been built. His tolerance of my occasional vulgar moods is a testament in itself of his unyielding devotion and love. Also, I thank my kids Yaman and Reem. I gifted this golden thesis as a boon to the spirit of my beloved late father Papa M. Rateb and my sweet mother M. Rateb (May God prolong the life of my mother); yes! I made you proud in a thousand miles away from home and I will (God helping me) for the rest of my life put smiles on your faces. In addition, I will like to thank all my family members especially, my sisters, my brothers, and family of my husband for their prayers, encouragement and support most especially Gift. To be honest, without their support, I might not even travel overseas to pursue my ambitions. Likewise, to my lovely and supportive family friends who supported me a lot in a time of needs and even throughout the writing of this thesis, we have numerous stories to tell the world and we will never forget. I will love to thank all Malaysians both lecturers and students in UUM especially Prof Norshuhdah for her support, Jordanian, Nigerians, Indonesians, Thai and Iraqi friends that I met during my journey and for their assistance, strength, and encouragement. Finally, this thesis is a product of our Relational Machines Group at Human-Centered Computing Research Lab headed by my amiable mentor Dr Azizi; you really inspire me and thank you for everything.

Universiti Utara Malaysia

# Table of Contents



Universiti Utara Malaysia

Universiti Utara Malaysia

Universiti Utara Malaysia

Universiti Utara Malaysia

Universiti Utara Malaysia

Universiti Utara Malaysia

## List of Tables



Universiti Utara Malaysia

Universiti Utara Malaysia

# List of Figures

Universiti Utara Malaysia

Universiti Utara Malaysia

## List of Algorithms



Universiti Utara Malaysia

## List of Appendices



UUM
Universiti Utara Malaysia

# CHAPTER ONE

# INTRODUCTION

## 1.1 Introduction and Background Study

Psychological stress has been identified by The World Health Organization (WHO) report as one of the modern-day killer epidemics and leading worldwide sources of years of well-being lost to illness in both women and men (Rogers et al., 2018; Herrera et al., 2017). This includes several physiological and mental issues related to stress diseases (Craven, 2016; Brown, 2015). Regarding the study, stress made a substantial contribution to the global burden of illness and connected to the loss of around 750,000 lives each year (Pavalanathan, 2018). For example, in Malaysia alone, almost 80 percent of employees experienced an increase in stress-related sickness (Wang et al., 2016). Without control and proper intervention, stress yields generous economic costs, in terms of both the budgets of well-being and social consideration and from different costs like the loss of workdays.

Sadly, with the demanding and stressful modern life, although 69 percent of people in the population perceives that stress is a major problem, only 31 percent know how to handle successfully with it (Bashir & Ramay, 2018; Rosenquist et al., 2017; Doherty et al., 2015). Therefore, it is important to highlight that an individual with stress history requests assistance from others to prevent the potential risk of stress.

There is a range of methods to help individuals to manage their stress (Cohen & McKay, 2017; Craven, 2016). These include pharmacological treatment (medication), psychological techniques, and social support (Corrigan & Phelan, 2015). First, medication can be a successful method to help individuals to cope with stress. However, it is not without troubles and should be seen as a temporary option, not a final solution. A significant portion of the medications used to decrease stress symptoms can have severe consequences and other side effects reactions. For example, benzodiazepines can influence an individual's coordination and attention if the amount is too high (Wellman & Wilson 2010).

Second, the psychological therapies that are proven to have a positive effect to alter individual's thought and behaviour patterns to manage their stress, where; 1) Cognitive Behavioural Therapy (CBT) offers people some assistance with uncovering and modify negative thoughts or perspectives that are producing and causing anxiety and stress, 2) Relaxation Training (RT) incorporates progressive muscle unwinding and profound breathing, and 3) Supportive Therapy (ST), where clinician listens to and validates individuals moods (Mauss et al., 2017).

Third, social support (informal support) could be used as a better alternative to provide intervention in overcoming possible stressors. Social support can be defined as the care or help from others that an individual can feel, notice, or accept and gives mutual support or self-help for people facing various health-related problems. (Cooper et al., 2016; Rosenquist et al., 2017; Doherty et al., 2018).

From this spectrum, social support has become an immensely widely held and highly significant concept in the research literature of mental health and psychological well-being (House, 2001; Abdullah et al., 2015; Zhou et al., 2016; Mejova, 2017). Moreover, Albrecht and Martin (2009) reported the several benefits of social support which contain: positive variations in symptoms, improved recovery and versatile responses to the diagnosis of disease, enhanced quality of life, enhanced choice making, and expanded survival time.

The social support system has four different functions (e.g., Cohen & Wills, 1995; Mincu & Taşcu, 2015; Mustafa et al., 2015; Wang et al., 2016). First, the emotional support conveys a person esteemed for his or her particular value and experiences. The results of this support are enhanced of self-esteem and consider as close support, where, informational support assists a person to define, understand, and cope with problems. This function often has been labeled as advice and cognitive guidance.

Universiti Utara Malaysia

Another support dimension, the companionship support assists to divert individuals from their problems or to serves positive emotional feelings and attitudes. Events such as spending time with friends on vacation and leisure activities are listed under this category. The instrumental support refers to provide material resources, financial aid, and other required services. This is also known as material support and instrumental support. Any behaviour that is providing labour, money or any other kind of direct solution to a problem comes under this type of support.

An essential point behind the behaviour of support-seeking is the determination of social support networks according to the strength of the relationship between the individuals in the network (either weak tie or strong tie relationship) (Both et al., 2014) which extracted from social support ties network theory. Ties preserved by pairs can span from weak to strong pertinent to the kinds of exchanges, the regularity of contact, closeness, and length of the relationship. As technologies to support stressed individuals take on a growing aspect in health care (particularly in mental consideration fields), these technologies should be able of recognizing a human's functioning procedure (i.e., mental state), and offer actions suitable to the predictable condition of the individual (Rosenquist et al., 2017). Furthermore, the introduction of Web 2.0 (social media), a socializing and networking platform has transformed social interaction into the technological era and offers extraordinary opportunities for solving problems in an extensive diversity of disciplines with information techniques (Simoncic, 2015).

Universiti Utara Malaysia

Moving to research on social support networks media within a medical context, there has been an evolving interest in utilizing social support networks as a mechanism for health. Also, researchers have experienced to capture the entire trends of a specific disease outbreak, typically influenza, through social support networks monitoring (Vorvoreanu, 2015). Taking into account work like Choudhury et al., (2016) has highlighted some of the advantages in taking social support networks media as an assessment tool of individual behavioural health like social language, activities, and expression in a natural setting.

SNSs like Facebook and Twitter are getting popular with all types of people that provide them with a new platform for social support for sharing their emotions and thoughts in daily life (Williams & Taylor 2014). Moreover, stressed individuals are usually trying to escape from social activities and situations. Therefore, by acknowledging this issue, the description of the activities of social support networks media and altering social network ties can offer an estimation of these types of withdrawal and escapes. Thus, it can be utilized as a mechanism within a social context, in such a way that might assist in the detection of stress in individuals. This approach is called "human computation" (Howe, 2016).

These online techniques have assisted in solving demanding problems and challenging issues that cannot be handled by social support network media. Thus, by applying these design models to psychology could be an exciting new opportunity for research (Morris & Picard, 2014). It permits programmers to organize human resources as needed like Panoply, a crowdsourcing intervention based on cognitive-based therapies and cognitive restructuring to support people to regulate stressful emotions (Morris, 2015).

Also, this concept is similar to the configuration problems in Configuration-Based Systems (CBS). CBS deals with the arrangement of a set of components and items to reach for particular purpose T (Fohn et al., 2013). Some applications for real-world systems utilized the configuration algorithm namely: automotive engineering (Freuder et al., 2011), telecommunication manufacturing (Juengst & Heinrich, 2015), and health care (Stumptner, 2017).

## 1.2 Problem Statement

Stress is purely the body's reaction to changes that generate challenging demands. It decreases performance and causes mental and physical diseases such as anxiety, depression, and high blood pres-sure. There are several digital applications were developed to help stressed one, including voice-response telephone calls (Friedman, 2014; Tutty et al., 2015; Kidd, 2017), phone-based (Groote et al.,2015; Huang et al.,2016), wearable sensors (Cook & Song, 2009; Farrell & Lewandowsky, 2013; Fletcher et al.,2016; Kim, et al.,2017), ambient intelligence (Ramos et al., 2015; Bosse et al.,2016), software agents (Franklin & Graesser, 2000; Hoogendoorn et al., 2010; Azizi et al.,2011), and the Internet-based (Zhou et al.,2017).

Moreover, tremendous advancements in crowdsourcing have provided a new alternative to support a stressed individual among social support networks. However, this approach (Morris, 2015; Aktas & Sertel-Berk, 2015) has no means of automated processes to decide which individuals are capable and willing to offer support. Further, since the crowd is usually various, both regarding inspiration and skill set, there is a condition where the support cannot be utilized by others (Morris & Picard, 2014; Aktas & Sertel-Berk, 2015; Doherty et al., 2018).

Universiti Utara Malaysia

Support provision tasks consider as a configuration problem that has always been subjects of interest for researchers in the field of Artificial Intelligence (AI). They can be seen as the recipient: a person requests support and the providers: people provide support to help. It is important to identify how to allocate resources between support recipients and support providers to meet recipient needs. Currently, there is no direct mechanism to show the interaction between the support recipient and support provision. The models were developed in separation for simulation purposes only (House, 2001; Barrera, 2015; Mincu & Taşcu, 2016; Yamaguchi et al., 2017). Exceptionally, the model built by Aziz et al., (2011) showed the integration between them but only worked for non-dynamic fashion. Thus, full functional support cannot be utilized. In addition, the model was designed as a one-off support solution. Therefore, it could not recommend appropriate support providers if the support is not enough or the burden of the support providers is not sufficient.

Universiti Utara Malaysia

Besides, some configuration algorithms for computationally challenging problems are often randomized (Stumptner, 2017; Wei & Blake, 2015), and their behaviors can vary significantly between multiple runs. Thus, an algorithm will not achieve the same performance, even when run repeatedly with fixed resources on a single problem instance. Therefore, the resources arrangements were chosen to play an important role to minimize some cost of the algorithm's performance across the input data (Choudhury et al., 2016; Vorvoreanu, 2015; Williams & Taylor, 2014).

To overcome the aforementioned gaps, there is a need to develop a new integrated model. This model re-allocates the resources between support recipients and support providers through a dynamic priority configuration algorithm. It takes the needs of the support recipient and the preferences of the potential support providers into account to find the utilized support that matches the needs of the support recipient. If the support is not enough or the provider's burden is high, the system still readjusts again to the needs of the recipient and allows re-assigning social support based on changes of user needs throughout time. The proposed solution was evaluated through verification and validation methods such as mathematical analysis, and human experiments.

### 1.3 Research Questions

1) How can factors from psychology related to aspects of stress, and social support recipient and provider be represented using a computational model?
2) How to integrate support recipient and provider models to address the dynamics of social support exchange?
3) How to develop a configuration algorithm to assign support among selected members within their resources and preferences?
4) How to evaluate the appropriateness of the integrated configuration algorithm with the social support networks?

## 1.4 Research Objectives

The main objective of this study is the development of an automated formation of social network support that analyses human behaviour and supports stressed people. Specifically, this research attempts to achieve the following objective:

1) To represent factors from psychology related to aspects of stress, and social support recipient and provider using a computational model.
2) To integrate support recipient and provider models to address the dynamics of social support exchange.
3) To develop a configuration algorithm to assign support among selected members within their resources and preferences.
4) To evaluate the appropriateness of the integrated configuration algorithm with the social support networks.

Universiti Utara Malaysia

## 1.5 Research Scope

In this study, the dynamics of recipients need provider preferences within social support networks were investigated through a computational model of both recipient and providers in the term of four types of seeking and providing social support (informational, emotional, instrumental, companionship). For this purpose, significant concepts and numerous primary factors and theories (e.g. Weak Tie/Strong-Tie Support Network, Stress Buffering Hypothesis) related to the particular conditions are used to construct a computational model. The developed models were evaluated within a social support network perspective. The validation analysis involves thirty groups of graduate students with age ranging from 25 years to 34 years. They were selected from UUM (University Utara Malaysia). Each recipient suggested four support providers based on his/her social support networks. Therefore, different thirty groups were categorized (different combinations of respondents were identified as the different recipients and different providers) to validate the proposed model. Each group has five respondents with each respondent refers to a support recipient and four support providers. It is worth to indicate that the model is limited to the fundamental factors and theories existed in the psychological area.

## 1.6 Related Research Domains

Universiti Utara Malaysia

The proposed research methodology includes several research domains that are related to the research objectives. These domains are specified with some brief explanations of how they contribute to this study.

### a) Computer Science

The computer science domain provides a computational standard to formalize and prove the theoretical models of clinical psychology and cognitive science. For example, computer simulations and formal methods are a specific kind of techniques used within this domain, specifically for the specification, design, development, and evaluation of the models. In this study, using the automated configuration algorithm from a knowledge-based system, it contributes towards the design and development of a high-performance algorithm for difficult computational problems to recognize and allocate resources between support recipients and support providers by re-assigning support over social support networks.

**b) Cognitive Science and Computational Psychology**

Computational psychology provides the fundamental hypothesis and grounding theories of stress and social support seeking and providing within social networks. Recently, computational models are frequently used as tools for investigating human behaviours and cognitive functions. The models have been used to explore the essence of psychology and various cognitive functionalities through the ongoing detailed understanding by specifying corresponding computational models of representations and mechanisms.

## 1.7 Significant of the Study

Universiti Utara Malaysia

Helping someone who is stressed can be very important in the health care community. Several supportive family members or friends can often make a big difference in supportive others. This study addresses how a social support network can be formed, taking the needs of the support recipient and the possibilities of the potential support providers into account to reduce the helping burden. In general, the findings of this study will redound to the benefit for both society and computer science fields. First, within the societal perspectives, the designed solution plays an important role in social well-being and helps to manage stress among vulnerable people by analysing and recommending informal support providers. Secondly, from the computer science perspective, it provides the mechanism for optimizing resource usage by exploring the computer simulations and formal methods for the specification, design, development, evaluation of the models to be implemented in support platforms. Besides, the findings stretch guidelines and design requirements for computer developers.

## 1.8 Contributions of the Study

The contributions of this study span in two folds:

1) **Theoretical**: The first theoretical contribution is computational models of social support recipient and provision that includes a list of theories, factors, and relationships of social support recipient and provision. This contribution provides insight on computational perspectives that never been seen before to simulate the dynamics of social support recipient and provision. Thus, it will help psychologists and computer scientists to better understand those processes without conducting experiments on human subjects. The second theoretical contribution from this study is the dynamics of a configuration algorithm that utilizes computational models to assigns social support of members within social support networks. The integration between formalized models of support seeking and provision behaviours with a configuration algorithm provides a foundation to design fully automated support for people with stress.

Universiti Utara Malaysia

2. **Practical**: There are three practical contributions to this study. The first practical contribution is an algorithm to be implemented in social support network platforms. Next is this study provides an alternative solution for mental health monitoring. Finally, it also provides a technical know-how solution as a system's guidelines to develop automated stress management that leverages social support exchange over social support networks.

### 1.9 Outline of the Study

The organization of this thesis is divided into seven chapters; given below:

Chapter 1: Introduction

This chapter establishes the concept and fundamentals of the study. It starts with a simple background of the study and stating the questions and objectives of the study.

Chapter 2: Literature Review

This chapter covers details discussion of the important concept in social support networks, stress, social support, and configuration approach. A detailed discussion of modelling will be covered which is based on mathematical analysis and differential equations.

Chapter 3: Research Methodology

This chapter explores the rationale behind the usage of the configuration algorithm over social support network analysis. Details of the research methodology will be discussed in

Universiti Utara Malaysia

line with activities to be followed during the study. Each phase will be discussed with a method to be used.

Chapter 4: Computational Model Development

Chapter Four contains details of the developmental phases involved in the proposed models. The chapter clearly stated the phases and activities undertaken to develop these models such as the domain, design, and operational phases. The chapter is divided into four main sub-sections namely the recipient model, provider model, integrated model, and dynamic configuration algorithm.

Chapter 5: Simulation Results

This chapter discusses full details on the simulation environment for the proposed models. This chapter presents results obtained on the simulation traces using a numerical simulation environment. The presented simulation traces were based on case conditions that defined the uniqueness of each trace. The simulation results were in four categories namely the recipient model, provider model, integrated model, and configuration algorithm results.

Chapter 6: Evaluation

This chapter presents the result of the evaluation of the proposed model. The evaluation results were in two categories namely verification and validation. The verification analysis includes both mathematical and automated verifications that are carried out on the model.

The validation analysis was employed on the proposed model by making use of real-world data.

Chapter 7: Conclusion

This chapter provides the implication of the study by stating how specifically the study can be useful for the development of automated social support assignments generally. The chapter also highlights the limitations of the study with suggestions on further work that can be done to improve the study.

**1.10 Operational Definitions**

- **Social support network**: it indicates the group of individuals who offer help to individuals. It represents the arrangement of psychological and otherworldly resources from the social support network sites, which is aimed at strengthening a person's ability to manage stress. In this study, four types of support will be provided (informational, emotional, instrumental, and companionship).

- **Weak Tie**: it refers to associations that involve frequent communication but are not considered to be close contacts or strong providers.

- **Strong Tie**: it refers to the relationship between the people in a very enclosed personal setup. Usually, strong ties comprise associations like families, friends, and spouses that are regularly acknowledged.

Universiti Utara Malaysia

- **Configuration Method (Knowledge-based Configuration)**: The method deals with the mutual influence of a set of variables and internal resources and tries to model interrelationships. In this study, it starts with broad specifications, and end with more specific information about the needed components of social recipient and provider, and how these components should be arranged.

- **Computational Model**: of a system is a mathematical model of it, at some chosen level of abstraction. Its purpose is to permit precise understanding, specification, and analysis of the system.

- **Temporal Trace Language (TTL)**: A method to check the validity of a computational model.

Universiti Utara Malaysia

### 1.11 Summary

This chapter displays the main idea of the study at the introductory part and states the core problem statement, research questions, research objectives, scope, and significance of the study. It also shows how the study will be organized in other chapters. The next chapter will cover important aspects of the literature review related to the proposed topics. A detailed background of the work had also been laid, which is further discussed in the next chapter. Chapter Two covers literature reviews within the domain of the proposed study. This provided a theoretical foundation for the study.

# CHAPTER TWO

# LITERATURE REVIEW

## 2.1 Introduction

This chapter explores important concepts in stress, social support, and configuration algorithm. Section 2.2 examines the underlying concepts behind stress among graduate students primarily on the effects on the society, while Section 2.3 concentrates extensively on combating stress, particularly different types of therapies, and platforms to help stressed persons. Later, an intensive review of factors and theories of social support and its types as presented in Section 2.4. Then, Section 2.5 examines concepts of Knowledge-Based Configuration and its application. Next, the importance of computational models in providing support and evaluation processes is introduced in Section 2.6 and Section 2.7 respectively. Finally, the conclusion summarizes this chapter.

Universiti Utara Malaysia

## 2.2 Stress among Graduate Students

Graduate students are of the perception that their educational experience is highly stressful and has consistently scored above average on stress scales (Faro, 2013; Wang et al., 2016; Felizardo et al., 2017). Stress can result in negative outcomes such as poor academic performance, reduction in cognitive functioning, impaired coping, and incompletion of graduate studies (Talaei et al., 2010; Mejova, 2017; Pavalanathan, 2018).

Stress is also associated with a gamut of physical and psychological symptoms such as anxiety, altered appetite, sleep pattern disturbances, headache, and increased heart rate (Kurebayashi et al., 2015; Nelwati et al., 2017).

Several studies have confirmed the high-stress nature among graduate students at the age of 25 to 34. In one of the more extensive studies on the mental health needs of graduate students, Hyun et al. (2016) found that 58 % of graduate students in this range of age had an emotional or stress-related problem. Results also showed that 46% of graduate students felt overwhelmed frequently or all of the time.

Besides, studies have shown that graduate students report higher levels of stress when compared with both undergraduate students (Mejova, 2017; &Wang et al., 2016) and the general population (Schafer, 2014; Greenberg & Valletutti, 2017). Studies by Oswalt and Riddock (2015) and Kernan et al. (2017) both found that about 75% of their graduate student samples reported being stressed or very stressed.

Moreover, according to Thawabieh (2017), factors that tended to increase the graduate students' perception of stress included: (1) finances, 2) relationships and 3) career and 4) time management. Also, balancing peer activities, and home life can be difficult.

Universiti Utara Malaysia

### 2.3 Methods to Combat the Stress

Many people do not receive any support in our society when in need; precisely, in the developed countries where people are more fractioned, individualistic, and mobile, people are unable to sustain healthy mental lives. There are numerous methods to help people manage stress. These are pharmacological treatment (medication), psychological techniques, platforms to help stressed individuals, and social support.

#### 2.3.1 Pharmacological Treatment

Different types of medication can be used to deal with stress, there has been constant research over stress and the cells of the brain that are involved in it. As per the researchers, there is a connection between the regulation of different neurotransmitters and problems involving stress. These neurotransmitters are specific chemical messengers in the brain that are responsible to send and receive signals between its different cells. There are three major stress neurotransmitters – Gamma-Aminobutyric Acid (GABA), norepinephrine, and serotonin (Wellman &Wilson 2010; Spiegel & Riba, 2015).

The important medications that involve stress relief are Benzodiazepines (Bzds), Norepinephrine, and Serotonin Reuptake Inhibitors (NSRIs) and Selective Serotonin Reuptake Inhibitors (SSIs). Norepinephrine and Serotonin Reuptake Inhibitors (NSRIs) and Selective Serotonin Reuptake Inhibitors (SSIs) fall in the category of 'antidepressants' which are widely used to treat depression and anxiety disorders.

Insomnia and anxiety can be relieved with Benzodiazepines which hail under the category of ‘sedatives’. People can face withdrawal symptoms if they are highly dependent on benzodiazepines and suddenly decrease the dosage.

The symptoms of stress are only decreased while living on only medication, which is one of the main problems. The root causes of stress remain unattended. The symptoms of anxiety may trouble people once they stop being on medication (Goldsmith & Parks, 2016). Table 2.1 describes several advantages and disadvantages of important medication options.

Table 2.1.

*Advantages and Disadvantages of Medications Options*

| **Type** | **Mechanism** | **Advantages** | **Disadvantages** |
|---|---|---|---|
| Benzodiazepines (Wellman & Wilson, 2010; Spiegel & Riba, 2015). | • Increase the activity of the GABA neurotransmitter system | • Reduce anxiety, excessive excitement.<br>• Make people feel quiet and calm. | • Drowsiness, sedation, dizziness and loss of balance.<br>• Effects are most serious when it is combined with alcohol or with other sedative medications. |
| Antidepressants (Wellman & Wilson, 2010; Goldsmith & Parks, 2016). | • Work through the serotonin and norepinephrine neurotransmitter system | • Safe, effective, non-addictive.<br>• They have not been shown to have any long-term effects. | • It is that they often have side-effects. For most people, mild and short-lived, for others, might be more troubling. |

Universiti Utara Malaysia

### 2.3.2 Psychological Techniques

Psychological techniques goal to change an individual's feeling and behaviour patterns, such as 1) Cognitive-Behavioural Therapy (CBT), 2) Mindfulness-Based Cognitive Therapy (MBCT), 3) Relaxation Training (RT), 4) and Supportive Therapy (ST).

#### Cognitive-Behavioural Therapy

Cognitive Behavioural Therapy (CBT) explains how people think about a situation that triggers their feeling. Also, it illustrates how people will behave or react towards when an incident occurred. Currently, there are numerous empirically supported interactive multimedia CBT systems are available these days, of which *Good Days Ahead* and *Beating the Blues* is highly popular (James, 2016). These programmes constitute eight one-hour sessions, coupled with practice assignments between each session. Although these computer programs can reduce anxiety and depression substantially, they do not address family problems, which affect an individual's wellbeing in the long-term. They focus only on certain issues and deal with only current problems. Moreover, regular CBT sessions are highly time-consuming.

#### Mindfulness-Based Therapy

Mindfulness-Based Therapy (MBT) is the practice of meditation skills to observe, describe, acting with awareness, and acceptance of the situation without judgment (Kumar et al., 2018; Ruths et al., 2013). This mechanism is effective as an approach to improve intentional control, awareness and acceptance towards an experience of the event. Advantage of awareness to experience is to recognize the transient nature of experience and to query the actual accuracy of the individual's perspective or thoughts. In a specific term, mindfulness-based therapies teach individuals that '*thoughts are not the truths*' (Twohig et al., 2012; Munteanu, 2016). However, even though MBT is most effective in cases where the onset of depression is not triggered by any life events; it shows low results for depression caused by major life events. In other words, stress instigated by autonomous and ruminative type of negative thinking patterns that are driven internally is effectively controlled by MBT, though it is ineffective in easing stress linked with severe life events.

**Relaxation Training**

A relaxation response restores the balance of the system by deepening breathing, decreasing stress hormones, retarding heart rate and blood pressure, and relaxing muscles (Wilson et al., 2012). This calmness response is stimulated by relaxation techniques like deep breathing, visualisation, progressive muscle relaxation, meditation and yoga. These activities if performed diligently can reduce everyday anxiety levels and raise an individual's happiness and inner peace (Schredl, 2015). Besides, they also help an individual to effectively handle stresses that lead to anxiety and mood and physical symptoms and train him/her to remain cool. The appropriate relaxation technique should match the lifestyle and be able to concentrate on the mind and disrupt daily thoughts to stimulate the relaxation response.

**Supportive Therapy**

In counselling and/or supportive psychotherapy, a psychologist interacts with the patient and validates his/her feelings. Hence, it forms a more helpful and better choice. This method uses all practical means possible to help reduce stress (Mowbray et al., 2015; Spence, 2018). They follow a positive approach concerning the treatment and apprise patients on the type and expected course of their depression. They also advise them on handling and adapting to it. These therapists at times tend to incorporate skills attained from previous therapies. For instance, a counsellor might choose a specific assignment task that worked well during CBT sessions (Mejova, 2017). A good therapist is generally very proactive and provides clear-cut advice and suggestions (Butler et al., 2013; Zheng, 2017).

### 2.3.3 Platforms to Support Stressed Individuals

Universiti Utara Malaysia

Technological innovations like smartphones and wearable devices have prompted researchers to find ways with which these devices can deal with stressful conditions (Bullock et al.,2015). For instance, wearable sensors have been developed to provide support for stressed persons. However, some studies have shown that advances in technology can result in addictive behaviour and contribute to stress and mental health risks (Boydell, 2013; Dubey et al.,2014).

Apart from this, the technological advances in the field of computer science also compel us to pursue this research. For example, a range of technologies such as ambient intelligence (Choudhury et al., 2016; Simoncic, 2015), wearable sensors (Talaei et al., 2010; Wang et al., 2016; Mejova, 2017), mobile applications (Bullock et al.,2015), and software agents (Bouteyre, Maurel, & Bernaud, 2018; Mejova, 2017) have been utilized to a system that can offer support for stressed persons.

**Internet-Based Technology**

The Internet and Computer-Mediated Communication (CMC) interface signify novel means of personal communications. They have been used for psychotherapeutic interventions for more than a decade as considered as an omnipresent source for health information. The amount of time spent in the same chat room, mailing list, forum, or website determines the intensity of closeness (Daum, 2011).

A lot of research has been finished to study the effects of the internet on the day-to-day lives of people and their communal associations (Segerstad, 2012; Caplan & Turner, 2013). Over the last ten years, a different type of social help engaging CMC interfaces that comprise e-mail, virtual communities, chat, instant messaging (IM), text messaging (SMS), web pages, etc. has been gradually increasing.

For example, Web sites like WebMD which offer interactive, searchable common medical and psychological well-being data have flourished. However, the disadvantages of those examples entail the requirement of a computer that is connected to the Internet and the decontextualisation of the distributed data that could cause misinterpretations, (Caplan& Turner, 2013; Eden & Heiman, 2015). There are many explanations provided for the collapse of current computer-focused intermediations and their inability to deliver captivating user experiences, their want for partnerships covering various streams, including design, psychology, and engineering (Schueller et al., 2014). More research is required to improve the design procedure.

**Mobile Based Technology**

Currently, a lot of wearable devices are employed, like smartphones and wearable sensors to assess physiological or behavioural information in our everyday lives (Boydell, 2013; Dubey et al., 2014; Lanata et al., 2015). At present, the only essential point of supply of smartphones is the universal cell phone. Whenever an individual uses a cell phone, some data is left behind. Newer smartphones have started using sensors like microphones, accelerometers, and GPS, as well as usage-tracking functions for call and SMS histories. Studies have shown that clinicians have a lot to gain from a mobile health application, particularly Personal Digital Assistants (PDAs).

Several systems that are compatible with all types of PDAs have made it possible to record and track patient information (Santoro et al., 2014; Gallagher et al., 2015). Literature about health sciences reveals that PDAs are popular these days. One example given by Huang (2016) was related to “The Moment”, a mobile application specially made for people suffering from depression or bipolar disorder. This application helps identify their emotional patterns, monitor their emotional ups and downs, and instead of having to fight against them, help these people ultimately come up with a way to live with their emotions. Table 2.2 summarizes platforms to support stressed individuals.

Table 2.2.

*Platforms to Support Stressed Individuals*.

| **Platforms** | **Examples** | **References** |
|---|---|---|
| Internet-Based Technology | • Computer-Mediated Communication (CMC).<br>• WebMD. | • Gainsbury & Blaszczynski, 2014.<br>• Donkin et al., 2015.<br>• Gallagher et al., 2015. |
| Online Social Support Group | • Medhelp<br>• SpillNow<br>• OverTheLine. | • Cranwell & Seymour-Smith, 2012.<br>• Peterson, 2014.<br>• Bullock et al., 2015. |
| Mobile Based Technology | • Personal Digital Assistants (PDAs)<br>• The Moment | • Santoro et al., 2014.<br>• Huang, 2016.<br>• Gallagher et al., 2015. |

Universiti Utara Malaysia

### 2.3.4 Social Support

Social support constitutes interpersonal interaction, which includes providers and recipients and their feelings and thoughts and how these evolve over the years (Albrecht & Martin, 2009; Macniven et al., 2016). The group of individuals who offer help to a person is referred to as 'social support networks.' It refers to the arrangement of psychological and otherworldly resources from the social network, which is aimed at strengthening an individual's ability to manage stress (Cooper et al., 2009; Koetsenruijter et al., 2015;

Hendrickx et al., 2016; Goldsmith & Parks, 2016). Table 2.3 shows the relationship between different levels of social support and various kinds of disease.

Table 2.3.

*Different Level of Social Support and it related to Well-being.*

| Level of social support | Diseases | Psychology |
|---|---|---|
| **Low social support** (Jacobson, 2001; Uchino, 2009; Taylor, 2011; Leung, 2017). | • Have various kinds of disease and slower recovery.<br>• Cardiovascular disease, inflammation and less effective immune system functioning.<br>• More complications during pregnancy, more functional disability, pain associated with rheumatoid arthritis. | • Higher rates of major mental disorder (e.g. social phobia, major depression disorder, eating disorder). |
| **High Social Support** (Cohen & Wills, 1995; Barrera, 2015; Mitchell, 2018) | • Positive health outcomes, including faster recovery from coronary artery surgery.<br>• Less susceptibility to herpes attacks, and a lower likelihood to show age-related cognitive decline. | • Reduce psychological stress (e.g., anxiety or depression) |

Generally, there has been plentiful recent highlighting on the characteristics of the social support network to manage stress (Cooper et al., 2009; & Aktas & Sertel-Berk, 2015; & Yamaguchi et al., 2016; & Mejova, 2017). Figure 2.1 shows how social support is associated with the Health-Related Quality Of Life (HRQOL).

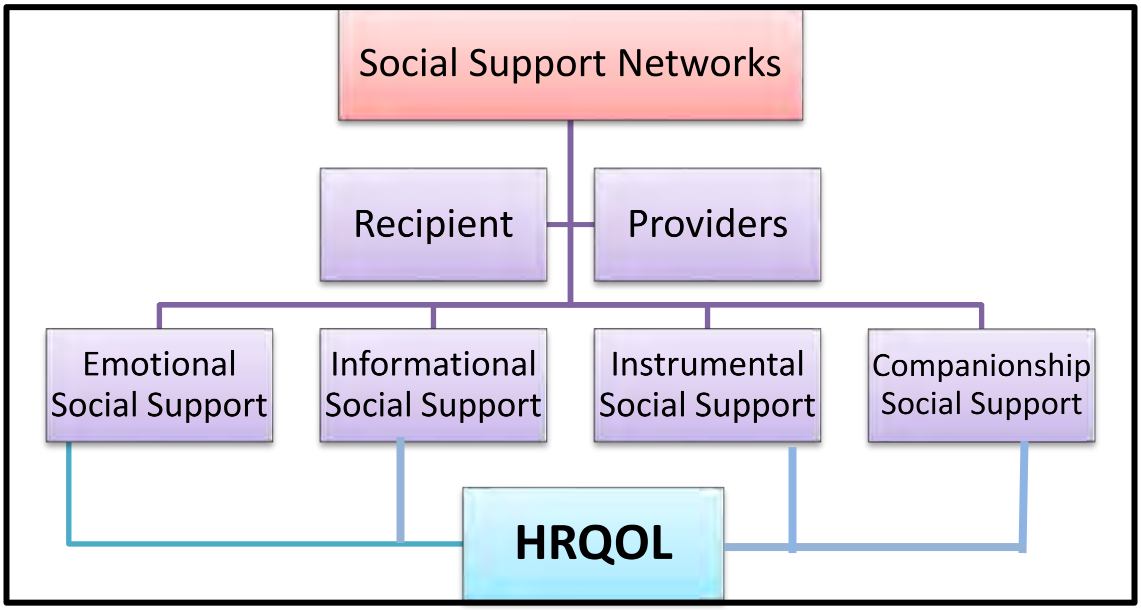



*Figure 2.1.* The Role of Social Support Network on HRQOL (Mejova, 2017).

This Figure shows the association between social support and HRQOL in patients within social support networks such as social support can positively affect copying behaviour and illness representation. HRQOL is a concept that incorporates multiple disciplines about emotional, mental, physical and social functioning.

This concept surpasses direct measures of life expectancy, population health and causes of death. Well-being is a related concept of HRQOL that evaluates all positive conditions of an individual's life like contentment and positive emotions. Table 2.4 summarizes the advantages and disadvantages of the previous methods of combating stress. The details about concepts in social support will be covered in Section 2.4.

Table 2.4.

*Advantage and Disadvantage for Therapy Types.*

| Type of Therapy | Advantage | Disadvantage |
|---|---|---|
| Medication (Spiegel & Riba , 2015; Wellman & Wilson, 2010) | • Can be effective.<br>• Help stimulate and mimic a well-functioning body. | • Short-term option.<br>• Not a solution.<br>• Many of the medications have serious side effects and other consequences |
| Psychological Therapies (Morris,2015; Mauss et al., 2014; James, 2016) | • Helpful, has few physiological side effects (important for older adults who are often taking more than one type of medication)<br>• Offers the possibility of effective treatment for those who have not responded to medications. | • Time-consuming (eight to ten weeks or longer)<br>• Psychotherapy alone is not effective in people with severe stress.<br>• Overemphasizing the logical and thought-oriented components of one's mental life. |
| Social support (Wang et al. ,2016; Rosenquist et al., 2017; Granovetter, 2015; Doherty et al., 2018) | • The best method of protecting us from the effects of stress (when emotional support is easy to come by)<br>• Related to Health-Related Quality Of Life (HRQOL)<br>• Indeed, it encompasses all the previous methods | • Unhappy or poor-quality relationships harm mental health and well-being. |

## 2.4 Social Support

The concept of social support has been studied in detail by several researchers. From the attachment theory (Bowlby, 1982), social support is conceptualized as an interpersonal process that involves one partner's support-seeking efforts and the other partner's caregiving responses. There are several theoretical explanations for the relationship between social support and perceived stress. Most notable are the buffering hypothesis (Cohen, 1988; Fyrand, Kvien, & Glenna, 2014; Lin et al., 2017), which states that social support buffers or shields individuals from negative effects of prolonged stress following a crisis (Aneshensel & Stone, 1982; Thoits, 1982). Buffering is described as any social support effect that intervenes between stressors and health in Figure 2.2.

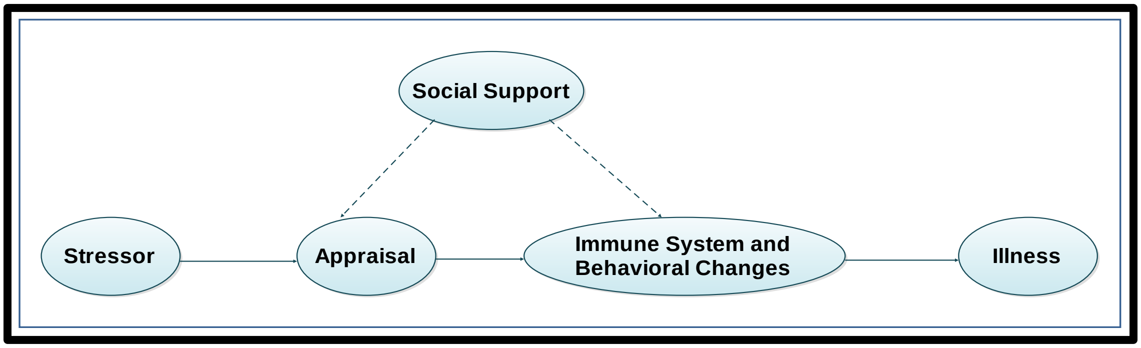



*Figure 2.2.* The Buffering Hypothesis (Lin et al., 2017).

As shown in Figure 2.2, as per the buffering hypothesis, the social group only alleviates the stress levels of an individual by controlling his/her immune responses, coping behaviour, and stress appraisal and does not have any direct impact on the stress.

Universiti Utara Malaysia

### 2.4.1 Type of Social Support

Additionally, previous researchers (Cobb, 1988; Cohen & Wills, 1995; Goldsmith & Parks, 2016) look at social support more structurally, in which they have defined social support as a system where an individual gets care, respect, support and valued participation in a network of individuals for mutual benefit. These individuals offering support could be a spouse, relatives, friends, colleagues or other members of the community. Some other researchers, however, focus more on the functional aspect of social support ( Barrera, 2015; Yamaguchi et al., 2016). Finally, social support is defined as emotional, informational, companionship, and instrumental assistance provided by significant others, like co-workers, supervisors or family members as seen in Table 2.5 (Thoits, 2011; Knoll, Burkert, & Schwarzer, 2014).

Table 2.5.

*The Types of Support Related to Kinds of Network Tie.*

| **Support Types** | **Description** | **Ties** | **Examples** |
|---|---|---|---|
| Emotional Support | • Provisions of confidant support, attachment.<br>• Results in the enhancement of self-esteem and functions as close support. | Strong | • Offer emotional support to someone by listening and offering sympathy after they had bad news. |
| Instrumental Support | • Provision of tangible support, material aid.<br>• Include any behavior that providing labor, money, or any other kind of direct solution to a problem. | Strong | • Provision of material resources like money to someone who's lost their job, helping someone who is disabled by preparing dinner. |
| Informational Support | • Provision of advice, guidance, appraisal, and problem-solving.<br>• Assists a person to define, understand and cope with problems. | Weak | • Offer information, guidance, and advice. |
| Companionship Support | • Refers to groups, chatting, and other social activities that help people recognize that they are valuable parts of something larger than themselves.<br>• Include activities such as spending time with others in leisure and recreational activities. | Strong | • Include both mere presence of others and engaging in activities with others such as seeing a movie when someone needs relaxation |

Universiti Utara Malaysia

#### 2.4.1.1 Informational Support

The informational support consisted of general advice on ways to approach her problems and specific advice on effective study skills. Informational support allows individuals to accept and understand stressful circumstances and helps them cope with problematic events. Informational support has also been referred to as "advice," "appraisal support," and "cognitive guidance" (Cohen &Wills, 1985). According to Cutrona and Shur (1994), "Informational support includes advice (e.g., 'I think you should tell your supervisor'), factual input (e.g., 'If you do not treat the infection quickly, it will get worse') and feedback on actions (e.g., 'You should not have told her so bluntly')".

This study described informational support provision as consisting of advice, information, and training aimed toward reducing the symptoms of physical illness. Much research demonstrates the influence of informational support as applied to several issues and in varied contexts. Besides, conscientiousness predicts low-stress exposure (Lee-Baggley et al. 2005, Vollrath, 2001), probably because conscientious persons plan for predictable stressors and avoid impulsive actions that can lead to financial, health or interpersonal problems. Conscientiousness relates to perceiving events as challenges rather than threats and to positive appraisals of coping resources (Penley & Tomaka 2002, Vollrath, 2001; Rademacher & Wang, 2014). As individuals with high conscientiousness are more sociable, positive and goal-orientated they are less likely to become as distressed as highly neurotic

Universiti Utara Malaysia

individuals. Vollrath (2000) showed that students with more adaptive personalities such as high conscientiousness were less affected by daily stress.

#### 2.4.1.2 Emotional Support

In particular, emotional support in the context of close relationships such as family members and friends foster further positive social relationships and the development of interpersonal characteristics. According to Burleson, Kunkel, and Birch (2015), perceived emotional support between friends or partners is of great significance to the maintenance of these relationships. Emotional support provision is the provision of "empathy, love, trust and caring". Emotional support is the kind of support that involves expression of love, care and empathy. It refers to the availability of people to listen to one's problems with empathy, caring and understanding (Cutrona, 1996; Samter, 2002; Roberts, Newman, Apa, & Brown, 2015).

Universiti Utara Malaysia

According to Cutrona and Russell (2015), Emotional support provision includes expressions of caring (e.g., 'I love you'), concern (e.g., 'Are you feeling better?'), empathy (e.g., 'You must have been hurt by his coldness'), and sympathy (e.g., 'I am so sorry you are ill') (p.116). Thus, several studies have demonstrated the relationships between emotional support and psychological, physical, and relational results. Bolton and Oatley (1987) found that emotional support reduced individuals' depressive symptoms. Similarly, in Kessler and Essex's (1982) and Krause's (1987) studies, emotional support was linked with better mental health outcomes. Cramer also indicated that emotional support helped recipients improve psychological adjustment (Cutrona & Russell, 1990; Iacovelli, Spencer, Gengaro, & Hall, 2017).

#### 2.4.1.3 Instrumental Support

Instrumental support refers to the perceived availability of people who can provide functional aid in completing daily tasks (such as making meals or providing transportation) if needed (Nurulla, 2010; Owens, 2017). According to Cutrona and Russell (1990), "tangible support" represents instrumental assistance, which involves the provision of resources necessary for solving problems when an individual face difficult circumstance. Cohen and Wills (1985) also explained tangible support by using the term "instrumental support" which is "the provision of financial aid, material resources, and needed services.

Previous research has provided evidence of the effects of tangible support on physical or psychological illness. In particular, scholars have found tangible support to be significantly beneficial to people's health in a wide range of situations. Tangible support reduces stressors or alters the nature of the stressor itself (Wilcox &Vernberg, 1985; Nurulla, 2010; Owens, 2017).

As such, tangible or instrumental support has been determined to be helpful for patients with mental illnesses (Wethington & Kessler, 1986). Examples of tangible support include the provision of needed goods (e.g., money, food, books) and offering of services (e.g., babysitting, transportation, typing) (Cutrona & Shur, 1994). Individuals who received

Universiti Utara Malaysia

tangible support believed money, care, or other forms of assistance evidenced the love or esteem of the providers of such support. Tangible support is likely most effective when recipients agree that the type of tangible aid is suitable for them and the situation (Cohen & McKay, 2017; Mccrae & John, 2011).

### 2.4.1.4 Companionship Support

Companionship support moderates stress by providing recipients with a sense of belonging and contact with others (Krohne, 2012; Kuppens & Diener, 2015). It alleviates the concerns and worries brought on by stressful events and positively influences mood which it later reflects the degree of mutual interests between provider and recipient (Cohen &Wills, 1985).

Furthermore, companionship support fosters a sense of belonging among people with similar interests and concerns (e.g., "We would like you to join our support group") (Cutrona & Shur, 1994; Krohne, 2012; Kuppens & Diener, 2015). Vietnam veterans, Keane et al. (1985) determined that positive social contact and companionship support (as one type of social support) relieved symptoms of post-traumatic stress disorder.

Previous studies have analysed the influence of companionship support, also known as "social integration". This type of support aids individuals in coping with physical or psychological illnesses. For instance, companionship support has been found to protect recipients against the loss of morale due to medical problems (Cutrona & Russell, 2015; Lauritz, Preez, Cassimjee, & Ghazinour, 2015).

### 2.4.2 Social Support Seeking and Providing Behaviour

The different important factors involved in providing and receiving support stated in the literature will be discussed herein. The social support research community considers the following features as needing social support: (1) stress risks, (2) receipt factors, (3) relationship factor, (4) provision factor, and (5) motivational support (Bolger & Amarel, 2011; Koetsenruijter et al., 2015; Hendrickx et al., 2016). In the case of the *stress risk factor*, it is based on the individual's ability to recognise the need for support and his desire to receive additional support. The factor takes into consideration the stressors and appraises the stressor factors. This factor can be affected by how the individual considers the stressors, his vulnerabilities (mental illness risks), and his expectation while receiving additional support (Lee et al., 2013; Macniven et al., 2016).

Universiti Utara Malaysia

Several studies have observed that the level of stressors can be related to the degree of the support level received. For instance, the situations considered to be stressful by both the recipient and the provider, are more likely to trigger additional support response as compared to the non-stressful situations (Bolger & Amarel, 2011; Albrecht & Martin, 2009).

When the need is recognised, the support provider would determine the necessity of assistance, and then, would offer support (Adelman et al., 2000; Haines et al., 2011; Rogers et al., 2018; Herrera et al., 2017). While trying to comprehend the support process, another point to be considered includes the *recipient factor*. An important way of ensuring support is requesting for it. Requests can be made directly or in an indirect manner. The direct request processes can differ from the indirect techniques concerning the inextricably fused features; like their clear communicativeness and demand parameters (Haines et al., 2011; Rogers et al., 2018; Shen et al., 2016).

In such scenarios, an individual's personality greatly determines whether a direct or an indirect request would be expressed, for instance, individuals with a neurotic personality request support using unpleasant emotional gestures. Several reports which have observed individual personality and the support garnered, have observed that people with higher self-esteems i.e., who are more assertive gather better social support as compared to individuals having a neurotic personality (Adelman et al.,2000; Both et al., 2014).

An additional parameter regarding the recipient support factor is the need for support (requested support). The individuals should identify the necessity for support and must be ready to receive any type of assistance. Generally, this parameter is affected by the individual's point of view to their expectations from others (i.e., perceived support availability) (Tausig & Michello, 2010; Hyung-Chul et al., 2017).

In the *relationship* factors, the features of the relationships (ties) present between the individual, i.e., the support recipients and the support providers are very relevant for activating the support selection behaviours. It also includes mutual interest (i.e., experimental and situation-based similarity), along with satisfaction with the relationship.



Universiti Utara Malaysia

This is an eventual part of the socio-cultural system which includes a fine equilibrium between giving support and receiving it. Hence, it should be noted that two antecedents are present which are closely related to the relationship parameters, i.e., the acceptance of the social norms and their reciprocity norms (Adelman et al.,2000; Haines et al.,2011; Mustafa et al., 2015; McQuaid et al., 2016).

The social norms comprise of the perception regarding individual responsibility, their intimate relationships, and obligations. As an example, any individual feels responsible (i.e., considers his responsibility) concerning other people who depend on him. This increases the probability of support being offered in the relationships (either in a weak tie or a strong tie relationship). In the reciprocity norms, earlier interactions and previous supportive exchanges between the individuals affect the future willingness displayed by the recipient and the support provider (Tausig & Michello, 2010; Hyung-Chul et al., 2017). Earlier incidences of frustration and failure of previous attempts could affect a person's motivation and desire to offer support. Hence, with this regard, any individual who has refused to receive any type of support earlier would have a lesser likelihood of receiving more support in the future (Helgeson, 2013).

The type of support which is needed is highly related to the recipient individual's preference for the social ties, as already stated above. The fourth parameter is based on the *support provision attributes*. The support providers, who have to offer support, are



Universiti Utara Malaysia

motivated by many factors. There are many studies which indicate that the social support providers who have an empathic and an altruistic attitude would develop an altruistic motivation for helping others (Adelman et al., 2000; Both et al., 2014). Though this condition is more applicable in the weaker tie networks, it is invariably useful to determine the support pattern even in the stronger tie network.

Additionally, focusing on other individuals would escalate the probability of providing support by increasing the feeling of empathy, which could later develop into efficacy. It is also based on the willingness of the support provider to offer support. Hence, if the provider is more willing, he/she would offer more support and help and vice versa. The provider's willingness also depends on the individual's personality traits and altruistic behaviour (Etzion, 2009; Helgeson, 2013; Hyung-Chul et al., 2017). Therefore, willingness and a more altruistic behaviour of the provider would result in more acceptability for helping as compared to those providers who do not possess these traits. Finally, the last feature involves *motivation in support*. This feature depends on the effect of choosing a support provider to the individual's relationship perspective based on his/her support requirement (Haines et al., 2011; Mincu & Taşcu, 2015). These precursor parameters tend to explain the individual and the interpersonal traits which can impact an individual's decision to seek help and support from some specific social network member. Table 2.6 summarizes all factors and sub-factors on social support process.

Universiti Utara Malaysia

Table 2.6.

*Factors of Social Support Recipient and Provider.*

| Factors | Sub-factors | References |
|---|---|---|
| Stress risk | • Perceptions of stressors,<br>• Vulnerability (risk in mental illness),<br>• Expectations support from others. | (Albrecht & Martin, 2009; Bolger & Amarel, 2011; Lee, 2013; Macniven et al., 2016). |
| Receipt | • The need of support (Type of support and social tie preference: weak tie and strong tie)<br>• individual's personality (a neurotic personality) | (Adelman et al.,2000; Tausig & Michello, 2010; Haines et al.,2011; Both et al.,2014; Rogers et al., 2018) |
| Relationship | • Social norms (individual responsibility, intimate relationship and obligation)<br>• Reciprocity norms (willingness of both support recipients and providers) | (Etzion ,2009; Tausig & Michello, 2010; Haines et al.,2011; Helgeson,2013; Goldsmith & Parks, 2016; Shen et al., 2016) |
| Provision | • provider's willingness to help (personality attributes like agreeableness, and altruistic behaviour) | (Etzion,2009; Haines et al.,2011; Helgeson,2013; Goldsmith & Parks, 2016; Hyung-Chul et al., 2017) |
| Motivation in support | • Future goal orientation (Weak tie)<br>• Emotional goal orientation (Strong tie) | (Adelman et al.,2000; Tausig & Michello, 2010; Haines et al.,2011; Both et al.,2014; Mincu & Taşcu, 2015) |

### 2.4.3 Social Support Network and Mental Health

Researchers on social support often make a distinction between two social relationships when referring to the sources of social support (Dodson et al., 2016) which are extracted from the strong tie/weak tie support network theory. In this theory, how an individual manages the support seeking technique while taking into consideration his additional relationships and personal needs, have been explained. The strong ties generally refer to the relationship between the people in a very enclosed personal setup. Usually, the strong ties comprise of associations like families, friends, and spouse that are regularly acknowledged (Adelman et al., 2000; Albrecht & Martin, 2009; Dodson et al., 2016). On the other hand, a weak tie refers to associations which involve frequent communication but are not considered to be close contacts or strong providers (Adelman et al., 2000; Both et al., 2014).

The person's desires for support generally affects his choice of the support providers present in any relationship (Cohen & Wills, 1995; Gross & John, 2009; Zheng, 2017). To explain further, many reports have observed that individuals who have a long-term point of view (or have future goal orientations) find it difficult to obtain proper information-based support from their close relationships as they usually consider that their close friends lack the skills or information needed for solving the individual's problems (Albrecht & Martin, 2009). But, if the individual has a greater desire to seek emotional support (or called as emotional goal orientation), then such an individual would tend to select a stronger tie support system over a weak tie group (Wellman & Wilson, 2010; Goldsmith & Parks, 2016).

The social support network is vast and has facilitated individuals to research on topics of diverse nature ranging from social science (Carpentier et al., 2013), to political science (Ganim Barnes et al., 2014), and community health (Agarwal, 2014; Paul & Dredze, 2013). Most outlets that directly allow people to connect through digital communication



Universiti Utara Malaysia

technology and feature interactive aspects fall under the umbrella of social support networking (Zorn et al., 2013). Wang suggests that organizations engage in social networking to a) build relationships, b) facilitate collaboration or c) heighten user engagement through fun and entertaining activities (Wang et al., 2016). By analysing the data being created via various social support network, a person can directly provide information on global events.

As far as medical research is interested, there has been a considerable rise in the use of social media as an instrument for public health in the last few years. Data from Twitter have been used to identify the spread of flu symptoms through various statistical models that analysed geo-tagged tweets to predict the spread of infectious diseases (Sadilek et al., 2012). Researchers have also used application of the Ailment Topic Aspect Model to over 1.5 million health-related tweets, to build insights about diseases and find out inter-relationships between ailments and behavioural risk factors (Paul & Dredze, 2013).

Additionally, monitoring of public opinion on a public health topic can offer vital inputs on the most persuasive type of messages (Lamb, 2014). Krieck et al. (2011) tried to improve the traditional communication mediums of disease outbreak, with the information gathered from Twitter. They demonstrated that to detect the relevancy of a tweet to an outbreak, self-reported symptoms are the most dependable signal. Attempts have been made by researchers to capture the overall trend of specific disease outbreaks, typically influenza, by observing social media (Sheppes & Gross, 2011; Broniatowski et al., 2013; Collier et al., 2014). Several reports have observed that information present on the individual's social support network profile reflects their real personalities (De Choudhury et al., 2016). Current research has also indicated that the social support networks techniques which strive to support the personal and the professional relationships would greatly benefit from the user's personality insight. The "Big Five" model describing the personality dimensions is a very popular and thoroughly researched personality measure structure, used in recent times. This model represents 5 different personality domains: Agreeableness, Conscientiousness, Extroversion, Openness, and Neuroticism in Table 2.7 (Srivastava & Salakhutdinov, 2012). This research helps establish the fact that individuals' social environments carry key information that helps understand and intervene in mental health. Mental health situations mostly display implicit changes in behaviour and language, such as a shift in word usage, a switch in the types of topics, or a shift in frequency of posts (Gamon et al., 2013; De Choudhury et al., 2016).

Universiti Utara Malaysia

Table 2.7.

*The "Big Five" Factors Represent Personality of the Individuals*.

| Personality Types | Description |
|---|---|
| Openness to Experience | • Curious, intelligent, and imaginative.<br>• High scorers tend to be artistic and sophisticated in taste and appreciate diverse views, ideas, and experiences. |
| Conscientiousness | • Responsible, organized, persevering.<br>• Conscientious individuals are extremely reliable and tend to be high achievers, hard workers, and planners. |
| Extroversion: | • Outgoing, amicable, assertive.<br>• Friendly and energetic, extroverts draw inspiration from social situations. |

Table 2.7 Continued.

| | |
|---|---|
| Agreeableness | • Cooperative, helpful, nurturing.<br>• People who score high in agreeableness are peace-keepers who are generally optimistic and trusting of others. |
| Neuroticism | • Anxious, insecure, sensitive.<br>• Neurotics are moody, tense, and easily tipped into experiencing negative emotions. |

### 2.4.4 Computational Analysis Techniques on Social Support Networks

Kautz (2013) suggested FluTracker, constructed a probabilistic model which can forecast with high accuracy whether an individual is going to fall ill, and recall based on his/her social ties and co-locations with other people, as disclosed by his/her Twitter posts. For example, for influenza surveillance, Google Flu Trends offers exact predictions of flu infections. These predictions are based on online search queries to find influenza outbreaks indirectly by tracking the frequency of Internet searches for terms associated with influenza-like diseases. Similarly, the Linguistic Inquiry Word Count (LIWC) is a highly popular and certified tool that is used for the psychometric analysis of language data (Pennebaker et al., 2010). It aids in identifying languages related to all types of ailments.

Some researcher like Zhang et al., (2010) used knowledge-based configuration approach for modelling and predicting emotion dynamics to obtain an approximate solution for model learning. Likewise, Elhadad & Gravano (2013) believed that status updates on Facebook could be used to predict depressive incidents, the same results can be found in several works of literature that were applied in different social platforms (Kotikalapudi et al., 2012; Gamon et al., 2013; Resik et al., 2013; De Choudhury et al., 2016).

Universiti Utara Malaysia

Another research team, Nie et al. (2012) recommended a Support Vector Machine (SVM) model in which the browsing habits of users are analysed to predict their mental health status. They executed a system called WebMind that offers advice for correcting mental disorders. For tackling mental health problems, Zhou et al. (2017) suggested a framework for multimodal monitoring for handling mental health issues. In this model, the users' online social activities and physiological signals that are perceived through ubiquitous sensors are applied in natural situations for checking their mental health states.

In other related work, for the same reasons, the reality mining technique was used by some researchers to identify behavioural patterns (Pentland, 2013), which possibly offer good signs of progress in health education efforts by integrating data mining with psychology in social network services (Wang et al., 2016).

Universiti Utara Malaysia

From another viewpoint, some researchers like Lin et al. (2015) suggested a Deep Neural Network (DNN) model integrate the two types of user-scope attributes to identify users' psychological stress by employing real online micro-blog data. In recent times, the exceptional ability of Deep Neural Networks (DNN) in learning features from high volume unlabelled data has been established by extensive research on deep learning (Hinton, & Salakhutdinov, 2007; Bengio, 2010; Ngiam, 2011; Srivastava & Salakhutdinov, 2012). Table 2.8 summarizes techniques used for mental health with different social media platforms.

Table 2.8.

*Techniques Used in Social Media to Tackle Mental Health.*

| Techniques | Application | Social Media | References |
|---|---|---|---|
| Data Mining | Depression Detection Model Based on Sentiment Analysis | Micro-blog | (Wang, et al., 2016; Pentland, 2013) |
| Crowdsourcing | probabilistic model based on the CES-D (Centre for Epidemiologic Studies Depression Scale) screening test | Twitter | De Choudhury et al. (2016) |
| Data Mining | Clustering and classification analysis | Facebook | Elhadad, & Gravano (2013) |
| Data Mining | Support Vector Machine (SVM) model. | Users web browser (WebMind) | Nie et al. (2012) |
| Ubiquitous Sensors | Pervasive multimodal sensors based on modern computer vision, machine learning techniques. | Twitter | Zhou et al. (2017) |
| Natural Language Processing | Linguistic Inquiry Word Count (LIWC) | Twitter | (Pennebaker et al., 2010; Resnik et al., 2013) |
| Data Mining | Deep Neural Network (DNN) model | Micro-blog | (Hinton, & Salakhutdinov,2007; & Bengio,2010; Lin et al., 2015) |
| Data Mining | Multimodal learning based on Deep Neural Network (DNN) | Twitter | (Ngiam,2011; Srivastava & Salakhutdinov ,2012) |
| Configuration Based System | Configuration algorithm: MoodCast | Facebook | (Zhang et al.,2010) |

Universiti Utara Malaysia

## 2.5 Configuration Based System

The Configuration Based Systems (CBS) is one of the most effective application areas of Knowledge-Based Systems (KBS) (Barling et al., 2018; & Collins & Feeney, 2015). KBS is a technique capable of supporting explicit representations of knowledge on a specific domain of expertise and capable of using it to provide solutions to problems in that domain (Dojat et al., 2011; Geschwende et al., 2014; Wei & Blake, 2015). Several researchers have proved that CBS is one of the most significant methods of organizing the knowledge in institutions if applied inappropriate parts and to appropriate tasks (Dojat et al., 2011; Gierl & Rutkowski, 2013; Song et al., 2015).

Universiti Utara Malaysia

An arrangement of parts is also known as a configuration. Therefore, a configuration task is a problem-solving activity which chooses and organises combinations of parts to meet given specifications (Bo et al., 2015). For example, computer engineers and salespeople configure computer systems from various computing devices, memory devices, input and output devices, buses, and software. Dieticians configure diets from different combination of foods. However, previous examples have shown that identifying and evaluating these variables without using the configuration methods is not enough because of a variety of reasons. First, these variables and sub-variables have a large number of interrelationships existing among them. Second, the system performance is influenced not only by the variables but by their mutual effectiveness as well.  This makes it necessary to apply a configuration approach.

Configuration problems start with broad specifications and end with more specific information about the needed components and how these components should be organized (Yang et al., 2014). Technically, configuration utilises a predefined set of potential items/components to start the process of creating a technical system (Stumptner, 2017; Wei & Blake, 2015). Its focus is not just on the outside environment or on its internal resources but the set of variables' mutual influence (Fohn et al., 2013; Van Der Aalst et al., 2015). Figure 2.3 describes an example of a configuration that is a solution to a configuration problem. Therefore, this example reflects that the core element of solving a configuration problem is selecting and arranging parts. Therefore, to solve a configuration problem, the instantiation of a potentially large subset of the predefined classes is needed. The search space of possible solutions to a configuration problem the set of all possible subsets of components.

UUM
Universiti Utara Malaysia

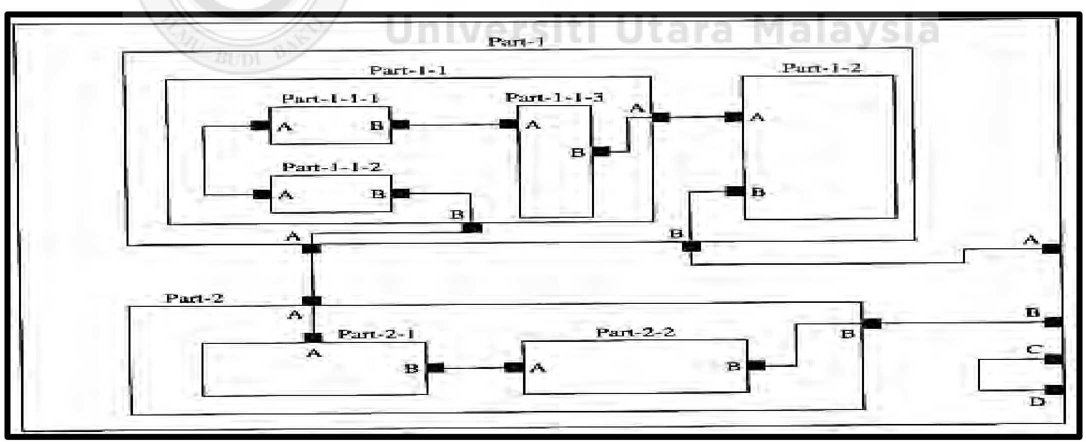



*Figure 2.3*. Example of Solution to Configuration Problem (Yong et al., 2014).

In Figure 2.3, all components are shown as boxes and the top-level component is configuration-1.it has two parts, Part-1 and Part-2. The arrangement of the configuration is indicated by the part-of hierarchy, displayed graphically by the containment of boxes and by the interconnections among parts. Each part has several ports, labelled A, B, C, or D. For example, the B port of Part-1-1-1 is connected to the A port of Part-1-3. In this study, the meaning of arrangement here refers to the assignment of social supports as it is possible to determine where social support could be located in an assignment, and which social supports in a set could be added to an assignment as elaborated it in details in Section 4.5.1.

### 2.5.1 Concepts in Configuration Methods

In the area of Artificial Intelligence, especially for technical systems, there have been different developments of various methods, which could be successfully applied (Amilhastre et al., 2016; Gierl & Rutkowski, 2013; Song et al., 2015). After conducting a general analysis of the configuration problems, researchers have been able to identify four central elements (with regards to knowledge types) concerned with configuration (Ardissono et al., 2011). These aspects are:

- A set of objects in the application domain and these objects' properties (parameters) as well.
- A set of relations found between the domain objects. Taxonomical and compositional relations are particularly important for configuration.

- A task specification which specifies what demands a configuration has to meet (configuration objectives).
- Control knowledge regarding the configuration process.

Often, a configuration is referred to as "routine design". The basis of this often lies in the classification of synthesis tasks according to Brown and Chandrasekaran (2000). Configuration domains differ in their representation of arrangements. For example, Figure 2.3 represents an arrangement using a port and connector model. The ports of each part correspond to the different roles that subparts can have for each other. Therefore, variation in the search requirement and the available domain knowledge for different configuration tasks lead to variation in the methods.

Configuration methods work through recognizable phases as it maps from user specifications to abstract descriptions of a configuration, and they refine abstract solutions to detailed configurations specifying arrangements and further requirements. Figure 2.4 shows the relevant spaces for defining configuration problems (Wei & Blake, 2015).

Universiti Utara Malaysia

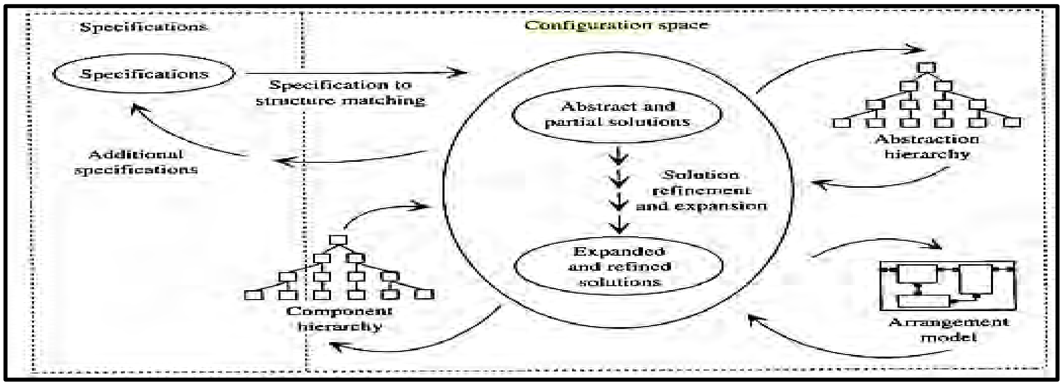


*Figure 2.4.* Spaces in Configuration Tasks (Wei & Blake, 2015).

Figure 2.4 represents spaces of configuration problem, it distinguishes between solution expansion and solution refinement phases, not to imply that they are independent, but to emphasize the distinct meanings of part requirement hierarchies, functional abstraction hierarchies, and physical containment hierarchies. An incremental approach is often taken to perform the configuration.

Universiti Utara Malaysia

A configuration result is represented by every step and it could also include simulating or testing with constraint techniques. There are generally two types of configuration methods: representation-oriented, and task-oriented (Stumptner, 2017). With the representation-oriented view, the main objective is finding the right representation to express the problem domain structure. Representation-oriented methods can be rule-based configuration, dynamic constraint satisfaction problem, and resource-based configuration, among others. The task-oriented view, on the other hand, focuses on identifying the sub-problems to be solved (Stumptner, 2017; Fohn et al., 2013; van der Aalst et al., 2015). The hierarchical method and case-based reasoning can be classified under task-oriented methods.

### 2.5.2 Implementation of Configuration Algorithms

In many areas of the academia and industry, configuring algorithms automatically to gain higher performance is becoming increasingly pertinent and important. A parameterised target makes use of the methods of configuration algorithm, comprising the algorithm, a performance metric and a set of example data (van der Aalst et al., 2015). Given a data set, the goal is to come up with a parameter configuration which performs as well as possible. Configuration algorithm, systems like the ParamILS (Hutter et al., 2009), GGA (Sellmann &Tierney, 2012), IRACE (Birattari et al., 2011), and SMAC (Hutter et al., 2013) have been able to showcase impressive performance improvements, given a wide range of applications.

The configuration task is executed for a set of parameters by a target algorithm with a given configuration space and a collection of training instances. Additionally, the algorithm is given a performance metric to improve like the runtime or solution quality of the target algorithm and a configuration budget like the total runtime allowed for the configuration process (Lindauer & Hutter, 2014). The configuration space is the cross-product of the parameters (which, for discrete parameters, is exponential in the number of target algorithm parameters). The configuration consists of top-level (non-conditional) parameters and conditional parameters (Lindauer & Hutter, 2014). Yong et al., (2014) describes the workflow of the configuration algorithm in Figure 2.5.

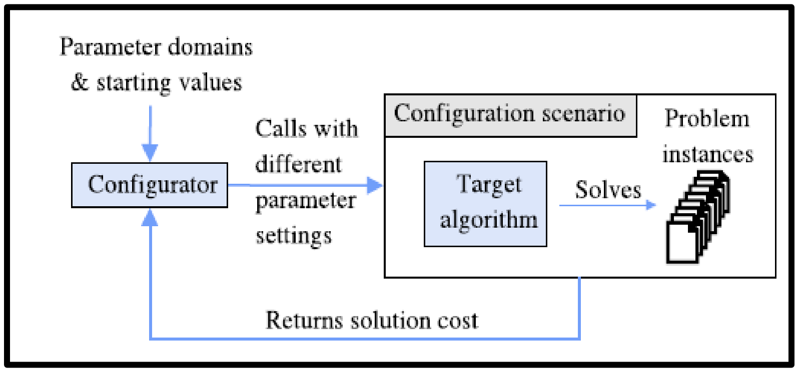



*Figure 2.5.* Visualization of a Configuration Algorithm (Yong et al., 2014).

As shown in Figure 2.5, given one or more problem instances, a configuration procedure implements the target algorithm with stipulated parameter settings. It then gathers information about the performance of the algorithm and utilises this to decide about the target algorithm. The target algorithm to be configured and a collection of instances are some of the factors included in a configuration scenario.

Universiti Utara Malaysia

### 2.5.3 Dynamic Support Models

There is a clear role for dynamic support methods in healthcare applications. Zhang et al., 2010 proposed a support model called MoodCast for predicting emotion dynamics in the social network based on a configuration approach to obtain an approximate solution for model learning. MoodCast method based on a dynamic continuous factor graph model for modelling and predicting users' emotions in a social network. MoodCast incorporates users' dynamic status information (e.g., locations, activities, and attributes) and social influence from users' friends into a unified model.

Morris proposed and constructed a crowdsourcing support model (Panoply) which would help the individuals generate healthy and positive reappraisals for the stressful circumstances (Morris, 2015). This technique received a lot of support from the crowd workers. A lot of research conducted in the field of emotional regulation, cognitive neurosciences, and clinical psychology has influenced the therapeutic process that forms the major backbone of this model.

Berg and Coady (2012) developed the dynamic support model known as the Pervasive Health Adaptive Client Technology System (PHACTS). The system's architecture integrates three distinct but related components, which correspond to three separate stakeholder perspectives. These perspectives include: (1) the general practitioner, (2) the patient or home-care giver, and (3) additional healthcare professionals. Each of these perspectives includes the ability to generate context-sensitive medical data included in the client system and to further meaningfully coalesce information across the integrated subsystems corresponding to individual stakeholders. Stakeholders possess the ability to customise their view and modify the collection strategies and classification of the persistence and sensitivity of the data collected.

Tichon and Shapiro (2013) constructed a support model for explaining social support in cyberspace for a support group for children with siblings who have special needs. The model begins with an external stressor on the child that causes them to seek social support. Social support messages are sent to other children who receive social support and respond by sending social support messages in kind to the first child. Such a model is good in that



Universiti Utara Malaysia

it emphasizes the interactional nature of social support between sender and receiver. The model is circular, however, implying that children send messages to each other indefinitely. Lepore et al (2008) tested two models explaining the association between social support and psychological distress in cancer patients. The models tied social support to one particular outcome and did not consider the transactional nature of changing social support conditions as one's health condition and support environmental change.

Moshidi (2018) developed a care and support model for Human Immune Deficiency Virus (HIV) and Acquired Immune Deficiency Syndrome (AIDS). A key step in the development of this model is to explore and describe the experiences of professional nurses regarding the care and support they receive while providing care to HIV and AIDS patients. Since, the health care workers have a pivotal role in the management of HIV and AIDS and their well-being is consequently crucial as it could impact negatively on the quality of caregiving.

Universiti Utara Malaysia

### 2.6 Modelling

Modelling is the scientific way to gain benefits in understanding the real-world systems. It is merely human constructing to ease the complexity of a particular phenomenon in the real world. Models always come in various forms. For example, conceptual models (Tomé Klock et al., 2015), graphical models, statistical models (Freedman et al., 2015), logical models (Bouzeghoub & Kedad, 2010), and mathematical or computational models (Mui et al, 2012). These different types of models serve a particular function based on the complexity of the domain problem.

In more recently, formal modelling technique (computational modelling) are also being used interestingly to model different complex circumstances using grounded theories (i.e., data is not necessarily available where existing theories are enough to be used in constructing the model). Such these models can be seen in transportation (Bosse et al., 2016) and health care (Klein et al., 2015). From those foundations, this study will use computational modelling process (i.e. the computational modelling to imitate the real system) as a core component in developing social support assignment model.

Formal modelling (computational modelling) refers to the process that gives a detailed description of a set of processes or certain phenomenon saw in the current world to acquire a deep comprehension of these phenomena and to predicate the result of natural processes over particular input parameters (Aziz, 2011). From another angle, computational modelling in this research also called dynamic modelling because it can describe how system properties change over time (Silchenko & Tass, 2015).

Universiti Utara Malaysia

Moreover, it involves several modelling techniques to interpret relationships between variables such as mathematical modelling (using mathematical equations to explain the relationship between variables like a differential equation) and describe entities relation informal logic order (e.g., first-order logic and rule-based). For example, emotional concept model (Malehi, 2015), the decision-making model (Hoogendoorn et al., 2010) and a model of physical and mental health (Klein et al., 2015). Overall, computational models are much promising as an alternative way when real-world experiments are not easy to conduct.

### 2.6.1 Theoretical and Techniques of Computational Models

Despite the clear reasons for the use of computational models in multiple facets, it can be categorized into two main purposes, theoretical understanding and practical application. From a theoretical point of view, it became easy to understand how the actual system works. In contrast, a practical model will make the predictions of the real system whereby a set of feasible actions will be taken (Ellner & Guckenheimer, 2006). In more specific, dynamic equations are usually used to express theoretical models, and those equations are yet simple enough for scientists to comprehend the underlying process. From another angle, it is useless to replace an observed system with a complex model that difficult to comprehend when it has not increased our deeper understanding of the observed domain.

On the other hand, practical models generally move out simplicity to provide more comprehensive and precise predictions for an observed system. Therefore, practical models are frequently very complex and only developed for computer simulations objectives (Ellner & Guckenheimer, 2006). Concerning this, practical models are involved in numerical accuracy to accurate the details of the processes, whereas this is not existing in theoretical models. Therefore, the details of the processes can be neglected solely if it has a smaller amount of influence in determining better numerical accuracy. However, the opposite case in theoretical models, whereas the details of processes can be ignored if they are theoretically not related to addressing essential theoretical issues (Aziz, 2012).

### 2.6.2 Computational Models in Psychology

In more recently, developing intelligent digital artefacts based on incorporating knowledge and information from the human-directed disciplines such neuroscience, biomedical science, cognitive science, psychological and social science (Bosse et al., 2016). The obtained knowledge (human functioning knowledge) aids the developed application to achieve more detailed analysis, like human functioning analysis that observes human's operation and therefore appropriate activities and better actions will be made. Examples of human functioning knowledge can be seen in (Itti & Koch, 2001) for understanding visual attention, (Both et al., 2012) support depressed person, (De-Carolis et al., 2013) and support elderly people for better living.

Universiti Utara Malaysia

Also, Bosse et al., (2016) have stated that within human-directed scientific areas such cognitive science, neuroscience, and psychology, models have been and are being generated for various aspects of human functioning and if such models of a human process are represented in a formal and computational format, and incorporated in artefacts that perceive a mental and physical state of the human, then such artefacts are capable to accomplish a more detailed analysis of the human's based functioning. By doing so, it will enable these artefacts to efficiently influence the state of humans by undertaking activities in a knowledgeable approach that enhance an individual's performance and wellbeing (Boss et al., 2011).

Overall, models to study mental and physical state are important to develop human-aware systems capable to support humans in a knowledgeable manner (Bibri, 2015). Psychology is the domain of studying behaviour and the human mind in both fields; practical and theoretical (Farrell & Lewandowsky, 2013). Research in psychology aims to know and describe the theoretical structure of feeling, behaviour, and though. Also, since the process of the human mind is complex, and it has great influence in behavioural flexibility, computational modelling is more favourable to illustrate the processes and its interactions (Farrell & Lewandowsky, 2013).

Universiti Utara Malaysia

Furthermore, computational modelling can further the level of the details of the process and increase the scale of input-output interactions. As a result, computational modelling is very significant to explain the level of human behaviour (Kumar et al., 2018; Zhang, 2015).

Computational models are used as a powerful way to study the human mind and gives a clear understanding on how it works, therefore this approach to study the human mind is called cognitive modelling (Bosse et al., 2016). Haring et al. (2013) defined cognitive modelling a method to study the human mind, how the human memory is organized to mimic reality, how the human memory is utilized for the organization of actions. Table 2.9

explains enough examples of various computational models and shows what techniques used in developing them as well.

Table 2.9.

*Examples of Computational Models and Its Techniques.*

| **Author** | **Year** | **Title** | **Techniques** |
|---|---|---|---|
| Manley et al., | 2005 | A Dynamic Model to Support Surge Capacity Planning in a Rural Hospital | Differential Equation |
| Marsella and Gratch | 2009 | EMA: A process model of appraisal dynamics | Rule-based |
| Soleimani and Kobti | 2012 | A Mood Driven Computational Model for Gross Emotion Regulation Process Paradigm | Differential Equation |
| Steephen | 2013 | Hed: A computational model of affective adaptation and emotion dynamics | Differential Equation |
| Mollee & van der Wal | 2013 | A computational agent model of influences on physical activity based on the social cognitive theory | Differential Equation |
| Bosse, Duell, Memon, and van der Wal | 2016 | A Computational Model of the Relation between Regulation of Negative Emotions and Mood | Differential Equation |

## 2.7 Evaluation Process in Computational Modelling

An essential step in the process of developing computational models is evaluation. Evaluation process refers to a set of actions that ensures the model has been developed appropriately. In another word, it refers to a range of activities carried out to prove that the model process and its predictions are rigour and credible significantly (Antoniadou et al., 2014). Generally, those activities that ensure the reliability and accuracy of computational models are verification and validation (V&V) (Anderson et al., 2007).

### 2.7.1 Verification

In computational modelling, verification refers to the processes that prove the developed computational model is implemented correctly. Simply, the verification process deals with checking the equations of the developed model are right (i.e., to prove the model is developed in the right way) (Anderson et al., 2007). From previous pieces of literature, some verification methods are available to check the correct implementation of computational modelling.

For example, stability analysis (mathematical proofing to determine equilibrium points) (Bosse et al., 2016), sensitivity analysis (i.e., to make sure that model parameters are sufficiently accurate to ensure the output of the model remains predictable) (David, 2013), and Routh–Hurwitz stability criterion (Gbenga, 2012). All these methods are used to make

Universiti Utara Malaysia

sure that a particular computational model is free-error and represents the underlying concepts of the modelled problem (Merk, 2011; Klein et al., 2015).

### 2.7.2 Validation

On the other hand, the validation process is an essential part to ensure that the developed model has been developed about the real world. The validation process is always concerning to build the right model (e.g., to prove the right model has been developed) (Anderson et al., 2007). There are several validation approaches have been proposed in evaluating the different type of computational models in social systems.

For example, conceptual or theoretical validation (experts are determining how the constructed model based on fundamental data is accurate in characterizing the real world), cross-model validation ( refers to the comparison between different models to determine the validity), external validation (refers to external experiments against the real world), data validation (refers to the accuracy of actual and generated data (i.e. real world and computer data), internal validation (refers to the validity of the proposed model based on computer simulations) (Bharathy & Silverman, 2010; Kumar et al., 2018).

Furthermore, examples of such studies that applied internal and external validity can be seen in (Hoogendoorn et al., 2010; Klein et al., 2015). Table 2.10 summarizes techniques used for evaluation.

Table 2.10.

*Techniques Used in the Evaluation Process.*

| **Author/Year** | **Paper** | **Evaluation Techniques** |
|---|---|---|
| Anderson et al., (2007). | Verification, validation and sensitivity studies in computational biomechanics. | Internal validation |
| Hoogendoorn et al., (2010). | Formal Analysis of Intelligent Agents for Model-Based Medicine Usage Management. | External Validation |
| Bosse et al., (2016). | Incorporating human aspects in ambient intelligence and smart environments. | Stability Analysis Verification |
| Kumar et al., (2018). | Understanding Human Driving Behaviour through Computational Cognitive Modelling. | Cross-Model Validation |
| Klein et al., (2015). | Encouraging Physical Activity via a Personalized Mobile System. | Sensitivity Analysis Verification |

## 2.8 Summary

The chapter has illustrated the concepts of stress and therapy and showed different methods to cope with stress. Moreover, theories and factors of social support network have mentioned as well. Social support networks and its effect on society and how it offers measures for person daily life have explained in detail. Also, the concept of configuration approach and its applications for different domains has detailed and extensive works of literature have reviewed to give enough information related to the previous chapter. Next, the concepts of human functioning models (computational models) and evaluation processes of those models are hugely introduced. Next chapter describes the methodology that has been used to conduct this study.

Universiti Utara Malaysia

# CHAPTER THREE

# RESEARCH METHODOLOGY

## 3.1 Introduction

This chapter introduces the methodology that will be used in conducting this research. First, Section 3.2 shows the overall research methodology as a guideline for this research. Later, the next subsections describe problem identification and motivation (Section 3.2.1), objectives of the solution (Section 3.2.2). Next, Section 3.2.3 presents the design and development and it follows by Section 3.2.4 that describes the demonstration. Section 3.2.5 discusses the evaluation phase while Section 3.2.6 describes the processes to answer the research questions. Finally, Section 3.3 summarizes this chapter.

Universiti Utara Malaysia

## 3.2 Research Methodology

This section introduces the research methodology that includes all standard elements and tools in designing an automated social support assignment model. This research methodology is adapted based on the Design Science Research Process (DSRP) to achieve the intended objectives (Peffers et al., 2014; Gacenga et al., 2017). This methodology can be summarized into five stages namely: 1) Problem Identification and Motivation, 2) Objectives for the Solution, 3) Design and Development, 4) Demonstration, 5) and Evaluation. These stages are illustrated in Figure 3.1. Each stage has different activities to accomplish the corresponding research objectives.

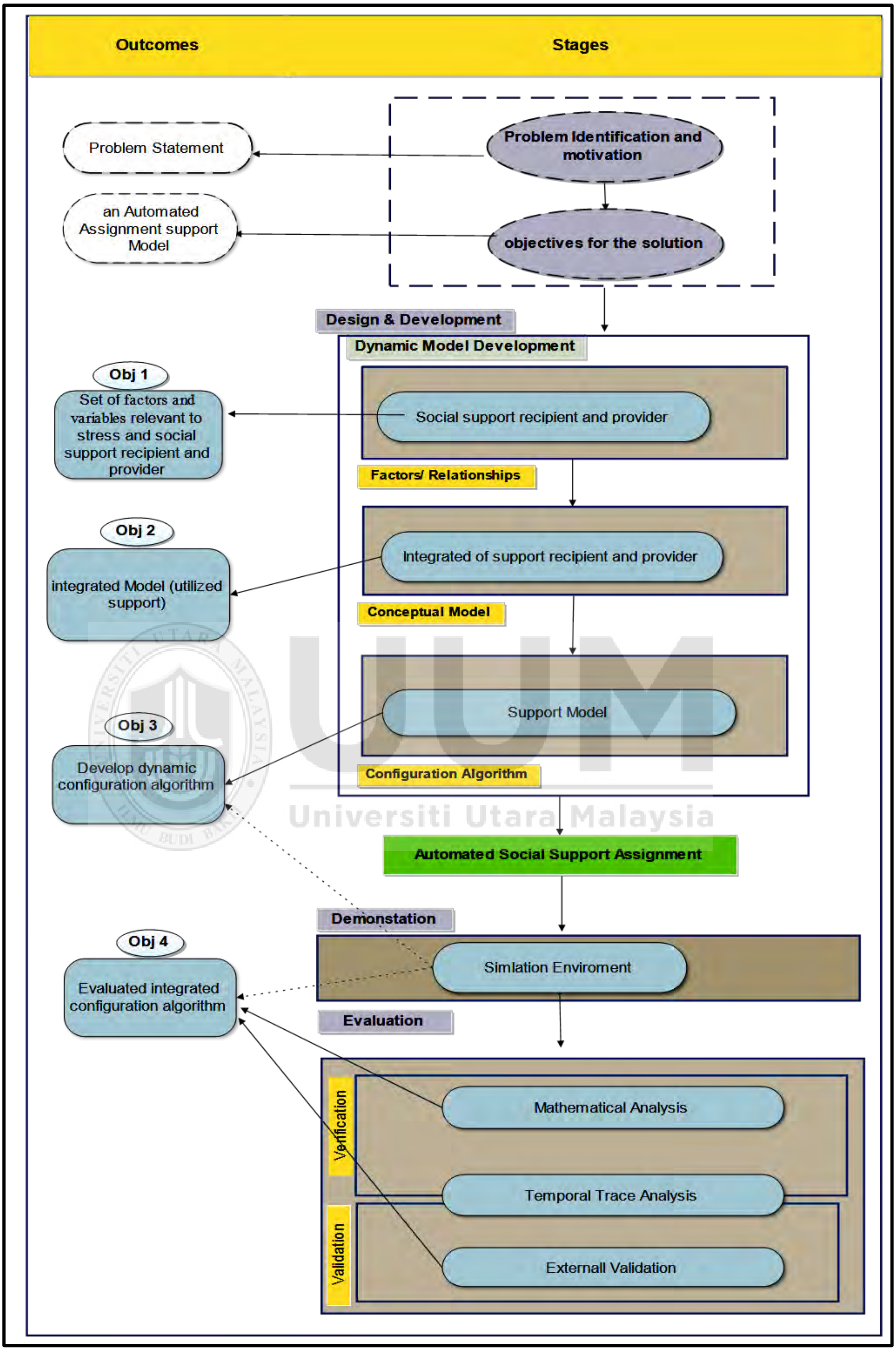



*Figure 3.1.* Research Methodology.

The research methodology is used as a guide to develop and validate the computational model that can be grouped into five phases namely; domain, design, operational, simulation and evaluation phases. Figure 3.2 depicts the expected outcomes of these five models.

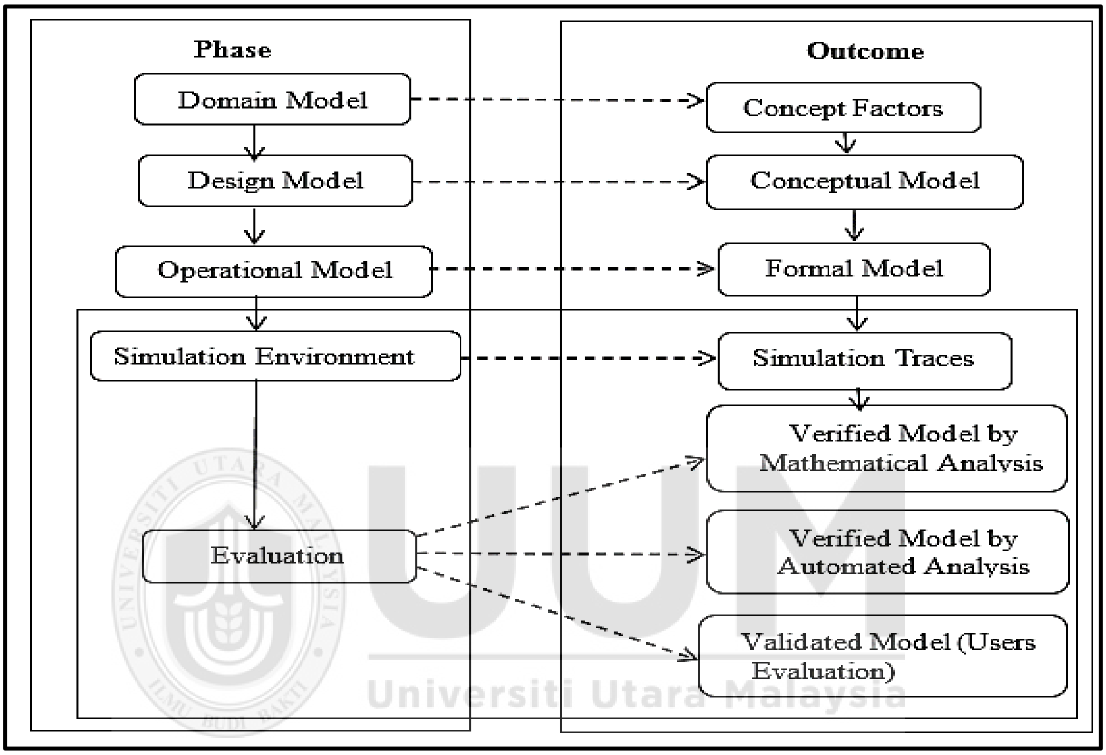



*Figure 3.2*. Methodology Model Flow with Outcomes.

This methodology has been employed by many agent-based modelling research domains such as agriculture (Schreinemachers & Berger, 2015), economics (Luna & Stefansson, 2012), social behaviour (Conte & Paolucci (2014), environment (Serrano, Moncada, Garijo & Iglesias, 2016), medicine (Wang, Butner, Kerketta, Cristini & Deisboeck 2017) and energy consumption (Rai & Robinson, 2018). Each of these phases has different activities to achieve the study objectives.

### 3.2.1 Problem Identification and Motivation

In this phase, the research problems were based on reviewed literature to consolidate the identified problems. During this stage, important factors and scenarios in social support recipient and provision processes when individuals are experiencing stress were exploring. Social support allows individuals to share their interest, preferences, and social interaction. During the intense events, the usage of social support networks will be substantially and significantly affected by an individual's usage (e.g. increase/decrease communication among their social networks).

However, the current social support processes are not yet sophisticated enough to support dynamic interactions. Also, there is no dynamics automated mechanism in assigning social support for stressed people. Therefore, there is a need to automate this process by developing a dynamic model of social support seeking and providing behaviours within an individual's social networks. Figure 3.3 shows how the research problem was identified.

Universiti Utara Malaysia

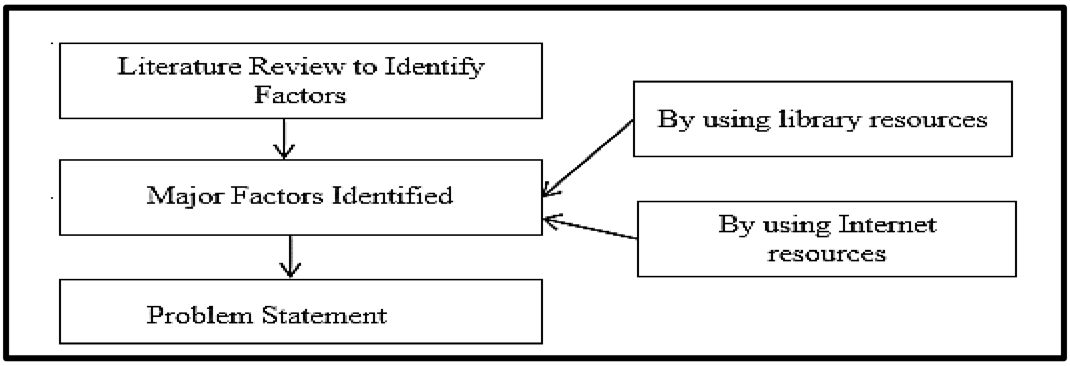
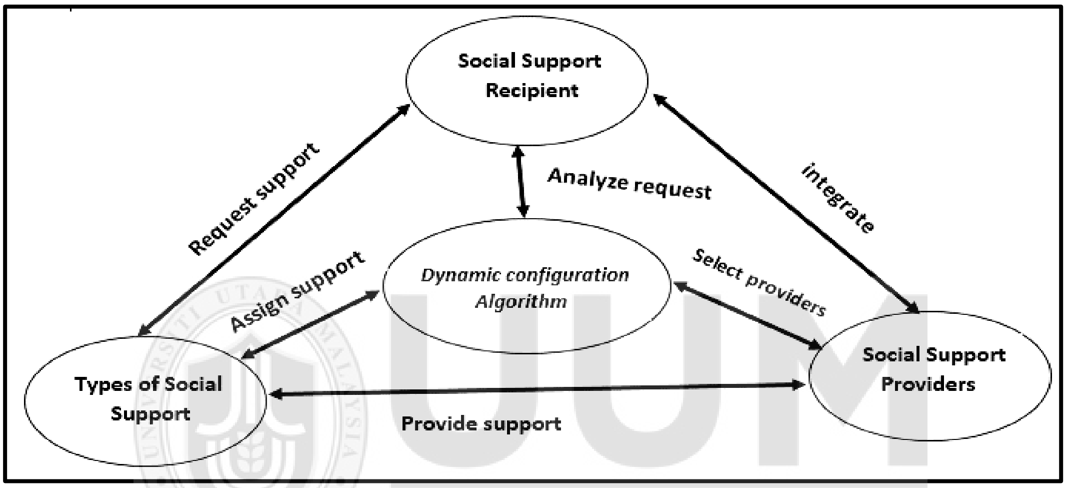



*Figure 3.3.* Problem Identification.

Figure 3.3 shows that the literature review is a source to identify the research problem presented in this study. Thus, it scrutinizes the definition of problem statement and identification of social support factors that lead to seek and provide support exchange.

### 3.2.2 Objectives of the Solution

To simplify the mechanism of support recipient and providers in support provision task, the dynamic configuration algorithm was proposed and developed. The obtained algorithm can be used as the basis to develop an automated social support assignment model to facilitate the required support exchange between recipients and providers (as presented in Figure 3.4).




Universiti Utara Malaysia

*Figure 3.4.* Social Support Components through Configuration Algorithm

Figure 3.4 depicts a proposed work that allows a combination of social support components. These components are social support recipient, social support providers, and types of social support.

### 3.2.3 Model Design and Development

This stage aims to design a computational model of support recipient and provision and development of a configuration algorithm to automate the social support assignment. All processes during this stage can be grouped into three parts, namely: 1) a dynamic model development, 2) an integrated model development, and 3) a dynamic configuration algorithm development.

#### 3.2.3.1 Dynamic Model Development

To develop a computational social support model, three different developmental steps are followed. These are domain model, design model, and operational model. These steps are explained as follows:

**Domain Model**

This step focuses on constructing the domain model that involves all the expected factors and variables and its relationships that related to the supporting receipt and provision process (dynamic model). Those factors were identified from the literature reviews where theories, models, empirical pieces of evidence, and expert reviews were examined to determine the needed factors for this study. Figure 3.5 summarizes the applying activities for developing a domain model. The outcome from this phase is used to achieve the first research objective (will be covered in Chapter Four 4.2.1 & 4.3.1).

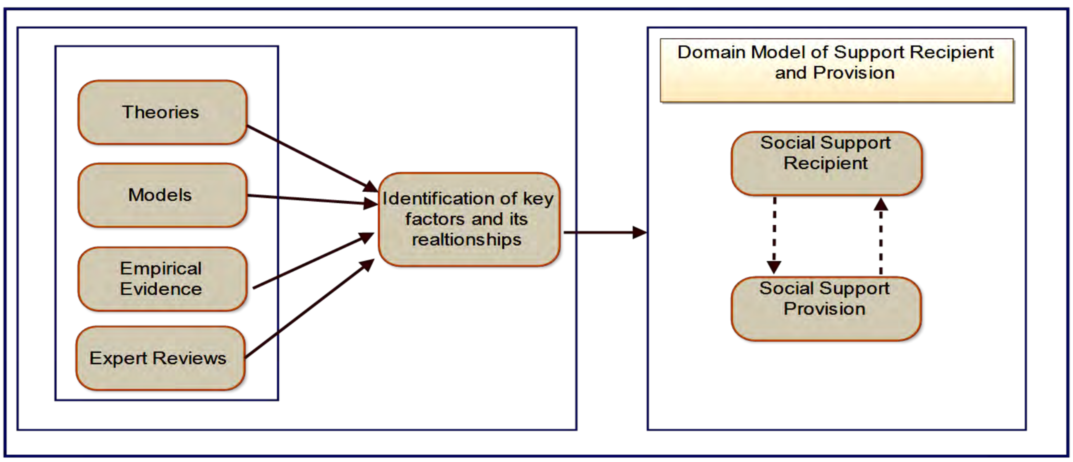



*Figure 3.5.* Domain Model Activities.

**Design Model**

This second phase is dedicated to the identification of the model's factors and its relationships. Figure 3.6 shows the activities that were followed to achieve the representation (will be covered in Chapter Four 4.2.2 & 4.3.2). The representation followed the procedure used by Bosse, Hoogendoorn, Klein, Treur and van der Wal (2016).

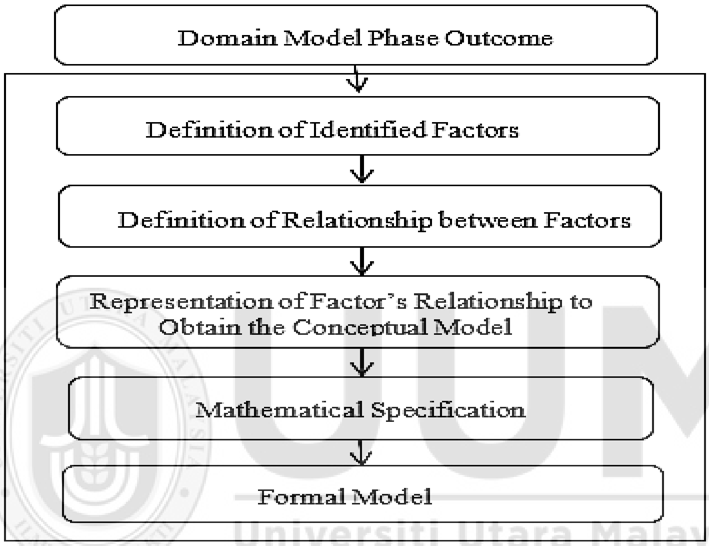



*Figure 3.6.* Design Model Activities

The obtained factors from the domain phase were given concept in the context of the study which is the definition of identified factors activity. Later, it follows by the definition of relationship activities (instantaneous or temporal) where each factor interacts with other factors based on the underpinning theories. It is important to distinguish that temporal factors are time-bound and evolve with respects to changes in time, whereas instantaneous factors are not time-bound. The criteria to construct these relationships were based on the related theories, models and empirical studies (as obtained from literature).

For instance, if *A*, *B*, *C*, D and *E* were identified as factors obtained from domain model phase then the design model is given in Figure 3.7.

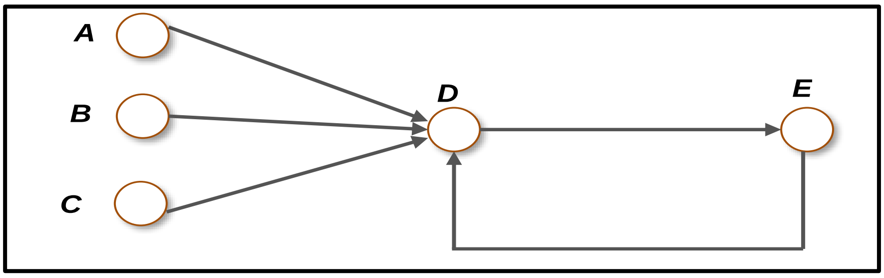



*Figure 3.7*. Example of Design Model.

It could be seen that the design model depicts the relationship between all factors. Factor *D* was identified by the instantaneous relationship between factors *A, B, C* and *E*, whereas factor *E* was identified by a temporal relationship towards factor *D*.

**Operational Model**

This phase is related to the construction of the computational model. In this phase, the obtained design model from the second phase is formalized using a set of in differential equations. Figure 3.8 shows the applying activities to make operational model.

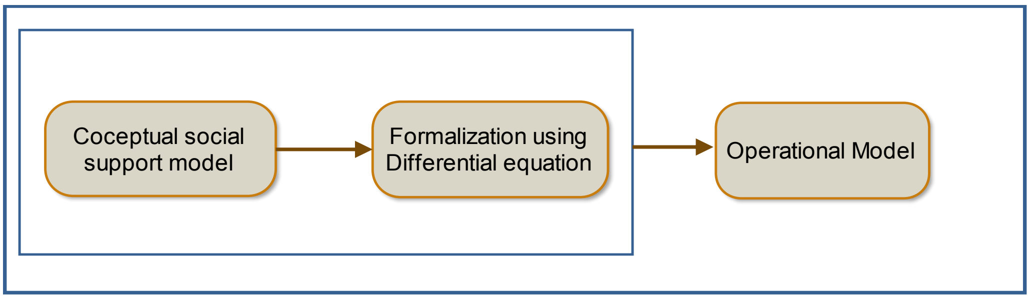



*Figure 3.8.* Operational Model Activities.

First, the formalization begins with the symbolic representation of the design model. The major difference between the design model and operational model is that the outcome of the domain model provides a conceptual model while the outcome of the operational model produces the formulated and simulation-ready model. For instance, from Figure 3.7 under design model, the relationship of the three identified factors under domain model phase was presented. It can be seen that *A, B* and *C* interacted to determines the phenomenon in *D.* Based on this assumption it can be concluded that from equation 3.1 and 3.2 that if these are non-zero or not equal to 1 then it depicts the conditions of the concept stated in Table 3.1 which can be further formalized to obtain equation 3.3. Furthermore, the value of $E$ is based on the value of $D$ over time as explained in Equation 3.4. Assuming $D$ is a combination of factors as depicted in Figure 3.7, therefore;

$$D = f\,[A, B, C, E\,] \qquad (3.1)$$

where $0 \leq A \leq 1$, $0 \leq B \leq 1$, $0 \leq C \leq 1$, $0 \leq D \leq 1$, and $0 \leq E \leq 1$ (3.2)

Universiti Utara Malaysia

Table 3.1.

*Example of Different Conditions of D and E*

| Concepts | *A* | *B* | *C* | *D* | *E* |
|---|---|---|---|---|---|
| *A* | | + | + | + | + |
| *B* | | | + | + | + |
| *C* | | | | + | + |
| D | | | | | + |
| *E* | | | | | |

$$D(t) = W_1 \,.\, \big[\alpha.\ A(t) + (1-\alpha).\ B(t)\big] + W_2\, C(t) + W_3 \,.\, E(t) \qquad (3.3)$$

where $\sum_{j=1}^{3} W_j = 1$ , and $W_1$, $W_2$, and $W_3$ are the weight factors with $\alpha$ *is* the proportional factor, $0 \leq \alpha \leq 1$.

$$E\,(t+\Delta t) = E(t) + \psi\ .[(D(t) - E(t)).(1 - E(t)).\ E(t)].\ \Delta t \qquad (3.4)$$

where $\psi$ is the change rate factor and $\Delta t$ is change interval in time and $0 \leq \psi \leq 1$.

From Equation 3.3, it can be inferred that $D$ will be high when any of $A$, $B$ and $C$ is high. This gives the computational model for D as stated in Table 3.1. This formalized model can be further implemented in a simulation environment (will be covered in Chapter Four 4.2.3 & 4.3.2).

### 3.2.3.2 Integrated Model Development

To accomplish an automated social support assignment of individuals within a social support network, an approach has been tackled in which the dynamic domain model for support receipt-provision process is utilized as the foundation for a configuration process. There are three fundamental steps to design the configuration algorithm. First, the information about individual's states and profiles were fed into a dynamic model of social receipt and provision (factors and variables).

Second, those models were integrated to determine the utilized social support used in third steps, which resulted in requirements and constraints. Third, this piece of information is used to select social support members within the observed social support networks as seen in Figure 3.9. The result of this stage achieves the second research objective.

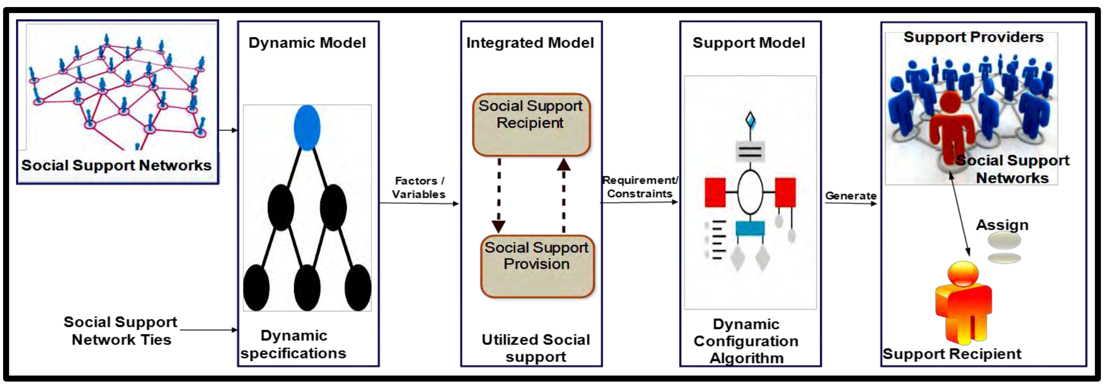



*Figure 3.9.* The Interactions between Support and Dynamics Models.

As can be viewed in Figure 3.9, the essential information of all members within social support networks and a potential social support network ties is being used as input to the dynamic model. Moreover, within the dynamic model, information about support recipient's well-being, such as stress can be monitored. This is important as it is a crucial indicator when to trigger the support model. For example, the expected result from this integrated model is the assignment of social provision tasks for support members in social support networks. Figure 3.10 visualizes the outcomes of these interactions.

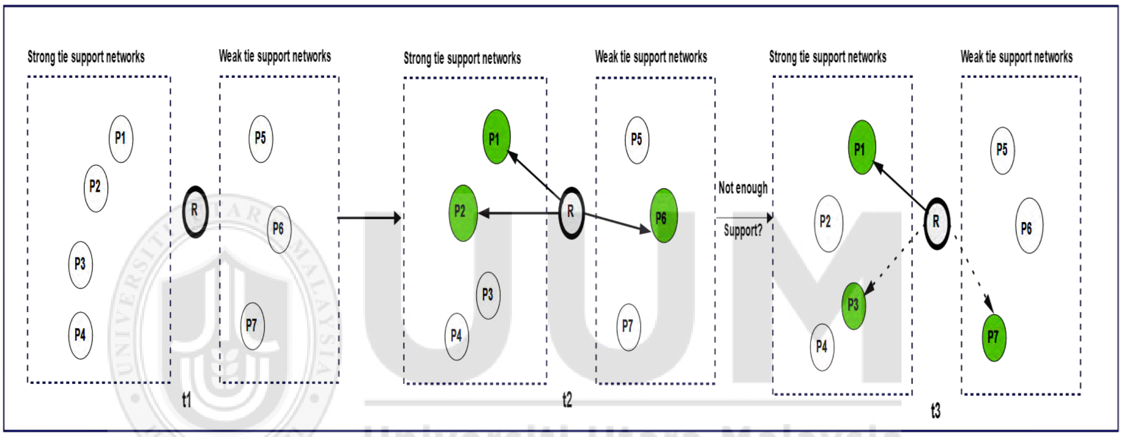



*Figure 3.10.* Dynamic Social Support Re-Assignment with Social Support Networks.

From Figure 3.10, *R* needs social support from the support networks providers (*P1, P2,..., P7*). In this scenario:

1) The support model will extract important information from the domain model of both support recipient and support providers before is performing a configuration process throughout time at *t1*.
2) Based on several pre-determined requirements and constraints, the support model will generate a list that contains potential members to provide support at *t2*. Possible support providers will be selected either from a weak tie network, or a strong tie network, or both networks.

3) If the support is not enough or the burden of the support provider is high, the model will re-assign members based on the needs of the social support recipient throughout time at *t3*. This process will continue until possible support providers are covered.

#### 3.2.3.3 Dynamic Configuration Algorithm

The dynamic configuration algorithm is a key component in developing a support model. The configuration system is one of the most effective application domains of knowledge-based systems. The focal idea of this approach is it expects every individual can be seen as "resource providers" as required in the model. The construction of relationships among requested and provided support are not viewed in terms of one-to-one matching but based on the choices and preferences. In this step, a configuration algorithm is treated as a black-box optimization problem as shown in Figure 3.11.

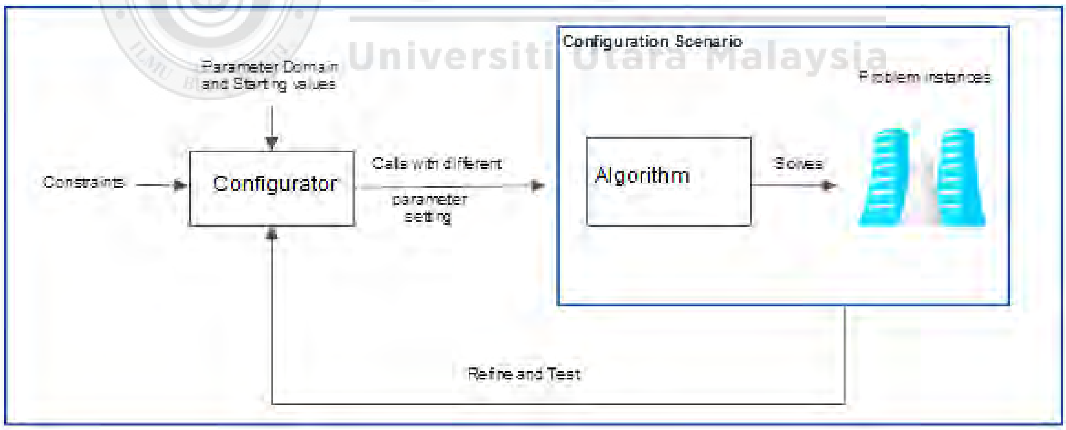



*Figure 3.11.* The workflow of the Configuration Algorithm.

Figure 3.11 shows that configuration procedures execute the algorithm with particular parameter settings on one or more problem instances and receive feedback about the algorithm's performance, a configuration scenario contains the algorithm to be constructed and a set of instances. Based on this, a sequence of stages was defined to develop a dynamic configuration algorithm.

In this study, information like stress, tie's preferences, support provision preferences, and support receipt preferences are used to generate support provision process. Therefore, by employing this information together with a collection of configuration rules, a dynamic algorithm to generate a group of social support providers to deliver support will be developed in Figure 3.12. Before initiating this model, a collection of constraints, (e.g., percentage of assigned supports, and preference number of providers) will be initialized.

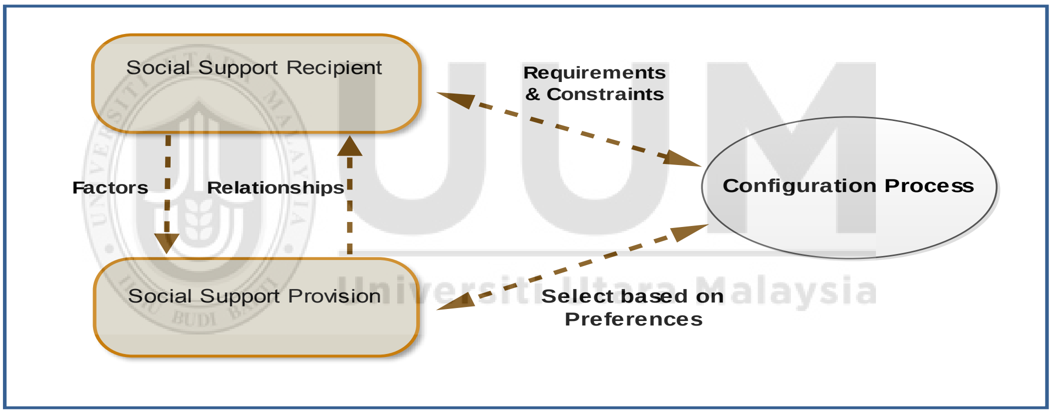



*Figure 3.12.* Dynamics Support of Recipient and Provision in Configuration Process.

Figure 3.12 shows the information flows between social support recipient and provision based on the configuration process. Algorithm 3.1 shows the main steps in the configuration process.

Algorithm 3.1

*The General Steps of a Configuration Algorithm*.

| |
|---|
| 1) *Start (r, p)* |
| 2) *r =Fr (Ir, Er, Nr, Cr)* *//requested support where* $0 \leq Fr \leq 1$ |
| 3) *p = Fp (Ip, Ep, Np, Cp)* *//provided support where* $0 \leq Fp \leq 1$ |
| 4) *q ↔ support provider burden* *// where* $0 \leq q \leq 1$ |
| 5) *a ↔ acceptable burden* *// where* $0 \leq a \leq 1$ |
| 6) *d ↔ provided support* *// where* $0 \leq d \leq 1$ |
| 7) *g ↔ assigned support* *// where* $0 \leq g \leq 1$ |
| 8) *L ↔ list of assigned members* |
| 9) *If r >0 and p>0 then* |
| 10) *Activate support_ assignment() else return to step 1* |
| 11) *If q >a then return to step 1 else go to step 12* |
| 12) *If g>=d then constructs L* |
| 13) End |

For example, six different fictional persons are studied under several parameters and attributes for social support receipt and provision as the following scenario:

> *"Ahmad experiences stress and seeks for help. From his personality and preferences, he needs more informational support (0.8). What is more, he prefers members from a weak tie network (0.7) to a strong tie network (0.1). Within his social support networks, he has two members in a strong tie and four members in a weak tie network."*

From these members, the support provision availability is the following (*;* **Anas** (*strong, 0.3*), **Ali** (*strong, 0.1*), **Mohammad** (*weak, 0.5*), **Noor** (*weak, 0.7*), **Amal** (*weak, 0.6*), **Fras** (*weak, 0.4*). Note that this information is generated from the dynamic model of support receipt and provision process. Using a support tie preference, he prefers 88 % from support members in a weak tie, and 12 % from a strong tie. The algorithm generates this result as presented in Figure 3.13.

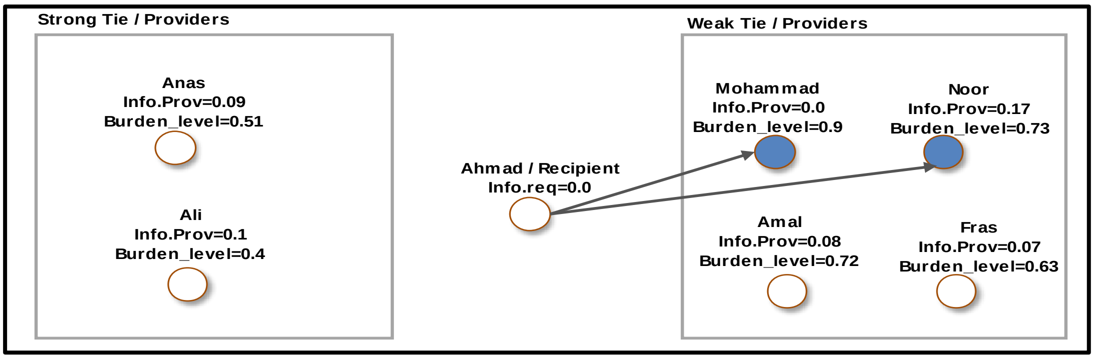



*Figure 3.13.* Example of Selected Providers.

Based on the assignment process in the configuration algorithm, both Mohammad and Noor will be selected. The results from this stage achieve the third research objective.

### 3.2.4 Demonstration

This stage consists of a step called simulation. Next sub-sections discuss the details of this phase.

#### 3.2.4.1 Simulation

The obtained computational model in the operational phase was implemented in a numerical simulation environment. The outcome of the simulation phase provides insight into complex social support phenomena by showing the interplays among factors. The simulation environment was implemented in a numerical simulation programming environment (e.g. Matlab programming). Figure 3.14 shows the activities that are performed to achieve the simulation results.

Universiti Utara Malaysia

In this environment, the executable model was simulated by assigning a set of selected scenarios of related cases. Later, these cases generated simulation outputs (presented in Chapter Six). The results obtained from this phase achieves the third and fourth research objectives.

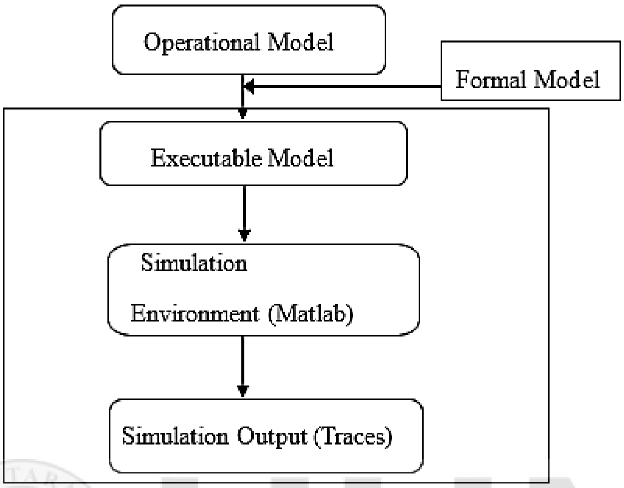



*Figure 3.14.* Simulation Process Activities.

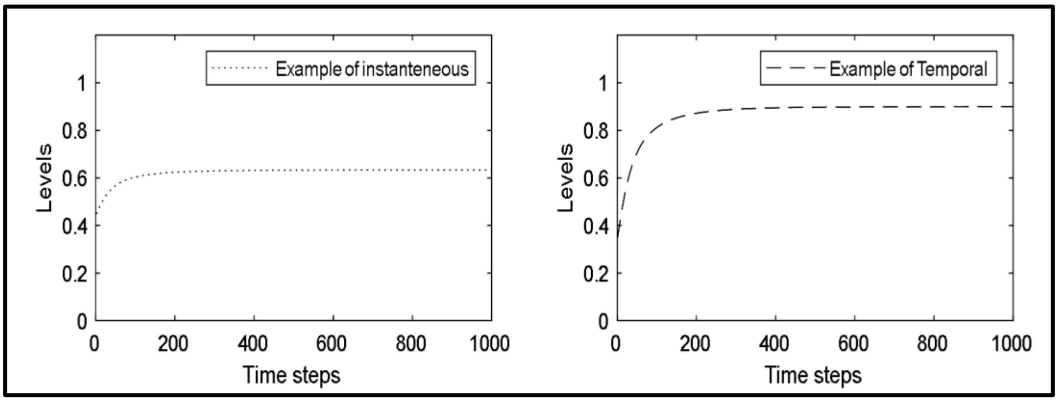
Universiti Utara Malaysia

For example, the simulation trace for Equation 3.3 using parameter combinations as stated in Table 3.2 is depicted in Figure 3.15. From Figure 3.15 it can be seen that the combinations of *A, B* and *C* provide a simulation trace that stabilized at time steps 100.

Table 3.2

*Example of Values of A, B and C*

| **Concept** | *A* | *B* | *C* |
|---|---|---|---|
| **Values** | 0.3 | 0.7 | 0.5 |




(a) Simulation Trace of *D* (b) Simulation Trace of *E*

*Figure 3.15.* Examples of Simulation Traces.

Based on the simulation results, the correctness of the model (how the model works) can be evaluated.

### 3.2.5 Evaluation

The evaluation phase ensures the developed model provides the actual representation of the phenomenon under investigation. Moreover, it also helps to gain insight into reflection and improvement of the computational model (Gangemi, Catenacci, Ciaramita & Lehmann, 2017). The evaluation phase was done in two sub-phases namely, verification and validation (as shown in Figure 3.16).

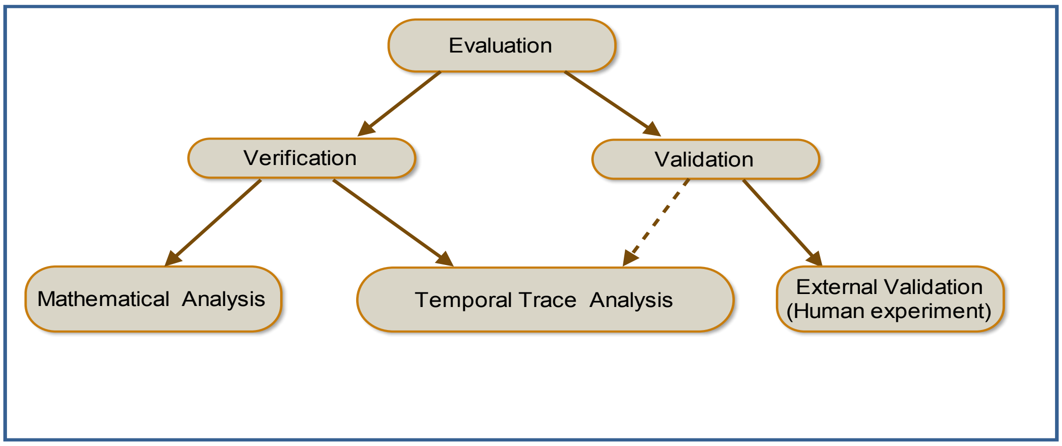



*Figure 3.16.* Evaluation Activities.

The result of this stage yields the fourth research objective.

UUM Universiti Utara Malaysia

#### 3.2.5.1 Verification

In general, the verification process aims to determine that the purpose of formalization is sufficiently achieved by evaluating the degree of correctness of the representation of the real target system as intended by the study (Thacker, Doebling & Hemez, 2018). Figure 3.17 depicts the verification process that was used in this study.

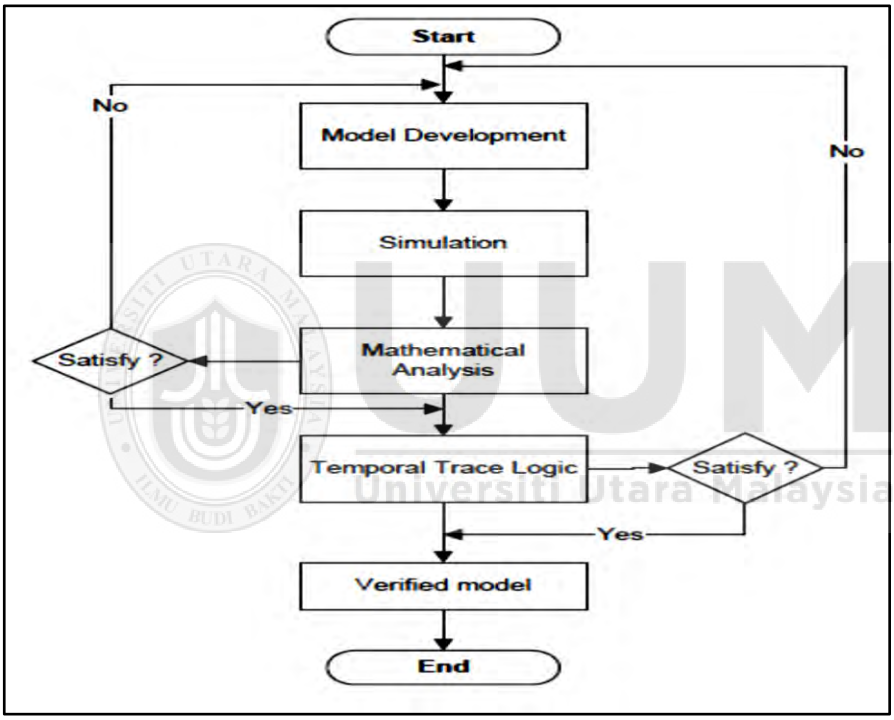



*Figure 3.17.* Verification Process.

**Mathematical Analysis**

There are many types of mathematical analyses such as real analysis, complex analysis, functional analysis, differential equation analysis, measurable analysis and numerical analysis (Balakrishnan, 2016). In this study, the numerical stability analysis (equilibria analysis) was used to check the stability of finite specifications of the model (Das, Goswami, Chatterjee, & Mukherjee, 2017).

This approach is widely used in agent-based simulation studies such as Cai, Cao, Ma and Wang (2016), Das, Goswami, Chatterjee and Mukherjee (2015), Bogacz, Brown, Moehlis, Holmes and Cohen (2017), Lux and Marchesi (2000), Epstein (1999) and Tanaka and Sugeno (1992). The analysis begins by setting the model derivative (or all derivatives) to zero (as shown in Equation 3.5 and 3.6).

$$\frac{dy}{dx} = f(y) \tag{3.5}$$

The equilibria or constant solutions of this differential equation are the roots of this equation:

$$f(y) = 0 \tag{3.6}$$

For the proposed model equilibria analysis was used to describe situations within the models where the values (continuous) approach a limit under certain conditions and stabilize. It means, if the dynamics of a model is described by a differential equation, then equilibria can be estimated by setting a derivative (or all derivatives) to zero. Figure 3.18 visualizes several types of stability points.

It can be deduced from Figure 3.18 (a) to (c) that stability point is reached as the model simulation traces derivatives converges. This occurs when the model expands, and the round-off error tends to zero or the truncation error vanished to zero.

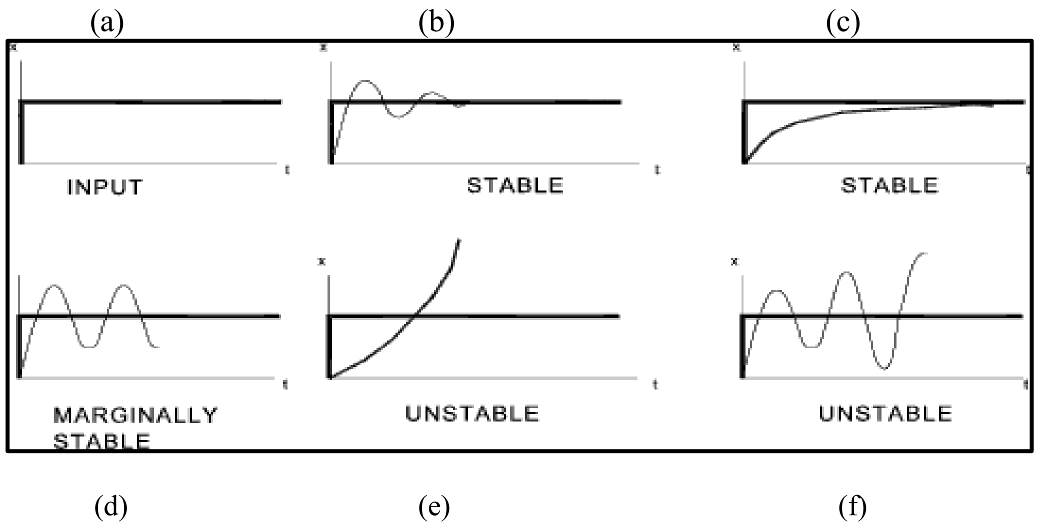



*Figure 3.18.* Types of Stability Points (Kundur, Paserba, Ajjarapu, Andersson, Bose, Canizares & Cutsem, 2004).

**Automated Verification**

The Temporal Trace Language (TTL) is used to perform an automated verification of specified properties and states against generated traces (Sharpanskykh & Treur, 2010; Bianculli, Ghezzi & Krstić, 2014). This was done by defining the proposed model ontology *Ont* which was assigned truth-values {true, false} based on the set of ground atoms *At(Ont)*. The set of all possible states for the ontology *Ont* was denoted by STATES (*Ont*). Therefore, STATES (*InteractionOnt*) is the set of *all interaction states*. The standard satisfaction relation |= between states and state properties was used as *S* |=*P* which means that property *P* holds in state *S* (Lei, Qiu, & Shao, 2014; Ferrère, Maler & Ničković, 2015).

The standard satisfaction relation was comparable to *Holds*-predicate in the modal logic formalization which represented the dynamic nature of the model. In addition to this, a fixed time *T* is assumed which is linearly ordered. Therefore, a trace γ over the model ontology *Ont* and time frame *T* as a time-indexed set of states is formalized as $\gamma$ (t $\epsilon$T), within the STATES(*Ont*), this condition is mapped as;

$$\gamma : \mathrm{T} \rightarrow \quad STATES\ (O\mathrm{nt})$$

Thus, from the TTL, direct references based on the model case conditions were made to the time points and simulation traces while the relationship is presented as a *state (*g*, t, output(R))|= p*, which means that state property *p* is true at the output of role *R* in the state of trace g at time point *t*. In this verification, these kinds of atoms were referred to as *Holds atoms*. Based on such *Holds atoms* the dynamic properties (from the differential equations) were built using the basic logical connectives and quantification. For example, the following dynamic properties were expressed based on the model factor of situational demands (*S)*. In any trace, for any points in time *t1* and *t2* after *t1*, if the agent *A* has the level of situational demands *S* at t1 in the trace, then agent A has the level of situational demands *S* at *t2* in this trace. In a formalized form, this statement can be represented as:

$$\begin{aligned} &\forall \gamma \in t1,\ t2 \\ &\quad [state\ (\gamma, t1,\ internal)\ |= S\ \&\ t1 \leq t2 \\ &\qquad \Rightarrow state\ (\gamma, t2,\ internal)\ |= S] \end{aligned}$$

Based on this concept, several dynamic properties were formulated using a sorted predicate logic approach.

#### 3.2.5.2 Validation

The validation process ensures that the developed model behaviour is considerably similar to the actual behaviour of the modelled problem. In this study, the major step to check the validity of the system is an external validation (human experiment). In this study, human experiment procedures were carried out to prove that the model has been integrated and working correctly within social support networks. Hence, it necessitated the development of the adoption of user evaluation where the needs of the users 'were used to determine the workability of the model (Morris & Picard, 2014).

The descriptive research approach is widely used in behavioural computational science to give further clarification and explanation that mathematical relation might not provide. Thus, this study made use of descriptive research approach to validate the computational models based on Madigan et al (2015) suggestion that research can be used to descriptive research approach for better validation.

According to (Barlas, 2002), the descriptive analysis considers as theory-based, it typically consists of small sample size (20–30 respondents) regardless of the number of respondents because the purpose is to find the validity of the internal structure of the model and how the behavior is generated rather than being able to aggregate output behavior of the model (data-driven). So, the validation included a combination of respondents and focused on the groups within the same social support network rather than focusing on the respondents themselves.

Thirty groups of graduate students from UUM (University Utara Malaysia) were selected based on their social support networks with age ranging from 25 years to 34 years old. The voluntary respondents were found to be able to measure their stress for this study. Therefore, there are different thirty groups (different combinations of twenty respondents were identified as a different recipient and different providers) were chosen to validate the proposed model. Each group has five respondents, one respondent refers to support recipient and four respondents refer to support providers.

Moreover, for the potential experiment study, a pre-post-test design will be applied. This experiment is made of thirty groups and divided into two types. The first type (recipient) requested support. The second type (providers) offers support provision based on recipient needs. The results from these two parts of support exchange are analysed to assign the right set of support members and then measures the stress level of the recipient prior and after the support assignment.

**Online Questionnaire**

The study instrument was based on the questionnaire research approach which made use of closed-ended questions to get more detailed information from selected respondents. The questionnaire is divided into four sections (A, B, C, D). Section A focused on the demographic of the respondent such as gender, age, level of education, and monthly income (as shown in Appendix IX). Section B extracts on seeking social support that focused on personality traits of the respondents. Section C provides information gathered about social support provision while Section D is used to examine the satisfaction of social support.

The questionnaire was given on the target recipient and provider in simple, clear and easy to understand manner also helps the user to be more receptive to the questions (see Appendix IX). The pre-test and post-test used three questionnaires namely; the Personality Test, DASS (The Depression, Anxiety and Stress Scale), and Interpersonal Support Evaluation List (ISEL). First, the Personality Test (adapted 10-item inventory) measures an individual on the factors (dimensions) of personality (Goldberg, 2017). This construct is important as it determines how a person interacts with his/her environment and can help the recipient to determine the support request.

Second, (DASS-21) is a set of three self-report scales designed to measure the emotional states of depression, anxiety and stress. Each of these three scales contains seven items, divided into subscales with similar content. In this study, only a stress scale has been adopted. Third, the Interpersonal Support Evaluation List (ISEL) questionnaire adapted 40-items measure of perceptions of social support.

This measure is a 40-item scale made up of four subscales. (Cohen & Hoberman, 2016). These subscales are designed to measure four dimensions of seeking and providing social support (informational, emotional, instrumental, and companionship) as seen in Appendix IX.

**Validation Protocol**

The validation protocol is implemented in three stages for two types of individuals in social support networks. The types of individuals are the recipient (requested support) and providers (support provision). The pre-test phase was performed on the first day of three weeks to measure the stress of recipient prior support. Later, on the last day of the three weeks post-test was conducted. The third stage of the experiment is conducted to determine the satisfaction of the provided social support. These activities were summarized in detail in Chapter Six.

Whereas, reinforcements are incorporated on the designed model factors of the prototype (informational social support, emotional social support, instrumental social support, and companionship social support), to assign suitable social support for proper recipients.

Universiti Utara Malaysia

### 3.3 Summary

This chapter has explicated the study methodology to be applied in achieving the intended research objectives (as mentioned in Chapter One). The methodology consists of six stages, namely; problem identification and motivation, the objective for the solution, design and development, demonstration, and evaluation. Table 3.3 shows a summary of each stage and all methods/ tools that were used to achieve the defined objectives.

Table 3.3.

*A Summary of Research Methodology Stages.*

| Stage | Method/Tool | Outcome | Objectives |
|---|---|---|---|
| Problem identification and motivation | Literature Review and expert interview | Problem statement. Objectives | |
| Objective for the solutions | Applying DSRP to develop an automated assignment support model | Developing a formal assignment support model | Main obj. |
| Design and development | A differential equation, symbolic representations. | Formal model/dynamic configuration algorithm / integrated model with a social support network | Obj. 1, 2, &3 |
| Demonstration | Numerical programming platform (Matlab) | Simulated model & integrated model within a social support network | Obj. 3, 4 |
| Evaluation | Mathematical verification temporal trace analysis (TTL), and human experiment | Evaluated Model | Obj. 4 |
| Communication | Conferences and journals | Publications | |

# CHAPTER FOUR

# MODEL DEVELOPMENT

## 4.1 Introduction

This chapter discusses detail explanation on the formalization of a support recipient model, support provider model, and the development of an integrated model to build a dynamic configuration algorithm (support model). First, Section 4.2 shows the development of the support recipient model and the main concepts of social support receipt. Next, Section 4.3 shows the development of a support provider model and the main concepts of social support provision. Section 4.4 describes the development of the integrated model. Section 4.5 explains the major components of the support model and its algorithms. While Section 4.6 discusses how these steps were utilized in the development of a prototype. Finally, Section 4.7 concludes this chapter.

Universiti Utara Malaysia

## 4.2 Computational Support Recipient Model Development

One point that can be made to understand the social support process is a recipient factor. Despite evidence that primarily shows the stress plays an important role in seeking support, yet severely stress individuals seems to reduce social support process (Aziz & Ahmad, 2013; Barbara, 2016). This condition is highly related to the individual's personality (Aktas, & Sertel-Berk, 2017; Ball, Levin, & Rajamani, 2018). Normally, a neurotic personality tends to attract a negative relationship between social support provider and social engagement (Borji, Sihite, & Itti, 2016; Bosse et al., 2018). Also, characteristics of the relationship (ties) between support recipient and provider are equally important to activate support selection behaviours as it increases the likelihood of support offering for certain relationships (either strong tie or weak tie relationship).

### 4.2.1 Domain Model

The main aim of this phase is to identify key factors and its interplays to determine types of requested social support. This was conducted based on literature review and empirical studies as stated in Chapter Three. The results from this phase have presented twenty-five (25) important factors that were grouped into three categories based on its relationship. These categories are external, instantaneous and temporal factors. The external factors are independent factors that contribute to other factors. While, instantaneous factors are dependent factors that are non-time bound, contrary to temporal factors. Tables 4.1, 4.2 and 4.3 summarize these categories.

Table 4.1

*External Factor Concept of Support Recipient*

| No | Factor | Formal | Description | Theory | Reference |
|---|---|---|---|---|---|
| 1 | Personal Resources | *Pr* | Individual ability to access needed services like financial incomes, material resources. | CMR, TS | Andalibi & Haimson, 2016; Lazarus & Folkman, 1984. |
| 2 | Negative Events | *Nv* | Represents three types of events: life, chronic, and daily events | CMR, BSR, TS | Attig, 2015; Andalibi & Haimson, 2016 |
| 3 | Situational Demands | *Sd* | Strains in environment concurrent with a stressful event that related to specific internal or external demands (e.g pressure) | CMR, BSR | Andalibi & Haimson, 2016; Bolger & Amarel, 2015 |

Table 4.1 Continued.

| | | | | | |
|---|---|---|---|---|---|
| 4 | Emotional Experience | *Ex* | Individual's experiences when facing a stressful event that impacts his/her emotion. | CMR, BB | Berjot, 2016; Cohen, 2011; Collins & Feeney, 2015 Seidman & Bolger, 2017 |
| 5 | Personality Attributes | *Pa* | Characteristic patterns of thoughts, feelings, and behaviors over time and across situations (e.g. neuroticism and extraversion) | CMR, FFM | Bolger & Amarel, 2015; Carolan, 2013; Carver etal., 2015 |

Cognitive Motivational Relational Theory (CMR), Transactional Stress Theory (TS), Broaden-and-Build Theory (BB), Five-Factor Model (FFM), Behavioural Self-Regulation Model (BSR).

From Transactional Stress (TS) theory (Bulletin & Angeles, 2015), stressors are defined as events (negative events), problems, or pressures that potentially produce stress (Abouserie, 1994; & Andalibi & Haimson, 2016). Also, these negative events were caused by three types of stressors namely; life, daily, and chronic (Gadzella, 1994). First, life events are discrete and occur within a relatively brief time interval, such as a few months to a year (e.g., the birth of the first child, divorce) (Dohrenwend & Shrout, 1985).

Second, daily events refer to the irritating, frustrating, stressing demands and troubled relationships that one encounters daily (e.g., traffic jams, unexpected visitors, having a good meal) (Dohrenwend & Shrout, 1985). Third, chronic events are persistent as the accumulation of ongoing strains or enduring problems or conflicts (e.g., disabling injury, poverty, marital problems) (Towbes & Cohen, 1996; Andalibi & Haimson, 2016).

According to Behavioural Self-Regulation Model (BSR) (Shumaker & Brownell, 2012; Specht, 2015), it shows personal resources that are crucial components in coping with stressful life events. They can be defined as general features of the external, interpersonal, and personal's world that play a regulatory role in obtaining/maintaining proper health status. The personal resources were strongly associated with the prevalence of stress among recipient's individuals (Azizi et al., 2011; Wang, He, Liang, & Zhou, 2016). Also, situational demands play an important role in the behaviours and experiences of individuals with stress. Going further, levels of situational demand are important determinants of social behaviour and emotional experience (Uchino, 2012; Mohamed & Baqutayan, 2015). Additionally, situational demand refers to the extent that specific roles and competencies are required within a social setting (Bliese & Castro, 2017).

Furthermore, Lazarus' cognitive-phenomenological theory of psychological stress suggests that an individual's personality also influence the type of engaged coping (Lazarus, 1966). For example, maladaptive personality traits are more inclined to engage in avoidant coping due to the higher levels of neuroticism compared to other traits (Cloninger et al., 2015). High neuroticism level individuals tend to appraise stressful situations and their ability to successfully resolve stressors more negatively, thus causing them to choose a passive coping strategy (Bolger & Amarel, 2017).

Universiti Utara Malaysia

Table 4.*2*

*Temporal Factor Concept of Support Recipient*

| No | Factor | Formal | Description | Theory | Reference |
|---|---|---|---|---|---|
| 1 | Skills of Coping with Stress | *Sc* | Represents the experience of skills to cope with stress | CMR, CO | Lazarus, 1991; & Hale, 2014 |
| 2 | Imminence of Threat | *Im* | Refers to a condition before occurring threat which participate to rise threat (anticipated threat) | CMR, TS, CO | Schaefer, Coyne, &, & Lazarus, 2014 |
| 3 | Strong Tie Preferences | *Se* | Is the relationship between individuals that triggers a close personal network | SNP, WST | Brashers, Neidig, & Goldsmith, 2004; Iwasaki, 2016 |
| 4 | Weak Tie Preferences | *We* | Is the relationship between individuals that triggers expanded personal network | SNP, WST | Gordon, 2017; Haines & Beggs, 2016; Dodson et al., 2016 |

Cognitive Motivational Relational Theory (CMR), Transactional Stress Theory (TS), Coping Theory (CO), Support Network Preference Theory (SNP), Weak Tie/Strong-Tie Support Network (WST).

Table 4.2 shows four temporal factors for support recipient namely;

- Skills of coping with stress (*Sc*) that triggers by the concept of coping strategies,
- The imminence of threat (*Im*) that triggers by the concept of the intensity of the stressful event,
- Strong tie preferences (*Se*) that trigger by the concept of a closed social network,
- Weak tie preferences (*We*) that trigger by the concept of an expanded social network.

Table 4.*3*

*Instantaneous Factor Concept of Support Recipient*

| No | Factor | Formal | Description | Theory | Reference |
|---|---|---|---|---|---|
| 1 | Intensity of Stressful Event | *Ie* | Represents the degree of stress encountered by a person. | CMR, BSR | Andalibi & Haimson, 2016; Berkman, 2014; Attig, 2013 |
| 2 | Threat | *Th* | It refers to primary appraisal when the individual makes a conscious evaluation of the matter at hand (what is at stake) of whether it is a sense of threat. | CMR, TS, BSR | Wellman & Wilson, 2010; Bulletin & Angeles, 2015 |
| 3 | Challenge | *Ch* | It refers to primary appraisal when the individual determines that his or her resources are sufficient to meet the demands of the stressful situation. | CMR, TS, BSR | Carver & Connor-smith, 2013; Bulletin & Angeles, 2015 |
| 4 | Negative Emotion | *Ne* | It refers to an individual's thoughts surrounding an event that is fixed on threats or dangers in the environment. | CMR, BB | Cohen, 2011; Collins & Feeney, 2015 Goldsmith & Parks, 2016 |
| 5 | Positive Emotion | *Pe* | An existential courage to deal with a stressful event. It is attributed to perceiving the challenge | CMR, BB | Connor-smith & Flachsbart, 2016; Fang et al., 2015 |
| 6 | Acceptance | *Ac* | Individual who accepts the reality of a stressful situation would seem to be a person who is engaged in the attempt to deal with the situation | CMR, CO, BSR | Schwarzer & Knoll, 2015; Shumaker & Brownell, 2012; Specht, 2015 |
| 7 | Holdback | *Hb* | The individuals give up and no longer trying to face a stressful event. | CMR, CO, BSR | Sarason, Basham, & Sarason, 2013; Raina et al., 2015. |

Universiti Utara Malaysia

Table 4.3 Continued.

| | | | | | |
|---|---|---|---|---|---|
| 8 | Change | *Cg* | Individuals' condition when they are trying to face a stressful event in a trial to change the stressful situation. | CMR, CO, BSR | Nezlek & Kuppens, 2015; Schwarzer & Knoll, 2015 |
| 9 | Problem Focus | *Pf* | An existing skill of an individual to cope with a stressful event (It is associated with aggressive interpersonal efforts to alter the situation, as well as efforts to get the problem solved). | CMR, CO | Schaefer, Coyne, & Lazarus, 2014; Khoo, 2015; Ko et al., 2013. |
| 10 | Emotional Focus | *Ef* | Refers to thinking rather than acting to change the person-environment relationship. | CMR, CO | Zaumseil & Schwarz, 2015; Nezlek & Kuppens, 2013; Russell, 2013 |
| 11 | Informational Support Requested Preferences | *Ir* | Informational assistance includes advice and feedback on actions | SNP, SB, AT | Knoll, Burkert, & Schwarzer, 2014; Thoits, 2011 |
| 12 | Instrumental Support Requested Preferences | *Nr* | Instrumental assistance includes financial aid, material resources, and needed services (e.g. making meals or providing transportation) | SNP, SB, AT | Owens, 2017; Knoll, Burkert, & Schwarzer, 2014; Nurulla, 2010 |
| 13 | Emotional Support Requested Preferences | *Er* | Any kind of support that involves expression of love, care and empathy (e.g. listening and offering sympathy after someone had bad news) | SNP, SB, AT | Uchino, 2012; Mohamed & Baqutayan, 2015 |
| 14 | Companionship Support Requested Preferences | *Cr* | Include both mere presence of others and engaging in activities with others such as seeing a movie when someone needs relaxation | SNP, SB, AT | Lauritz, Preez, Cassimjee, & Ghazinour, 2015; Mohamed & Baqutayan, 2017. |

Universiti Utara Malaysia

Table 4.3 Continued.

| | | | | | |
|---|---|---|---|---|---|
| 15 | Expanded Social Network Preferences | *Es* | It represents a relatively heterogeneous, sparsely knit social network connected via weak ties. | SNP, WST, SB | Brashers, Neidig, & Goldsmith, 2004; Iwasaki, 2016 |
| 16 | Close Social Network Preferences | *Cs* | It represents a densely knit, exclusive social network connected via strong ties | SNP, WST, SB | Gordon, 2016; Haines & Beggs, 2016; Dodson et al., 2016 |

Cognitive Motivational Relational Theory (CMR), Transactional Stress Theory (TS), Broaden-and-Build Theory (BB), Coping Theory (CO), Support Network Preference theory (SNP), Behavioral Self-Regulation Model (BSR), Weak Tie/Strong Tie Support Network (WST), Stress Buffering Theory (SB), Attachment Theory (AT).

### 4.2.2 Design Model

In this phase, the identified recipient factors from the domain model are represented with the corresponding relationships. The relationship representations are based on literature review, theories and empirical evidence which form the conceptual model as depicted in Figure 4.1.

UUM
Universiti Utara Malaysia

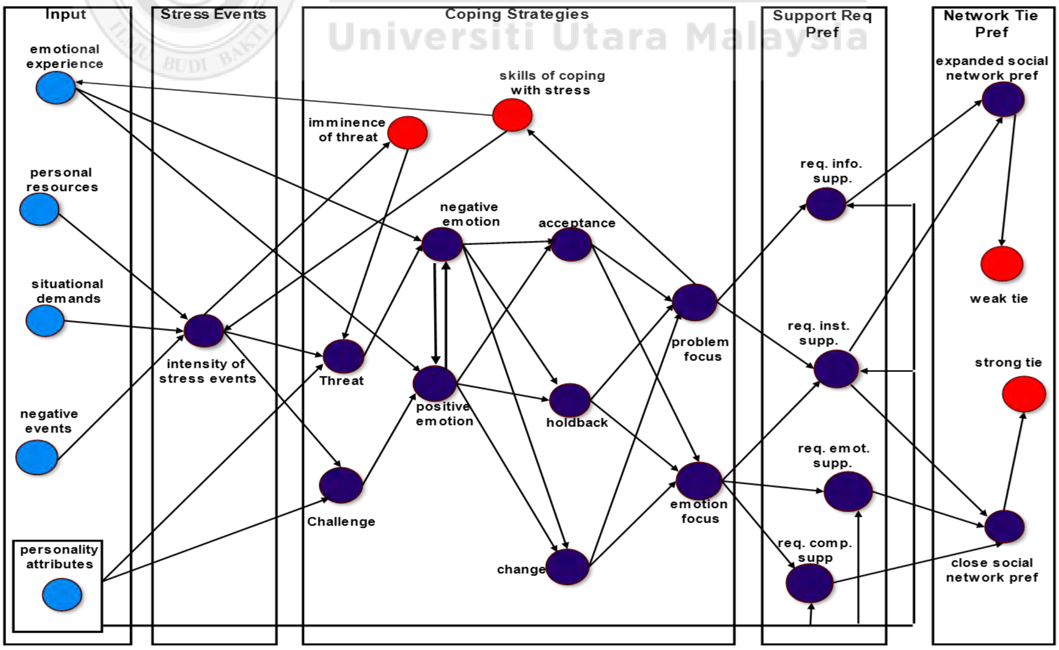



*Figure 4.1.* Conceptual Model of the Recipient Social Support.

Figure 4.1 shows the conceptual model showing the interactions of recipient social support factors. This conceptual model explicitly shows the interplaying and interactions between these factors with the processes involved in psychological behaviour social support change.

### 4.2.3 Operational Model

The main aim of this phase is to obtain an executable computational model to be executed in a simulation environment for further interpretation of the conceptual model. The differential equation technique was used to represent the identified factors and their relationships. The formalization nodes are designed using a set of parameters which are used to regulate or control the computational model. The operation model can be decomposed into four categories namely; stress event, coping strategies, support requested preferences and network tie preferences.

Universiti Utara Malaysia

#### 4.2.3.1 Stressful Event

To overcome with stress, human has developed its coping mechanism (Attig, 2013). In the case of a threatening situation, this coping mechanism will decide on which skills to be used and how to deal with the situation (Andalibi & Haimson, 2016; Aziz et al., 2011). It is important to consider that situations perceived by everyone can vary and may develop different coping skills. Therefore, a stressful event can be triggered by negative events, situational demands, personal resources, and skills of coping.

**Intensity of Stressful Event (*Ie*)**

Within support mobilization literature, the level of stress experienced by potential recipients is an important predictor in receiving support (e.g., Kaniasky & Norris, 1995; Hobfoll & Lerman, 1989; Yu, Wang, He, Liang, & Zhou, 2016). Normally, this can be related to the stressful events' intensity, a condition in which various factors such as personal resources (support), situational demands (pressure), negative events, and skills of coping with stress can play significant roles (Towbes & Cohen, 2015; Attig, 2017). The concept of the intensity of the stressful event is depicted in Figure 4.2.

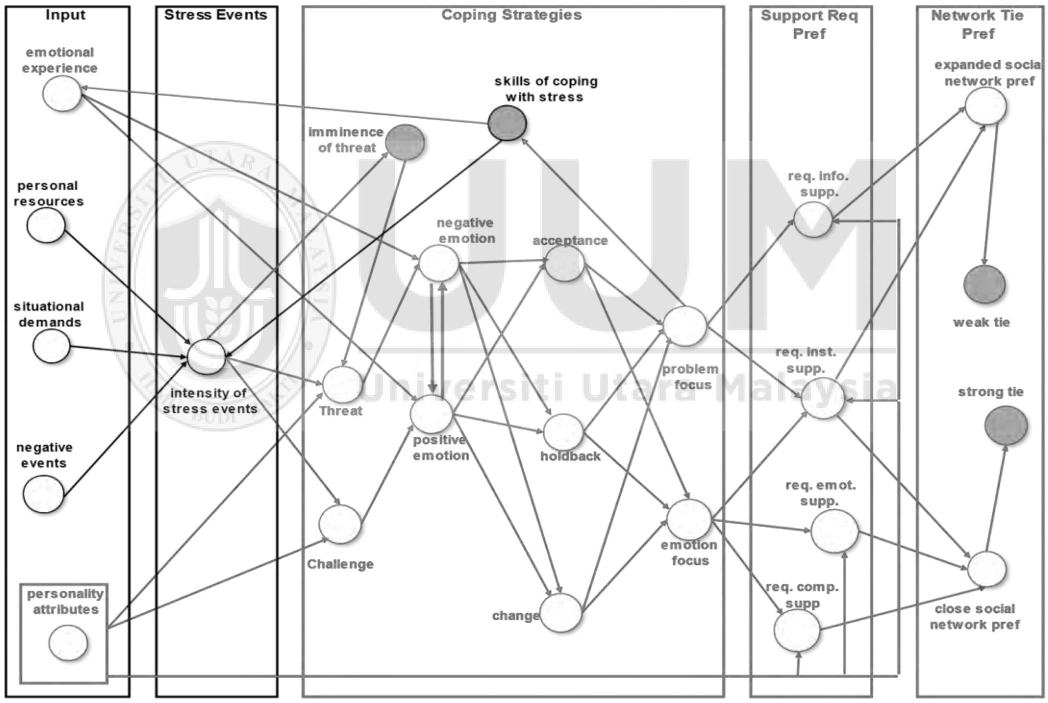



*Figure 4.2.* **Causal Relationship of Intensity of Stressful Event.**

Therefore, the intensity of a stressful event (*Ie*) is predicted by situational demands (*Sd*), personal resources (*Pr*), negative events (*Nv*), and skills of coping with stress (*Sc*). Table 4.4 shows conditions in the concept of the intensity of the stressful event.

Table 4.4

*Relationships between in Intensity of Stressful Event Concepts*

| **Concepts** | ***Ie*** | ***Pr*** | ***Nv*** | ***Sd*** | ***Sc*** |
|---|---|---|---|---|---|
| ***Ie*** | | - | + | + | - |
| ***Pr*** | | | - | - | + |
| ***Nv*** | | | | + | _ |
| ***Sd*** | | | | | _ |
| ***Sc*** | | | | | |

Universiti Utara Malaysia

Table 4.4 illustrates and describes the relationship between the concepts in the intensity of stressful event category. For example, the intensity of a stressful event (*Ie)* will be high when the negative event (*Nv*) and situational demands are high (*Sd*). Also, if the personal resources (*Pr*) and coping skills (*Sc*) are high, the intensity of a stressful event can be regulated to a normal level.

$$Ie\,(t) = [\beta_{e,}.Nv\,(t)+(1-\beta_e).Sd\,(t)].(1-Pr\,(t)).(1-Sc\,(t)) \qquad (4.1)$$

$\beta_e$ is the proportional factor and $0 \le \beta_e \le 1$ and negative events (*Nv*) are identified by employing weighted sum (*w*) of three kinds of events: chronic (*C*), life (*L*), and daily (*D*) as $Nv\,(t) = w_1.\,L\,(t) + w_2.C\,(t) + w_3.D\,(t)$, where $\sum_{j=1}^{3} w_j = 1$

The combination of personal resource, negative event, situational demand, and skills of coping with stress give the intensity of stressful event for the recipient through a proportional factor $\beta e$. Based on this, it can be pointed out that the intensity of the stressful event is low when either negative event or situational demand is low (Nelson & Barry, 2017; Hussar & Bailey, 2018). Also, from this equation, as skills of coping and personal resources are increasing, the intensity of the stressful event is decreasing.

#### 4.2.3.2 Support Recipient Coping Strategies

According to Lazarus & Folkman's (1984) Transactional Theory of Stress, there are two types of appraisals; primary and secondary (Wellman & Wilson, 2010). The primary appraisal evokes when the conscious evaluation of the matter at hand of whether it is a sense of a threat (a negative connotation) or a challenge (a positive connotation). Later, the secondary appraisal of stress decides on the way people cope with stress either by focusing on modifying the situation (problem-focused) or by altering the emotional consequences of the events (emotion-focused) (Dodson et al., 2016; Flynn & Lake, 2012). Figure 4.3 depicts the causal relationship of coping strategies.

Universiti Utara Malaysia

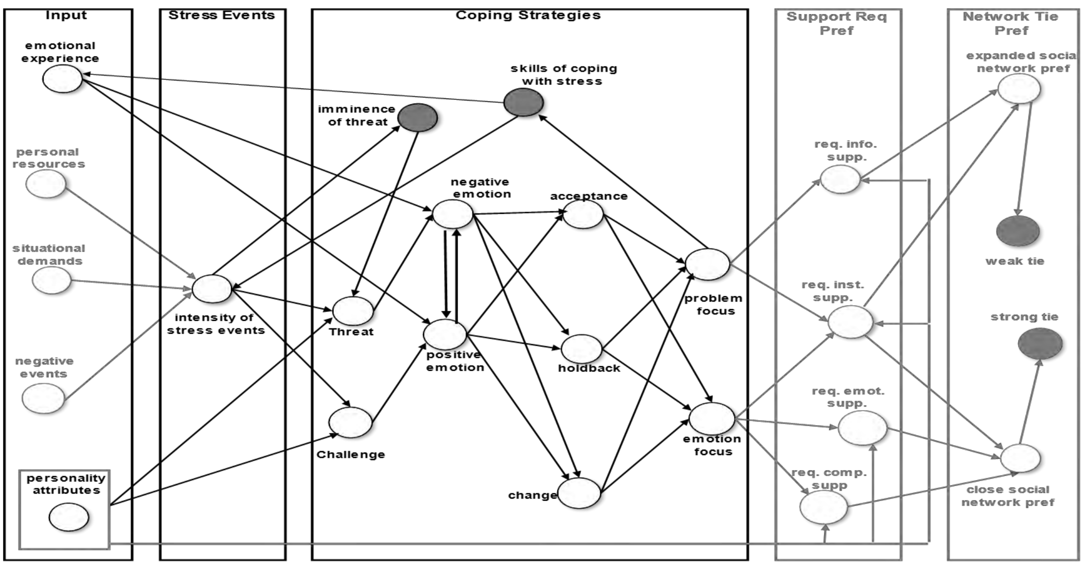



*Figure 4.3*. Causal Relationship of Coping Strategies.

Figure 4.3 shows the conceptual model of concepts in coping strategies that include two appraisals of coping strategies namely; primary appraisal (either challenge (*Ch*), threat (*Th*), or imminence to threat (*Im*) and secondary appraisal (problem focus (*Pf*) or emotion focus (*Ef*)). Then emotional experience (*Ex*) factor which expressed by either positive emotion (*Pe*) or negative emotion (*Ne*). Furthermore, the ways of coping scale ranging from several factors like acceptance (*Ac*, change (*Cg)*, and holdback (*Hb)*. Table 4.5 illustrates the relationships between concepts in coping strategies.

Table 4.5

*Relationships between Concepts in Coping Strategies*

| **Concepts** | ***Ie*** | ***Th*** | ***Ch*** | ***Ne*** | ***Pe*** | ***Ac*** | ***Hb*** | ***Cg*** | ***Pf*** | ***Ef*** | ***Im*** | ***Sc*** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Ie*** | | + | - | + | - | - | + | - | - | + | + | - |
| ***Th*** | | | - | + | - | - | + | - | - | + | + | - |
| ***Ch*** | | | | – | + | + | – | + | + | - | - | + |
| ***Ne*** | | | | | – | – | + | – | – | + | + | – |
| ***Pe*** | | | | | | + | – | + | + | – | – | + |
| ***Ac*** | | | | | | | – | + | + | – | – | + |
| ***Hb*** | | | | | | | | – | – | + | + | – |
| ***Cg*** | | | | | | | | | + | – | – | + |
| ***Pf*** | | | | | | | | | | – | – | + |
| ***Ef*** | | | | | | | | | | | + | – |
| ***Im*** | | | | | | | | | | | | – |
| ***Sc*** | | | | | | | | | | | | |

Table 4.5 illustrates and describes the relationship between the concepts in coping strategies category. For example, problem-focus coping (*Pf*) will be high when the

positive emotion (*Pe*), change (*Cg*), and acceptance (*Ac*) levels are high. Also, emotion-focus coping (*Ef*) will be high when the negative emotion (*Ne*) and holdback (*Hb*) levels are high.

**Threat (*Th*)**

Three factors are related to influence threat. First, the imminence of threat (*Im*) which refers to damage, but an anticipated one (imminence of threat) and it is more to a risk assessment part (Rothbart & Bates, 1998; Bolger & Amarel, 2015). Second, personality attributes (*Pa*) related to the primary appraisal (either challenge or threat). Third, the intensity of a stressful event (*Ie*) where threat occurs when an individual has high intensity of stressful event to cope with a stressor and, therefore, perceives being in danger (Blasovich & Mendes, 2013; Andalibi & Haimson, 2016).

$$Th\,(t) = [\Upsilon_h .\, Im\,(t) + (1-\Upsilon_h).\, Ie\,(t)].\,(1-Pa\,(t)) \quad (4.2)$$

where $\Upsilon_h$ is the proportional factor and $0 \leq \Upsilon_h \leq 1$

Universiti Utara Malaysia

The concept of threat is computed by a combination of the imminence of the threat, the intensity of stressful events, and personality attributes through a proportional factor $\Upsilon h$. Based on this, it can be pointed out that threat will be high when either the imminence of threat or the intensity of stressful events is high (Kuwabara, Van Voorhees, Gollan, & Alexander, 2017).

**Challenge (*Ch*)**

The concept of the challenge is different from that of threat based on how persons view it, where it may have a positive tone when compared with the threat. For example, a recipient may see the opportunity to prove him or herself, anticipating gain, mastery or personal growth from the venture (Blasovich & Mendes, 2013; Carver & Connor-smith, 2016). As a threat, personality attributes (*Pa*) and the intensity of a stressful event (*Ie*) related to the challenge. In contrast to threat, challenge (*Ch*) is positively related to personality attributes (*Pa*), and contrary to the intensity of stress through a proportional factor ($\varpi_c$).

$$Ch\ (t) = \varpi_c .\ Pa\ (t) + (1-\varpi_c).\ [(1-Ie\ (t)).\ Pa\ (t)] \qquad (4.3)$$

where $\varpi_c$ *is* the proportional factor and $0 \leq \varpi_c \leq 1$

The combination of the intensity of stressful events and personality attributes yields the challenge for the recipient through a proportional factor $\varpi_c$. Based on this, it implies that challenge is high when the personality attribute is high, and intensity of stressful events is low (Gall, Evans, & Bellerose, 2015; Schulenberg, Sameroff & Cicchetti, 2018).

**Negative Emotion (*Ne*)**

Three factors are pinpointed to contribute to negative emotion concept which is positive emotion (*Pe*), threat (*Th*) and emotional experience (*Ex*). Emotional experience (*Ex*) is contributed through the proportional combination of basic emotional experiences ($Ex_{base}$) and coping skills (*Sc*). In this case, when the threat is perceived, some fractions of emotional experience were translated as a negative emotion (*Ne*).

$$Ne\ (t) = Th\ (t).\ (1-Ex\ (t)).\ (1-Pe\ (t)) \qquad (4.4)$$

where *Ex* defined as: $Ex\ (t) = \lambda_e .\ Ex_{\text{base}}\ (t) + (1-\lambda_e).\ Sc(t)$ and $\lambda_e$ is the proportional factor and $0 \leq \lambda_e \leq 1$.

The combination of emotional experience, threat, and positive emotion generates negative emotion. This implies that for negative emotion to be high, both emotional experience and positive emotion must be reduced which can only occur when threat is high (Edwards, Hershberger, Russell, & Markert, 2017). Therefore, as the emotional experience and positive emotion are increasing, the negative emotion level is decreasing.

**Positive Emotion (*Pe*)**

From the literature, there are three major factors were identified to contribute to positive emotion namely challenge, negative emotion, and emotional experience. The view of positive emotion (*Pe*) is represented through a proportional factor of $\tau_p$ of a higher fraction of emotional experiences. Additionally, there is an opposite relationship between negative and positive emotion, which a person with a higher positive emotion has directly lower negative emotion and vice versa.

$$Pe\,(t) = [\tau_p .\ Ch\,(t) + (1- \tau_p).\ Ex\,(t)].\ (1-Ne\,(t)) \tag{4.5}$$

where $\tau_p$ *is* the proportional factor and $0 \leq \tau_p \leq 1$

The combination of emotional experience, challenge, and negative emotion gives a positive emotion for the recipient through a proportional factor $\tau_p$. The equation 4.5 implies that for a positive emotion to be high, then negative emotion must be reduced which only occurs when either challenge or emotional experience level is high (Dixon & Kurpius, 2016; Dyson & Renk, 2017; MacGeorge et al., 2005; Rutter & Sroufe, 2018).

**Acceptance (*Ac*)**

Research typically finds that responses to the ways of coping scale form several factors (e.g., Folkman & Lazarus, 1985; Folkman, Lazarus, 1989; Schwarzer & Knoll, 2015).

From the Self-regulation of Behaviour Theory (Scheier & Carver, 1988; Shumaker & Brownell, 2012; Specht, 2015) suggests that acceptance, change, and holdback presumably function in coping. Arguably, the acceptance concept is a functional coping response, in that a person who accepts the reality of a stressful situation would seem to be a person who is engaged in the attempt to deal with the situation. It also consists of negative and positive emotion.

$$Ac\,(\mathrm{t}) = \gamma_a .\, Pe\,(\mathrm{t}) + (1- \gamma_a).\, (1- Ne\,(\mathrm{t})) \tag{4.6}$$

where $\gamma_a$ *is* the proportional factor and $0 \leq \gamma_a \leq 1$

This equation depicts that acceptance is directly proportional to emotion which implies that if the positive emotion is likely to be low provided that the mutual resultant of negative emotion is high and acceptance level is low (Benton, Robertson, Tseng, Newton, & Benton, 2015; Furr, Westefeld, McConnell, & Jenkins, 2016).

Universiti Utara Malaysia

**Change (*Cg*)**

The change includes seeking assistance and focusing is on efforts to alter the existing situation based on perspectives and solving the problems (Nezlek & Kuppens, 2015). It includes several ways to cope with a stressful situation such as; confront the problem by taking appropriate actions, break down the problem into smaller steps, and work on one at a time, be persistent in attacking the problem, and double effort to change the situation (Troy & Mauss, 2016; Nezlek & Kuppens, 2015).

$$Cg\,(\mathrm{t}) = Pe\,(\mathrm{t}).\, (1- Ne\,(\mathrm{t})) \tag{4.7}$$

From this equation, as the positive emotion is increasing change level is increasing. This implies that for change to be high, the negative emotion must be reduced. This case can only occur when positive emotion is high (cf. Breznitz, 1983; Sarason, Levine, Basham, & Sarason, 2013; Raina et al., 2015).

**Holdback (*Hb*)**

One of the factors that can limit any recipient to cope within a situated environment is identified as "holdback" or negative consequences of such coping process. The individual with holdback tends to deny the reality of the event by allowing the event to become more serious, thereby making more difficult the coping occurs (Matthews, Siegel, Kuller, Thompson, & Varat, 1983; Reinhard, Given, Petlick, & Bemis, 2014). Therefore, the holdback is a negative evaluation or appraisal to the stressful circumstances, that's mean, individuals will give up and not trying to change the situation. Holdback has resulted from the interconnected between perceived positive (*Pe*) and negative emotion (*Ne*). The effect of holdback is the opposite of acceptance. Positive emotion decreases the level of holdback (Hb), while the opposite effect is induced by negative emotion.

$$Hb\,(t) = [1 - Pe\,(t)].\,Ne\,(t) \tag{4.8}$$

This equation implies that positive emotion reduces possibilities to develop future holdback (DeRoma, Leach, & Leverett, 2014; Hartley, 2015; Hysenbegasi, Hass, & Rowland, 2016).

**Problem-Focus Coping (*Pf*)**

A problem-focused strategy deals with interpersonal efforts to modify the situation and rationalize efforts to solve the problem.  Based on these concepts, three factors were identified to contribute to the concept of problem focus namely; acceptance, change, and holdback (as in Figure 4.3). This involves several strategies such as information gathering, resolving conflict, planning and making decisions (Lazarus & Folkman, 1984; Schaefer, Coyne, & Lazarus, 2014). Besides, problem-focused coping is considered to give satisfactory outcomes (improved coping skills) (Schwarzer, Knoll, & Rieckmann, 2014).

$$Pf\,(t) = \Upsilon_p .\ Ac\,(t).\ (1\text{-}Hb\,(t)) + (1\text{-}\ \Upsilon_p).\ Cg\,(t) \tag{4.9}$$

where $\Upsilon_p$ is the proportional factor and $0 \leq \Upsilon_p \leq 1$

The combination of acceptance, holdback, and change give the problem-focus coping for the recipient through a proportional factor $\Upsilon_p$. Based on this, it can be pointed out that problem-focus coping will be high when either the acceptance or change level is high Schwarzer, Knoll, & Rieckmann, 2017).

Universiti Utara Malaysia

**Emotion-Focus Coping (*Ef*)**

Emotion-focused coping is used to manage all forms of emotional stress including the feeling of depression, anxiety, frustration and anger (Hanson, 1997; Schwarzer, Knoll, & Rieckmann, 2014). Based on these concepts shown in the summarized Table 4.5, it could be concluded that emotion focus is high when either acceptance is low or high, and both holdbacks are high, and change is low. The presence of acceptance, change and holdback generate an emotional-focused coping (*Ef*) level with the opposite effect to the problem-focus coping.

$$Ef\,(t) = [\eta_{e,}.\ (1\text{-}Ac\,(t)).\ Hb\,(t)) + (1\text{-}\ \eta_e).\ Hb\,(t)].\ (1\text{-}Cg\,(t)) \tag{4.10}$$

Where $\eta_e$ *is* the proportional factor and $0 \leq \eta_e \leq 1$

From Equation 4.10, holdback increases the level of emotion focus (*Ef*), while the opposite effect is induced by acceptance and change. From Equation 4.10, as the acceptance and change levels are increasing emotion-focus coping is decreasing (Friedlander et al., 2014; Hickman, Bartholomae, & McKenry, 2016).

**Skill of Coping with Stress (*Sc*)**

According to coping theory (Lazarus, 1991; & Hale, 2014), the skill of coping with stress refers to an existing skill of an individual to cope with a stressful event. It occurs when an individual has a high level of problem-focus (*Pf)* and persists for a long period (accumulative exposure to problem-focus coping will increase the upcoming level of skill of coping with stress). Figure 4.3 shows how the skill of coping will be triggered by problem focus. The level of coping skills changes over time-based on the level of problem-focus coping (*Pf*). Parameter $\eta_s$ is used to determine the changing rate of temporal relationship. The changing process is measured in a time interval between (*t*) and *(t+*Δ*t)*.

$$Sc\,(t+\Delta t) = Sc\,(t) + \eta_s.\ [\ [Pf\,(t) - Sc\,(t)].\ (1 - Sc\,(t)).\ Sc\,(t)].\ \Delta t \qquad (4.11)$$

where $\eta_s$ is the change rate factor, $\Delta t$ is change interval in time and $0 \leq \eta_s \leq 1$

From Equation 4.11, as the problem-focus coping is increasing, the skill of coping with stress is increasing over time (Pruessner, Hellhammer, & Kirschbaum, 2017).

**Imminence of Threat (*Im*)**

Findings from (Lazarus & Folkman, 1984; Schaefer, Coyne, &, & Lazarus, 2014) have shown the imminence of threat (*Im)* refers to a condition before occurring threat which



Universiti Utara Malaysia

participates to rise threat (anticipated threat). The long-term concept intensity of a stressful event (*Ie*) that can be employed to measure imminence of threat (*Im*). The level of the imminence of threat changes over time-based on the level of intensity of a stressful event (*Ie*). For example, the imminence of threat will be high if there is a considerable presence of intensity of the stressful event. The changing process of the imminence of threat is measured in a time interval between ($t$) and $(t+\Delta t)$.

$$Im\ (t+\Delta t) = Im\ (t)+\alpha_i\ .[\ (Ie\ (t)-\ Im\ (t)).(1-\ Im\ (t)).\ Im\ (t)].\ \Delta t \qquad (4.12)$$

where $\alpha_i$ is the change rate factor, $\Delta t$ is change interval in time and $0 \leq \alpha_i \leq 1$.

From Equation 4.12, as the intensity of stressful events is increasing, the imminence of threat also increases over time (Baumeister, Campbell, Kreuger, & Vohs, 2016; Kernis, 2017).

#### 4.2.3.3 Support Request Preferences

The Buffering Hypothesis is one of the most important theories to explain the effect of social support for stressed individuals (Fyrand, Kvien, & Glenna, 2014). It states that social support buffers or shields individuals from the negative effects of prolonged stress (Thoits, 2011; Knoll, Burkert, & Schwarzer, 2014). Therefore, determining whether social support is a global constructor comprised of distinguishable types has implications for understanding the influence of social support on stress/outcome relationships (Knoll, Burkert, & Schwarzer, 2014). Social support can be categorized as; emotional, informational, companionship, and instrumental assistance provided by significant others, like co-workers, supervisors or family members. Figure 4.4 depicts the conceptual model of support requested preferences.

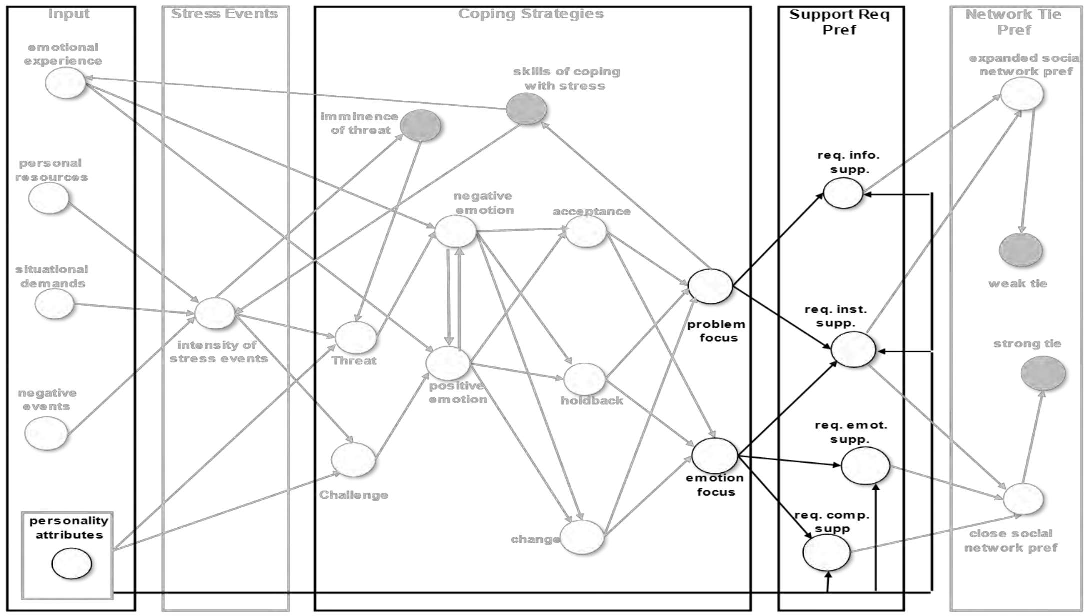



*Figure 4.4*. Causal Relationship of Support Requested Preferences.

Figure 4.4 includes four types of social support namely; informational support (*Ir*), emotional support (*Er*), instrumental support (*Nr*), and companionship support (*Cr*). Table 4.6 summarizes the relationships between these concepts as shown in Figure 4.4.

Universiti Utara Malaysia

Table 4.6

*Relationships between Concepts in Support Requested Preferences*

| Concepts | *Pf* | *Ef* | *Nu* | *Ir* | *Nr* | *Er* | *Cr* | *Co* | *Ev* |
|---|---|---|---|---|---|---|---|---|---|
| ***Pf*** | | – | – | + | + | – | – | + | + |
| ***Ef*** | | | + | – | + | + | + | – | – |
| ***Nu*** | | | | – | – | + | – | – | – |
| ***Ir*** | | | | | – | – | – | + | – |
| ***Nr*** | | | | | | – | – | – | + |
| ***Er*** | | | | | | | – | – | – |
| ***Cr*** | | | | | | | | – | + |
| ***Co*** | | | | | | | | | + |
| ***Ev*** | | | | | | | | | |

Table 4.6 describes the relationship between the concepts in support requested preferences category. From Table 4.6, it can be shown that (+) indicate to positive relation and (-) indicate to negative relation. For example, emotional request (*Er*) will be high when the neuroticism (*Nu*) level and emotion-focus coping (*Ef*) is high.

**Requested Informational Support (*Ir*)**

The informational support consisted of general advice on ways to approach problems, and specific advice on effective problem-solving skills (Cutrona & Russell, 1990; Post & Sullivan, 2016). The past researches have shown there are significant associations between informational requested support and conscientiousness personality traits (De Raad & Schouwenburg 2014; Rademacher & Wang, 2016). Conscientiousness refers to the extent that an individual is dependable, careful, responsible, organized, and has a high will to achieve. Besides, conscientious people have been found to have more frequent contact with weak members and relate to perceiving events as challenges rather than threats on positive appraisals of coping resources (Penley & Tomaka 2002, Vollrath, 2001; Rademacher & Wang, 2014; (Asendorf & Wilpers, 2017).

$$Ir(t) = \mu_{ir} . Pf(t) . Co(t) + (1- \mu_{ir}) . Co(t) \quad (4.13)$$

where $\mu_{ir}$ is the proportional factor and $0 \leq \mu_{ir} \leq 1$.

The combination of conscientiousness personality and problem-focused coping generates informational preference for support (*Ir*). Based on this concept, requested informational support is high when the combination of conscientiousness and problem-focused coping is high (De Raad & Schouwenburg 2014; Rademacher & Wang, 2016).

**Requested Emotional Support (*Er*)**

Emotional support is the kind of support that involves expression of love, care and empathy. Although emotional support is just one of several types of social support, some works of literature addressed this topic specifically with the correlation between emotional support and neurotic personality (Wanberg et al. 2000, Klein et al. 2004; Uchino, 2012; Wehrli, 2016; Mohamed & Baqutayan, 2017). Likewise, neuroticism refers to the extent to which individuals experience and display negative effects like anxiety, sadness, guilt, and is tied to the ability to cope with stress (Anderson et al. 2001; Russell, 2013). Neuroticism is generally assumed to be negatively associated with weak social relationships (Wanberg et al. 2000, Klein et al. 2004; Wehrli, 2016).

$$Er\,(\mathrm{t}) = \eta_{er}.\, Ef\,(\mathrm{t}).\, Nu\,(\mathrm{t}) + (1- \eta_{er}).\, Nu\,(\mathrm{t}) \qquad (4.14)$$

where $\eta_{er}$ is the proportional factor and $0 \leq \eta_{er} \leq 1$.

The integration of emotional-focused (*Ef)* and neurotic personality (*Nu)* gives emotional preference (*Er*) through a proportional factor $\eta_{er}$. Equation 4.14 depicts that the recipient 's emotional support is formed by two simultaneous contributory functions between neurotic personality and emotion-focused coping. Based on this, it can be pointed out that emotional support is low when neuroticism personality is low (Samter, 2002; Roberts, Newman, Apa, & Brown, 2017).

**Requested Instrumental Support (*Nr*)**

Instrumental support refers to the perceived availability of people who can provide functional aid in completing daily tasks (such as making meals, providing transportation, provision of financial aid, material resources, or needed services) if needed (Nurulla, 2010; Owens, 2017). Extraversion personality had a direct effect on instrumental support in addition to partially mediating the effects of both problem-focus and emotion focus coping styles (Russel et al., 2018). Thus, the proportioned combination of emotional-focused and problem-focused coping by factor $\psi_n$ with extraversion personality (*Ev*) gives instrumental preference (*N*r) over other support preferences.

$$Nr\ (t) = (\psi_n.Pf\ (t) + (1 - \psi_n).\ (Ef\ (t)).\ Ev\ (t)) \quad (4.15)$$

where $\psi_n$ is the proportional factor and $0 \leq \psi_n \leq 1$.

This formalization depicts that extraversion personality is directly proportional to instrumental support whereas emotional-focused and problem-focused coping are mutually exclusive to each other (Anderson et al. 2015; Malti et al., 2017).

**Requested Companionship Support (*Cr*)**

The last type of social support to be covered in this study is companionship support. This form of support is as important as the other aforementioned types of social support and plays a crucial role in helping individuals cope with stressful or difficult events. In this case, extraversion personality had a direct effect on companionship support (Lauritz, Preez, Cassimjee, & Ghazinour, 2015). Also, it refers to companionship support requested as the perception of both extraversion and emotion focus as illustrated in Figure 4.4. Based on this, it can be pointed out that companionship support preference is low when the extraversion personality is low.

Therefore, by combining both extraversion personality (*Ev)* and emotional-focused (*Ef),* it determines the value of companionship preference (*Cr*) through a proportional factor $\beta_c$.

$$Cr\,(t) = \beta_c . Ef\,(t).\, Ev\,(t) + (1 - \beta_c).\, Ev\,(t) \quad (4.16)$$

where $\beta_c$ *is* the proportional factor and $0 \leq \beta_c \leq 1$.

The combination of extraversion personality and emotion-focused coping generates companionship preference for support (*Cr*). Based on this concept, requested companionship support is high when either the emotion-focus coping or extraversion personality is high (Lauritz, Preez, Cassimjee, & Ghazinour, 2015).

#### 4.2.3.4 Network Tie Preferences

According to the strong tie/weak tie support network theory (Dodson et al., 2016), seeking support from the environment is important to reduce stress. People usually have different social support networks to which they are attached with different ties. First, the expanded social network involves less frequent interaction, lower levels of emotional intensity and intimacy, and lower feelings of reciprocity. Moreover, it also is less homophilous than closed social network (Gordon, 2017; Haines & Beggs, 2016).

Universiti Utara Malaysia

However, the closed social network involves more frequent interaction, emotional intensity and intimacy, and feelings of reciprocity (Adams, 2012, Iwasaki, 2016; Khoo, 2018). The closed social network is often homophilous and results in a densely knit, who are connected via strong ties also share other friendship circles. Figure 4.5 depicts the concept of network tie preferences.

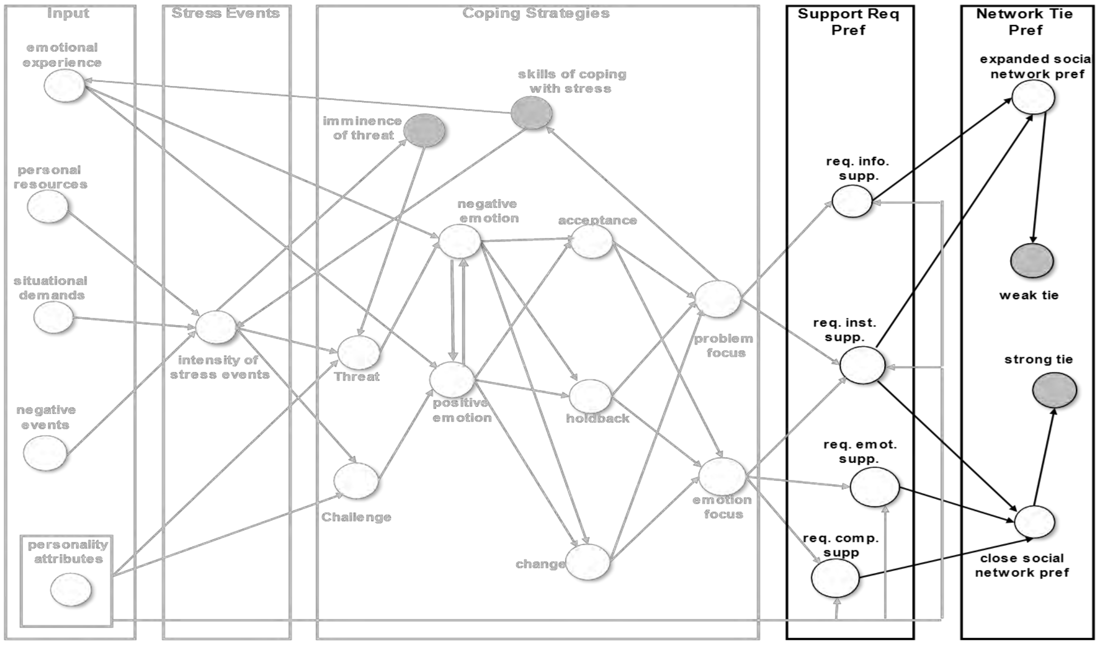



*Figure 4.5*. Causal Relationship of Network Tie Preferences.

Figure 4.5 shows the concepts in network tie preferences that include two types of network namely; expanded social network (*Es*) and closed social network (*Cs*), with two types of ties strong tie (*Se*) and weak tie (*We*). Table 4.7 illustrates the relationships between concepts in this category.

Universiti Utara Malaysia

Table 4.7

*Relationships between Concepts in Network Tie Preferences*

| **Concepts** | ***Ir*** | ***Er*** | ***Nr*** | ***Cr*** | ***Es*** | ***Cs*** | ***Se*** | ***We*** |
|---|---|---|---|---|---|---|---|---|
| ***Ir*** | | _ | _ | _ | + | _ | _ | + |
| ***Er*** | | | _ | _ | _ | + | + | _ |
| ***Nr*** | | | | _ | + | + | + | + |
| ***Cr*** | | | | | _ | + | + | _ |
| ***Es*** | | | | | | _ | _ | + |
| ***Cs*** | | | | | | | + | _ |
| ***Se*** | | | | | | | | _ |
| ***We*** | | | | | | | | |

Table 4.7 describes the relationship between the concepts in network tie preferences category. From Table 4.6, it can be shown that (+) indicate to positive relation and (-) indicate to negative relation. For example, a closed social network (*Cs*) will be high when the emotional requested (*Er*), instrumental requested (*Nr*), and companionship requested level (*Cr*) are high.

**Expanded Social Network Preferences (*Es*)**

For example, various studies have suggested that many individuals with problem-focused coping find it difficult to get appropriate support from close friends or acquaintances as they perceived this group of people to have limited knowledge or skills required to solve the individual's problems (Knoll, & Rieckmann, 2014; Simoncic, 2015). In other studies, the instrumental and informational support requests perceived towards the expanded social network preferences (*Es*) (Brashers, Neidig, & Goldsmith, 2016; Iwasaki, 2018).

Universiti Utara Malaysia

This homogeneity with others can limit the diversity of information and viewpoints obtained about topics, including health concerns (Adelman et al., 2016). It could be inferred that the expanded social network preferences are high when any two factors (information support or instrumental support) are high.

$$Es\ (t) = [Ir\ (t) + Nr\ (t)] / \Sigma\ Sr\ (t) \quad (4.17)$$

where $\Sigma\ Sr\ (t) = Ir\ (t) + Nr\ (t) + Er\ (t) + Cr\ (t)$ and $\Sigma\ Sr\ (t) > 0$

As the combination of information support and instrumental support is increasing, the expanded social network preferences are also increasing (Gordon, 2017; Haines & Beggs, 2016).

**Closed Social Network Preferences (*Cs*)**

For example, many individuals form close relationships with others find it easy to obtain emotional, companionship, and instrumental support from close friends and family members because they may feel that their close ties surplus experience or have a mutual interest about certain health conditions (Botwin, Buss, & Shackelford, 2017). However, if the individual's objective is to seek emotional-focused coping is greater, he/she tends to select strong tie support over a weak tie. Further, these types of support, including companionship (*Cr*), emotional (*Er*), and instrumental (*Nr*) (in some cases) are more related to strong tie (family and close friends) preference (Tinsley, 2017; Wang et al., 2016). Therefore, these constructs are simulated to generate closed social network preference (*Cs*).

$$Cs\,(t) = [Nr\,(t) + Er\,(t) + Cr\,(t)] \,/\, \Sigma\, Sr\,(t) \qquad (4.18)$$

where $\Sigma\, Sr\,(t) = Ir\,(t) + Nr\,(t) + Er\,(t) + Cr\,(t)$ and $\Sigma\, Sr\,(t) > 0$

Therefore, as the interplay between emotional support, instrumental support, and companionship support increases, the closed social network preference level also increases (Botwin, Buss, & Shackelford, 2017).

**Strong Tie (*Se*)**

According to the Support Network Preference Theory (Iwasaki, 2016), strong tie (*Se*) is a relationship between individuals that triggered by a close personal network. It is caused by a high level of closed social network (*Cs*) and continues (accumulative exposure to closed social network leads to strong tie selection). The level of the strong tie will be changed over time based on the current level of a closed social network preference. It is primarily contributed the accumulation exposure towards the closed social network in a time interval between $t$ and $t+\Delta t$.

$$Se\,(t+\Delta t) = Se\,(\mathrm{t})+\psi_s\,.[(Cs(\mathrm{t})\text{- } Se\,(\mathrm{t})).(1\text{- } Se\,(\mathrm{t})).\ Se\,(\mathrm{t})].\ \Delta t \tag{4.19}$$

where $\psi_s$ is the change rate factor, $\Delta t$ is change interval in time and $0 \leq \psi_s \leq 1$.

From Equation 4.19, as the closed social network is increasing strong tie is increasing over _time (Donnellan, Trzesniewski, Robins, Moffitt, & Caspi, 2016).

**Weak Tie (*We*)**

Weak tie (*We)* is a relationship between individuals that triggered by an expanded personal network. It caused by a high level of expanded social network (*Es*) and continues for a long period (accumulative exposure to expanded social network leads to weak tie) (Dodson et al., 2016). In general, a weak tie is primarily affected by the accumulated exposure towards an expanded social network. The level of the weak tie will be changed over time based on the level of an expanded social network. For instance, the weak tie will be high if there is a considerable presence of an expanded social network within a time interval between $t$ and $t+\Delta t$.

$$We\,(t+\Delta t) = We\,(\mathrm{t}) + \beta_{w.}\,[(Es\,(\mathrm{t})\text{- } We\,(\mathrm{t})).\ (1\text{- } We\,(\mathrm{t})).\ We\,(\mathrm{t})].\ \Delta t \tag{4.20}$$

where $\beta_w$ is the change rate factor, $\Delta$t is change interval in time and $0 \leq \beta_w \leq 1$.

From equation 4.20, as the expanded social network is increasing weak tie is increasing over time (Ottenbreit & Dobson, 2017).

### 4.3 Computational Support Provider Model Development

Recipient factors alone are not sufficient to ensure that support can be provided. For example, even when the partner is stressed, and the opportunity is there to provide support, support is not always given in time (Cutrona, 1996; Bierhoff & Rohmann,



Universiti Utara Malaysia

2016). The support provision is a dynamic process as it includes substantial changes in support requests for different conditions. From this perspective, the underlying model covers the integration of coping strategies, support provision preferences and adaptation concepts. For example, social support members who are faced with the condition to give support will be motivated by several factors. Many research works have maintained that there is a link that support-providers with experience empathy and altruistic attitude will regulate altruistic motivation to help others. The development of the support provider model is identical to the support recipient model with three phases; domain, design and operational.

### 4.3.1 Domain Model

This phase aims to identify key factors in determining the selection of social support provision. Previous literature and empirical studies (as stated in Chapter Three) provide important information to develop this model. The essential idea of this model comes from the provisioning process is highly dynamic in nature, and it requires demanding resources to monitor such a process in the real world (Aziz & Ahmad, 2013; Barbara, 2016). It reflects the dynamic viewpoints for the providers where the individuals typically occupy multiple roles in life; e.g. becoming a support provider of a person with stress, and therefore will require some rearrangement of individual's priorities. The results from this phase presented twenty-eight (28) important factors. The identified factors were grouped into three categories (external, instantaneous and temporal). Tables 4.8, 4.9 and 4.10 summarize these three groups.

Universiti Utara Malaysia

Table 4.8

*External Factor Concept of Support Provider*

| No | Factor | Formal | Description | Theory | Reference |
|---|---|---|---|---|---|
| 1 | Personal Resources | *Prp* | Include material resources like financial incomes, services needed. | CMR, TS | Andalibi & Haimson, 2016; Feeney & Collins, 2011, 2013. |
| 2 | Negative Events | *Nvp* | Represents three types of events: life, chronic, and daily events that generated stressors externally. | CMR, BSR, TS | Attig, 2015; Andalibi & Haimson, 2016 |
| 3 | Altruistic Attitude | *Al* | Refers to the level of prosocial behaviour that is motivated by a genuine desire to benefit another person. | AP, EA | Feigin et al. 2014; Penner et al. 2015. |
| 4 | Provider Situational Interest | *Ps* | It represents the experiential and situational concepts related to providers | RP, SNP | Hobfoll & Lerman, 2014 Feeney & Collins, 2015 |
| 5 | Recipient Situational Interest | *Rs* | It represents the experiential and situational concepts related to recipients. | RP, SNP | Hobfoll & Lerman, 2014 Feeney & Collins, 2015 |
| 6 | Personality Attributes | *Pa* | It refers to a positive or negative personality that includes values, commitments, and beliefs about provider. | CMR, FFM | Bolger & Amarel, 2015; Carolan, 2013; Carver etal., 2015; Mor & Winquist, 2012. |
| 7 | Knowledge Level | *Kl* | It refers to the level of knowledge that providers have to advise or provide support. | CMR, CO | Ooden, 2014; Kalkan & Epli-koç, 2014; Lakey, Cooper, & Cronin, 2015. |
| 8 | Function Provider in Networks | *Fp* | Refers to support provision based on weak tie or strong tie. | SNP, WST | Brashers, Neidig, & Iwasaki, 2016 |

Altruistic Personality Theory (AP), Five-Factor Model (FFM), Self-Determination Theory (SD), Reciprocity Theory (RP), Cognitive Motivational Relational Theory (CMR), Transactional Stress Theory (TS), Coping Theory (CO), Support Network Preference theory (SNP), Behavioral Self-Regulation Model (BSR), Weak Tie/Strong Tie Support Network (WST), Empathy–Altruism Theory (EA).

The support provider model reflects the realistic behaviour that could clarify conditions for providing support to handle stressed individuals, which was based on several external factors such as; negative events, altruistic attitude, personality attributes, provider and recipient situational interest, and knowledge level.

One of the main factors that influence support provision is limited resources (Feeney & Collins, 2014, 2017). One indicator of strained provider resources is the occurrence of a stressful event experienced by the potential support provider. On a stressful day, any potential providers may tend to take care of their own needs rather than others. Another factor could be strained in support provision is the provider's negative personality (Mor & Winquist, 2017; Trope, Igou & Burke, 2018). Typically, the negative personality attributes promote less supportive behaviour compared to the positive ones (Cialdini et al., 2016; Trobst, Collins, & Embree, 2017). For example, extraversion and agreeableness are associated with increased support provision, as it is related to empathy trait (Branje et al., 2015; Bowling, Beehr, & Swader, 2016; Trobst, Collins, & Embree, 2017). Conversely, neuroticism and psychological stress are associated with the provision of less support (Hinnen, Hagedoom, Sanderman, & Ranchor, 2017). Also, based on the altruistic personality theory, this attitude is a prosocial behaviour that is motivated by a genuine desire to benefit another person, without any expectation of benefits (Feigin et al. 2014; Eisenberg and Miller, 2016; & Penner et al. 2018).

Recipient and provider situational interests' concepts refer to mutual interest between them. Also, it reflects the degree of the mutual relationship between support recipient and provider so both support recipient and provider characteristics will increase companionship levels and support satisfaction. For example, the intimate relationship is positively correlated to the perceptions of companionship support (Hobfoll & Lerman, 2014) while interdependence and trust are associated with more support provision (Feeney & Collins, 2017).

Table 4.9

*Temporal Factor Concept of Support Provider*

| No | Factor | Formal | Description | Theory | Reference |
|---|---|---|---|---|---|
| 1 | Emotional Exhaustion | *Eh* | Negative psychological condition experienced by any individual who chose the wrong coping strategies | DABCX, BB | Burr, 2014; McCubbin & Patterson, 2015 |
| 2 | Committed Support | *Cm* | The long-term willingness to help based on being responsible and committed obligation. | SD, EA, AP | Williamson, 2015a, 2015b; Post, Bloemen, & Witte, 2016 |

Altruistic Personality Theory (AP), Self-Determination Theory (SD), Double ABCX Theory (DABCX), Broaden-and-Build Theory (BB), Empathy–Altruism Theory (EA).

Table 4.10

*Instantaneous Factor Concept of Support Provider*

| No | Factor | Forma l | Description | Theory | Reference |
|---|---|---|---|---|---|
| 1 | Intensity of Stressful Event | *Iep* | Represents the degree of stress encountered by a support provider where several factors such personal resources and negative events play important roles. | CMR, BSR | Azizi & Ahmad, 2013; Barbara, 2016; Andalibi & Haimson, 2016. |

Universiti Utara Malaysia

Table 4.10 Continued

| | | | | | |
|---|---|---|---|---|---|
| 2 | Threat | *Thp* | It refers to primary appraisal when the provider makes a conscious evaluation of the matter at hand (what is at stake) of whether it is a sense of threat. | CMR, TS, BSR | Bierhoff & Rohmann, 2016; Chappell & Reid, 2014; Columbia, 2015. |
| 3 | Challenge | *Chp* | A willingness to undertake change and face new activities. It differs from threat in term of how providers are viewing it where it has a positive tone compared to threat. | CMR, TS, BSR | Blasovich & Mendes, 2013; Andalibi & Haimson, 2016 |
| 4 | Problem Focus | *Pfp* | An interpersonal effort of an individual to alter the situation as well as rational efforts to get the problem solved. | CMR, CO | Flyckt, Fatouros-bergman, & Koernig, 2015; Buckley, & Birch, 2013. |
| 5 | Emotional Focus | *Efp* | Refers to entail efforts of an individual to control the emotional consequences of a stressful event (thinking rather than acting), | CMR, CO | Kalkan & Epli-koç, 2014; Lakey, Cooper, & Cronin, 2015. |
| 6 | Self-esteem | *Sf* | It is the level of the provider's overall cognitive perception of the self. | SD, SV, EA | Coope, 2015; Mccubbin, & Patterson, 2016. |
| 7 | Burden Level | *Bl* | The physical, psychological or emotional, social, and financial problems that can be experienced by providers. | BSR, SV | Otr & Schulz, 2015; Gracia & Herrero, 2014 |

Table 4.10 Continued

| | | | | | |
|---|---|---|---|---|---|
| 8 | Maladaptation | *Ma* | Referring to the provider outcome of adaptation that allows continued negative situations and needs for referral and assistance. | DABCX, CO | McCubbin and Patterson, 2015; Kielhofner & Forsyth, 2014; |
| 9 | Bonadaptation | *Ba* | Provider outcome that permits meeting the need to support the care recipient. | DABCX, CO | Kielhofner & Forsyth, 2014; Breines, 2015 |
| 10 | Empathy Capability | *Ec* | The level of a tendency to react to other people's observed experiences | EA, SD, AP | Hazen & Shaver, 2013 Shaver, Schanchner, &Mikulincer, 2015 |
| 11 | Altruistic Motivation | *Am* | The level of empathy feeling for the support providers that consider a motivator t of helping others. | EA, SD, AP | Coke, Batson, & McDavis, 2011; Shumaker & Brownell, 2012; Specht, 2015. |
| 12 | Willingness to Help | *Wh* | The level of providing and offering support from providers. | SD, EA, AP | Williamson, 2015a, 2015b; Post, Bloemen, & Witte, 2016. |
| 13 | Perceived Close Tie | *Pc* | Strong tie perceived where the partners feel responsible for one another's welfare. | ST, SNP | Reinhard, Given, Petlick, & Bemis, 2014. |
| 14 | Mutual Interest | *Mi* | Represents the characteristics of the relationship (ties) between support recipient and provider | RP, SNP | Uchino & Vaughn, 2015; Lavee, Mccubbin, & Patterson, 2016. |

Universiti Utara Malaysia

Table 4.10 Continued

| | | | | | |
|---|---|---|---|---|---|
| 15 | Informational Support Provided Preferences | *Ip* | The availability of people who can provide information or advice needed to solve problems. | SNP, SB, AT | Gooden, 2014; Kalkan & Epli-koç, 2014; Lakey, Cooper, & Cronin, 2015. |
| 16 | Instrumental Support Provided Preferences | *Np* | The provision of tangible aid and services that directly assist a person in need | SNP, SB, AT | Heaney & Israel, 2015, Denissen & Penke 2015, Holmes 2016. |
| 17 | Emotional Support Provided Preferences | *Ep* | The provision of empathy, love, trust and caring. . | SNP, SB, AT | Cutrona & Russell, 2015; Mohamed & Baqutayan, 2015. |
| 18 | Companionship Support Provided Preferences | *Cp* | Providing recipients with a sense of belonging and contact with others | SNP, SB, AT | Krohne, 2012; Kuppens & Diener, 2015; Mohamed & Baqutayan, 2015. |

Altruistic Personality Theory (AP), Self-Verification Theory (SV), Self-Determination Theory (SD), Reciprocity Theory (RP), Double ABCX Theory (DABCX), Cognitive Motivational Relational Theory (CMR), Transactional Stress Theory (TS), Coping Theory (CO), Support Network Preference theory (SNP), Behavioural Self-Regulation Model (BSR), Stress Buffering Theory (SB), Attachment Theory (AT), Empathy–Altruism Theory (EA), Strength of Tie Theory (ST).

### 4.3.2 Design Model and Operational Model

In this phase, the identified support provider factors from the domain model are represented with corresponding interrelationships based on selected literature, theories, and empirical evidence. Figure 4.6 shows these causal relationships that produce the conceptual model of a support provision process.

Universiti Utara Malaysia

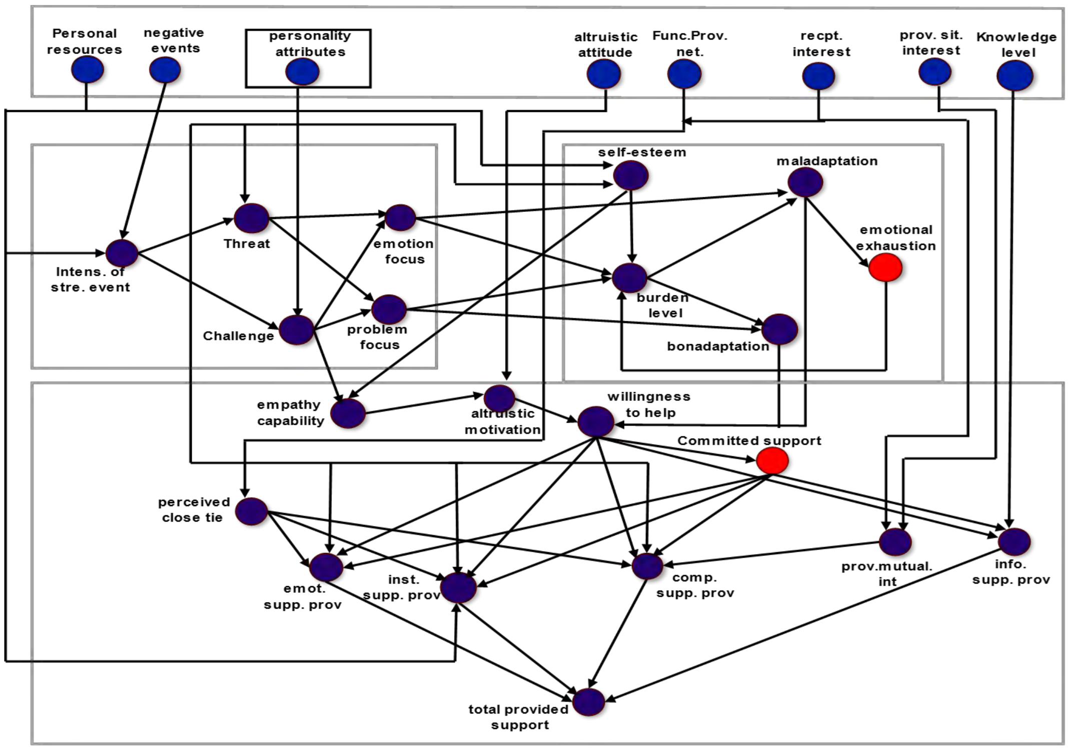



*Figure 4.6.* Conceptual Model of a Social Support Provider.

UUM
Universiti Utara Malaysia

Based on Figure 4.6, this conceptual model has explicitly showed the interplays and interactions between support provision factors. These interplays can be grouped into three main components namely; coping strategies, adaptation concepts, and support provision preferences.

### 4.3.2.1 Support Provider Coping Strategies

Feeney and Collins (2001) found that stressed individuals tend to provide support in a way that is different from those who are not stressed. For example, they tend to provide more controlling and compulsive support to their partners, regardless of the partners' need for support. Whereas normal individuals are more likely to provide the support that is contingent on the needs or support-seeking of their partners (Simpson, Rholes, Orina, & Grich, 2012; Aziz & Ahmad, 2013). Figure 4.7 depicts the concept of a provider's coping strategies.

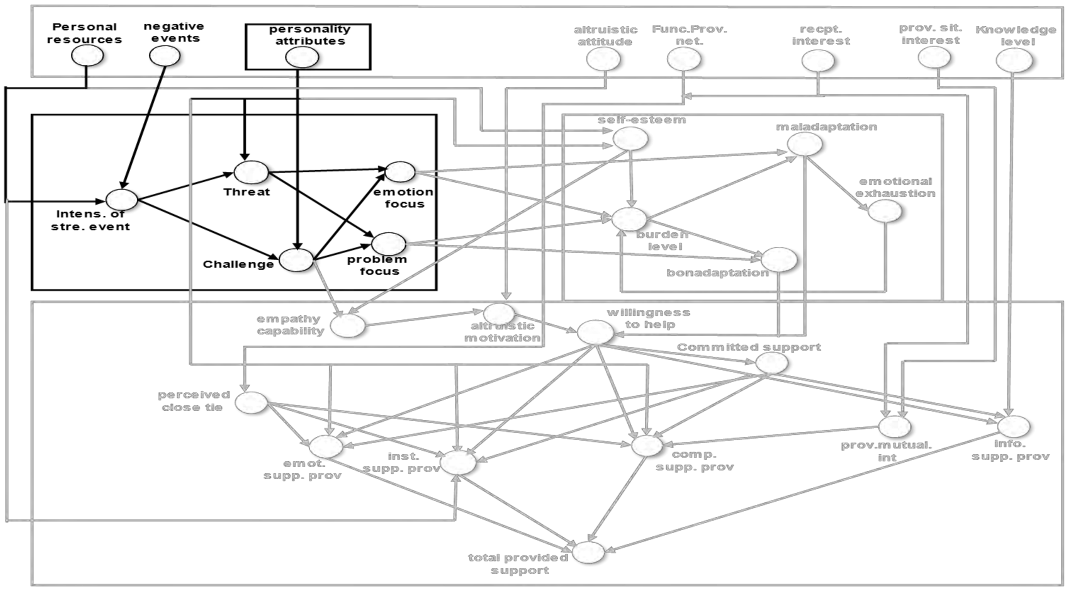



*Figure 4.7.* Causal Relationship of Provider's Coping Strategies.

Figure 4.7 shows the concepts within coping strategies that include two types of appraisals coping strategies namely; primary appraisal (challenge (*Chp*), threat (*Thp*)) and secondary appraisal (problem focus (*Pfp*) or emotion focus (*Efp*). Table 4.11 illustrates the relationships between related concepts in this category.

UUM Universiti Utara Malaysia

Table 4.11

*Relationships between Concepts in Provider's Coping Strategies*

| **Concepts** | ***Nvp*** | ***Prp*** | ***Pap*** | ***Iep*** | ***Thp*** | ***Chp*** | ***Pfp*** | ***Efp*** |
|---|---|---|---|---|---|---|---|---|
| ***Nvp*** | | - | - | + | + | - | - | + |
| ***Prp*** | | | + | - | - | + | + | - |
| ***Pap*** | | | | - | - | + | + | - |
| ***Iep*** | | | | | + | - | - | + |
| ***Thp*** | | | | | | - | - | + |
| ***Chp*** | | | | | | | + | - |
| ***Pfp*** | | | | | | | | - |
| ***Efp*** | | | | | | | | |

Table 4.11 describes the relationship between the concepts within coping strategies category. It can be shown that (+) indicate to positive relation and (-) indicate to negative relation. For example, a provider's challenge (*Chp*) will be high when the provider's personality attributes (*Pap)* are high.

**Intensity of Stressful Event (*Iep*)**

Within the model introduced, three aspects play important roles to regulate support and maintain the provider's health: 1) coping strategies, 2) adaptation concepts, and 3) support provision preferences. For the first aspect, stressors are related to specific internal or external demands (daily, life, and chronic stressors), which is previously defined as negative events, that the provider has to manage (Towbes & Cohen, 2015; Attig, 2017). This outcome is predicted by personal resources (*Prp*) and negative events (*Nvp*) which can be foreseen in the literature. From Table 4.11 that intensity of the stressful event is positively connected to negative events and negatively related to personal resources.

$$Iep(t) = \eta_i.Nvp(t)+(1-\eta_i). (Nvp(t)).(1-Prp(t)) \quad (4.21)$$

where $\eta_i$ is the proportional factor and $0 \leq \eta_i \leq 1$.

The intensity of stressful events (*Iep*) denotes the degree of stress experienced by a person based on stressor events (*Nvp*) and his or her resources (*Prp*). Also, if the personal resources (*Prp*) are high, the intensity of a stressful event is decreased (Hampton, Sessions Goulet, Marlow, & Rainie, 2017). It presents a condition in which the concept of the intensity of the stressful event is defined by the mutual contributions of personal resource and negative event.

**Threat (*Thp*)**

Threat represents how the provider reacts when facing the adversity in providing requested support. It consists of an array of personality attributes such as commitments, beliefs about oneself and the environment defining condition faced by the individuals (Chappell & Reid, 2014; Columbia, 2015). This choice of appraisal is related to the provider's personality. For example, positive personality provider (e.g., low in neuroticism) tends to be challenged rather than a threat (Simpson, Rholes, Orina, & Grich, 2012; Blasovich & Mendes, 2013; Andalibi & Haimson, 2016). Therefore, the appraisal of threat has resulted from the perceived personality attributes (*Pap*), and the intensity of a stressful event (*Iep*).

$$Thp(t) = (Iep(t).\,(1 - Pap(t))) \tag{4.22}$$

Additionally, the level of threat (*Thp*) can be defined by immediately the intensity of stressful events and personality attributes (*Pap*), in this case of a threat, a negative relation is established with personality attributes. This implies that threat will be high when the intensity of stressful events are high and personality attributes are low (Lenhart, Ling, Campbell, & Purcell, 2016).

**Challenge (*Chp*)**

In contrast to the perceived threat, the challenge has a positive tone and related to positive outcomes (Blasovich & Mendes, 2013; Andalibi & Haimson, 2016). Also, challenge (*Chp*) is positively related to personality attributes (*Pap*), while the opposite with the intensity of stressful events (*Iep*). Thus, the challenge is low when the personality attribute is low, and the intensity of stressful events is high (Dodson et al., 2016; Flynn & Lake, 2012).

$$Chp(t) = \beta_c . Pap(t) + (1 - \beta_c) . Pap(t) . (1 - Iep(t)) \tag{4.23}$$

where $\beta_c$ is the proportional factor and $0 \leq \beta_c \leq 1$.

Challenge (*Chp*) is positively related to personality attributes (*Pap*), while negatively with the intensity of stress through the proportional factor ($\beta_c$). It is seen from the formalization that challenge is high when the personality attribute is high (Hampton, Sessions Goulet, Marlow, & Rainie, 2018).

**Problem-Focus (*Pfp*)**

Individuals who believe that something can be done to resolve the problem (challenge) tend to use a more active or "engagement" coping strategy than people who appraise the situation as beyond their control (Folkman, Lazarus, Dunkel-Schetter, De Longis, & Gruen, 1986; Kalkan & Epli-koç, 2014).

Therefore, the problem-focused coping (*Pfp*), is positively connected to the challenge concept (Schwarzer, Knoll, & Rieckmann, 2017). Also, problem-focused coping delivers a positive effect on an adaptation process.

$$Pfp(t) = (Chp(t) . (1 - Thp(t))) \tag{4.24}$$

Equation 4.24 depicts that provider's problem focus is formed by the simultaneous contributory functions between threat and challenge. Also, it is inferred that threat is negatively related, and the challenge is positively related to the problem-focus concept (Garton, Haythornthwaite, & Wellman, 2015; Haythornthwaite, 2017).

### Emotion-Focus (*Efp*)

The emotion-focused coping induces internal changes within a person's attention or personal meanings (Batson, Duncan, Ackerman, Buckley, & Birch, 2013; Kalkan & Epli-koç, 2014; Lakey, Cooper, & Cronin, 2015; Lavee, Mccubbin, & Patterson, 2016). Individuals who are stressed and anxious are more likely to use emotion-focused strategies than problem-focused coping strategies (Endler & Parker, 1990; Mayer & Landis, 2015). These reviews revealed that two major factors produce provider' emotion-focus namely threat and challenge where an emotion focus level is high when a threat level is high, and a challenge level is low.

$$Efp(t) = (Thp(t).\,(1 - Chp\,(t))) \tag{4.25}$$

From the equation, the threat increases the level of emotion focus (*Efp*), while the opposite effect is induced by a challenge. Thus, the presence of threat and challenge generates emotional-focused coping (*Efp*) level with opposite relation to problem-focus (Granovetter, 2016; Haythornthwaite, 2017).

Universiti Utara Malaysia

### 4.3.2.2 Adaptation Preferences

According to the Double ABCX theory, provider adaptation is the outcome of the provider's processes in response to the stressor and pile-up of demands (McCubbin and Patterson, 2015). As in Burr (2014), it refers to the capability of an individual to cope while facing a stressful event. In addition, provider adaptation is a continuous variable, ranging from maladaptation to bonadaptation (McCubbin and Patterson, 2015). Figure 4.8 depicts the concept of a provider's adaptation preferences.

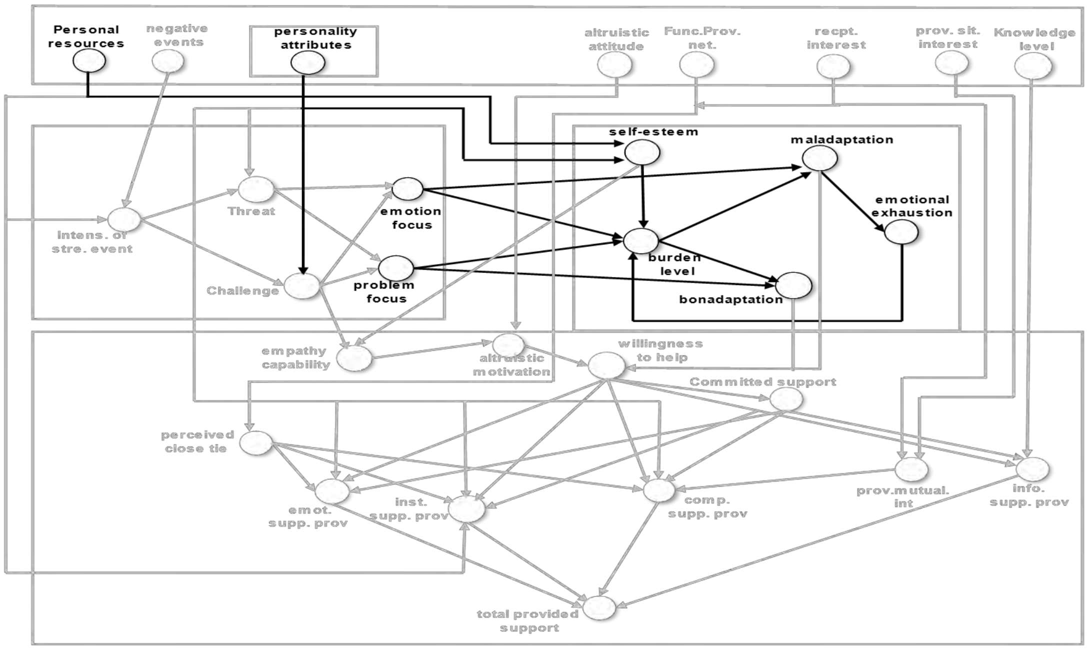



*Figure 4.8* Causal Relationship of Provider's Adaptation Preferences.

Figure 4.8 visualizes important concepts within provider adaptation preferences that include self-esteem (*Sf*), burden level (*Bl*), maladaptation (*Ma*), bonadaptation (*Ba*), and emotional exhaustion (*Eh*). Table 4.12 mapped the interplay of these concepts.

Table 4.12

*Relationships between Concepts in Provider's Adaptation Preferences*

| **Concepts** | ***Prp*** | ***Pap*** | ***Pfp*** | ***Efp*** | ***Sf*** | ***Bl*** | ***Ma*** | ***Ba*** | ***Eh*** |
|---|---|---|---|---|---|---|---|---|---|
| ***Prp*** | | + | + | - | + | - | - | + | - |
| ***Pap*** | | | + | - | + | - | - | + | - |
| ***Pfp*** | | | | - | + | - | - | + | - |
| ***Efp*** | | | | | - | + | + | - | + |
| ***Sf*** | | | | | | - | - | + | - |
| ***Bl*** | | | | | | | + | - | + |
| ***Ma*** | | | | | | | | - | + |
| ***Ba*** | | | | | | | | | - |
| ***Eh*** | | | | | | | | | |

**Self-Esteem (*Sf*)**

According to Swann's self-verification Theory, it proposes that individuals with low self-esteem are often being viewed as negative, and leading them to provide less support (Giesler, Josephs, & Swann, 1996; Swann, 1997; Lakey, Cooper, & Cronin, 2015; Lavee, Mccubbin, & Patterson, 2016). In this sense, individuals with self-esteem can better tolerate challenges and demands. In contrast, individuals with low self-esteem can be thought of as having a weakness in the face of developmental challenges (Baumeister, Campbell, Kreuger, & Vohs, 2003; Kernis, 2013). Therefore, a combination of personal resources (*Prp*) and personality attributes (*Pap*) triggers improved the level of self-esteem (*Sf*) through a proportional contribution ($\alpha_s$) as presented in Equation 4.26.

$$Sf(t) = \alpha_s \mathrm{Pr}p(t) + (1 - \alpha_s).Pap(t) \tag{4.26}$$

where $\alpha_s$ is the proportional factor and $0 \leq \alpha_s \leq 1$.

Universiti Utara Malaysia

This equation shows that there is an exclusive contributory between personality and personality resources, as it implies that self-esteem is high when either personality attributes or personality resources are high (Morelli, Lee, Arnn, & Zaki, 2015, Nurullah, 2017).

**Burden Level (*Bl*)**

The second aspect is related to the provider's adaptation preferences is a burden level. According to Behavioural Self-Regulation Model (BSR) (Shumaker & Brownell, 2012; Specht, 2015), it is derived from the chosen coping strategies (problem-focus or emotion- focus). For example, several studies show that provider's emotion-focused appraisal amplifies the perception of provider burden, while provider's problem-focused appraisal decrease the perceived burden (Otr & Schulz, 2015; Post, Bloemen, & Witte, 2016). Another significant concept that is related to burden level is self-esteem. Individuals with higher levels of self-esteem are likely to report less perceived burden level (Sarason et al., 2010; Gracia & Herrero, 2014). Four factors are pinpointed to contribute to the perceived burden level. These are problem-focus (*Pfp*), emotion-focus (*Efp*), self-esteem (*Sf*), and emotional exhaustion (*Eh*).

$$Bl(t) = (1 - [\gamma_b . Pfp(t) + (1 - \gamma_b).\ (Sf(t)]\ ).(\ \sigma_b . Eh(t) +\ (1 - \sigma_b). Efp(t)) \tag{4.27}$$

where $\gamma_b$ is the proportional factor and $0 \leq \gamma_b \leq 1$.

From the formalized concept, it implies that for burden level to be high, then problem-focus and self-esteem level must be reduced which can only occur when either emotion-focus or emotional exhaustion will be high (Rainie et al., 2015; Stern & Messer, 2016; Wellman, Quan-Haase, Witte, & Hampton, 2017).

**Maladaptation (*Ma*)**

Maladaptation or the negative end of the adaptation continuum can be defined as a continued imbalance between the demands and the provider's capabilities to meet the demands. Furthermore, it refers to the continued negative situation and needs for referral and assistance (Rodriguez & Cohen, 2013; Seidman & Bolger, 2017). Several studies investigate the negative consequences for the provider support, such as emotional exhaustion, burden, or maladaptation (Shumaker & Brownell, 2012; Specht, 2015; Seidman & Bolger, 2017). Two main factors define the concept of maladaptation namely emotion-focus and burden level. The maladaptation (*Ma)* is computed using the combination of burden and emotion-focused coping levels. Parameter provides a proportional contribution factor for these concepts.

$$Ma(t) = \omega_m . Efp(t) + (1 - \omega_m). Bl(t) \tag{4.28}$$

where $\omega_m$ is the proportional factor and $0 \leq \omega_m \leq 1$.

The equation shows that both attributes contribute directly to the progression of maladaptation that shows the maladaptation will be high when either the emotion-focus is high, or burden level is high (Raine, Horrigan, Wellman, & Boase, 2016).

**Bonadaptation (*Ba*)**

Bonadaptation refers to meeting the needs to support the recipient which involves adjusting to, being influenced by, and shaping the condition (Kielhofner & Forsyth, 2014, Breines, 2015). This process involves a fundamental shift in the meaning, purpose, or direction of a person's life (Stukas, 2015; Uchino & Vaughn, 2015). From the Double ABCX model of bonadaptation, the continuum is defined as a minimal discrepancy between the demands and the family's capabilities, to achieve a balance in family functioning. Contrary to the maladaptation two main factors that define the concept of bonadaptation are problem-focus and burden level.

$$Ba(t) = \eta_b . Pfp(t) + (1 - \eta_b). (1 - Bl(t)) \tag{4.29}$$

where $\eta_b$ is the proportional factor and $0 \leq \eta_b \leq 1$.

Equation 4.29 shows that bonadaptation has a positive relationship with the problem-focus and a negative relationship with the burden level (Fox, 2015; Rainie et al., 2016) through parameter $\eta_b$ to a proportional contribution factor in respective relationships.

**Emotional Exhaustion (*Eh*)**

From Double ABCX theory of provider's adaptation (McCubbin and Patterson, 2015), emotional exhaustion (*Eh)* is an unsatisfactory outcome that individuals feel after experiencing the effect of maladaptation. Repeated maladaptation over a long period will trigger an exhaustion phase. Later, this condition will increase the perceived burden level for providers. Emotional exhaustion increases and decreases over time depending on the current level of maladaptation (*Ma*). Besides, bonadaptation is related to the high personal accomplishment and provided social support (high willingness to help), while maladaptation is linked to the emotional exhaustion (Chappell & Reid, 2014; Columbia & Columbia, 2015; Flyckt, Fatouros-bergman, & Koernig, 2017) which influence the perceived burden level.

$$Eh\,(t+\Delta t) = Eh\,(t) + \psi_e \,.\, [(Ma\,(t) - Eh\,(t)).\,(1- Eh\,(t)).\,Eh\,(t)].\,\Delta t \quad (4.30)$$

where $\psi_e$ is the change rate factor, $0 \leq \psi_e \leq 1$, and $0 \leq \Delta t \leq 1$.

From formalized Equation 4.30, the parameter $\psi_e$ is used to determine the changing rate of temporal relationship which reflects if there is a considerable presence of maladaptation, the amount of emotional exhaustion will increase (Cohen & Wills, 2014; Burleson & MacGeorge, 2018).

#### 4.3.2.3 Support Provision Preferences

The third aspect is related to the social support provision preferences that explain whether support providers are always available reliably and willing to give support during a challenging time. If the willingness (*Wh*) is high, then one is more likely to provide supports or vice versa (Gooden, 2014; Kalkan & Epli-koç, 2015; Lakey, Cooper, & Cronin, 2017). As mentioned in Section 4.2, social support is defined as the combination of emotional, informational, companionship, and instrumental assistance provided by significant others, like co-workers, supervisors or family members (Thoits, 2011; Knoll, Burkert, & Schwarzer, 2014). Figure 4.9 depicts the concept of support provision preferences.

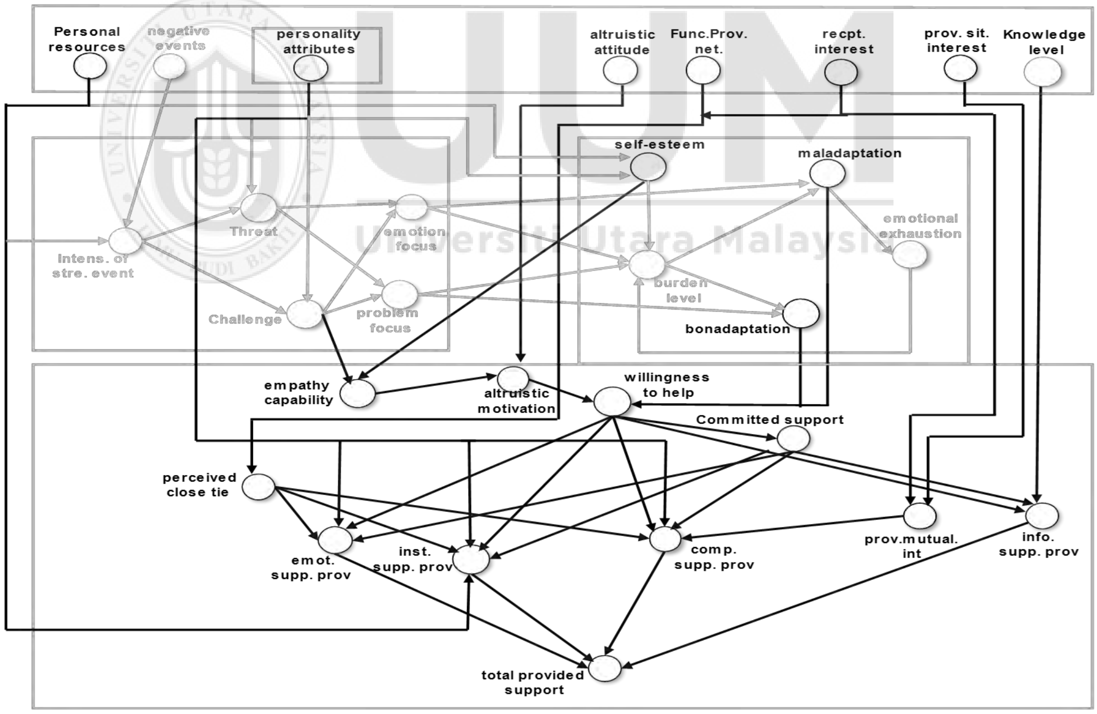



*Figure 4.9.* Causal Relationship of Support Provision Preferences.

Figure 4.9 shows the concepts within support provision preferences that include concepts of willingness to help (*Wh*), informational support provision (*Ip*), emotional support provision (*Ep*), companionship support provision (*Cp*), instrumental support provision (*Np*), altruistic attitude (*Al*), empathy capability (*Ec*), altruistic motivation (*Am*), perceived close tie (*Pc*), mutual interest (*Mi*), and committed support (*Cm*). Table 4.13 illustrates and describes the relationships between these concepts.

Table 4.13

*Relationships between Concepts in Support Provision Preferences*

| **Concepts** | ***Am*** | ***Wh*** | ***Cm*** | ***Ip*** | ***Np*** | ***Ep*** | ***Cp*** | ***Pc*** | ***Mi*** | ***Ag*** | ***Evp*** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Am*** | | + | + | + | + | + | + | + | + | + | + |
| ***Wh*** | | | + | + | + | + | + | + | + | + | + |
| ***Cm*** | | | | + | + | + | + | + | + | + | + |
| ***Ip*** | | | | | - | - | - | - | - | - | - |
| ***Np*** | | | | | | - | - | + | - | + | - |
| ***Ep*** | | | | | | | - | + | - | + | - |
| ***Cp*** | | | | | | | | + | + | - | + |
| ***Pc*** | | | | | | | | | + | + | + |
| ***Mi*** | | | | | | | | | | - | + |
| ***Ag*** | | | | | | | | | | | - |
| ***Evp*** | | | | | | | | | | | |

Table 4.13 describes the relationship between the concepts within the support provision preferences category. It can be shown that (+) indicate to positive relation and (-) indicate to negative relation. For example, informational support provision (*Ip*) will be high when the willingness to help (*Wh*) and altruistic motivation (*Am*) are high.

**Empathy Capability (*Ec*)**

According to the Attachment Theory, those with a stressed attachment style tend to have less self-esteem and negative personality attributes, because they feel that they

Universiti Utara Malaysia

should be getting more love and more attention from their partners and are worried that their partners will leave them (Hazen & Shaver, 2013; Shaver, Schanchner, & Mikulincer, 2015). Those expressions of emotions and empathy by the support provider play an important role in social support provision. Two main factors that define the concept of empathy capability namely challenge and self-esteem (as presented in Figure 4.9). The presence of both challenge (*Chp*) and self-esteem (*Sf*) provide the empathy capability (*Ec*) through a proportional factor ( $\lambda_e$).

$$Ec(t) = \lambda_e . Chp(t) + (1 - \lambda_e). (Sf(t)) \tag{4.31}$$

where $\lambda_e$ is the proportional factor and $0 \leq \lambda_e \leq 1$.

This equation implies that empathy capability level will be high when either challenge or self-esteem level is high (Shaver, Schanchner, & Mikulincer, 2015; Yu, Wang, He, Liang, & Zhou, 2017). Therefore, the combination of self-esteem and challenge will lead to empathy capability.

Universiti Utara Malaysia

**Altruistic Motivation (*Am*)**

From the Self-Determination Theory (SDT), the main driving force behind provided social support has been based on motivation (Cresswell & Eklund, 2017). It determines if motivation affects the development of provided social support to overcome the stress of others. Individuals (Coke, Batson, & McDavis, 2011; Shumaker & Brownell, 2015; Specht, 2018). Many research works have maintained that there is a link that support-providers with empathy capability and altruistic attitude will regulate altruistic motivation to help the others (Aldwin & Revenson, 2016; Baker & Berenbaum, 2017). In this case, two main factors define the concept of altruistic motivation, namely;

altruistic attitude and empathy capability (as presented in Figure 4.9). Thus, a provider's altruistic motivation is a factor that enhances or hinders support provision in providing support.

$$Am(t) = \beta_m . Al(t) + (1 - \beta_m) . (Ec(t)) \tag{4.32}$$

where $\beta_m$ is the proportional factor and $0 \leq \beta_m \leq 1$.

A combination of altruistic attitude ($Al$) and empathy capability ($Ec$) determine the level of the altruistic motivation ($Am$) by a proportional factor ($\beta_m$). This implies that altruistic motivation level will be high when either the altruistic attitude or empathic capability is high (Coke, Batson, & McDavis, 2011; Shumaker & Brownell, 2015; Specht, 2018).

**Willingness to Help (*Wh*)**

In general, the support provision process is mainly driven by the willingness to help (Post, Bloemen, & Witte, 2016). Another important factor that is related to the provider's willingness to help is an altruistic motivation. For example, if the altruistic motivation is high, then one is more likely to provide support, later leads to an increment of willingness to help or vice versa (Derlega, Sherburne, & Grimshaw, 2015; Brashers, Neidig, & Goldsmith, 2017). Also, the adaptation approaches (bonadaptation and maladaptation) directly influence the willingness to help (Botwin, Buss, & Shackelford, 2016). For example, the individual with bonadaptation contributes to a higher willingness to help level compare those who are not (maladaptation).

$$Wh(t) = \lambda_w . Ba(t) + (1 - \lambda_w) . [1 - (1 - Am(t)) . Ma(t)] \tag{4.33}$$

where $\lambda_w$ is the proportional factor and $0 \leq \lambda_w \leq 1$.

This formal equation shows that the willingness to help level will be high when either bonadaptation or altruistic motivation level is high (the contrary effect can be seen from the maladaptation factor). In conclusion, the provider's willingness to help is related to adaptation approaches and altruistic motivation. For example, the individuals tend to choose bonadaptation and they are highly altruistic that contribute to a higher willingness level to help compare those who are not (Aldwin & Revenson, 2016; Baker & Berenbaum, 2017).

**Perceived Close Tie (*Pc*)**

From the Strength of Tie (ST) Theory, the defining perceived close tie is that partners feel responsible for one another's welfare and give benefits in response to the others' needs, and thus both members are expected to provide support when the partner is in need (Reinhard, Given, Petlick, & Bemis, 2014). The perceived close tie is important in social network and has a high predictive value of an individual's instrumental, companionship, and emotional support. Therefore, the factors contributing to these relationships are determined by two major concepts, namely; function in a social network (*Fp*) and recipient interest (*Rs*) that reflects the level of intimacy and satisfaction between recipient and provider.

$$Pc\ (t) = Fp\ (t).\ Rs\ (t) \qquad (4.34)$$

This concept provides a positive relationship between function in social network and recipient interest that perceived close tie level will be high when both function in social network and recipient interest levels are high (Derlega, Sherburne, & Grimshaw, 2015; Brashers, Neidig, & Goldsmith, 2017).

Universiti Utara Malaysia

**Mutual Interest (*Mi*)**

From Reciprocity Theory, characteristics of the relationship (ties) between support recipient and provider are equally important to activate social support (mutual interest) (Uchino & Vaughn, 2015; Lavee, Mccubbin, & Patterson, 2016). Certain relationship characteristics are also associated with the level of provided support from these relationships. First, the mutual interest is positively correlated with both recipient situational interest and provider situational interest that related to a set of activities, though its association with provided support is substantially stronger (Kaul & Lakey, 2013). Second, previous interaction and past mutual interest will reflect the future willingness of support providers. Thus, mutual interest (*Mi*) has resulted from the interaction between recipient situational interest (*Rs*) and provider situational interest ($Ps$).

$$Mi(t) = \sum sim(Rs(t), Ps(t)) / n_{m} \tag{4.35}$$

where $n_{m} \neq 0$ and $sim(Rs, Ps) = \begin{cases} 1, & Rs = Ps \\ 0, & Rs \neq Ps \end{cases}$

UUM Universiti Utara Malaysia

In this case, higher similar interaction between support recipient and provider will yield a higher mutual interest level (Uchino & Vaughn, 2015; Lavee, Mccubbin, & Patterson, 2016).

**Information Support Provision (*Ip*)**

Informational support provision can be defined as the provision of information that a person can use to address problems. In many ways, it refers to the availability of people who can provide information or advice needed to solve problems that arise. Also, informational support provision is strongly related to the knowledge level of support provider (Matthews, Siegel, Kuller, Thompson, & Varat, 2016; Reinhard, Given, Petlick, & Bemis, 2018). Three factors are pinpointed to contribute to this concept. These factors are willingness to help (*Wh*), committed support (*Cm*), and knowledge level (*Kl)*. These causal relationships are presented in Figure 4.9. The interplay between these concepts is modelled using a weighted approach.

$$Ip(t) = [Wi_1.Kl(t) + Wi_2Cm(t)].Wh(t) \tag{4.36}$$

where $\sum_{j=1}^{2} W_{ij} = 1$ , $W_{i1}$ and $W_{i2}$ are the weight factors.

Equation 4.36 presents a condition in which the concept of an informational provision is defined by the mutual contributions of committed support, knowledge level, and willingness to help. For example, the informational support was coming from people who have knowledge level about the situations (MacGeorge, 2015; Ridings & Gefen, 2016; Wright, 2018).

Universiti Utara Malaysia

**Instrumental Support Provision (*Np*)**

Instrumental support provision can be defined as the provision of tangible aid and needed services that directly assist a person in need" (Heaney & Israel, 2018). Agreeableness personality is associated with positive relations to alter and has been shown to foster peer acceptance and friendship among recipient (Flyckt, Fatouros-bergman, & Koernig, 2015; Barbee, Derlega, Sherburne, & Grimshaw, 2014; Brashers, Neidig, & Goldsmith, 2015; Iwasaki, 2016).

From the literature, there are five major factors are pinpointed to contribute to this concept which is a willingness to help (*Wh*), committed support (*Cm*), perceived close tie (*Pc*), personal resources (*Prp*), and agreeableness personality (*Ag*) (Brashers et al., 2015; Mathieson, Logan-Smith, Phillips, MacPhee, & Attia, 2017). Instrumental provision (*Nr*) is calculated by employing weighted sum (W) of agreeableness (*Ag*), perceived close tie (*Pc*), and personal resources (*Pr*).

$$Np(t) = Wh(t).[\,\tau_n\, Cm(t) + (1 - \tau_n\,).(Wn_1.Ag(t) + Wn_2.Pc(t) + Wn_3\mathrm{Pr}p(t))] \tag{4.37}$$

Where $\sum_{j=1}^{3} W_{nj} = 1$, $W_{n1}$, $W_{n2}$, and $W_{n3}$ are the weight factors, $\tau_n$ is the proportional factor, and $0 \le \tau_n \le 1$.

The interplays imply that the instrumental support provision level will be high when either perceived close tie, personal resources, agreeableness personality, or willingness to help level is high. For example, instrumental support provision is more helpful for facilitating individuals with high agreeableness personality, personal resources, and strong tie (Gass, & Chag, 2013; Zaumseil & Schwarz, 2018).

**Emotional Support Provision (*Ep*)**

Emotional support is related to the close relationships such as family members and friends and aims to foster further positive social relationships and the development of interpersonal characteristics. Emotional support provision is the provision of "empathy, love, trust and caring" and it is necessary for individuals seeking comfort and security during stressful events, by allowing them to feel as if they are cared for by others (Cutrona & Russell, 2015). There are four major factors are pinpointed to contribute to this concept which is a willingness to help (*Wh*), committed support (*Cm*), perceived close tie (*Pc*), and agreeableness personality (*Ag*) (Albrecht, Burleson, & Goldsmith,



Universiti Utara Malaysia

2013; Barbee, Derlega, Sherburne, & Grimshaw, 2014; Brashers, Neidig, & Goldsmith, 2015).

$$Ep(t) = Wh(t).[\,\psi_e\, Cm(t) + (1 - \psi_e).(We_1.Ag(t) + We_2.Pc(t))] \quad (4.38)$$

where $\sum_{j=1}^{2} W_{ej} = 1$, $W_{e1}$ and $W_{e2}$ are the weight factors, $\psi_e$ is the proportional factor, and $0 \leq \psi_e \leq 1$.

This equation shows that emotional support provision will be high when either perceived close tie, agreeableness personality, or willingness to help is high. For example, emotional support provision is useful for dealing with agreeableness personality and strong tie (Sarason, Levine, Basham, & Sarason, 2014; Reinhard, Given, Petlick, & Bemis, 2016).

**Companionship Support Provision (*Cp*)**

Companionship support moderates stress by providing recipients with a sense of belonging and contact with others (Krohne, 2012; Kuppens & Diener, 2015). Extraversion is associated with increased support provision, as it is an empathy trait (Trobst, Collins, & Embree, 2013; Bowling, Beehr, & Swader, 2014). Conversely, neuroticism, and psychological stress are associated with the provision of less support (Hinnen, Hagedoom, Sanderman, & Ranchor, 2016). For example, individuals who report more extraversion perceived greater perceptions of companionship support provision than those who are not (Asendorpf & van Aken, 2013; Branje, van Lieshout, & van Aken, 2014). There are five major factors are pinpointed to contribute to this concept which is a willingness to help (*Wh*), committed support (*Cm*), perceived close tie (*Pc*), extraversion personality (*Ev*), and mutual interest (*Mi*) (Asendorpf & van

Aken, 2013; Branje, van Lieshout, & van Aken, 2014; Hinnen, Hagedoom, Sanderman, & Ranchor, 2016).

$$Cp(t) = Wh(t).[\,\mu_c\, Cm(t) + (1 - \mu_c).(Wc_1.Evp(t) + Wc_2.Pc(t) + Wc_3.Mi(t)\,)] \tag{4.39}$$

where $\sum_{j=1}^{3} W_{cj} = 1$, $W_{c1}, W_{c2}$ and $W_{c3}$ are the weight factors, $\mu_c$ is the proportional factor, and $0 \le \mu_c \le 1$.

Equation 4.39 reflects the exclusive contributory between committed support, perceived close tie, mutual interest, and extraversion personality. This implies that companionship support provision will be high when either perceived close tie, mutual interest, extraversion personality, willingness to help is high (Evans, 2014, Cranwell & Seymour-Smith, 2016, Peterson, 2017).

**Committed Support (*Cm*)**

According to Empathy–Altruism Theory (EA), committed support (*Cm*) is the concept that has been initiated to explain the process of willingness to help in facing stressful events. Willingness to help is highly coupled with the view of individual responsibility and obligation (committed support). For example, it is a common fact that many individuals will feel responsible (personal responsibility) for anyone dependent upon them. Because of this, it increases the likelihood of support offering for a certain relationship (either strong tie or weak tie relationship). Moreover, previous failure and frustration of past efforts may influence to reduce an individual's motivation and willingness to provide support. For this reason, if individuals always refuse to provide support, it is more likely to provide less support in future. Therefore, the temporal



Universiti Utara Malaysia

relation of committed support is increasing when willingness to help ($Wh$) is high over some time.

$$Cm\,(t+\Delta t) = Cm\,(t) + \sigma_c \,.\, [(Wh\,(t) - Cm\,(t)).\,(1 - Cm\,(t)).\,Cm\,(t)].\,\Delta t \tag{4.40}$$

where $\sigma_c$ is the change rate factor, Δt is change interval in time, and $0 \leq \sigma_c \leq 1$.

From Equation 4.40, as the willingness to help is increasing, the committed support is also increasing over time (Aldwin & Revenson, 2016; Baker & Berenbaum, 2017).

## 4.4 Integrated Model Development

The integrated model utilizes the outcomes from both recipient and provider models to identify the utilized social support which refers to the actual use of social support that providers can offer to the recipient. First, from the recipient model, the integrated model used requested informational support, requested emotional support, requested instrumental support, and requested companionship support. Second, from the support provider model, the integrated model used provided informational support, provided emotional support, provided instrumental support, and provided companionship support. Thus, to deal with outcomes from each model, the development phases of the integrated model include domain, design and operational phases.

### 4.4.1 Domain Model Phase

The concept of integration in this work is to compute the utilized social support to help support recipients to reduce their stress. In this phase, the integrated factors of the model were identified based on literature review, empirical studies and expert opinions. All these factors were derived from Sociometer Theory (SO) (Leary & Baumeister, 2010), where the individuals who utilize available support from others receive additional benefits and decrease the level of stress later. This includes adaptive inferential feedback from others (Panzarella, Alloy, & Whitehouse, 2014), resources for problem-solving (Yang & Clum, 2011), exposure to positive events, and the physical interruption of suicide attempts. The results of this phase produce a set of six important support factors. Table 4.14 shows a summary of the identified integrated factors.

Table 4.14

*Summary of Integrated Concepts*

| No | Factor | Notation | Related Theory | Reference |
|---|---|---|---|---|
| 1 | Utilized Informational Support | *Ui* | SO, SB | Leary & Baumeister, 2010; Panzarella, Alloy, & Whitehouse, 2014 |
| 2 | Utilized Emotional Support | *Ue* | SO, SB | Leary & Baumeister, 2010; Panzarella, Alloy, & Whitehouse, 2014 |
| 3 | Utilized Instrumental Support | *Un* | SO, SB | Leary & Baumeister, 2010; Panzarella, Alloy, & Whitehouse, 2014 |
| 4 | Utilized Companionship Support | *Uc* | SO, SB | Leary & Baumeister, 2010; Panzarella, Alloy, & Whitehouse, 2014 |
| 5 | Short Term Stress | *Ss* | GAS | Aziz & Ahmad, 2013; Barbara, 2016 |
| 6 | Long Term Stress | *Ls* | GAS | Aziz & Ahmad, 2013; Barbara, 2016 |

Sociometer Theory (SO), General Adaption Syndrome Model (GAS), Stress Buffering Theory (SB)

### 4.4.2 Design Model and Operational Phase

The phase deals with identified factors from the domain model to show the causal relationships of the integrated concepts, where the different parts that have made up the support integrated model are presented in Figure 4.10.

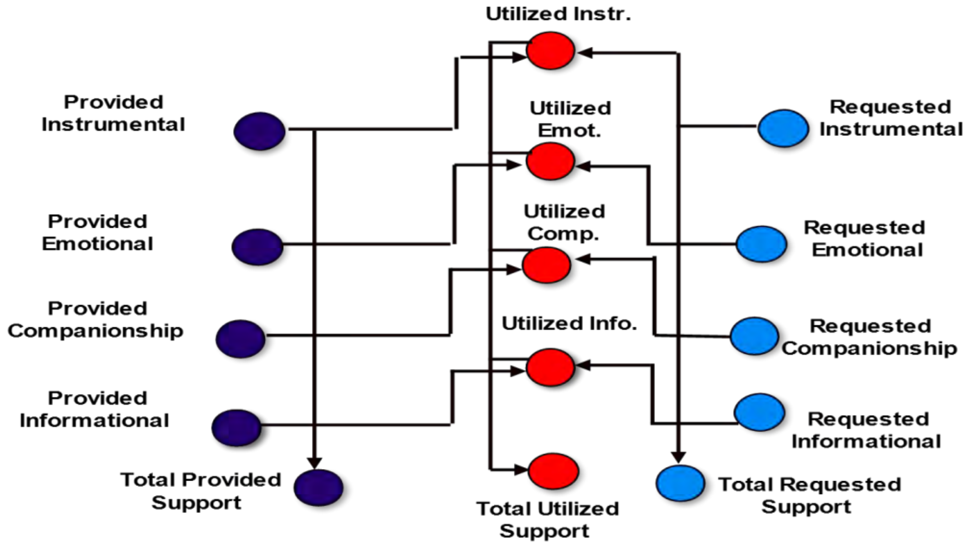



*Figure 4.10.* Causal Relationship of Utilized Social Support.

From Figure 4.10, the concepts in an integrated model include utilized informational support (*Ui*), utilized emotional support (*Ue*), utilized instrumental support (*Un*), and utilized companionship support (*Uc*). The utilized social support reflects the actual use of social support that support provider can offer to help recipients meet their requests. In this case, there are two scenarios. First, if the support provider can offer support more than or equal the requested support, then the provided support was completely covered the whole needs of requested support. Second, if the support provider can offer support less than requested support, then the provided support has partially covered the needs of any requested support.

**Utilized Informational Support**

The utilized informational support *(Ui)* describes the actual use of informational support based on the current provided informational support to help support recipients meet their need (as presented in Figure 4.10). The casual relationship shows that two major factors contribute to the utilized informational support namely provided informational support and informational requested support. Utilized Informational Support is obtained by finding the ratio between provided information support (*Ip*) and requested informational support (*Ir*) (as be seen in Equation 4.41).

$$Ui\,(\mathrm{t}) = \min \quad \left[1,\ \frac{Ip\ (t)}{Ir\ (t)}\right] \tag{4.41}$$

Where *Ir* (t) ≠0, and min(.) is defined by min(*x,y*)=1 if *x*>=*y* or otherwise min(*x,y*)= *x/y*

This formal representation reflects that utilized informational support relies on the mutual contributing factors of information provided and requested support.

**Utilized Instrumental Support**

The utilized instrumental support *(Un)* defines the instrumental support that recipients can receive from the support provider to cover their requests. The casual relationship shows that two major factors contribute to the utilized instrumental support namely instrumental provided support and requested instrumental support as be seen in Equation 4.42.

$$Un(\mathrm{t}) = \min \quad \left[1,\ \frac{Np\ (t)}{Nr\ (t)}\right] \tag{4.42}$$

Where Nr (t) ≠0, and min (.) is defined by min(x,y)=1 if x>=y or otherwise min(x,y)=x/y.

**Utilized Emotional Support**

The utilized emotional support *(Ue)* describes the actual use of emotional support that recipients received from support providers to meet their need. The casual relationship shows that two major factors contribute to the utilized emotional support namely provided emotional support and requested emotional support. Utilized emotional support is calculated by finding the ratio between provided emotional support (*Ep*) and requested emotional support (*Er*) (as be seen in Equation 4.43).

$$Ue(\mathrm{t}) = \min \left[1, \frac{Ep\ (t)}{Er\ (t)}\right] \tag{4.43}$$

where *Er* (t) ≠0, and min( .) is defined by min(x,y)=1 if x>=y or otherwise min(x,y)= x/y

This formal representation reflects that utilized emotional support relies on the mutual contributory factors of emotional provided support and emotional requested support. If the emotional provided support is higher or equal than requested emotional support, this means it completely covers an individual's needs. Otherwise, it is partially covered (*Ep* (t) / *Er* (t)).

**Utilized Companionship Support (*Uc*)**

The utilized companionship support *(Uc)* describes the companionship support that recipients received to meet their needs. The casual relationship shows that two major factors contribute to the utilized companionship support namely provided companionship support and requested companionship support as to be seen in Equation 4.44.

$$Uc(\mathrm{t}) = \min \left[1, \frac{Cp\ (t)}{Cr\ (t)}\right] \tag{4.44}$$

Where Cr (t) ≠0, and min(.) is defined by min(x,y)=1 if x>=y or otherwise min(x,y)=x/y

Therefore, to identify the long-term stress for the recipient, the short-term stress can be determined based on the total of utilized social support *(Us)*.

**Short-term Stress (*Ss*)**

According to the General Adaption Syndrome Model (GAS) has been introduced by Hans Selye (1950), which is used to illustrate the body's short-term and long-term reaction to stress. The underpinning concept of GAS is the fight or flight is a sequence of reactions to stress (Aziz & Ahmad, 2013; Barbara, 2016). Short-term stress (*Ss*) is defined as a reaction to a stressful event or any stimuli that disturb the physical or mental state of individuals. In respect to the stressful event, short-term stress can be triggered by two concepts, which are the recipient's intensity of a stressful event (*Ie*) and a total of utilized support (*Us*). Figure 4.11 shows how short-term stress can be represented.

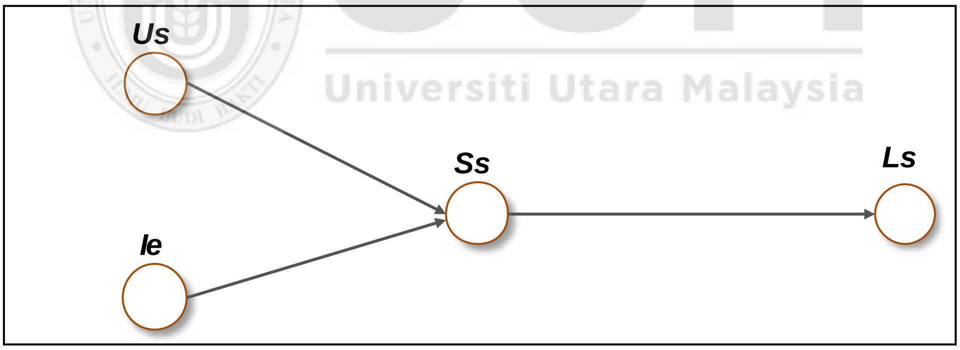



*Figure 4.11*. Causal Relationship of Short-term Stress.

From this representation, the short-term stress will be increased when a high level of intensity of the stressful event and low level in a total of utilized support was observed. The notion of short-term stress models a relationship between the total of provided support (*Ps*) over requested support (*Rs*) and intensity of stressful events. It can also be represented in a mathematical equation as provided below in Equation 4.45.

$$Ss\,(t) = \beta_{Ss}.\,Ie(t).\,(1 - Us\ \ (t)) \qquad (4.45)$$

Where $Us(t) = \sum(Ps(t)/Rs(t))$, and $\beta_{Ss}$ is the proportional factor, $0 \leq \beta_{Ss} \leq 1$

Equation 4.45 shows that there is a simultaneous contributory causal linkage between the intensity of stressful events and a total of utilized support. This implies that when the intensity of stressful events increased, the short-term stress level is increased which occurs when a utilized social support level is low. However, when the short-term stress repeated over time, it causes long- term stress (*Ls*). The long- term stress is a physical and mental disturbance of individuals for a long time after exposure to a stressful event (Barbara, 2016). The level of long-term stress increased or decreased over time depending on the level of short-term stress. It is primarily contributed the accumulation exposure towards short term stress in a time interval between *t* and $t+\Delta t$. It can be represented in a mathematical equation as provided below in Equation 4.46.

$$Ls(t + \Delta t) = Ls(t) + \alpha_{Ls}\ .\,[(Ss(t) - Ls(t)).\,(1 - Ls(t)).\,Ls(t)].\,\Delta t \qquad (4.46)$$

Where $\alpha_{Ls}$ is the changing rate factor, $0 \leq \alpha_{Ls} \leq 1$, and Δt is change interval in time.

Figure 4.12 depicts the concepts in an integrated model and its relationship with the support recipient and provider models (note that the greyish nodes represent the temporal factors).

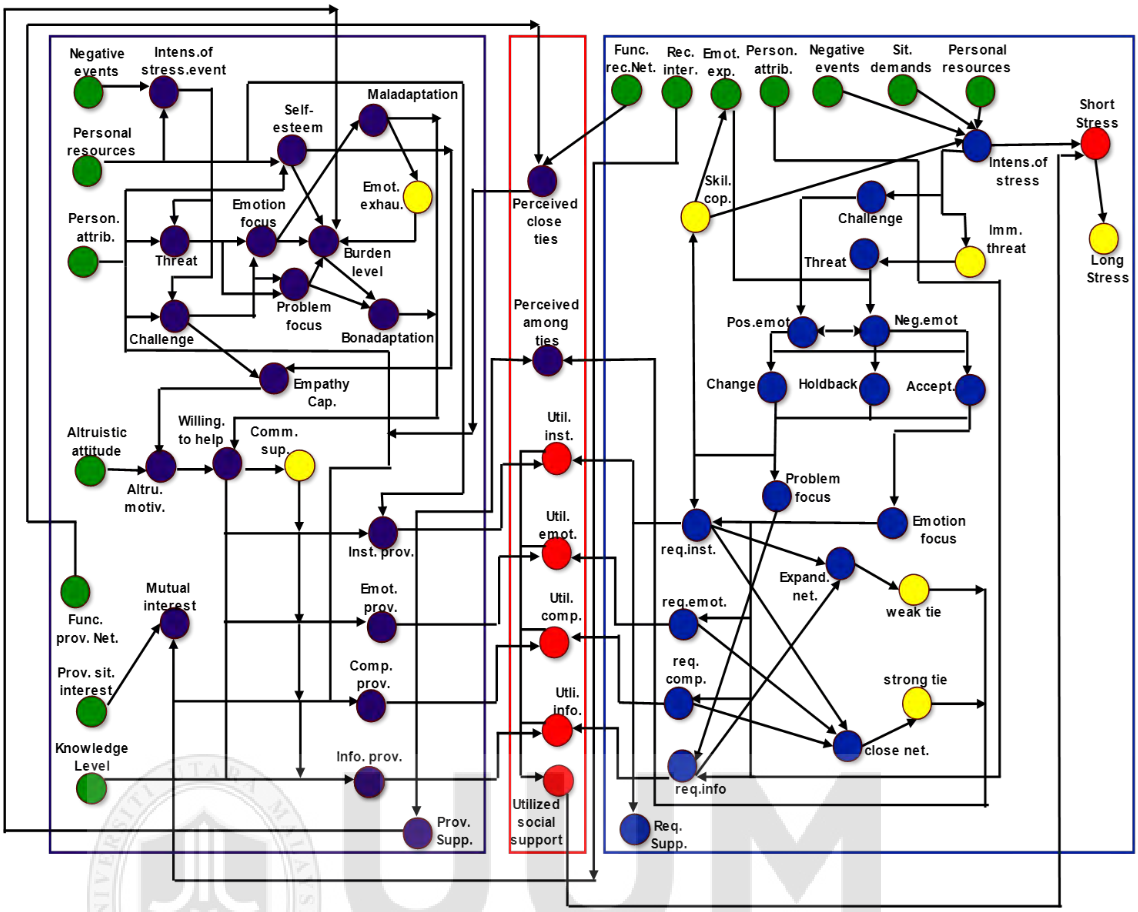



*Figure 4.12.* Conceptual Model of Integrated Model.

### 4.5 Dynamic Integrated Support Model Development

In this study, a configuration algorithm is designed as a building block to develop a support model. There are five main components were developed. These components are: 1) individual receipt and provision attributes, 2) support preference generation, 3) network ties, 4) stress component, and 5) support feedbacks. Figure 4.13 illustrates the interplays of these components.

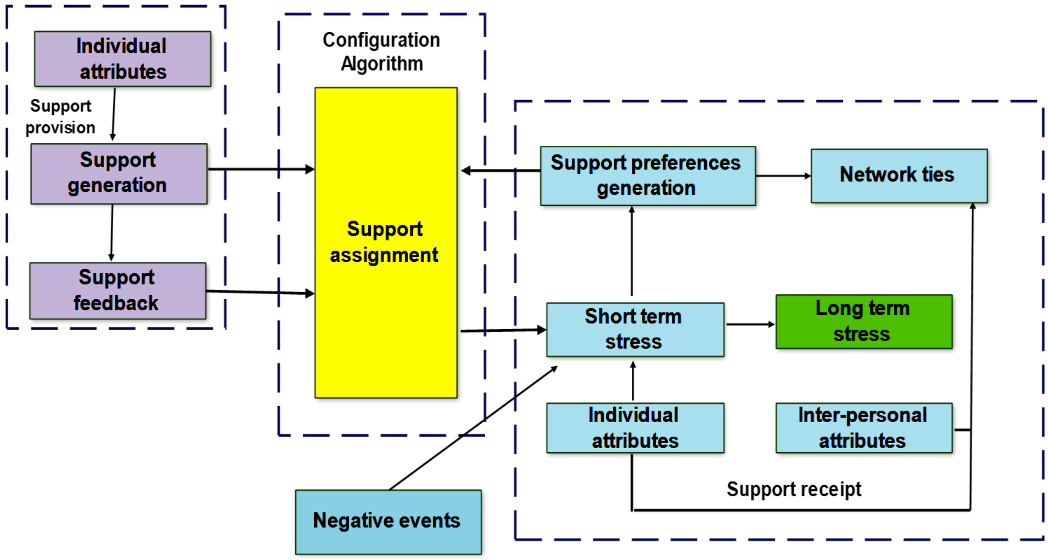



*Figure 4.13*. Overall Structure of a Dynamic Support Model.

As depicted in Figure 4.13, the individual receipt and provision attributes were the first components that reflect an individual's personality characteristic for both support recipients and providers. Then, network ties that determine the degree of strength of social support network either strong tie or weak tie. Similarly, this triggered information will be channelled to the social network ties component, which acts to determine an individual's tie in seeking help. After the social support-tie preference is selected, then the support generation is regulated. Support preference generation refers to the types of social support requested and provided during the process. In this model, a stress component is represented by negative events which act as an external factor stimulus that triggers short-term stress. Such a stress condition is amplified by individual receipt attributes such as neurotic personality, which later accumulates in certain periods to develop a long-term stress condition. The short-term stress also plays an important to evoke support preference pertinent to the receipt attributes. Finally, the support provision attributes will determine the level of support feedbacks towards the support recipient.

### 4.5.1 Applying Configuration Model in Automated Social Support

To apply configuration model in a computational social support domain, three elements are needed: 1) a functional requirement, 2) a sub-model for selecting parts and determining their mutual requirements, 3) a sub-model for arranging parts. First, a functional requirement for a configuration task describes the requirements that configuration must satisfy. These requirements reflect the environment in which the configured product must function and the uses to which it will be incorporated as seen in Figure 4.14.

A requirement may also indicate which optimizing criteria should be used to guide the search, such as minimizing short-term stress or long-term stress or preferring some type of social support over others. A functional requirement describes capabilities for desired behaviours. For example, personality attributes have high strong correlated with social support types, in this case, a requirement might say that the individual needs to be able to cope with stress through his/her personality attributes, previously discussed in Chapter Four.

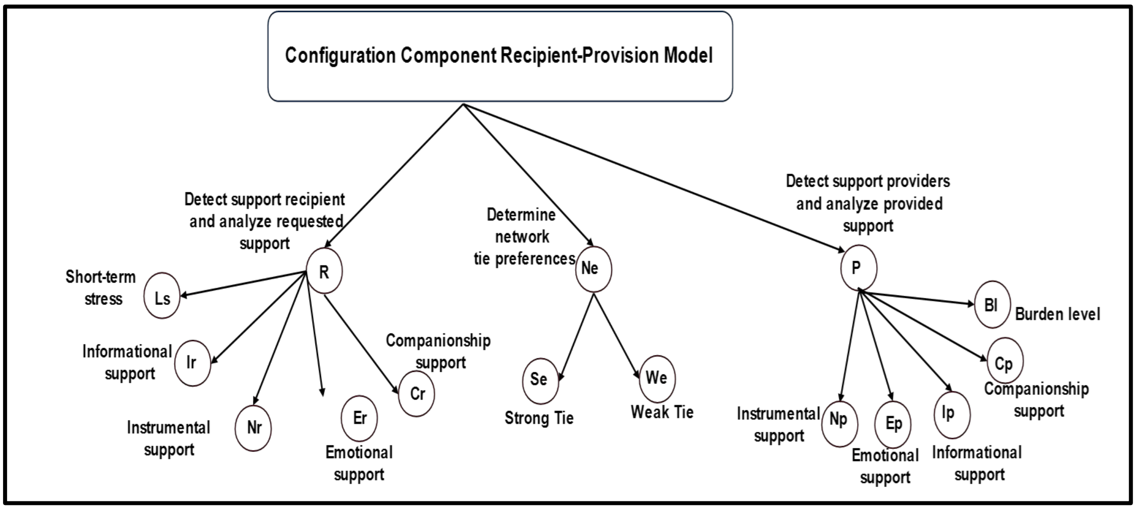



*Figure 4.14*. Configuration Example Requirements for Functional Hierarchy.

Figure 4.14 shows the needed requirements before the configuration algorithm started. For example, in terms of support recipient, the values of requested informational support requested emotional support, requested instrumental support, requested companionship support, and his/her short-term stress. Simultaneously, the same for support providers and network ties preferences.  Secondly, a sub-model for parts specifies the kinds of parts that can be selected for a configuration and the requirements that parts have for other parts. Some parts require other parts for their correct functioning or use. For example, social support parts for recipient include requested informational support, requested emotional support, requested instrumental support, and requested companionship support (as shown in Figure 4.15).

A part model defines required-component relations so that when a configuration process considers a part description, it can determine what additional parts are needed. For example, requested informational support requires provided informational support, weak tie.

Universiti Utara Malaysia

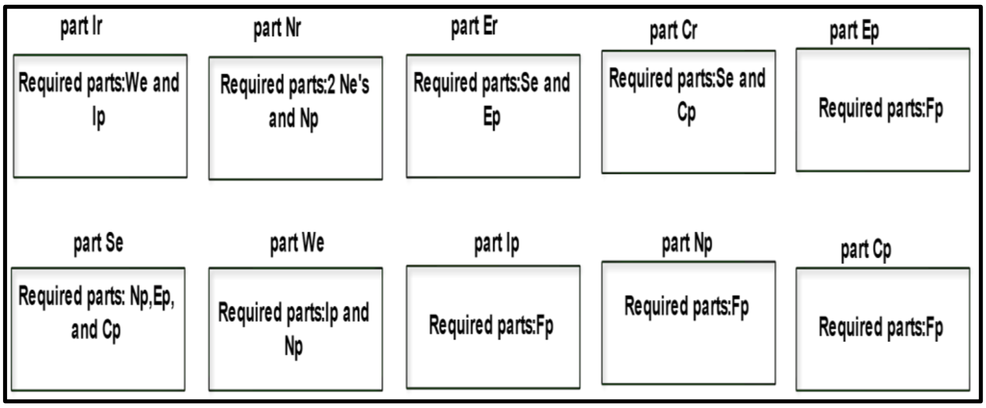



*Figure 4.15*. Parts Sub-Model for a Recipient-Provision Model.

Thirdly, a sub-model for spatial arrangement provides a description of the placement of parts and specifies what arrangement of parts are possible as seen in Figure 4.16. Together, the arrangement model and the requirement form a basis for describing which arrangement is acceptable and preferred. The meaning of arrangement here refers to the assignment of social supports as it is possible to determine where social support could be located in an assignment, and which social supports in a set could be added to an assignment.

For example, in this case, the arrangement model assigns a correct set of support providers based on their ability and the type of support they can provide. Arrangement models constrain the set of possible configuration rules because they govern the consumption of resources, such as burden level, ties, and a number of providers. These resources are limited and consumed differently by different arrangements.

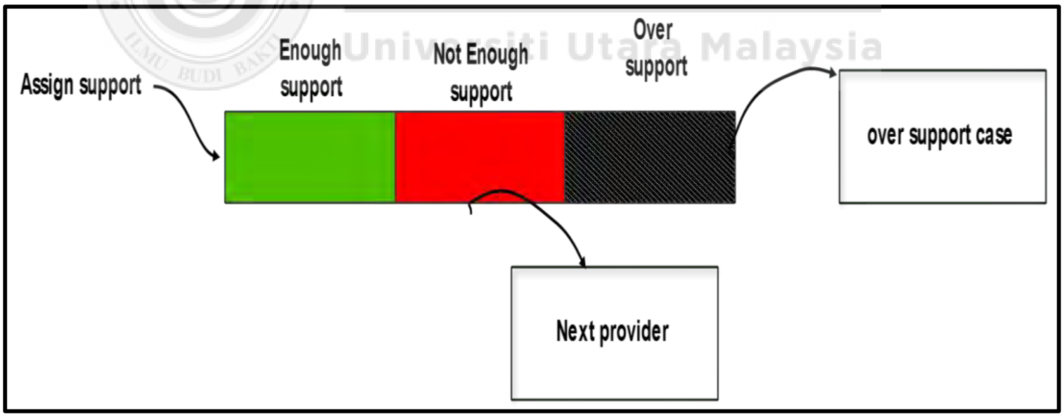



*Figure 4.16.* Arrangement Sub-Model for a Recipient-Provision Model.

Finally, Figure 4.15 and Figure 4.16 show the major requirements and constraints in support recipient-provision model. As well as, factors that can be used in the configuration process (Support Model) to utilize support recipient information to choose support members that are obtainable for support provision. The crucial information (*requirements*) needed for a configure process are; 1) tie's preferences, 2) long-term stress, 3) support receipt preferences, 4) function in social networks and 5) support provision preferences. Using this information with a set of configuration rules, an algorithm to generate a set of social support members to provide support was developed. At before the execution of the algorithm, a set of constraints, like preference number of providers, the level of acceptance requested and provided support, and a level of acceptance burden must be initialized first.

To achieve an intelligent assignment of people to a social support network, an approach has been followed in which the dynamic domain model for support receipt-provision process is used as a basis for a configuration process. The description of how a domain model can be used to support a person is sometimes called a support model. Based on the required support, this support model selects people from an individual's social network and assigns them to the social support network. More importantly, the result of this stage is to build procedures/ models which include a set of sequential steps in the configuration process. There are two procedure models to develop this algorithm. First, the random selection approach when the support provider was selected randomly without specific criteria. The second model is the priority selection model based on two criteria to select the support provider; the tie selection and an average of provided social support.

### 4.5.2 Random Selection Model

Algorithm 4.1 shows the implementation process for the random selection model. The differences between random selection model and priority selection model that random selection model selected the provider randomly without specific criteria.

Algorithm 4.1

*Random Selection Algorithm.*

```
Algorithm 1 // Random Selection
Input: Negative events (Nv), Personal attributes (Pa), and Number of Providers (n)
Output: A set of selected support providers
Start:
Initialization
    Pa, such that 0 ≤ Pa ≤1
    Nv, such that 0 ≤ Nv ≤1
    i, such that 1 ≤ i ≤ n
    t, such that t← 1
While (t<=numStep && (Sr>0 || Sp>0)
    If (Ls>=stressTh || i>n)                // evaluate the long- term stress level
      Then
          P_se ← [Se / (We+Se)] . 100        // percentage of strong tie
          P_we ← [We / (We+Se)] . 100        // percentage of weak tie
               Then
               InfoSupp (Ir, Ip, Bl)         // assign informational support
               EmotSupp (Er, Ep, Bl)         // assign emotional support
               InstSupp (Nr, Np, Bl)         // assign instrumental support
               CompSupp (Cr, Cp, Bl)         // assign companionship support
          Else
               Select_Next_Provider_ Randomly (i, n)
                    If (Ls>=stressTh)
                        Then
                          Select_Next_Provider_ Randomly (i, n)
                    Else
                        Select i
  t← t +1
      Else
    Exit( )
End
```

Algorithm 4.1 shows the sequence of steps to implement the random selection model. The process in this algorithm like priority model except there are no specific criteria to select the next support provider. The selection process for the next support provider is shown in Algorithm 4.2.

Universiti Utara Malaysia

Algorithm 4.2

*Random Selection Next Provider.*

```
Select_Next_Provider_ Randomly (i, n)
1 If (i<=n)
     Then
2        Iep← Rnd (Iep)
3        Bl ← Rnd (Bl)
4            i ←i+1
  Else
5        Exit ( )
End
```

Algorithm 4.2 shows the steps to select the next support provider in a random model. It shows the selection of the support providers randomly without any specific criteria. First, the evaluation of the counter for several support providers will take place. Then, the intensity of the stressful event and burden level of support provider will be updated. The steps in random selection can be summarized as seen in Appendix I.

Universiti Utara Malaysia

**4.5.3 Priority Selection Model**

The priority selection model (as shown in Algorithm 4.3) offers social provision tasks based on individuals within their unique preferences and resources. Thus, a member with a high network tie (strong tie) will be chosen first and followed by a member with a high support provision and so forth. For example, if the companionship support is needed, then support provider within a strong tie network is preferred over a weak tie. The steps in priority selection can be summarized as in Appendix III. The first step in the priority selection model starts with check support receipt long term stress and need of help to start the process. Second, determine the support network preferences. Simultaneously, it checks the intensity of stressful event for the provider, and check the provider's burden level (*Bl*). Later it determines the provider's proportion of support and checks perceived close tie and need of help from a strong tie network and address the support. Based on this, the matching process between recipient and provider will begin. As a result, a configured support recipient-provider combination will be produced.

Algorithm 4.3

*Priority Selection Algorithm.*

```
Algorithm 3 // Priority Selection
Input: Negative events (Nv), Personal attributes (Pa), and Number of Providers (n)
Output: A set of selected support providers
Start:
Initialization
    Pa, such that 0 ≤ Pa ≤1
    Nv, such that 0 ≤ Nv ≤1
    i, such that 1 ≤ i ≤ n
    t, such that t← 1
While (t<=numStep && (Sr>0 || Sp>0)
        If (Ls>=stressTh || i>n)            // evaluate the long term stress level
            Then
                Pse ← [Se / (We+Se)] . 100              // percentage of strong tie
                Pwe ← [We / (We+Se)] . 100              // percentage of weak tie
                Pc ← (Func_recp + Func_prov)/2          // perceived close tie
                    If (Pc>=priorityTh)
                        Then
                            InfoSupp (Ir, Ip, Bl)    // assign informational support
                            EmotSupp (Er, Ep, Bl)    // assign emotional support
                            InstSupp (Nr, Np, Bl)// assign instrumental support
                            CompSupp (Cr, Cp, Bl)   // assign companionship
                                                       support
                    Else
                            Select_Next_Provider_Prority (i, n)
                                If (Ls>=stressTh)
                                    Then
                                        Select_Next_Provider_Prority (i, n)
                                Else
                                    Select i
    t← t +1
        Else
        Exit( )
End
```

UUM Universiti Utara Malaysia

Algorithm 4.3 shows the sequence of order to implement the priority selection model. The second algorithm shows the sequence order to implement the function to assign social support as seen in Algorithm 4.4. Whereas, requested support represented by *Rs* and provided support by *Ps*.

Algorithm 4.4

*Requested Support Assignment.*

```
AaaignSupp (Rs, Ps, Bl)
If (Rs>supportTh)  &&  (Ie<=intensityTh)  &&   (Bl<=burdenTh)
     Then
       Pps ← (1-Bl)
     Else
          NextSupp (Rs, Ps, Bl)
  End
           If (Ps>supportTh)                    // check provided support
                   Then
                       As ←Ps*Pps        // assigned support
                       Ns ← (Rs/n)        //  needed support
           End

                If (Ps>=Ns)
                      Then
                          Rs ← (Rs-As)
                          Ps ← (Ps-As)
                          Bl ← (Bl+As)
                      Else
                              Select_Next_Provider_Prority (i,n)
                End
End
```

Universiti Utara Malaysia

Algorithm 4.4 shows the steps to implement the social support assignment. First, it evaluates current levels of requested support (*Rs*), the intensity of the stressful event, and burden level (*Bl*). If the burden level is acceptable, the proportion of support (*Pps*) will be determined and support will be assigned accordingly. Otherwise, it selects the next support provider as in Algorithm 4.5. Next, it evaluates provided support (*Ps*) to determine assigned support (calculated by multiplying provider's proportion of support and provided support) and needed support (computed by dividing the requested support over the number of providers by averaging value of requested support). Then, it compares provided support with the needed support to update requested support, provided support, and provider's burden level.

Algorithm 4.5

*Priority Selection Next Provider.*

```
Select_Next_Provider_Priority (i, n)
1  If (i<=n)
        Then
2               If (ΣPs(i)>Max_support)
                     Then
3                       select i
4                       Iep← Iep(i)
5                       Bl← Bl (i)
                   Else
6                       i ←i+1
7                       Select_Next_Provider_Priority (i, n)
         Else
8                 Exit ( )
     End
End
```

Algorithm 4.5 shows the steps to implement the selection of the next provider in the priority model. This algorithm evaluates support provision ranks as a mechanism to select the most preferred social support providers. Therefore, members with a high support provision will be chosen first, and so forth.

Universiti Utara Malaysia

## 4.6 Prototype Development

This section presents the development of the prototype in this study which was based on the proposed models. This stage is imported to validate the proposed approach. The prototype is further used to evaluate issues around psychological seeking and providing social support process. All identified and implemented factors, as discussed in Chapter four, were encapsulated to design the prototype to evaluate the model. To achieve this, a prototype was designed systematically by employing rapid prototyping activities. The prototyping activities used was based on an evolutionary approach from Forward, Badreddin, Lethbridge and Solano (2014) and Leifer and Steinert (2016). This approach was used to keep or retain all design parts which will form the final or finished prototype. First, it begins with the design of a use-case diagram (as in Figure 4.17).

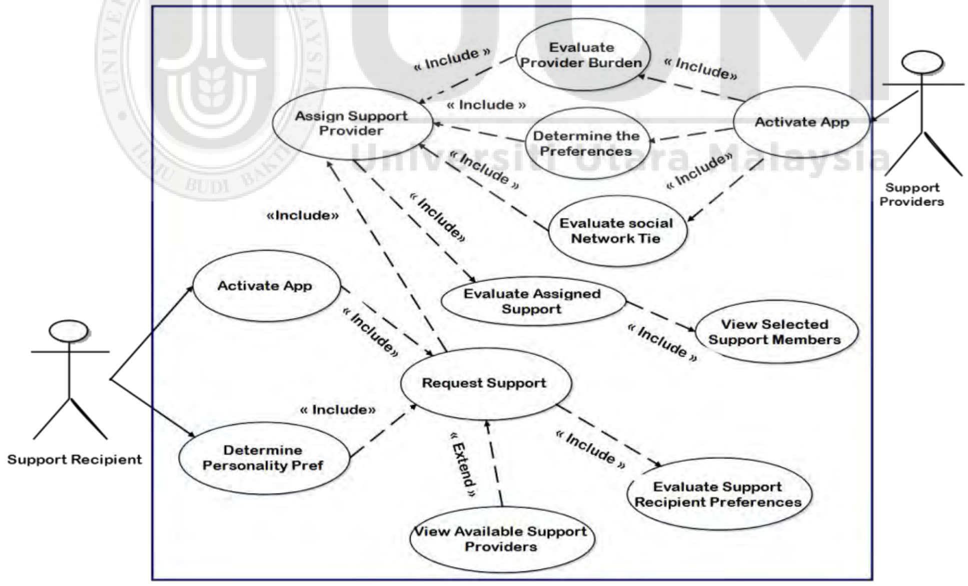



*Figure 4.17.* Prototype Use-Case Diagram**.**

The Use-Case diagram represents scenarios in which prototype interacts with people and the goals of the prototype. First, the support recipients interact with the prototype by activating the prototype, determining personality preferences, and requesting support. Second, the support providers interact with the prototype by activating the prototype, determining burden level, and provision preferences. Besides, the prototype will show the level of requested support, provided support, and selected the suitable providers based on the assigned support. Figure 4.18 shows the sequence diagram for the assign support process as it is the backbone in this prototype.

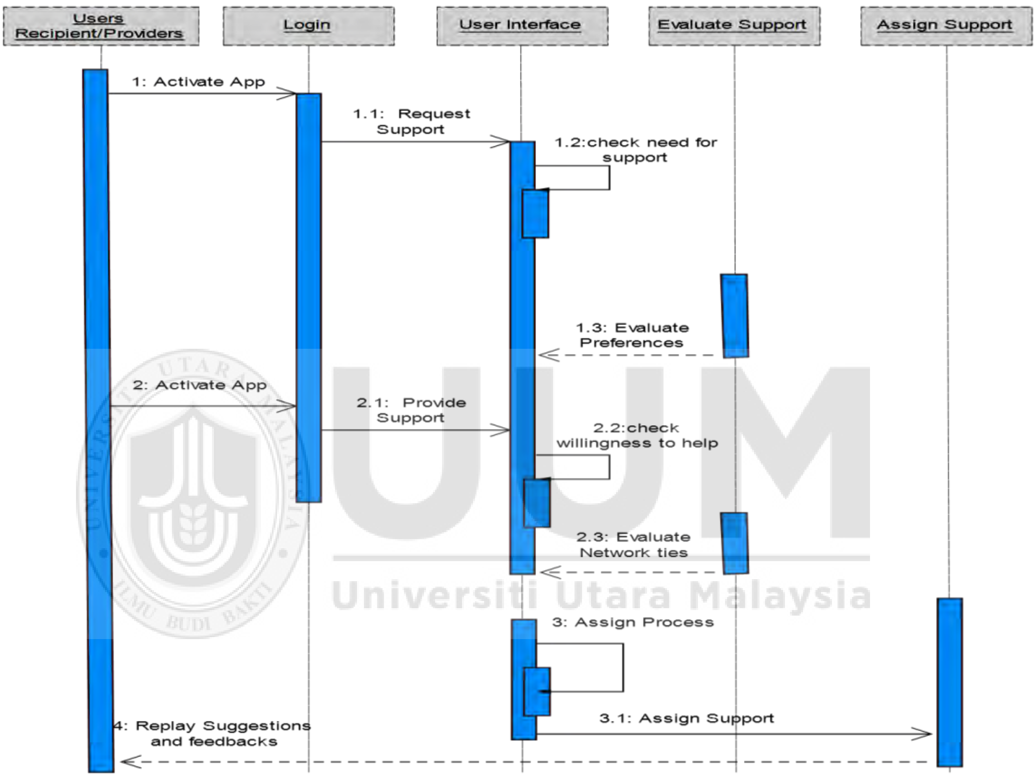



*Figure 4.18.* Prototype Sequence Diagram for Assign Support Process.

Figure 4.18 shows a sequence diagram that provides explanations of how operations are carried out between the objects. Also, it represents the time focus and visualizes the order of the interaction visually to represent the flow of messages. Also, it captures the interaction between objects in the context of a collaboration.

In this diagram, there are five major objects in support recipient-provision model namely; users (recipient and providers), login, user interface, evaluate social support, and assigned support. Figure 4.19 shows the state chart diagram in this prototype.

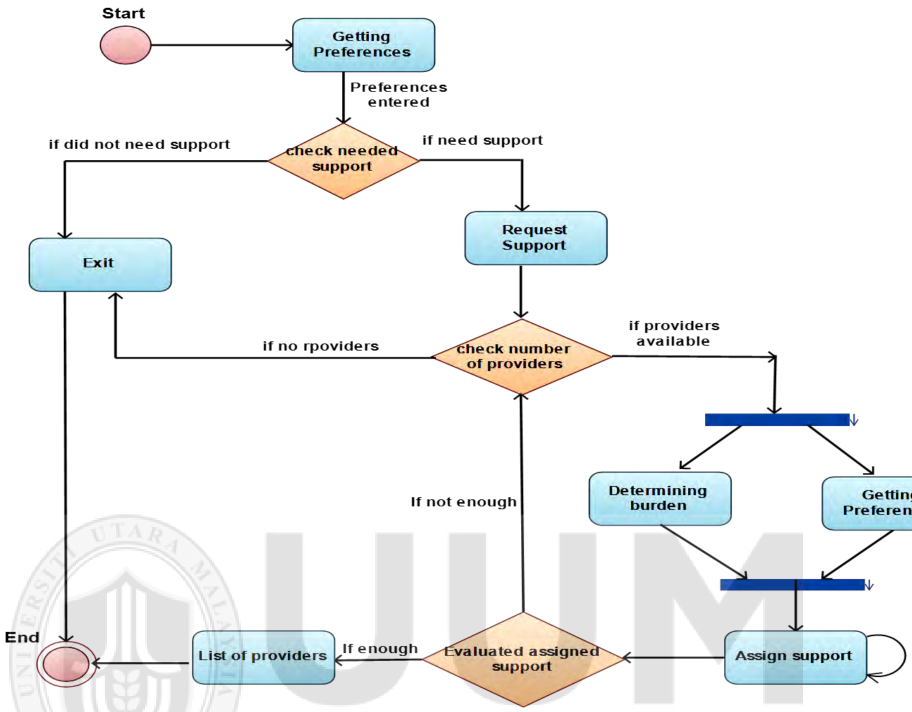



*Figure 4.19.* Prototype State Chart Diagram.

State chart diagram shows the assigned support object as shown the sequence of operations that entered it in Figure 4.18. The state chart diagram starts with the acquiring preferences state and needed support. Later, it evaluates the availability of providers and determines their current burden level. Finally, it follows by determining the assigned support and selecting the list of support providers. As the next step, the Class diagram is developed for this purpose (refer to Appendix II).

### 4.6.1 Prototype Architecture

The prototype architecture includes components such as the recipient, providers, personality attributes, thresholds, automated assignment interface and the environment.

Figure 4.20 shows the overview of the prototype architecture where the arrows depict the flows among each component.

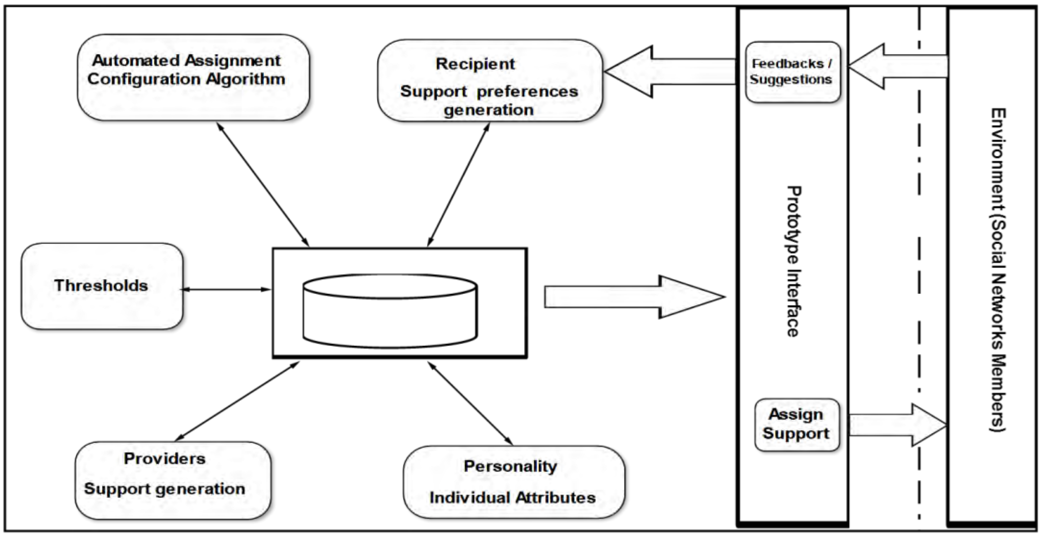



*Figure 4.20.* Prototype Architecture.

The automated assignment component using the configuration algorithm is a responsible interpretation of assigning support which is the central coordination of the prototype. This automated assignment housed model that is used to interpret the seeking support by support recipients and providing support by support providers within the close social network. Information such as personality traits, negative events, personality resources, types of social support, thresholds are stored within the recipient and providers models. The recipients later receive feedback and suggestions based on their responses about which providers can help them.

## 4.7 Summary

This chapter shows the first step to address the quest to help persons with stress from a computational perspective. It explores some computational models namely; support recipient, support provider, and integrated model. These computational models are based on related theories to explain various observed aspects, factors, and conditions for stressed persons. Moreover, it represents the support model in terms of the dynamic configuration algorithm about support provision and receipt together to select social support members within the observed social networks. More importantly, this support model will assign support provision task among selected members in line with their resources and preferences. There are two procedure models can be used to intelligently form a social support network around persons experiencing stress.  The first model is called the priority selection model. The priority selection model based on two criteria to select the provider for helping namely; the level of tie and the average of provided social support for the individual. In addition, the development of a prototype known as Help Me which is done based on the external factors of the models in Chapter 4.

Universiti Utara Malaysia

# CHAPTER FIVE

# SIMULATION RESULTS

## 5.1 Introduction

This chapter presents result obtained on the simulation traces using numerical simulation environment. The presented simulation traces were based on case conditions which defined the uniqueness of each trace. This chapter is organized as follows: Section 5.2 presented the simulation environment and Section 5.3 described the simulation parameters. Furthermore, Section 5.4 shows the simulation of a support recipient whereas Section 5.5 shows the simulation of the support provider. Besides, Section 5.6 shows the simulation of an integrated model. Finally, Section 5.7 presented the results of the case study by using configuration algorithm and Section 5.8 concludes this chapter.

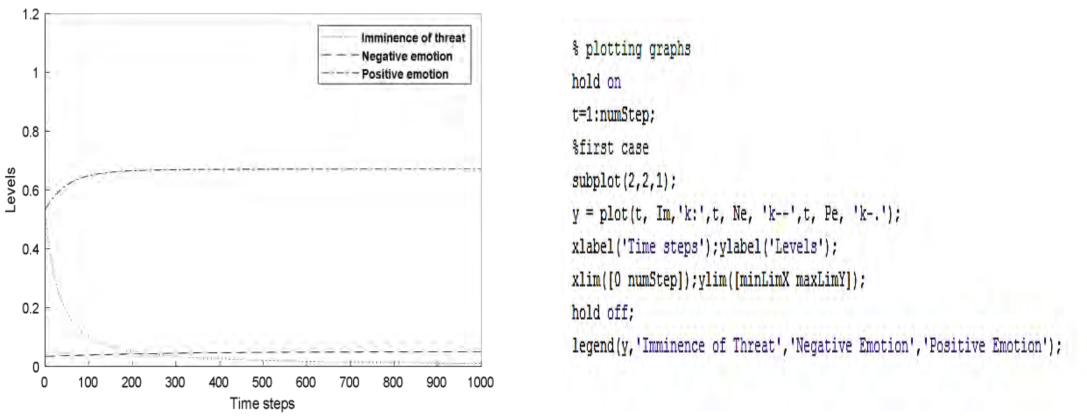
Universiti Utara Malaysia

## 5.2 Simulation Environment

This study made use of a simulation environment to critically experiment on the proposed models. It was conducted by using various combinations of parameters and factors of the proposed models. The results of these parameter variations of the proposed model concept are to obtain real-life situation conditions on the various parameters of selected case studies. It gives the simulated behaviours of the proposed model which allows better insight into the functionalities of the model at different selected cases. Also, the simulation environment was used to demonstrate the robustness of the proposed model by visualizing the model execution for underpinning theories used in the study.

This is done by interpreting the simulation traces of the proposed model with the grounding theories and selected literature. Based on a suggestion by Grimm et al (2015), the model must be robust to avoid inconsistencies between the proposed model simulation traces (as generated by the proposed model) and the literature (with the underpinning theories). These simulation traces are obtained through the implementation of different agent attribution for some selected cases out of the various instances. The simulation was conducted concerning time ($t$) to provide insight into the temporal changes that occur with an agent in specific case conditions. Figure 5.1 (a) shows an example of the designed and deployed simulation environment using a numerical programming language (Matlab), whereas Figure 5.1 (b) shows the code to implement this example.

Universiti Utara Malaysia




**(a)** **(b)**

*Figure 5.1.* Model Simulation Environment

Generally, based on the literature, three cases were selected for each model (support recipient, support provider, and integrated). These cases represent how to support recipient and support provision behaviours behave based on several dimensions of four social support namely; informational social support, emotional social support, instrumental social support, companionship social support. The next subsection discussed the experimental parameter setting with values used for these 10 selected case conditions.

### 5.3 Simulation Settings

In this study, the parameter settings were obtained using a systematic approach as suggested by Vidotto and Vicentini (2007), Vidotto, Massidda and Noventa (2010) and Vidotto (2013). These guidelines explicitly highlighted the critical role on which parameter play on accurate description, prediction and investigation of the model behaviours. The proposed model parameter values were in two different forms namely the concept parameters and the regulating factor parameters. The model concept parameter estimation has followed a suggestion by Ding (2014), Chen et al (2016), Aster, Borchers and Thurber (2011), Treur and Umair (2011), and Vidotto, Massidda and Noventa (2010) that values ranging from 0.1 to 0.3 are considered as low values, while from 0.4 to 0.6 can be group as an average, and 0.7 to 1 are high values.

In equation's parameters (weight factor and proportional parameter), there are several values that have been used. For instance, Vidotto and Vicentini (2007) suggested that 0.33 is the weightage best value for three contributional factors. For the proportional parameter, 0.5 has been suggested by Vidotto, Massidda and Noventa (2010) and Vidotto (2013). In general, this study is made use of low values as $< 0.5$, whereas high value is defined as ≥ 0.5 for the simulation parameters. The differences in the simulation traces depict the unique differences in each model attribution to time. A detailed description of the designed and developed simulators for all models (recipient model, provider model, and integrated model) are presented in Sections 5.4, 5.5, and 5.6 respectively.

## 5.4 Support Recipient Model Simulation Results

For the recipient model, the simulator was developed using the same programming language as in support provider. Algorithm 5.1 shows the pseudo-code for the proposed model execution which illustrates how the simulation was designed.

Algorithm 5.1

*Support Recipient Model Simulation Pseudo-Code*

```
Start
numSteps, such that numStep← 1000
array size, such that 1 ≤ array size ≤ numSteps
instantaneous parameter, such that instantaneous parameter ← instantaneous
parameter (1)
temporal parameter, such that temporal parameter ← 0.3
 Select Scenario
        Case [n]
        New_Input[t] ← Input [ Pr, Sd, Pa, Co, Nu, Ev, De, Le, Ce, t]
End

New_ Instantaneous[t] ← Instantaneous [Nv, Ie, Th, Ch, Cg, Hb, Ac, Ne, Pe, Ef, Pf,
Ir, Er,
                                        Nr, Cr, Es, Cs, Ex, t=1]

Do      t=2: numStep
     New_ Instantaneous[t] ← Instantaneous [Nv, Ie, Th, Ch, Cg, Hb, Ac, Ne, Pe, Ef,
     Pf, Ir,
                                        Er, Nr, Cr, Es, Cs, Ex, t]
          New_temporal[t+Δt] ← temp [Se, We, Im, Sc, t+Δt]
Until t=numSteps
End
```

Universiti Utara Malaysia

The Matlab GUI programming language code as shown in Algorithm 5.1 has four major parts namely the parameter initialization, declaration of concepts, concept operation, and simulation implementation. The first part is where the simulation parameters used to control and regulate the simulation environment were initialized. Declaration and initialization of concepts used in the model in the simulation environment were carried out in the second part. Also, in this section, all initial values were assigned for both instantaneous and temporal concepts. The third part explains how the model concepts were operationalized. Later, the fourth part involves the implementation of case conditions by plotting the values to generate simulation traces. In this part, the extreme case was selected for the support recipient model. Several simulations have been performed to discover interesting patterns among recipients' support tie preferences behaviours and their social support preferences. Some anticipated patterns can be discovered with variations within individual and inter-personal attributes.

### 5.4.1 Variations of Support Recipient Behaviour

Support recipient, in this case, was attributed with different personal resources (*Pr*), conscientiousness personality (*Co*), neuroticism (*Nu*), situational demands (*Sd*), negative event (*Nv*), and extraversion (*Ev*) as shown in Table 5.1.

Table 5.1

*Values of Support Recipient with Extreme Case Condition.*

| **Concepts** | **Pr** | **Sd** | **Nv** | **Ev** | **Nu** | **Co** |
|---|---|---|---|---|---|---|
| Condition 1 | 1 | 0 | 0 | 0 | 0 | 1 |
| Condition 2 | 1 | 0 | 0 | 1 | 0 | 0 |
| Condition 3 | 0 | 1 | 1 | 0 | 1 | 0 |
| Condition 4 | 0 | 1 | 1 | 1 | 0 | 0 |

A different combination of personality attributes, personal resources, and negative events are expected to allow support recipient requested different types of social support as seen in Figure 5.2.

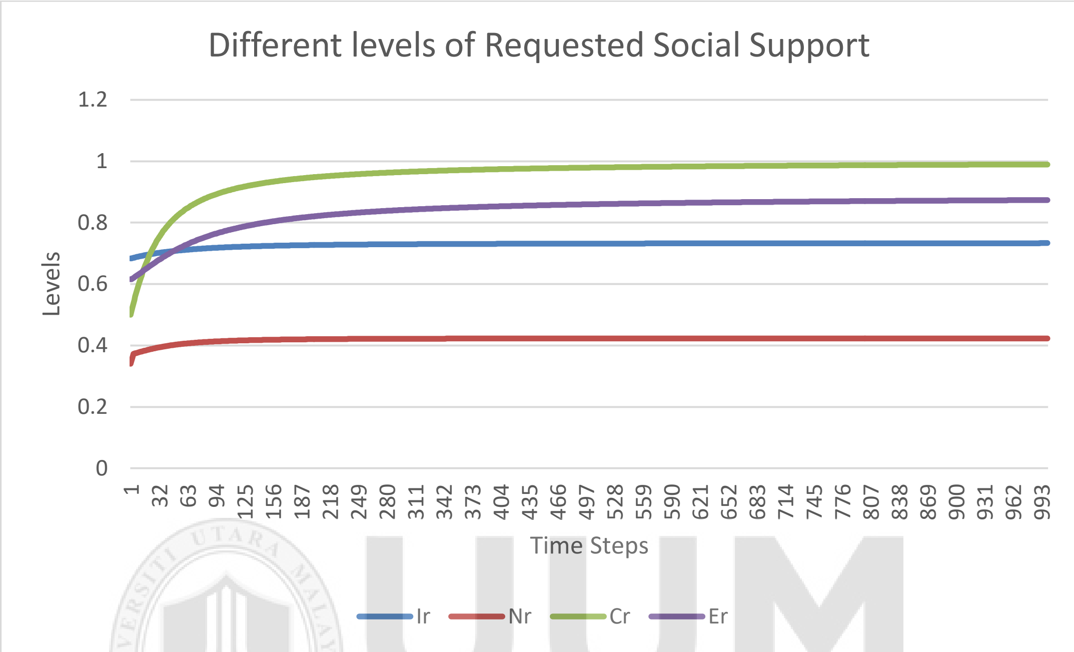
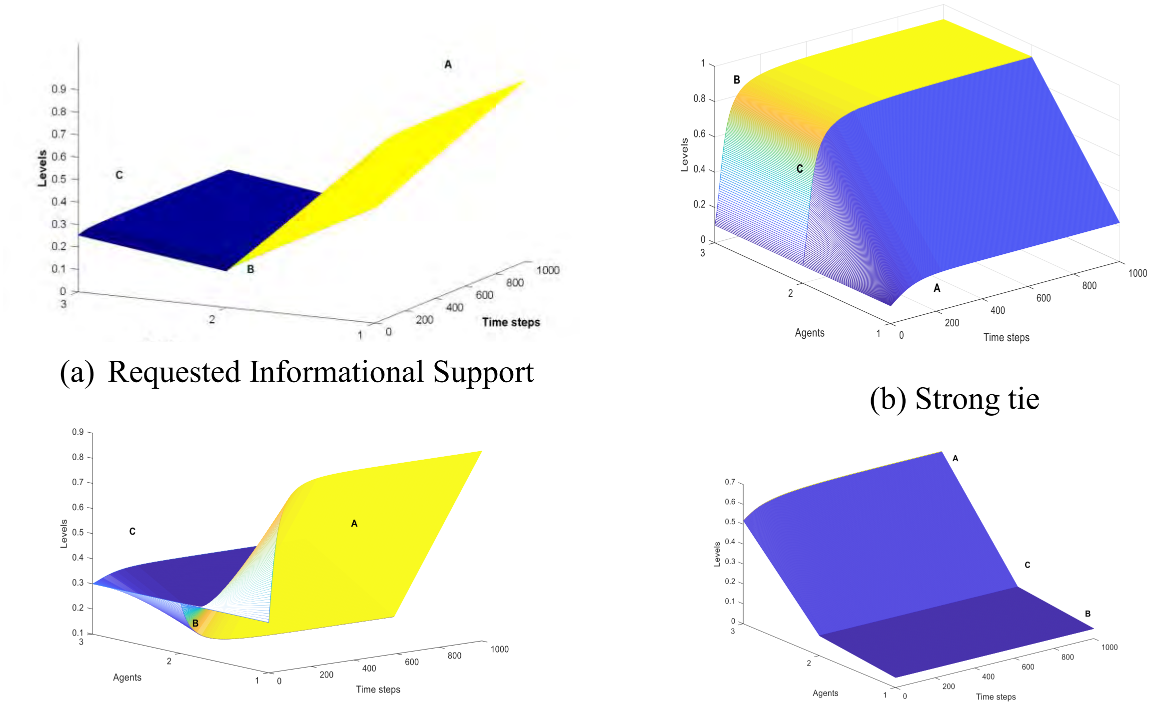



*Figure 5.2.* Simulation of Extreme Case of Support Recipient.

The next part, in this case, deal with simulation of three individuals (A, B, and C) conditions exposed to a different level of stressful events and different parameter settings as shown in Table 5.1. An individual A has requested the highest value of informational support, then individual C, and the lowest values of individual B close to zero. In this simulation trace, it shows both individuals (A and C) developed better coping skills through the selection of problem-focused coping. Figure 5.3 depicts the comparison between the conditions of individual A, B, and C by showing the values of requested information support, strong tie, weak tie, and problem-focused coping of the three individuals A, B, and C.



(a) Requested Informational Support

(b) Strong tie

(c) Weak Tie

(d) Problem-focused coping

*Figure 5.3.* Simulation Results for Multi Support Recipients.

Universiti Utara Malaysia

Figure 5.3 (a) shows the values of requested informational support of the three individuals. Individual A requested the highest value of informational support, then individual C, and lowest values of individual B. Based on Figure 5.3 (b) and Figure 5.3 (c), it is observed that information requested leads weak tie. The weak tie was found to reach one whereas strong tie close to zero. This implies that when recipient acquires this case condition attribution then its support will be characterized by a high weak tie and low strong tie which indicates that the recipient will be able to the incoming stressors through informational requests from his/her expanded social networks (Gordon, 2017; Haines & Beggs, 2016; Dodson et al., 2016).

Also, based on Figure 5.3 (c), the individual A received support from his expanded social network which will trigger weak tie preferences compared with individuals B and C. This finding was found to be consistent with (Knoll, Burkert, & Schwarzer, 2014; Thoits, 2011). Figure 5.3 (d) shows the values of problem-focused coping of the three individuals where recipient A has the highest value of problem-focused compared to other individuals.

In this case condition 1, the recipient was characterized with high ability to request informational support, lack support from a strong tie, whereas the seeking and requesting support from weak tie was high as presented in Figure 5.4 (a), (b), (c) and (d) respectively.

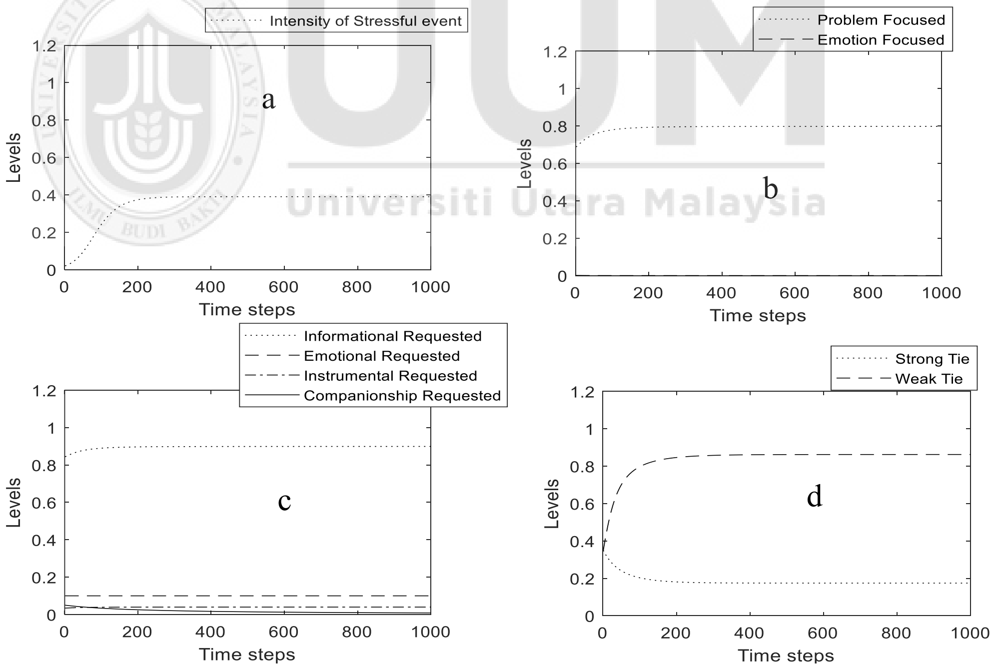



*Figure 5.4.* Simulation of Support Recipient with Requested Informational Support.

From Figure 5.4 (a), it clears in this case that recipient's threat is low, since he/she faced low negative events and situational demands, and thus his/her intensity of stressful events is low.  Based on Figure 5.4 (b), it is observed that recipient in this case cope by using problem-focused coping strategy.

This implies that when a recipient acquires this case condition attribution then its support will be characterized by low emotion-focused and high problem-focused coping and later high skill of coping with stress. Figure 5.4 (c) shows the requested social support types. The support recipient, in this case, requested highest of information social support compared to other social support types. Figure 5.4 (d) shows the social network tie preferences. It found that recipient seeks and requests support from a weak tie more than from a strong tie. In case condition 2 as shown in Table 5.1, the recipient was characterized with high ability to request instrumental support, whereas the seeking and requesting support from both ties weak tie and strong tie as seen in Figure 5.5 (a), (b), (c) and (d) respectively.

Universiti Utara Malaysia

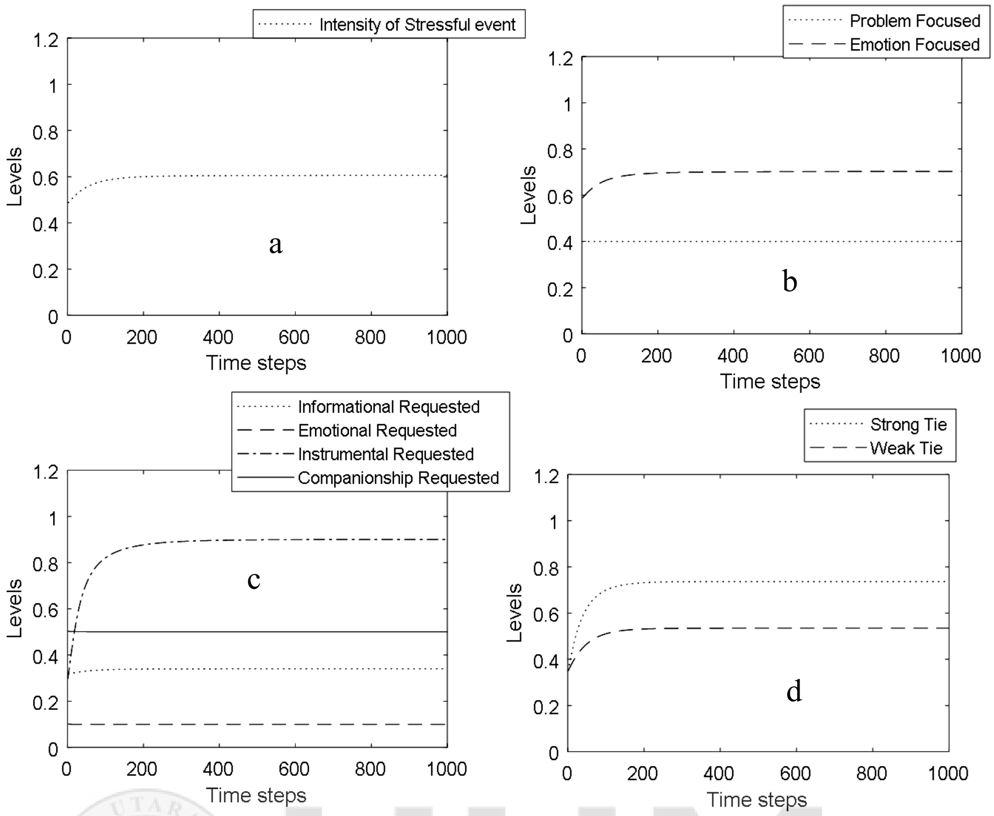
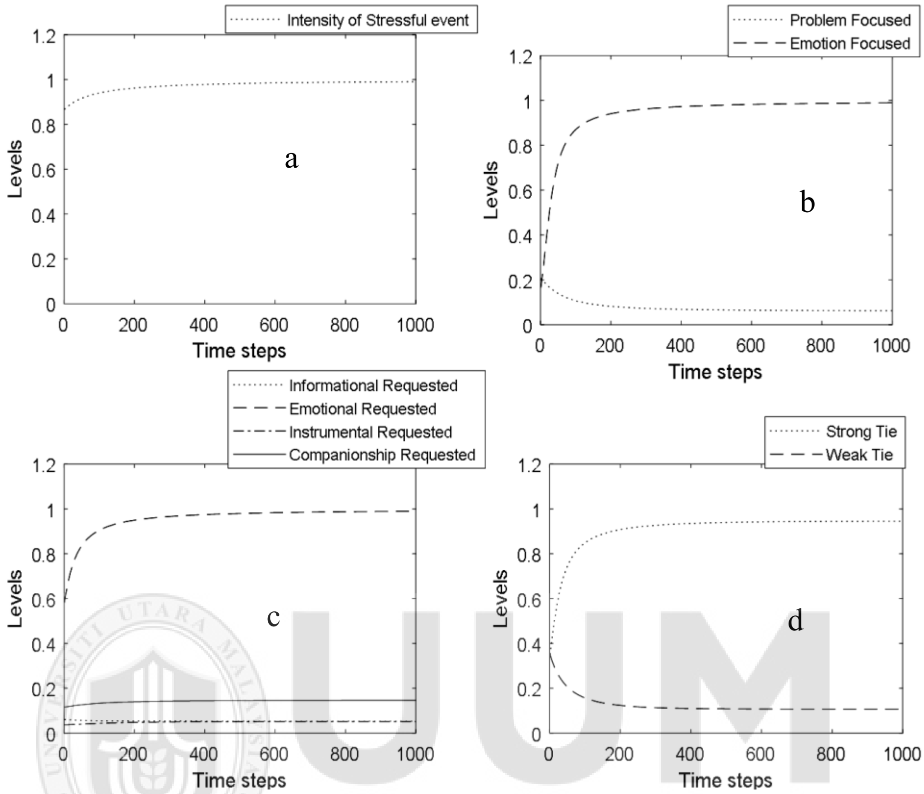



*Figure 5.5.* Simulation Results of Support Recipient with Requested Instrumental Support.

Universiti Utara Malaysia

Figure 5.5 (a) shows the level of intensity of stressful events of this recipient. It is observed that this recipient copes with the stress by using more problem-focused coping strategy rather than emotion-focused coping but there is a close margin between them as seen in Figure 5.5 (b). This implies that when a recipient acquires this case condition attribution then its support will be characterized by both emotions focused and high problem-focused coping. Figure 5.5 (c) shows the requested social support types of this recipient and Figure 5.5 (d) shows the social network tie preferences. From these simulation results, it shows that that recipient seeks and requests support from both weak tie and strong tie and in line with results from Owens (2017) and Brashers, Neidig, & Goldsmith (2004). In case condition 3 as shown in Table 5.1, the recipient was characterized with high ability to request emotional support as presented in Figure 5.6 (a), (b), (c) and (d) respectively.




Universiti Utara Malaysia

*Figure 5.6.* Simulation of Support Recipient with Requested Emotional Support.

Figure 5.6 (a) shows the level of intensity of stressful events of this recipient. In Figure 5.6 (b), it is observed that this recipient copes with the stress by using an emotion-focused coping strategy. Figure 5.6 (c) shows the requested social support types. The support recipient, in this case, requested highest of emotional social support compared with other social support types. Figure 5.6 (d) shows the social network tie preferences where strong tie support is preferred over a weak tie. (Haines & Beggs, 2016; Dodson et al., 2016).

Furthermore, a combination of extraversion, situational demands, and negative events are expected to help any individuals to increase potentially request of companionship social support (as in Table 5.1, case condition 4). In this case, the recipient was characterized with a high ability to request companionship support as seen in Figure 5.7. (Haines & Beggs, 2016; Lauritz, Preez, Cassimjee, & Ghazinour, 2015).

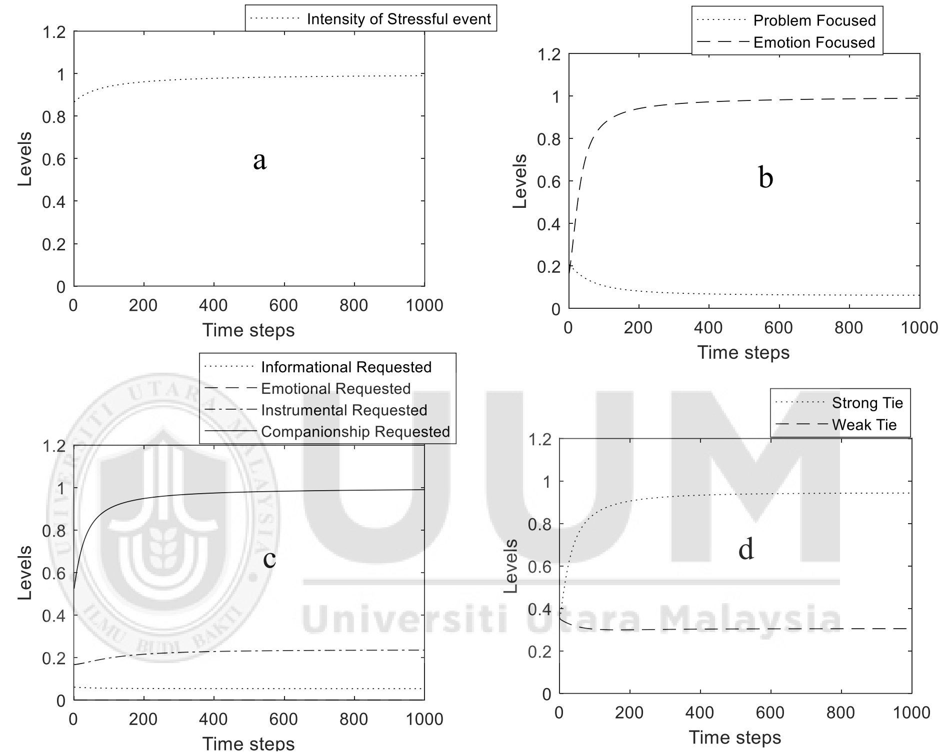



*Figure 5.7.* Simulation of Support Recipient with Requested Companionship Support.

Based on Figure 5.7 (d), it is observed that requested companionship leads the selection of a strong tie preference. (Dodson et al., 2016; Mohamed & Baqutayan, 2015) as a mechanism to cope with stress. Figure 5.7 (b) shows a person with high extraversion personality, tends to choose companionship support as a coping process (Haines & Beggs, 2016; Lauritz, Preez, Cassimjee, & Ghazinour, 2015). Based on Figure 5.7 (c), this recipient requested companionship support from their closed social network. Thus, the strong tie preferences will be increased over time. This finding was found to be consistent with (Haines & Beggs, 2016; Lauritz, Preez, Cassimjee, & Ghazinour, 2015) which found that an individual with a high extraversion personality would get less support from a weak network tie, even during a stressful event.

### 5.5 Support Provider Model Simulation Results

For support provider, the simulator was developed using the same programming language as in support recipient which illustrates how the simulation was programmed by using Matlab. In this section, an extreme case was designed for support providers with different settings, exposed to a different set of stressful events and parameter settings.

#### 5.5.1 Variations of Support Provider Behaviour

Support providers, in this case, was attributed with different personal resources (*Prp*), altruistic attitudes (*Al*), agreeableness (*Ag*), knowledge level (*Kl*), negative event (*Nvp*), function provider in a social network (*Fp*) and extraversion (*Evp*) as shown in Table 5.2.

Table 5.2

*Values of Support Providers with Extreme Case Condition.*

| Concepts | Prp | Al | Nvp | Evp | Fp | Ag | Kl |
|---|---|---|---|---|---|---|---|
| Condition 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| Condition 2 | 1 | 1 | 1 | 0 | 1 | 1 | 0 |
| Condition 3 | 0 | 1 | 0 | 0 | 1 | 1 | 0 |
| Condition 4 | 0 | 1 | 1 | 1 | 1 | 0 | 0 |

A different combination of personality attributes, personal resources, and negative events are expected to allow support providers offered different types of social support as seen in Figure 5.8.

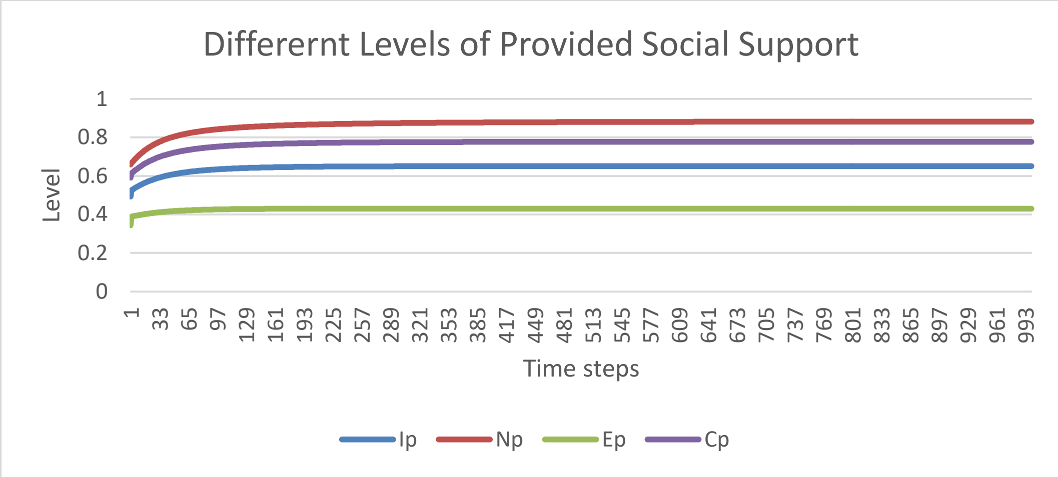
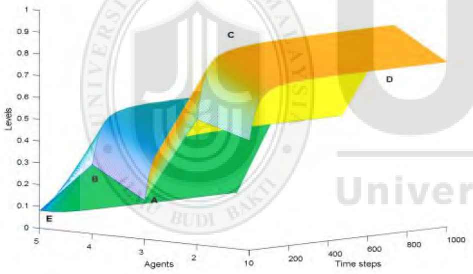


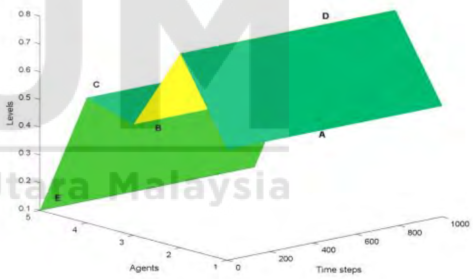

*Figure 5.8.* Simulation of Extreme Case of Support Providers.

The second part, in this case, is to simulate preferences of instrumental provision and burden level of A, B, C, D, and E as seen in Figure 5.9.

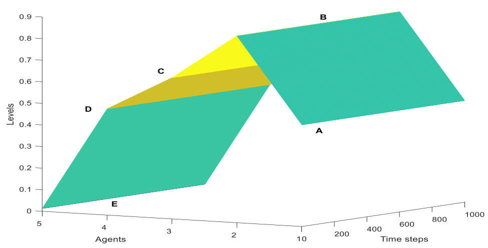
Universiti Utara Malaysia



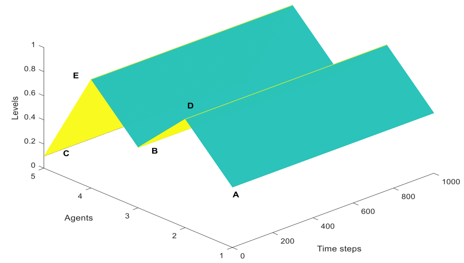

(a) Provided Instrumental Support




(b) Support Provider's Burden Level




(c) Provided Emotional Support




(d) Provided Companionship Support

*Figure 5.9.* Simulation of Multi Support Provider.

Figure 5.9 (a) shows the values of provided instrumental with individual B provided the highest value of instrumental support. In this simulation trace, providers A and B used a bonadaptation approach to solve the perceived problem through problem-focused coping strategy and later will decrease provider burden level.

From Figure 5.9 (c), In this simulation, an individual C provides the highest value of emotional support. One of the factors that can be used to explain this simulation is the increasing function in social network value and level of agreeableness personality. By the same token, research has consistently established a significant relationship between social network ties and provided social support. For example, several studies reported that providers who were in strong tie satisfied with helping others more than weak ties (Denissen and Penke 2015; Holmes, 2016). Having this in motion, it provides a positive view of social support and later will be translated as support received by the recipient.

Figure 5.9 (d) shows the values of provided companionship support of the five individuals. In this simulation trace, it is observable that individual C also provide companionship support but lesser than individual D since he/she has a lower mutual interest with recipient situation and high emotional exhaustion (Cutrona & Russell, 2015). In case condition 1, support providers can be characterized with high ability of willingness to help that later tend to commit support with low of emotional exhaustion (Gooden, 2014; Lakey, Cooper, & Cronin, 2015). After running the simulation code, the simulation traces obtained for this provider are presented in Figure 5.10.

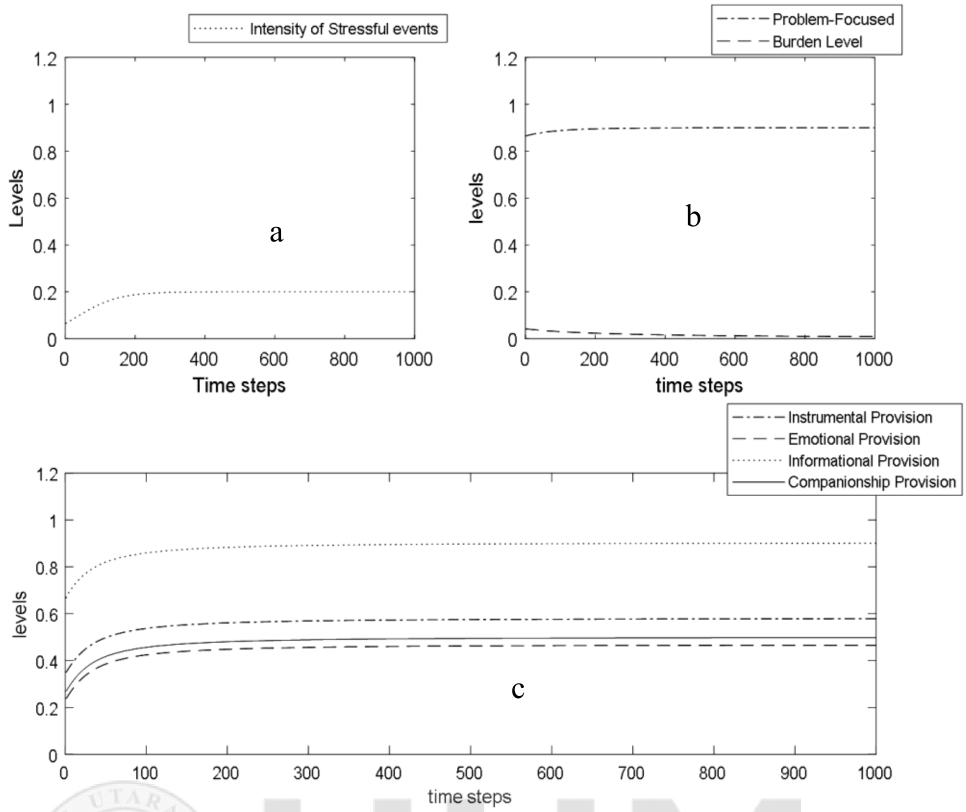



*Figure 5.10.* Simulation of Support Provider with Provided Informational Support.

Universiti Utara Malaysia

Figure 5.10 (b) shows a very wide range margin between the problem-focused and burden level and it is consistent with the findings in Kalkan & Epli-koç (2014). Figure 5.10 (c) shows the provision of social support types. The results have shown that the support providers offer the highest support information provision compared with other social support types. In case condition 2, this provider has been attributed with high personality attributes (*Pap*), agreeableness (*Ag*) personality, function provider in a social network (*Fp*), altruistic attitudes (*Al*), low extraversion (*Evp*), recipient interests (*Rs*), provider interests (*Ps*), knowledge level (*Kl*), personal resources (*Prp*) and negative event (*Nv*) as seen in Figure 5.11. Normally, an individual tends to provide instrumental support as a mechanism to help the recipient (Tausig & Michello, 2012; Cutrona & Russell, 2015).

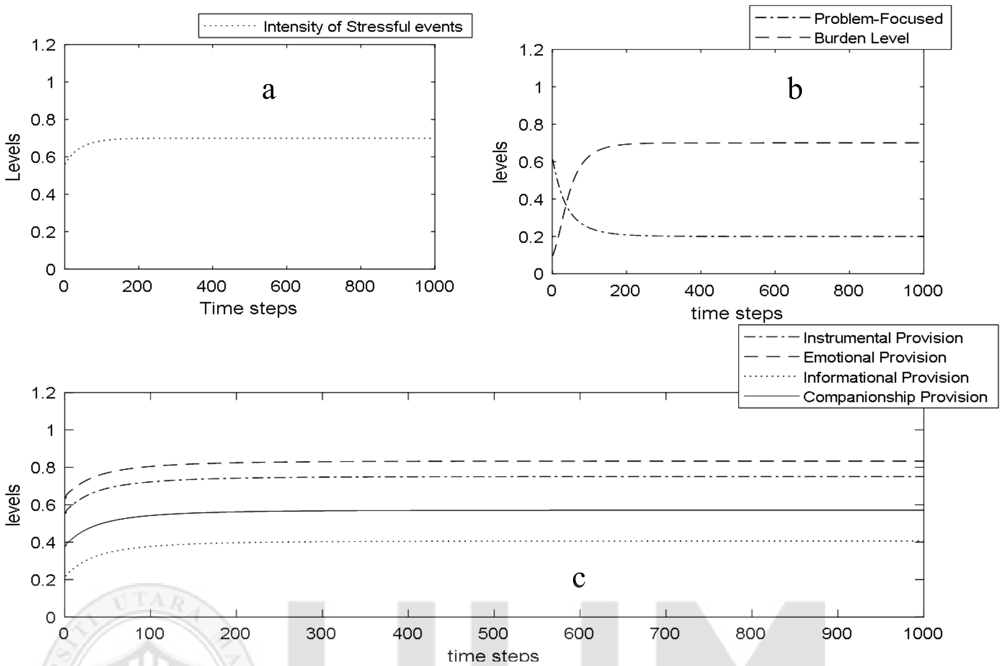



*Figure 5.11.* Simulation of Support Provider with Provided Instrumental Support.

Figure 5.11 (a) visualizes the level of intensity of stressful events that lead to problem-focused coping skills (as depicted in Figure 5.11(b)). The support providers, in this case, offer the highest of support instrumental provision compared with others social support type (Cutrona & Russell, 2015). In case condition 3, provider was attributed with high agreeableness (*Ag*) personality, function provider in a social network (*Fp*), altruistic attitudes (*Al*), negative event (*Nv*), high personality attributes (*Pap*), and low extraversion (*Evp*), recipient interests (*Rs*), provider interests (*Ps*), and knowledge level (*Kl*) personal resources (*Prp*) as shown in Figure 5.12.

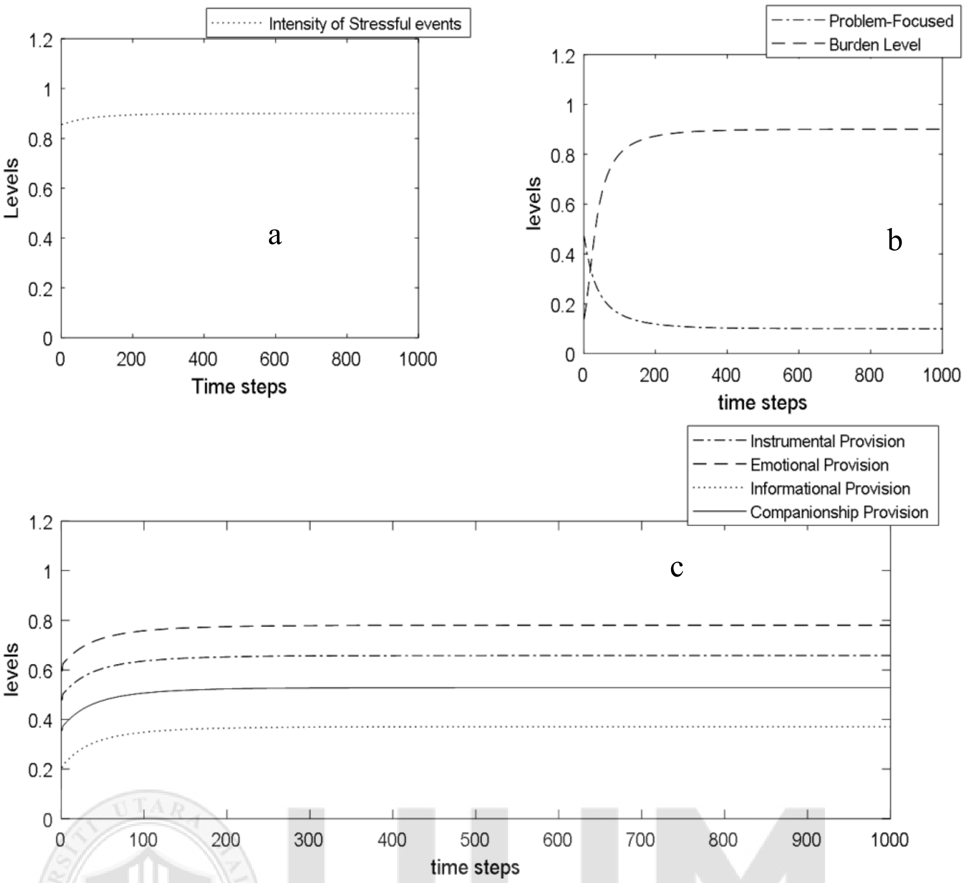



*Figure 5.12*. Simulation of Support Provider with Provided Emotional Support.

Figure 5.12 (c) shows the provision of social support types for this case. The support providers offer the highest support emotional provision compared with other social support types. In case condition 4, the provider D is attributed with high personality attributes (*Pap*), extraversion (*Evp*), recipient interests (*Rs*), provider interests (*Ps*), negative event (*Nv*), function provider in a social network (*Fp*), altruistic attitudes (*Al*), low agreeableness (*Ag*), personal resources (*Prp*), and knowledge level (*Kl*). Figure 5.13 shows a person with high with extraversion personality tends to provide companionship support as a coping process. These results are in line with existing literature as in (Branje et al., 2015; Hinnen, Hagedoom, Sanderman, & Ranchor, 2016).

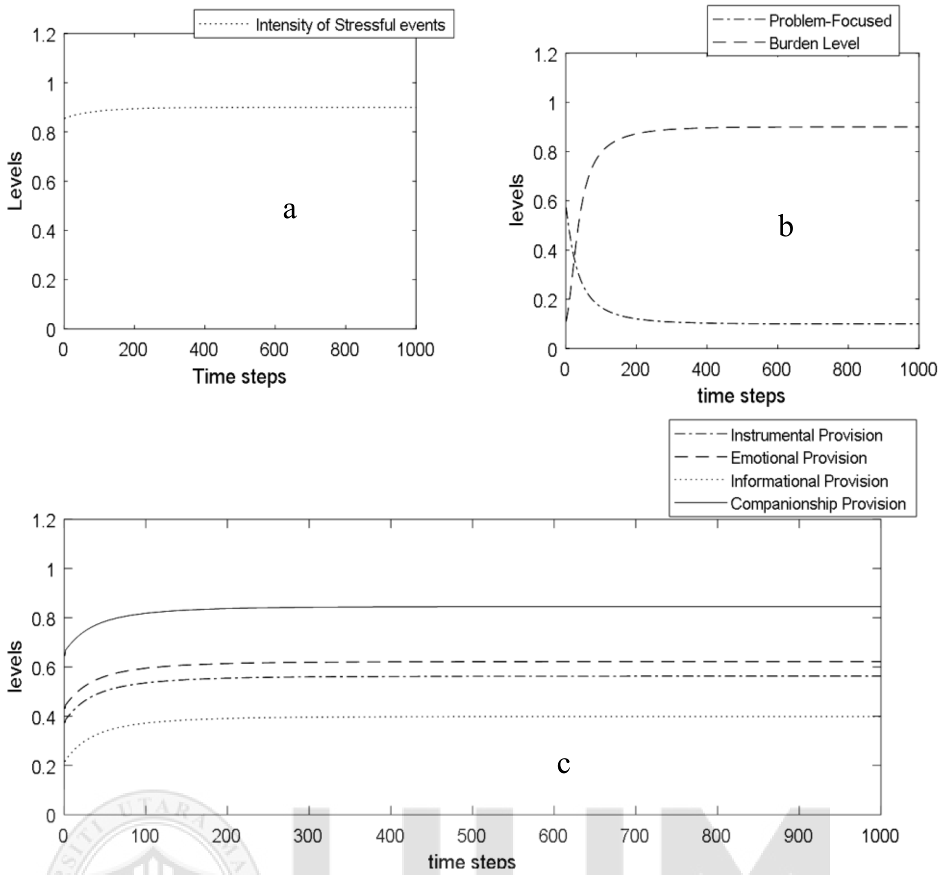



*Figure 5.13*. Simulation of Support Provider with Provided Companionship Support.

Universiti Utara Malaysia

Figure 5.13 visualizes the high level of intensity of stressful events that lead to emotion-focused coping skills where the support providers offer highest of support companionship provision compared with others social support type (Cutrona & Russell, 2015).

### 5.6 Integrated Model Simulation Results

This section covers several simulation results for the integrated model as depicted in Algorithm 5.2.

Algorithm 5.2.

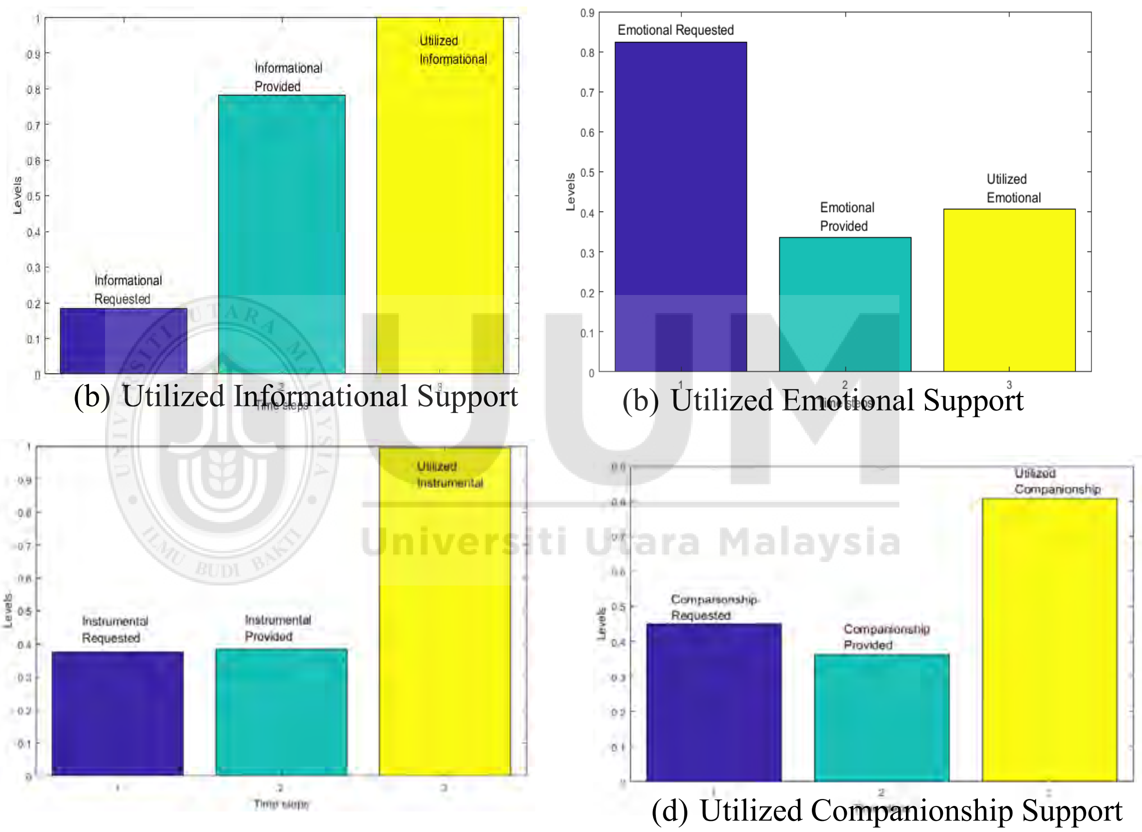
*Integrated Model Simulation Pseudo-codes*

```
Start
numSteps, such that numStep← 1000
array size, such that 1 ≤ array size ≤ numSteps
instantaneous parameter, such that instantaneous parameter ← instantaneous parameter (1)
temporal parameter, such that temporal parameter ← 0.3

Select Scenario
        Case [n]
        New_Input[t] ← Input [ Pr, Sd, Pa, Co, Nu, Ev, De, Le, Ce,
                                    Prp, Nvp, Pap, Al, Evp, Ag, Kl, Rs, Ps, Fp, Prp, t]
End

          New_ Instantaneous[t] ← Instantaneous [Nv, Ie, Th, Ch, Cg, Hb, Ac, Ne, Pe, Ef,
                    Pf, Ir, Er, Nr, Cr, Es, Cs, Ex, Iep, Thp, Chp,
                    Efp, Pfp, Ip, Ep, Np, Cp, Pc, Mi, Sf, Ba, Ma, Bl, Wh, Ec, Am, t=1]

Do      t=2: numStep

        New_ Rec_Instantaneous[t] ← Instantaneous [Nv, Ie, Th, Ch, Cg, Hb, Ac, Ne, Pe,
         Ef, Pf, Ir, Er, Nr, Cr, Es, Cs, Ex, t=1]

        New_ Pro_Instantaneous[t] ← Instantaneous [ Iep, Thp, Chp, Efp, Pfp, Ip, Ep, Np,
        Cp, Pc, Mi, Sf, Ba, Ma, Bl, Wh, Ec, Am, t=1]

        New_ Intg_Instantaneous[t] ← Instantaneous [ Iep, Thp, Chp, Efp, Pfp, Ip, Ep, Np,
        Cp, Pc, Mi, Sf, Ba, Ma, Bl, Wh t=1]

        New_Rec_temporal [t+Δt] ← temp [Se, We, Im, Sc, t+Δt]
        New_Pro_temporal [t+Δt] ← temp [Cm, Eh, t+Δt]
        New_Intg_temporal [t+Δt] ← temp [Ls, t+Δt]

Until t=numSteps
End
```

Algorithm 5.2 shows the steps to implement an integrated support model in three stages. The first stage includes concepts related to the recipient model. The second stage relates concepts in a provider model, and the last one involves concepts related to the integrated model. In this section, the extreme case was designed for several support recipient and providers with different settings, exposed to different parameter settings.

### 5.6.1 Variations of Support Recipient and Provider Behaviour

This case showed the utilized supports that were driven from both recipient and provider in Table 5.1 and Table 5.2. Simulation results can be found in Figure 5.14.




(b) Utilized Informational Support

(b) Utilized Emotional Support

(c) Utilized Instrumental Support

(d) Utilized Companionship Support

*Figure 5.14.* Simulation of Utilized Informational Support.

UUM Universiti Utara Malaysia

Figure 5.14 (a) shows the values of informational requested and informational provided are needed to determine the utilized informational support. Whereas, Figure 5.14 (b) shows that when the emotional provided less than requested emotional support, the utilized emotional support will be low which means these providers can only offer limited support for the recipient to cope with stress.

Figure 5.14 (c) shows the instrumental provided equally to the requested instrumental then the utilized instrumental can be considered as highly utilized. It means that a provider can offer enough support to the recipient in coping with stressful situations. Also, Figure 5.14 (d) shows the values of companionship requested, companionship provided, and utilized companionship support respectively. In this case, the utilized companionship supports lesser than one since the providers can offer only limited support to the recipient.

### 5.7 Configuration Algorithm Simulation Results

In this part, Algorithm 5.3 shows the step for the execution model to illustrate how simulation was programmed by using Matlab.

Universiti Utara Malaysia

Algorithm 5.3

*Configuration Algorithm Simulation Pseudo-codes*

**Start**
Initialize *numSteps*
Initialize *array size*
Initialize *instantaneous parameter of recipient*
Initialize *instantaneous parameter of provider*
Initialize *instantaneous parameter of Integrated part*
Initialize *temporal parameter of recipient*
Initialize *temporal parameter of provider*
Initialize *temporal parameter of Integrated part*
Initialize *instantaneous equations at t=1*
Do    t=2: numStep/2
    Compute *Instantaneous equations of recipient*

```
        Compute Instantaneous equations of provider
        Compute Instantaneous equations of Integrated part
        Compute temporal equations of recipient
        Compute temporal equations of provider
        Compute temporal equations of Integrated part
 Until t=numSteps/2
For     t= numStep/2: numStep
        For     num_providers= 1: n
             Check threshold for stress
             Compute network tie preferences
             Check threshold for each type of support
            Compute proportion of the support
            Compute assigned support
            Update requested support
            Update provided support
            Update burden level of each provider
            Update short stress for the recipient
        End
End
End
```

Algorithm 5.3 shows four major sections namely the parameter initialization, declaration of concepts, concept operation and simulation implementation. In this section, a simple case study to show the results of the support model (configuration algorithm) is presented. For the sake of brevity, only requested informational support and informational provision will be discussed.

### 5.7.1 Case Study (Support Assignment)

In this case study, six different fictional persons are studied under several parameters and attributes for social support receipt and provision as presented in Table 5.3.

Table 5.3

*Values of Parameters of Providers in Case Study.*

| **Concept/Provider** | **Anas** | **Ali** | **Mohammad** | **Noor** | **Amal** | **Fras** |
|---|---|---|---|---|---|---|
| Personal resources (*Prp*) | 0.6 | 0.1 | 0.6 | 0.7 | 0.5 | 0.9 |
| Negative event (*Nvp*) | 0.3 | 0.8 | 0.7 | 0.3 | 0.1 | 0.1 |
| Altruistic attitudes (*Al*) | 0.8 | 0.4 | 0.8 | 0.9 | 0.8 | 0.7 |
| Recipient interests (*Rs*) | 0.2 | 0.4 | 0.2 | 0.2 | 0.1 | 0.1 |
| Provider interests (*Ps*) | 0.1 | 0.5 | 0.4 | 0.1 | 0.3 | 0.2 |
| Knowledge level (*Kl*) | 0.3 | 0.1 | 0.6 | 0.9 | 0.8 | 0.7 |
| Personal attributes (*Pap*) | 0.7 | 0.2 | 0.5 | 0.7 | 0.8 | 0.3 |
| Agreeableness (*Ag*) | 0.4 | 0.4 | 0.3 | 0.1 | 0.2 | 0.1 |
| Extraversion (*Evp*) | 0.3 | 0.1 | 0.1 | 0.2 | 0.1 | 0.3 |
| Function provider in social network (*Fp*) | 0.9 | 0.8 | 0.4 | 0.1 | 0.2 | 0.3 |

With these parameter's values, consider this example:

> *"Ahmad experiences stress and seeks for help. From his personality and Preferences, he needs more informational support (0.8). What is more, he prefers members from a weak tie network (0.7) to a strong tie network (0.1). Within his social support networks, he has two members in a strong tie and four members in a weak tie network."*

Universiti Utara Malaysia

From these members, the support provision availability is the following (*tie network, informational support;* **Anas** (*strong, 0.3*), **Ali** (*strong, 0.1*), **Mohammad** (*weak, 0.5*), **Noor** (*weak, 0.7*), **Amal** (*weak, 0.6*), **Fras** (*weak, 0.4*). Note that this information is generated from the dynamic model of support receipt and provision process. Using a support tie preference, he prefers 88 % from weak tie support members, and 12 % from strong tie members. Figure 5.15 visualizes the initialization of this process at *t*= 0.

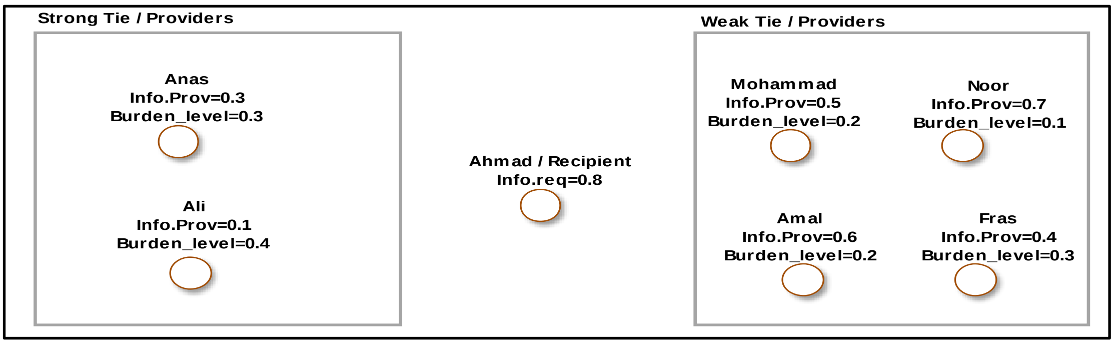



*Figure 5.15.* The Values of Provider's Parameters at Time *t*=0.

The information provision levels for all providers are presented in Figure 5.16.

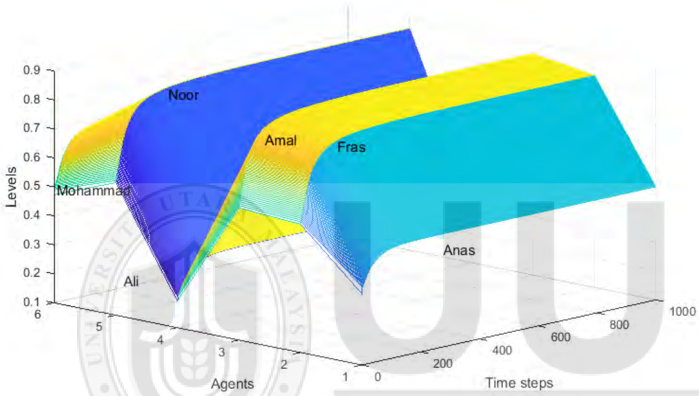



*Figure 5.16.* The Informational Provision at Time t=0.

Based on Figure 5.16, Noor has the highest value of informational support (0.7), compared to others, Amal (0.6), Mohammad (0.5), Fras (0.4), Anas 0.3, and Ali (0.1). For simplicity, the current simulations used the following threshold's parameters: *stressTh*, *supportTh, burdenTh*, and *intensityT*h before started running the algorithm with those initialized threshold parameters shown in Table 5.4. These settings were obtained from previous systematic experiments to determine the most suitable parameters' values in the model.

Universiti Utara Malaysia

Table 5.4

*Threshold's Parameters with Values in the Case Study*

| Parameter | Value | Description |
|---|---|---|
| *stressTh* | 0.4 | If stress level higher than *stressTh* then the process will be started. |
| *supportTh* | 0.2 | If the requested support or provision support higher than *supportTh* then the recipient need help, or the provider can offer the support. |
| *burdenTh* | 0.7 | If burden level higher than *burdenTh* then the process will be stopped. |
| *intensityTh* | 0.7 | If intensity level higher than *intensityTh* then the process will be stopped. |

Based on available information, the algorithm generates the simulation results as shown in Table 5.5.

Table 5.5

*The Proportion of Support and Assigned Support for each Provider at t=1.*

| Providers | Proportion _ Support | Assigned_Support |
|---|---|---|
| Anas | 0.7 | 0.21 |
| Ali | 0.6 | 0.06 |
| Mohammad | 0.8 | 0.4 |
| Noor | 0.9 | 0.63 |
| Amal | 0.8 | 0.48 |
| Fras | 0.7 | 0.28 |

Since there six members in the network, the requested information needed from all providers can be computed by using an averaging approach. Therefore, each provider can provide at least an informational support level at 0.13. Thus, in this case, all providers can provide the informational support to Ahmad (except Ali as his support provision level is lesser than 0.13) From this time frame, the levels for requested informational support, provided informational support, and burden level for each provider are shown in Table 5.6.the most suitable parameters' values.

Table 5.6

*The Requested Information, Provided Information and Burden Level at t=1.*

| Providers | Info. Req | Info. Prov | Burden Level |
|---|---|---|---|
| Anas | 0.59 | 0.09 | 0.51 |
| Mohammad | 0.4 | 0.1 | 0.6 |
| Noor | 0.07 | 0.17 | 0.73 |
| Amal | 0.32 | 0.12 | 0.68 |
| Fras | 0.52 | 0.12 | 0.58 |

Based on Table 5.6, Figure 5.17 shows the assigned provider at $t$=1.

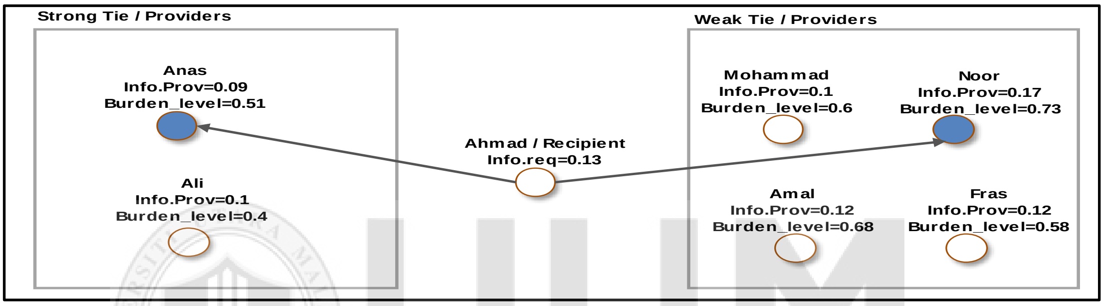



*Figure 5.17.* The Assigned of Providers at $t$=1.

As the support provided is not adequate, at $t$=2, the proportion of support for each provider (*Pps*) and the assigned support for each provider (*As*) was computed again with results as shown in Table 5.7.

Table 5.7

*The Proportion of Support and Assigned Support for each Provider at t=2.*

| Providers | Proportion _ support | Assigned_support |
|---|---|---|
| Mohammad | 0.4 | 0.4 |
| Amal | 0.32 | 0.038 |
| Fras | 0.42 | 0.05 |

The algorithm will recalculate the requested information, provided information, and burden level's values according to each provider shown in Table 5.8.

Table 5.8

*The Requested Information, Provided Information and Burden Level at Time t=2.*

| **Providers** | **Info.req** | **Info.Prov** |
|---|---|---|
| Mohammad | 0 | 0 |
| Amal | 0.28 | 0.082 |
| Fras | 0.47 | 0.07 |

According to the above values, the algorithm has re-assigned provider as presented in Figure 5.18.

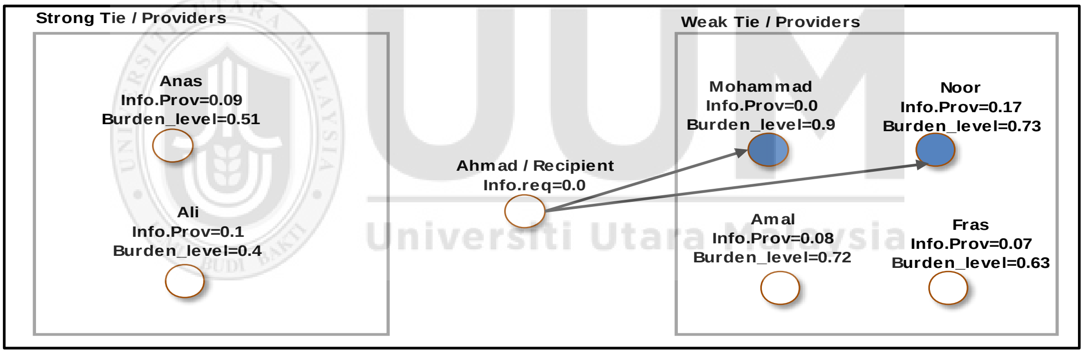



*Figure 5.18.* The Assigned of Providers at Time *t*=2.

Based on Figure 5.18, at *t*=2, Mohammad was selected since Mohammad's information provision is higher than Anas. Therefore, the final value for requested informational support for Ahmad based on six providers is presented in Figure 5.19.

Universiti Utara Malaysia

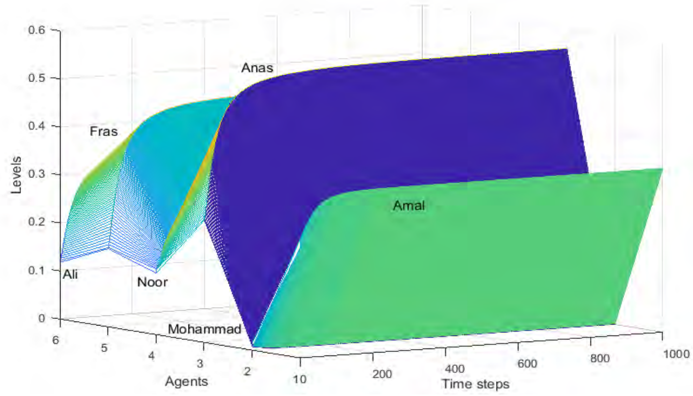



*Figure 5.19.* The Requested Information at $t$=2.

Based on several pre-determined requirements and constraints, the support model generated a list that contains potential members to provide needed support. In this case, if the support is not enough or the burden of the support provider is high, then the model will re-evaluate the need for social support recipient throughout time. Figure 5.23 shows the same results of the requested information as in Figure 5.22 but for both $t$=1 and $t$=2.

Universiti Utara Malaysia

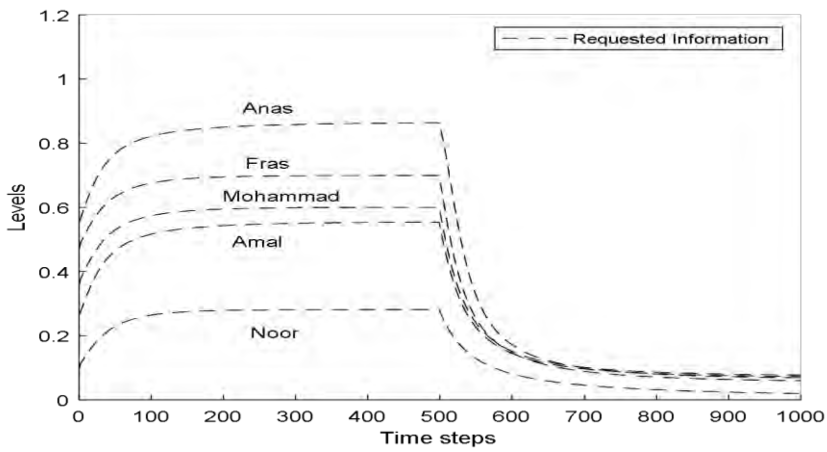



*Figure 5.20.* The Requested Information Support for Ahmad at Time $t$=1 and $t$=2.

### 5.7.2 Simulation Results

In this study, the integrated model presented in Chapter 4 is used to determine the effect of different variants of support networks. Three conditions have been simulated;

namely 1) no support is assigned, 2) random support assignment, and 3) priority support assignment as stated in Chapter 5. During this simulation, a person (support recipient) has been exposed to an extreme of stressors, to represent the prolonged stressors throughout a lifetime. The outcomes from these conditions are measured using the individual's long-term stress and requested informational social support that recipient is needed. These results show selection the right support members have a substantial impact on the course of the long-term stress on support recipient.

**Results #1: No Support Provided.**

During this simulation, a person receives no support from its social network. The person experiences very negative events throughout the simulation time. Since the person needs help, but no support has been provided, then a person is unable with the incoming stressors. This increases the long-term stress. In the case of a person that is vulnerably towards stress, the long-term stress increases faster, and it takes more time for the person to recover. Figure 5.21 shows the effect no informational support was given (despite high request). This condition is one of the precursors to developing depression if no support is given. (Azizi & Ahmad, 2013; Barbara, 2016).

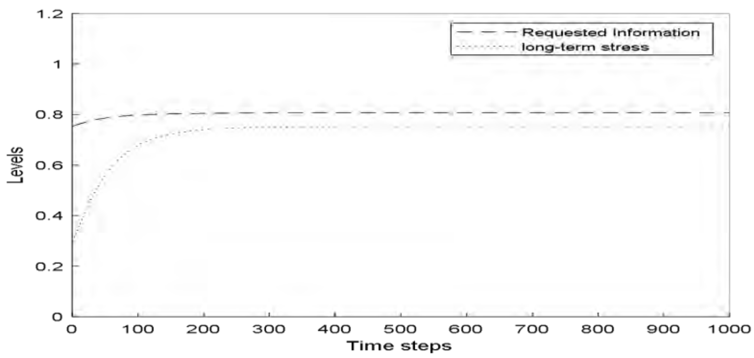



*Figure 5.21.* Recipient with No Support Provided.

**Results #2: Random Support Assignment.**

The analysis of random support assignment helps to understand the effect of support provision assignment without a proper strategy (random selection). As can be seen in Figure 5.22, this result provides evidence random selection is not the best choice if there are many possible variants in support requests and provider's preferences. Although, apparently the long-term stress is decreasing slightly, is not enough to guarantee a person to recover from the incoming stressors. In addition to this, there is a possibility to have a support provider with no support provision preference that matches with the support needed. Thus, a person will have at least a chance to recover. On the other hand, if a support provider with the right support preference was chosen, there is a risk that it might burden the provider (Zheng, 2017; & Bovier et al., 2015). Having this in motion will hamper the effectiveness of support receipt and provision process.

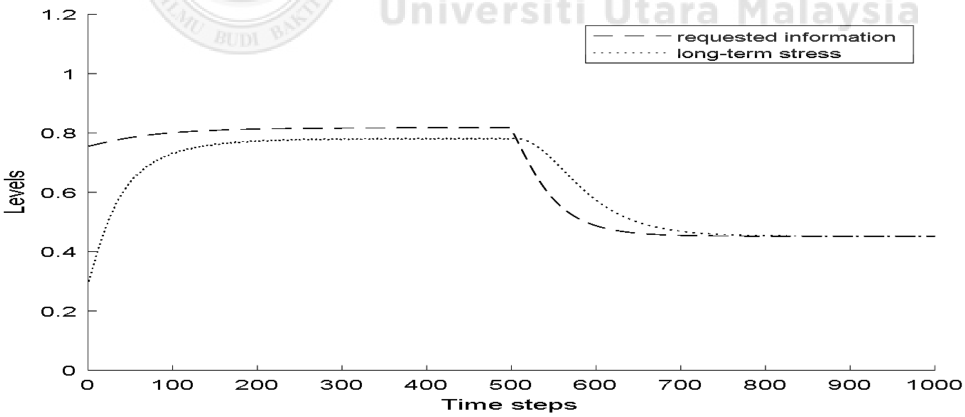



*Figure 5.22.* Recipient with Random Support Provision.

Based on Figure 5.22, there are gradually decreasing in both requested informational support and long-term stress over time with random support provision.

**Results #3: Priority Support Assignment.**

In this scenario, a person receives support from suggested support members by the priority approach. Figure 5.23 shows a more consistent and sharply decrease in a long-term stress level, compared to the random support assignment. For this scenario, it can be seen that the intensity of the stressful event is decreasing, and potentially to show that a person is accepting social support and improving the social interaction within a social support network. This condition occurs almost within the majority of individuals when they received the right support from support members (Attig, 2015; Andalibi & Haimson, 2016).

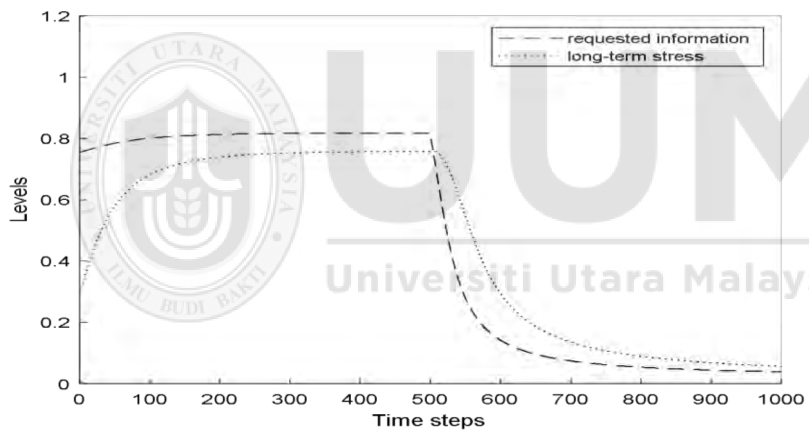



*Figure 5.23.* Recipient with Priority Support Provision.

Based on Figure 5.23, there are considerably decreasing in both requested informational support and long-term stress over time within priority support provision approach.

## 5.8 Summary

This chapter illustrates a variety of simulation experiments from the developed formal representations to generate simulation traces. Using these simulation traces, the results from the models can be visualized and verified, whether they follow several essential characteristics and patterns described by particular theories in the literature. Besides, the models have been designed to have both short and long-term mechanisms to recognize progression in states and dynamics of depression. Furthermore, this chapter has presented the simulation traces based on different case conditions for social support recipient and provision.

Universiti Utara Malaysia

# CHAPTER SIX

# EVALUATION

## 6.1 Introduction

This chapter explores the systematic determination of the merit and validity of the models and algorithm in this study. The evaluation phase was done in two phases namely, verification and validation as discussed in Section 6.2 and Section 6.3 respectively. In addition, Section 6.4 shows the validation process, data analysis, and user evaluation. Finally, Section 6.5 concludes this chapter.

## 6.2 Mathematical Verification

Mathematical analysis was conducted to verify the structural and theoretical correctness of the model. For this study, equilibria analysis is performed. The equilibria describe situations in which a stable situation has been reached. It means, if the dynamics of a system is described by a differential equation, then equilibria can be estimated by setting a derivative (or all derivatives) to zero. One important note that an equilibria condition(s) considered stable if the system always returns to it after small disturbances. These equilibria conditions indicate the correctness of the proposed models which is pivoted on the model concept. Model stability can be defined in terms of its response to external inputs or in terms of bounded inputs. This is because a model is stable if its impulse response zero as the time approaches infinity or if every bounded input produces a bounded output. One important note is the fact that an equilibria condition(s) is considered stable if the model always returns to its original position after small disturbances.

These equilibria conditions are interesting to be explored, as it is possible to explain to them using the knowledge from the theory or problem that is modelled. As such, the existence of reasonable equilibria is also an indication for the correctness of the model. Thus, the next subsection 6.2.1 and section 6.2.2 show the mathematical verification for both support recipient and provider models respectively.6.2.1 Support Recipient Model Mathematical Verification

To obtain possible equilibrium values for the other concepts, first the temporal equations previously presented in Equation 4.11, 4.12, 4.19 and 4.20 in Section 4.1 under Chapter Four are described in differential equations 6.1, 6.2, 6.3 and 6.4 respectively. These four differential equations 6.1, 6.2, 6.3 and 6.4 present the differential values for Skill of Coping with stress, Imminence of Threat, Strong Tie, and Weak Tie.

$$\frac{d\,Sc\,(t)}{dt} = \eta_s.\,[Pf - Sc].\,(1- Sc).\,(Sc) \tag{6.1}$$

$$\frac{d\,Im\,(t)}{dt} = \alpha_i\,.[\,Ie- Im\,].(1- Im).\,(Im) \tag{6.2}$$

$$\frac{d\,Se\,(t)}{dt} = \psi_s\,.[Cs- Se\,].(1- Se\,).\,(Se\,) \tag{6.3}$$

$$\frac{d\,We\,(t)}{dt} = \beta_w.[Es - We\,].(1- We\,).(We\,) \tag{6.4}$$

Assuming the parameters $\eta_s$, $\alpha_i$, $\psi_s$, and $\beta_w$ are nonzero, from equations 6.1, 6.2, 6.3 and 6.4, the following cases can be distinguishing.

$$[Pf - Sc].(1 - Sc).(Sc) = 0$$

$$[Ie - Im].(1 - Im).(Im) = 0$$

$$[Cs - Se].(1 - Se).(Se) = 0$$

$$[Es) - We].(1 - We).(We) = 0$$

Later these cases can be distinguished into

$$(Pf = Sc) \lor (Sc = 1) \lor (Sc = 0)$$

$$(Ie = Im) \lor (Im = 1) \lor (Im = 0)$$

$$(Cs = Se) \lor (Se = 1) \lor (Se = 0)$$

$$(Es = We) \lor (We = 1) \lor (We = 0)$$

From here, a first of conclusions can be derived where the equilibrium can only occur when $Pf=Sc$, $Sc=1$, or $Sc=0$. By combining these four conditions, it can be re-written into a set of relationship in $(A \lor B) \land (D \lor E)$ expression:

$$((Pf = Sc) \lor (Sc = 1) \lor (Sc = 0)) \land$$

$$((Ie = Im) \lor (Im = 1) \lor (Im = 0)) \land$$

$$((Cs = Se) \lor (Se = 1) \lor (Se = 0)) \land$$

$$((Es = We) \lor (We = 1) \lor (We = 0))$$

This expression can be elaborated using the *law of distributivity* as $(A \land D) \lor (A \land E) \lor, .., \lor (C \land F)$.

$$(Pf = Sc \land Ie = Im \land Cs = Se \land Es = We) \lor$$

$$(Sc = 1 \land Im = 1 \land Se = 1 \land We = 1) \lor$$

$$\vdots$$



UUM Universiti Utara Malaysia

$(Sc = 0 \wedge Im = 0 \wedge Se = 0 \wedge We = 0)$

Table 6.1 provides a summary of these equilibria.

Table 6.1

*Summary of Equilibrium Equation of Recipient Model*

| **Concept** | **Equilibrium Equations** | |
|---|---|---|
| Negative Event | $Nv = w_1.L + w_2.C + w_3.D$ | (6.5) |
| Intensity of Stressful Events | $Ie = [\beta_e.Nv + (1-\beta_e).Sd].(1-\mathrm{Pr}).(1-Sc)$ | (6.6) |
| Threat | $Th = [\gamma_h.\mathrm{Im} + (1-\gamma_h).Ie].(1-Pa)$ | (6.6) |
| Challenge | $Ch = \omega_c.Pa + (1-\omega_c).(1-Ie).Pa$ | (6.8) |
| Emotional Experience | $Ex = \lambda_e.Ex_{base} + (1-\lambda_e).Sc$ | (6.9) |
| Negative Emotion | $Ne = Th.(1-Ex).(1-Pe)$ | (6.10) |
| Positive Emotion | $Pe = [\tau_p.Ch + (1-\tau_p).Ex].(1-Ne)$ | (6.11) |
| Acceptance | $Ac = \gamma_a.Pe + (1-\gamma_a).(1-Ne)$ | (6.12) |
| Holdback | $Hb = (1-Pe).Ne$ | (6.13) |
| Change | $Cg = Pe.\ (1-Ne)$ | (6.14) |
| Emotion Focused | $Ef = [\eta_e.(1-Ac).Hb) + (1-\eta_e).Hb].(1-Cg)$ | (6.15) |
| Problem Focused | $Pf = \Upsilon_p.Ac.(1-Hb) + (1-\Upsilon_p).Cg$ | (6.16) |
| Informational Requested | $Ir = \mu_{ir}.Pf.Co + (1-\mu_{ir}).Co$ | (6.17) |
| Instrumental Requested | $Nr = (\psi_n.Pf + (1-\psi_n).(Ef).Ev)$ | (6.18) |
| Emotional Requested | $Er = \eta_{er}.Ef.Nu + (1-\eta_{er}).Nu$ | (6.19) |
| Companionship Requested | $Cr = \beta_c.Ef.Ev + (1-\beta_c).Ev$ | (6.20) |
| Expanded Social Network | $Es = [Ir + Nr]/\sum Sr$ | (6.21) |
| Closed Social Network | $Cs = [Nr + Er + Cr]/\sum Sr$ | (6.22) |

This later provides possible combinations of equilibria points to be further analysed which is of a huge amount of possible combinations (in this case, 34= 81 possibilities). As the number of possible combinations is enormous, developing a complete classification of equilibria is rather difficult. However, the analysis can be pursued further for some typical cases. It must be noted that for each distinguished case more information is available regarding the equilibrium values of the other variables based on the additional non-dynamic equations. Whereas some typical cases were further analysed as follows:

**Case #1: *Cs= Se* $\wedge$ *Es= We* $\wedge$ *Ie = Im* $\wedge$ *Sc =Pf***

From Table 6.1, the expression for *Th* can be obtained from Equation (6.7):

$$Th = [\gamma_h.\mathrm{Im} + (1-\gamma_h).Ie].(1-Pa)$$

By substituting *Ie =Im* from above equation and as shown in Figure 6.1 (b), this case is equivalent to:

$$Th = [\gamma_h.\mathrm{Im} + (1-\gamma_h).\mathrm{Im}].(1-Pa)$$

Assuming $\Upsilon_h = 0.5$, therefore;

$$Th = Im.(1-Pa)$$

Figure 6.1 (b) shows the stability point of the equation of $Th = Im.(1-Pa)$. It shows that the interplay between three factors namely; threat, imminence of threat, and personality attributes. In other words, it proves that there is a positive relationship between threat and imminence of the threat. However, both concepts are related negatively to personality attributes. This finding is supported by Minkley et al. (2014), Neigh, Gillipsie & Nemeroff (2015), and Schwabe, Haddad & Schachinger (2016).

From Table 6.1, the expression for *Ch* can be obtained from Equation (6.8):

$$Ch = \omega_c.Pa + (1-\omega_c).(1-Ie).Pa$$

By substituting *Ie =Im* from above equation and as shown in Figure 6.1 (c). So, this case gives;

$$Ch = \omega_c.Pa + (1-\omega_c).(1-\mathrm{Im}).Pa$$

Rearrange this;

$$Pa = \left(\frac{Ch}{(1-\mathrm{Im})}\right) \text{ and } \omega_{c=0}$$

Figure 6.1 (c) shows that the interplay between personality attributes, challenge, and imminence of the threat. This Figure proves that there is a positive relation between personality attributes and challenge, and both related negatively to the imminence of the threat. This finding is supported by Kudielka & Kirschbaum (2015), Tolin & Foa (2016).

From Table 6.1, consider Equation (6.9), the equilibria point is:

$$Ex = \lambda_e . Ex_{base} + (1 - \lambda_e). Sc$$

By substituting *Sc* =*Pf* in the equation of *Ex* can be obtained:

$$Ex = \lambda_e . Ex_{base} + (1 - \lambda_e). Pf$$

If the initial emotional experience =1 and $\lambda_e = 0$ as shown in Figure 6.1 (d) then;

$$Ex = Pf$$

Figure 6.1 (d) shows that the interplay between three factors namely; a problem-focused, skill of coping, and emotional experience. In summary, this case depicts the condition whereby the skill of coping leads to problem focus. It shows that the interplay between emotional experience, the skill of coping, and problem-focused coping. This finding is supported by Godin, Kittel, Coppieters and Siegrist (2005) and Varga and Freyberg-Inan (2012) studies where it was admitted that there is a connection between the three factors. Specifically, Coyle (2013) argued that the interplay of these factors usually causes a situation where aggressive interpersonal efforts to modify the situation and solve the problem is triggered.

From Table 6.1, Consider equations of the intensity of stressful event (6.6), the equilibria point is:

$$Ie = [\beta_e . Nv + (1 - \beta_e). Sd]. (1 - \mathrm{Pr}). (1 - Sc)$$

By substituting *Sc* =*Pf* in equation of *Ie,* thus:

$$Ie = [\beta_e . Nv + (1 - \beta_e). Sd]. (1 - \mathrm{Pr}). (1 - Pf)$$



Universiti Utara Malaysia

If the $\beta_e$=1 and apply the previous equation *Ex= Pf,* then;

$$Ie = (Nv).(1 - \mathrm{Pr}).(1 - Ex)$$

The above equation shows that the interplay between personality resources, emotional experience, negative events, and intensity of stressful events. It proves that there is a positive relationship between negative events and the intensity of stressful events, and both concepts related negatively to personality resources and emotional experience.

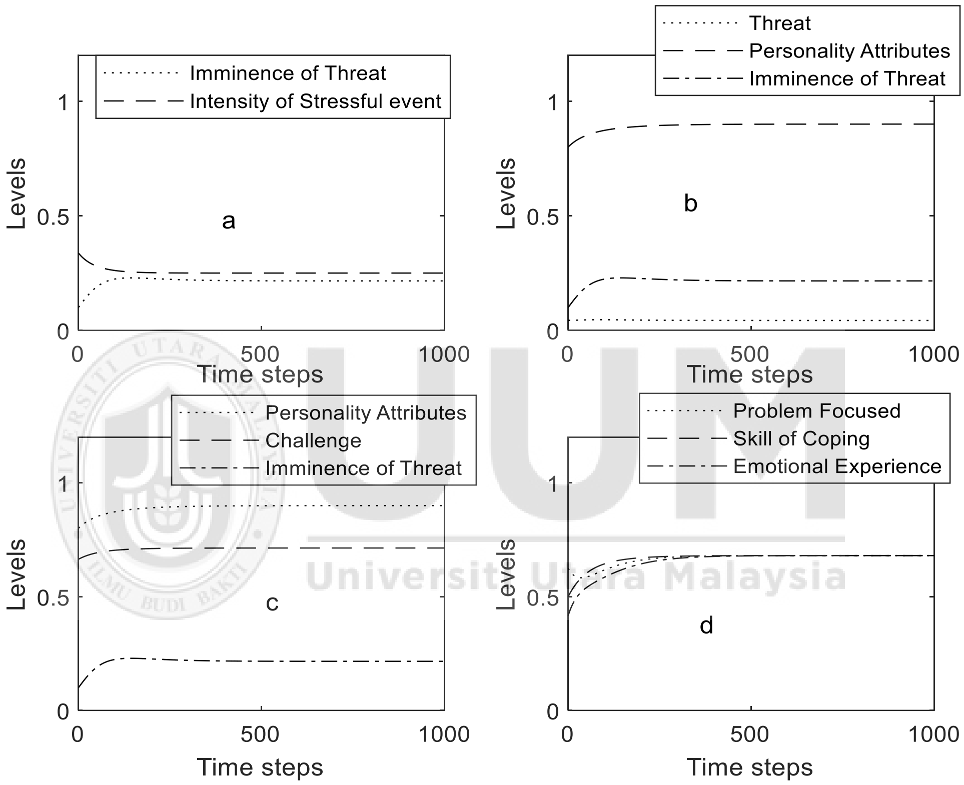



*Figure 6.1.* Simulation of Stability Point of Case 1 for Support Recipient.
(a) Intensity of Stressful Event. (b) Threat. (c) Challenge**.** (d) Problem-focus.

From Figure 6.1, several stability points were simulated in this case, which depicts that when the intensity of stressful events equals to the imminence of the threat. In summary, this first case example depicts the condition whereby the intensity of stressful events leads to the imminence of the threat. It shows that the interplay between the intensity of stressful events, emotional experience, and imminence of threat lead to problem-focused coping. Specifically, this phenomenon was referred to personality attributes by Schmader, Johns and Forbes (2016) which was admitted to be caused by threat and negative events.

**Case #2: *Sc =1***

From Table 6.1, the expression for *Ie* can be obtained from Equation (6.6):

$$Ie = (\beta_e.Nv + [(1-\beta_e).Sd].(1-\mathrm{Pr}).(1-Sc)$$

assuming $\beta_e$ is nonzero, thus threat equation provides an equilibria point as shown in Figure 6.2 (a);

$$Ie = \beta_e.Nv \quad \Rightarrow \quad Ie = (\frac{1}{\beta_e}).Nv$$

Figure 6.2 (a) shows a condition when the individuals have a high skill of coping, there is a positive relationship between the intensity of stressful events and negative events.

Using the same principle for emotional experience equation (6.9) from Table 6.1, and by substituting *Sc =1* in the equation of *Ex,* thus:

$$Ex = \lambda_e.Ex_{base} + (1-\lambda_e).Sc$$

If $\lambda_e$ is equal to one, the effect of the stability point can be summarized in Figure 6.2 (b);

$$Ex = Ex_{base}$$

Universiti Utara Malaysia

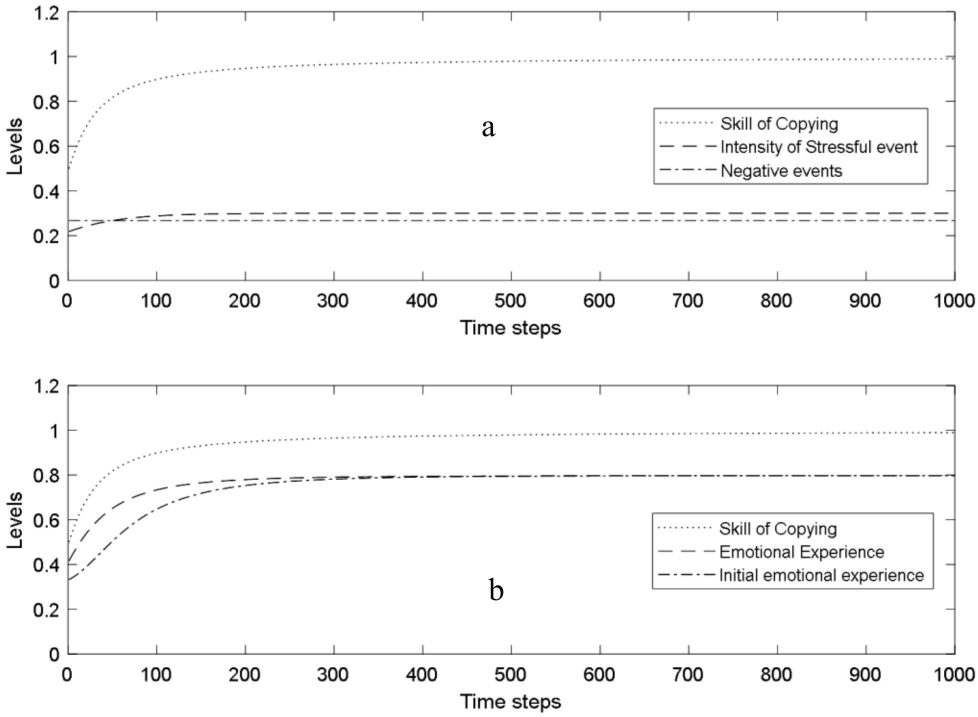



*Figure 6.2.* Simulation of Stability Point of Case 2 for Support Recipient.
(a) Skill of Coping with stress. (b) Emotional Experience.

Figure 6.2 (a) shows another case example is when the skill of coping with stress is high (*Sc*=1) which depicts a condition whereby the intensity of stressful events leads to negative events. It shows that the interplay between the skill of coping, negative events, and intensity of the stressful event. Figure 6.2 (b) shows that when the skill of coping high, the emotional experience directly proportional to initial emotional experience. This case was found to be consistency with Rader, May and Goodrum (2015) study which affirms that individual perception of emotional experience from the skill of coping with stress which might promise its social support. This condition also supported by May, Rader and Goodrum (2010) that low intensity of stressful events and negative events usually increase an individual's emotional experience to deal with a stressful situation.

**Case #3: *Im =1***

In this case, from Table 6.1, the expression of *Th* can be obtained from Equation (6.7):

$$Th = [\gamma_h.\mathrm{Im} + (1-\gamma_h).Ie].(1-Pa)$$

If *Im*=1, this case is equivalent to:

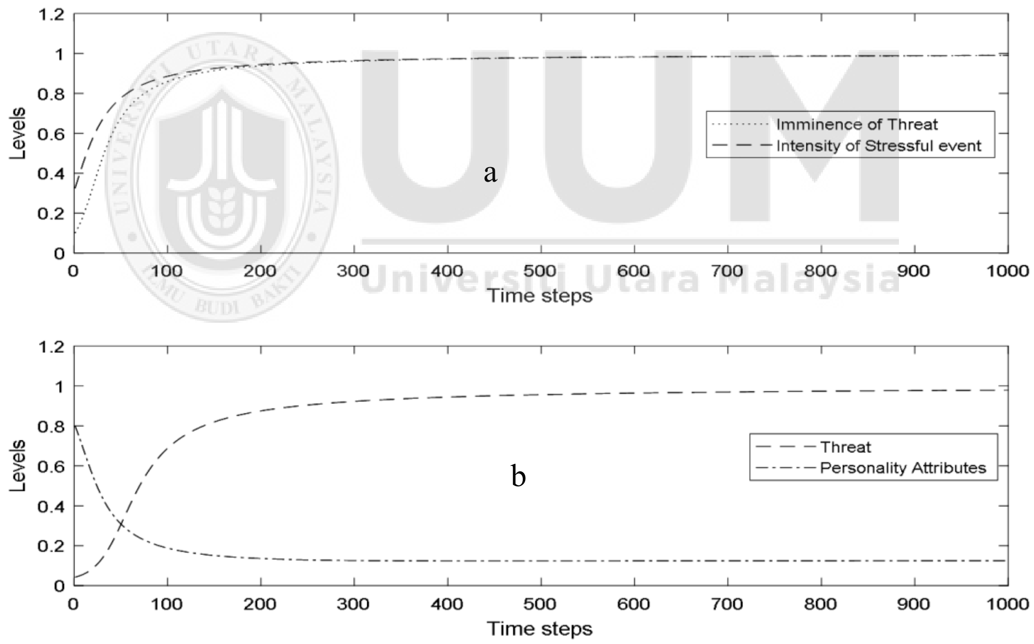
$$Th = [\gamma_h + (1-\gamma_h).Ie].(1-Pa)$$

As shown in Figure 6.3 (a), If $\gamma_h$ is zero, then

$$Th = Ie.(1-Pa)$$

Rearrange this, as shown in Figure 6.3 (b):

$$Pa = 1-(Th/Ie)$$




Universiti Utara Malaysia

*Figure 6.3.* Simulation of Stability Point of Case 3 for Support Recipient.
(a) Intensity of Stressful Event. (b) Personality Attributes.

Figure 6.3 (a) shows a third example of a condition where imminence of threat is high (*Im*=1). At this condition, the threat is positively triggered by the intensity of the stressful event and negatively with personal attributes. This implies that at a point that negative personal attributes become continuously obtainable attribute from both threat and intensity of stressful event as shown in Figure 6.3 (b). When people appraise their problem a threat, stress can elicit feelings of helplessness and a foreboding sense of loss. In addition, stressors perceived as less controllable, such as certain kinds of physical health problems, prompt negative personality attributes ((Harmer, Shelley, Cowen & Goodwin, 2014; Carver et al., 2015).

### 6.2.2 Support Provider Model Mathematical Verification

To obtain possible equilibrium values for the other concepts, first, the temporal equations previously presented in Equation 4.30 and 4.40 in Section 4.2 under Chapter Four are described in differential equations 6.23 and 6.24 respectively. These two differential equations 6.23 and 6.24 present the differential values for emotional exhaustion and committed support.

Universiti Utara Malaysia

$$\frac{d\,Eh(t)}{dt} = \psi_e . [Ma - Eh] . (1 - Eh) . (E) \tag{7.23}$$

$$\frac{d\,Cm\,(t)}{dt} = \sigma_c . [\,Wh\,(t) - Cm\,(t)] . (1 - Cm\,(t)) . (Cm\,(t)) \tag{7.24}$$

Assuming the parameters $\psi_e$ and $\sigma_c$ are nonzero, from equations 6.23 and 6.24, the following cases can be distinguished.

$$[Ma - Eh\,] . (1 - Eh) . (Eh) = 0$$

$$[Wh - Cm] . (1 - Cm) . (Cm) = 0$$

Later these cases can be distinguished into:

$$(Ma = Eh) \vee (Eh = 1) \vee (Eh = 0)$$

$$(Wh = Cm) \vee (Cm = 1) \vee (Cm = 0)$$

From here, a first of conclusions can be derived where the equilibrium can only occur when $Ma = Eh$, $Eh = 1$, or $Eh = 0$. By combining these two conditions, it can be re-written into a set of relationship in $(A \vee B) \wedge (D \vee E)$ expression:

$$((Ma = Eh) \vee (Eh = 1) \vee (Eh = 0)) \wedge$$

$$((Wh = Cm) \vee (Cm = 1) \vee (Cm = 0)) \wedge$$

This expression can be elaborated using the *law of distributivity* as $(A \wedge D) \vee (A \wedge E) \vee ,.., \vee (C \wedge F)$.

$$(Ma = Eh \wedge Wh = Cm) \vee$$

$$(Eh = 1 \wedge Cm = 1) \vee$$

$$\vdots$$

$$(Eh = 0 \wedge Cm = 0)$$

Table 6.2 provides a summarization of these equilibria.

Universiti Utara Malaysia

Table 6.2

*Summary of Equilibrium Equation of Provider Model*

| **Concept** | **Equilibrium Equations** | |
|---|---|---|
| Intensity of Stress | $Iep = \eta_i.Nvp + (1-\eta_i).(Nvp).(1-Prp)$ | (6.25) |
| Threat | $Thp = Iep.(1-Pap)$ | (6.26) |
| Challenge | $Chp = \beta_c.Pap + (1-\beta_c).Pap.(1-Iep)$ | (6.27) |
| Emotion-Focused | $Efp = Thp.(1-Chp)$ | (6.28) |
| Problem-Focused | $Pfp = Chp.(1-Thp)$ | (6.29) |
| Self-Esteem | $Sf = \alpha_s \mathrm{Prp} + (1-\alpha_s).Pap$ | (6.30) |
| Burden Level | $Bl = (1-[\gamma_b.Pfp + (1-\gamma_b).(Sf]).(\sigma_b.Eh + (1-\sigma_b).Efp)$ | (6.31) |
| Maladaptation | $Ma = \omega_m.Efp + (1-\omega_m).Bl$ | (6.32) |
| Bonadaptation | $Ba = \eta_b.Pfp + (1-\eta_b).(1-Bl)$ | (6.33) |
| Empathy Capabilities | $Ec = \lambda_e.Pap + (1-\lambda_e).(Sf)$ | (6.34) |
| Altruistic Motivation | $Am = \beta_m.Al + (1-\beta_m).(Ec)$ | (6.35) |
| Willingness to Help | $Wh = \lambda_w.Ba + (1-\lambda_w).[1-(1-Am).Ma]$ | (6.36) |
| Info-Provision | $Ip = (Wi_1.Kl + Wi_2 Cm).Wh$ | (6.37) |
| Emot-Provision | $Ep = Wh.[\psi_e Cm + (1-\psi_e).(We_1.Ag + We_2.Pc)]$ | (6.38) |
| Inst- Provision | $= Wh.[\tau_n Cm + (1-\psi_n).(Wn_1.Ag + Wn_2.Pc + Wn_3 \mathrm{Prp})]$ | (6.39) |
| Mutual Interests | $Pm = \sum sim(Rs, Ps)/n_m$ | (6.40) |
| Comp-Provision | $Cp = Wh.[\mu_c Cm + (1-\mu_c).(Wc_1.Evp + Wc_2.Pc + Wc_3.Mi)]$ | (6.41) |

This later provides possible combinations of equilibria points to be further analysed which is of a huge amount of possible combinations (in this case, 32= 9 possibilities). The analysis for provider ’equations can be pursued further for some typical cases. It must be noted that for each distinguished case more information is available regarding the equilibrium values of the other variables based on the additional non-dynamic equations. Whereas some typical cases were further analysed as follows:

Universiti Utara Malaysia

**Case #1: *Eh*= *Ma***

In this case, from Table 6.2 equation of burden level cab be obtained from Equation (6.31):

$$Bl = (1 - [\gamma_b.Pfp + (1-\gamma_b).(Sf]).(\sigma_b.Eh + (1-\sigma_b).Efp)$$

Figure 6.4 (a) shows the stability point when emotional exhaustion is equal to maladaptation, by substituting *Eh=Ma* in the equation of *Bl* can be obtained:

$$Bl = (1 - [\gamma_b.Pfp + (1-\gamma_b).Sf]).(\sigma_b.Ma + (1-\sigma_b).Efp)$$

Assuming $\gamma_b$ and $\sigma_b$ are equal to 1. Therefore, the burden level as shown in Figure 6.4 (b);

$$Bl = (1 - Pfp).(Ma)$$

From Table 6.2 equation of maladaptation, the expression of *Ma* can be obtained from Equation (6.32);

$$Ma = \omega_m.Efp + (1-\omega_m).Bl$$

By substituting *Bl* this case gives;

$$Ma = \omega_m.Efp + (1-\omega_m).[(1 - Pfp).Ma]$$

Assuming $\omega_m$ is equal to 1. Therefore, as shown in Figure 6.4 (c);

$$Ma = Efp$$

It is known in Table 6.2 that *Ba* can be obtained from Equation (6.33);

$$Ba = \eta_b.Pfp + (1-\eta_b).(1-Bl)$$

Assuming $\eta_b$ is equal to 1. Therefore, as shown in Figure 6.4 (d), then *Ba* is given as:

$$Ba = Pfp$$

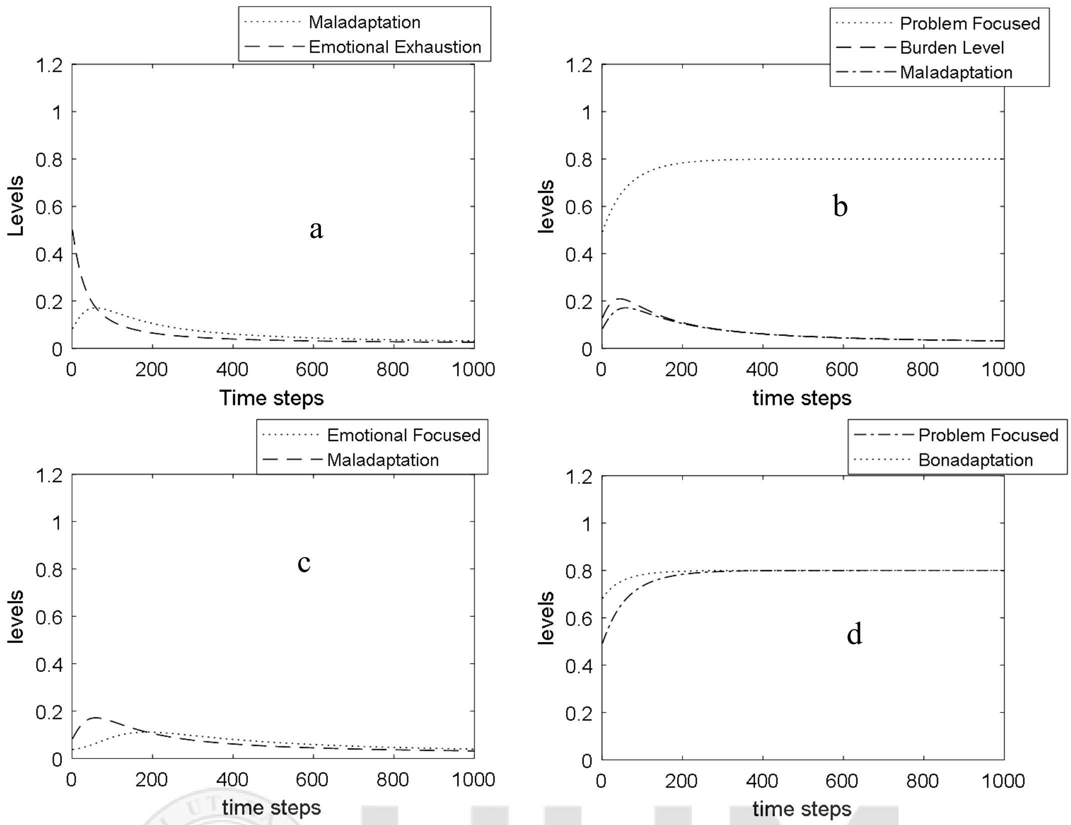



*Figure 6.4*. Simulation of Stability Point of Case 1 for Support Provider.
(a) Emotional Exhaustion. (b) Burden Level. (c) Maladaptation.
(d) Bonadaptation.

Universiti Utara Malaysia

Figure 6.4 (a) shows a condition where emotional exhaustion is equal to maladaptation. Figure 6.4 (b) shows that the interplay between three factors namely; problem-focused, burden level, and maladaptation. Simultaneously, it proves that there is a positive relationship between burden level, maladaptation, and both related negatively to problem-focused coping. This finding is supported by Mann, Hosman, Schaalma, & de Vries (2014), Pruessner, Hellhammer, & Kirschbaum (2015). In addition, Figure 6.4 (c) shows a condition where emotional–focused coping is found to be equal to maladaptation (positively related). Moreover, Figure 6.4 (d) shows a condition where problem-focused coping is found to be equal to bonadaptation (positively related). Furthermore, at this condition, bonadaptation is supported by problem-focused coping whereas emotional-focused coping will decrease that later reduce the maladaptation level. This finding is supported by Shumaker and Brownell (2012), McCubbin and Patterson (2015) and Specht (2015) studies where it was admitted that there is a connection between the three factors.

**Case #2: *Cm=1* $\wedge$ *Eh=0***

From Table 6.2, the expression of *Bl* can be obtained from Equation (6.31),

$$Bl = (1 - [\gamma_b.Pfp + (1 - \gamma_b).(Sf]).(\sigma_b.Eh + (1 - \sigma_b).Efp)$$

Assuming *Eh=0* as shown in Figure 6.5 (a), then;

$$Bl = (1 - [\gamma_b.Pfp + (1 - \gamma_b).(Sf]).((1 - \sigma_b).Efp)$$

Assuming $\gamma_b$ and $\sigma_b$ are zero. Therefore, the burden level as shown in Figure 6.5(b):

$$Bl = (1 - Sf).(Efp)$$

By substituting *Bl* in the equation of *Ba* equation,

$$Ba = \eta_b.Pfp + (1 - \eta_b).(1 - Bl)$$

Assuming $\eta_b$ is zero. Therefore, the results of bonadaptation as shown in Figure 6.5(c):

$$Ba = (1 - ((1 - Sf).(Efp)))$$

From Table 6.2, the expression of *Wh* can be obtained from Equation (6.36),

$$Wh = \lambda_w.Ba + (1 - \lambda_w).[1 - (1 - Am).Ma]$$

By substituting *Ba* in the equation of *Wh, and a*ssuming $\lambda_w$ is equal to one, then

$$Wh = (1 - ((1 - Sf).(Efp)))$$

From Table 6.2, the expression of *Ip* can be obtained from Equation (6.37),

$$Ip = (Wi_1.Kl + Wi_2Cm).Wh$$

By substituting $Wh$ in *Ip* equation and assuming $Wi_1$ and $Wi_2$are equal to *1, and Cm=1*(as shown in Figure 6.5(a))*,* then, as shown in Figure 6.5(d):

$$Ip = (\mathrm{Kl}).(1 - ((1 - Sf).(Efp)))$$

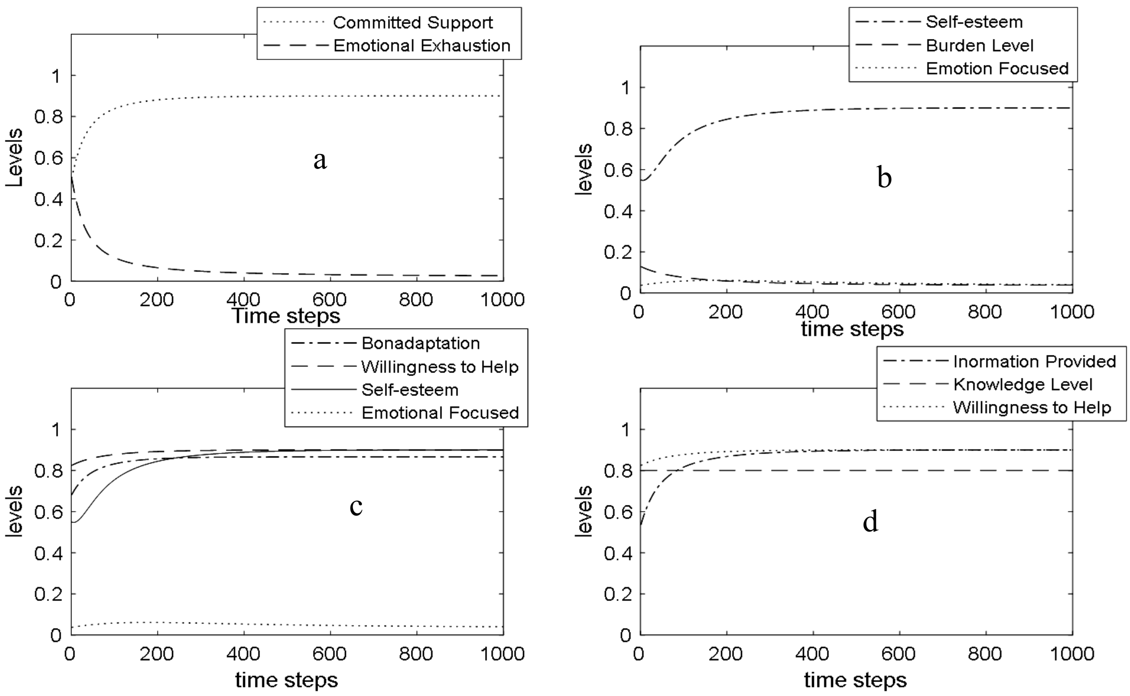



*Figure 6.5.* Simulation of Stability Point of Case 2 for Support Provider.
(a) Committed Support. (b) Burden Level. (c) Willingness to Help.
(d) Information Provided.

UUM
Universiti Utara Malaysia

Figure 6.5 (a) shows another case when emotional exhaustion is low (*Eh*=0) and committed support is high (*Cm*=1) which depicts a condition whereby burden level is positively related to emotional focused and negatively related to self-esteem as shown in Figure 6.5(b). This case was found to be consistency with Post, Bloemen, and Witte (2016) and Baker & Berenbaum (2017) studies which affirms that Provider's burden level is triggered by emotional coping strategies. Figure 6.5(c) shows a condition where bonadaptation is found to be negatively related to burden level and thus it negatively related to emotional focused and positively related to self-esteem as mentioned in the previous case. This affirmation was supported by Flyckt, Fatouros-bergman, and Koernig (2015) that suggested if the adaptation is high, then one is more likely to provide support and thus self-esteem is high and vice versa.

Furthermore, Figure 6.5 (d) shows a condition where bonadaptation is directly proportional to the willingness to help which generates the information provided level to be increased. Information provided is supported by high self-esteem and knowledge level and low emotional focused. In other words, it proves that there is a connection between the three factors namely information provided, bonadaptation, and self-esteem. These findings supported by McCarthy, Kissen, Yadley, Wood, & Lambert (2016), Parker, Martin, Colmar, & Liem (2017).

**Case #3: *Wh =Cm***

Figure 6.6 (a) shows that willingness to help is found equal to committed support. In this case, from Table 6.2 equation of emotional provision (6.38):

$$Ep = Wh.[\,\psi_e\, Cm + (1 - \psi_e).(We_1.Ag + We_2.Pc)]$$

If $\psi_e$, $We_1$, and $We_2$ are nonzero nor one, this case shown in Figure 6.6 (b), and it is equivalent to:

$$Ep = Cm.(Cm + Ag + Pc)$$

Using the equation of instrumental provision (6.39) from Table 6.2,

$$Np = Wh.[\,\tau_n\, Cm + (1 - \psi_n).(Wn_1.Ag + Wn_2.Pc + Wn_3\mathrm{Pr}p)]$$

If $\psi_n$, $Wn_1, Wn_2$ and $Wn_3$ are nonzero nor one, this case is shown in Figure 6.6 (c), and it is equivalent to:

$$Np = Cm.(Cm + Ag + Pc + \mathrm{Pr}p)$$

By substituting $Cm.(Cm + Ag + Pc) = Ep$, then

$$Np = Ep + \mathrm{Pr}p$$

Universiti Utara Malaysia

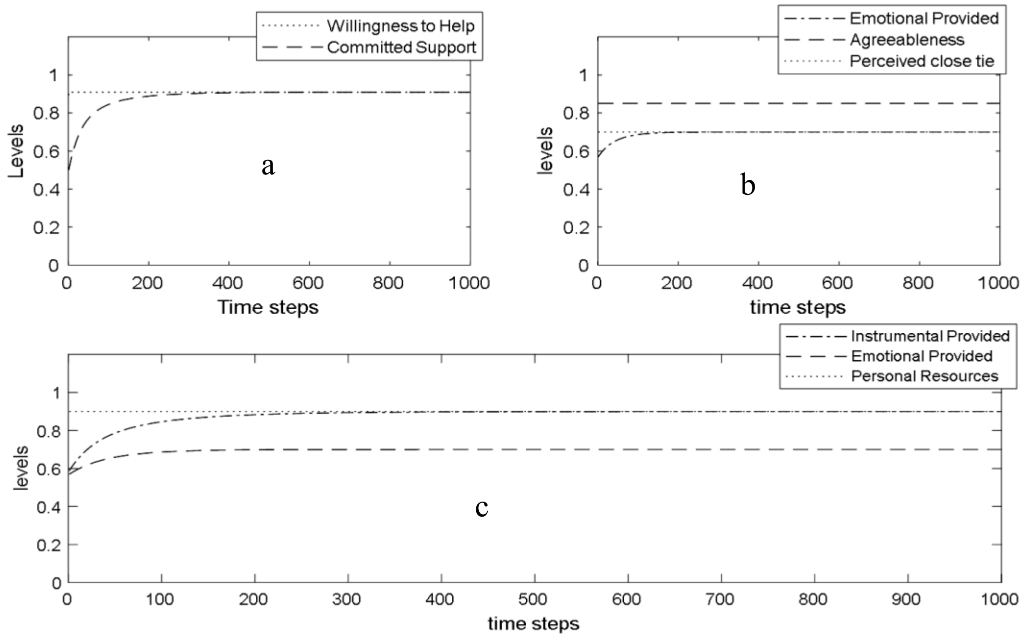



*Figure 6.6.* Simulation of Stability Point of Case 3 for Support Provider. (a) Willingness to Help. (b) Emotional Provided. (c) Instrumental Provided.

Universiti Utara Malaysia

Figure 6.6 (a) shows a case instance relates the point when willingness to help is found equal to committed support which depicts that both emotional provision and instrumental provision are characterized with a combination of agreeableness personality and perceived close tie except instrumental provision characterized by additional concept (personal resources). This was in line with Flyckt, Fatouros-bergman, and Koernig (2015), Denissen and Penke (2015), and Holmes (2016) results which assert that when a provider is challenged to perform an emotional provision (as seen in Figure 6.6 (b)) he/she can offer instrumental support if his/her resources are high. Figure 6.6 (c) proves that when agreeableness, perceived close tie and personal resources are high then the provider is satisfied with instrumental provision. In summary, these three case examples are part of the numerous different instances which depict the model equilibria conditions as obtained in the simulation traces discussed in Chapter Four previously.

### 6.3 Automated Verification

This section deals with the verification of relevant dynamic properties of the cases considered in both support recipient and provider models, which is consistent with the literature. The Temporal Trace Language (TTL) is used to perform an automated verification of specified properties and states against generated traces. Based on the concept discussed in Chapter Three, several dynamic properties were formulated using a sorted predicate logic approach. For the logical verification, the ability of the Temporal Trace Language (TTL) and its software environment as a specification language and verification tool was used. TTL allows researchers to verify both qualitatively and quantitatively the model under analysis and can reason about time. This was done by identifying case conditions from the proposed model and implementing it using TTL. This will be explored for both the support recipient model and support provider model in the next subsections 6.3.1 and 6.3.2 respectively.

#### 6.3.1 Support Recipient Model Automated Verification

To verify the recipient model that is discussed in Section 4.2 and presented in Figure 4.1 using automated verification, four case conditions were given in the verified properties (VP1 to VP4) which were introduced in semiformal and informal representations showing the prototype of these properties:

### VP1: High Problem Focused Increases Expanded Social Network

$$
\begin{aligned}
&\text{VP1} \equiv \forall\gamma\text{: TRACE, } \forall\text{t1, t2:TIME, } \forall\text{R1,R2,D1,D2:REAL} \\
&[\text{state}(\gamma,\text{t1})|= \text{has\_value(problem\_focused, R1) \&} \\
&\ \text{state}(\gamma,\text{t2})|= \text{has\_value(problem\_focused, R2) \&} \\
&\ \text{state}(\gamma,\text{t1})|= \text{has\_value(expanded\_social\_network, D1) \&} \\
&\ \text{state}(\gamma,\text{t2})|= \text{has\_value(expanded\_social\_network, D2) \&} \\
&\ \text{t1} < \text{t2 \& D1} = 0.5 \text{ \& R1} = 0.5 \text{ \& R2} \geq \text{R1}] \Rightarrow \text{D2} \geq \text{D1}
\end{aligned}
$$

Expanded social network and problem-focused coping have important influences on the recipient that seeking for support. The majority of past research made distinctions between problem-focused and expanded social network (Aldwin & Revenson, 2016; Baker & Berenbaum, 2017). Findings from a variety of research programs (see Albrecht, Burleson, & Goldsmith, 2011; Barbee, Derlega, Sherburne, & Grimshaw, 2013; Brashers, Neidig, & Goldsmith, 2015), suggest that many individuals find it difficult to obtain appropriate support from friends and family because they may feel that their close ties lack experience or have limited information about certain health conditions the individual is facing.

Universiti Utara Malaysia

### VP2: Holdback is Positively Related to Requested Emotional Support

$$
\begin{aligned}
&\text{VP2} \equiv \forall\gamma\text{:TRACE, } \forall\text{t1, t2:TIME } \forall\text{M1, M2, D:REAL} \\
&[\text{state}(\gamma, \text{t1})|= \text{has\_value(holdback, M1) \&} \\
&\ \text{state}(\gamma, \text{t2})|= \text{has\_value(requested\_emotional\_support, M2) \&} \\
&\ \text{M1} \geq 0.8 \text{ \& t2} = \text{t1+D \& t2} > \text{t1}\ ] \Rightarrow \ \text{M2} \geq 0.7
\end{aligned}
$$

Emotional requested support is just one of several types of social support, the majority of literature addressing this topic deals specifically with the correlation between emotional support and holdback or negative consequences of the coping process (Uchino, 2015; Mohamed & Baqutayan, 2018). Therefore, the holdback is one of the factors that can limit any recipient from cope within a situated environment. The holdback is often suggested that denial is useful, minimizing stress and thereby facilitating coping (cf. Breznitz, 2011; Sarason, Levine, Basham, & Sarason, 2013; Raina et al., 2015). Therefore, by denying the reality of the event allows the event to become more serious, thereby making more difficult the coping that eventually must occur (Matthews, Siegel, Kuller, Thompson, & Varat, 2013; Reinhard, Given, Petlick, & Bemis, 2014).

**VP3: Monotonic Increase of Acceptance Amplifies Future Positive Response over Weak Tie**

VP3≡ ∀γ: TRACE, ∀t1, t2: TIME, tb, te:TIME, ∀J1,J2, K1, K2:REAL
[state(γ,t1)|= has_value(acceptance, J1) &
state(γ,t2) |= has_value(acceptance, J2) &
state(γ,t1) |= has_value(response_weak_tie, K1) &
state(γ,t2) |= has_value(response_weak_tie, K2) &
tb ≤ t1 ≤ te & tb ≤ t2 ≤ te & t1 < t2 & J2 ≥ J1] ⇒ K2 ≥ K1

Individuals facing stressful situations, such as life-threatening illnesses, who find acceptance as a functional coping response, in that a person who accepts the reality of a stressful situation would seem to be a person who is engaged in the attempt to deal with the situation. Moreover, it is individuals' condition when they are trying to face the stressful event in a trial to change the situation and, arguably, weak-tie networks offer them certain advantages in terms of social support over strong-tie networks. In particular, one's preference for weak ties likely involves the importance of (a) access to different viewpoints, (b) reduced risk, (c) access to objective feedback from others, and (d) reduced role obligations.

**VP4: Monotonic Increase of Negative Emotion Amplifies Future Positive Response over Strong Tie.**

$$
\begin{array}{l}
\text{VP4} \equiv \forall \gamma\text{: TRACE, } \forall \text{t1, t2: TIME, tb, te:TIME, } \forall \text{J1,J2, D1, D2:REAL} \\
\text{[state}(\gamma\text{,t1)|= has\_value(negative\_emotion, D1) \&} \\
\text{state}(\gamma\text{,t2) |= has\_value(negative\_emotion, D2) \&} \\
\text{state}(\gamma\text{,t1) |= has\_value(response\_strong\_tie, J1) \&} \\
\text{state}(\gamma\text{,t2) |= has\_value(response\_strong\_tie, J2) \&} \\
\text{tb} \le \text{t1} \le \text{te \& tb} \le \text{t2} \le \text{te \& t1} < \text{t2 \& D2} \ge \text{D1 ]} \Rightarrow \text{J2} \ge \text{J1}
\end{array}
$$

According to Gross (2018), the way a person regulates his or her emotions contributes greatly to a social support network. Emotion regulation involves how a person can influence the emotions being experienced, in addition to when and how these emotions are felt and/or expressed. It has been empirically shown that in daily life situations, people regularly increase, decrease, and maintain both positive and negative emotions (Parrott, 2017); emotion regulation plays a large role in all our lives constantly. People use emotion regulation strategies and emotions to the extent that these emotions have emotional and companionship benefits (Tamir, 2015).

Universiti Utara Malaysia

### 6.3.2 Support Provider Model Automated Verification

To verify the support provider model that has been discussed in Section 4.4 and presented in Figure 4.4 using automated verification, four conditions were given for the verified properties (VP1 to VP4). These cases were introduced in semiformal and informal representations showing the prototype of these properties:

**VP1: High Self-Esteem Reduces Maladaptation**

$$
\begin{array}{l}
\text{VP1} \equiv \forall \gamma\text{:TRACE, } \forall \text{t1, t2:TIME } \forall \text{M1, M2, D:REAL} \\
\text{[state(}\gamma\text{, t1)|= has\_value(self\_esteem, M1) \&} \\
\text{state(}\gamma\text{, t2)|= has\_value(maladaptation, M2) \&} \\
\text{M1} \ge 0.8 \text{ \& t2= t1+D ]} \Rightarrow \text{ M2} \le 0.3
\end{array}
$$

A large literature spanning four decades shows high self-esteem precipitates positive coping skills like bonadaptation whereas low self-esteem causes ineffective or maladaptive coping and may lead to declines in overall health (Lazarus, 2011; Park, 2017). In coping and health literature, it is commonly suggested that high self-esteem triggers maladaptive strategies and can lead to mental health problems such as depression and anxiety (Baker & Berenbaum, 2017). Similarly, the traditional description of low self-esteem involves a low overall evaluation of the self, persistent feelings of inferiority, a sense of worthlessness, and often, feelings of loneliness and insecurity (Mruk, 2018).

**VP2: Empathy Capability Improves Willingness to Help**

VP2≡ ∀γ:TRACE, ∀t1, t2:TIME ∀V1, M1, M2, D:REAL
[state(γ, t1)|= has_value(empathy, V1) &
state(γ, t1)|= has_value(willingness_to_help, M1) &
state(γ, t2)|= has_value(willingness_to_help, M2) &
V1 ≥ 0.8 & t2= t1+D & M1 ≥ 0.5 ] ⇒ M2 ≥ M1

According to empathy–altruism hypothesis, it indicates that feeling empathy for the person in need is an important motivator of helping (Coke, Batson, & McDavis, 2011; Shumaker & Brownell, 2012; Specht, 2015). Several researchers (Hoffman, 2013; Krebs, 2015) have hypothesized that this motivation might be truly altruistic, that is, directed toward the end state goal of reducing the other's stress. Many research works have maintained that there is a link that support-providers with empathy capability and altruistic attitude will regulate altruistic motivation to help others (Murray et al., 2016).

**VP3: Monotonic Increase of Threat Amplifies Burden Level**

VP3≡ ∀γ: TRACE, ∀t1, t2: TIME, tb, te:TIME, ∀V1,V2, R1, R2:REAL
[state(γ,t1)|= has_value(threat, V1) &
state(γ,t2) |= has_value(threat, V2) &
state(γ,t1) |= has_value(burden, R1) &
state(γ,t2) |= has_value(burden, R2) &
tb ≤ t1 ≤ te & tb ≤ t2 ≤ te & t1 < t2 & R1 = 0.4 & V2 ≥ V1] ⇒ R2 ≥ R1

In the case of threat happened, it is burdening to the person's coping resources or taxing to the extent that it threatens his or her physical and psychological well-being. The individual makes a cognitive assessment of his or her ability to cope with the situation. In turn, the individual copes with the stress by engaging in cognitive and behavioural efforts to manage the physical and emotional demands that are beyond the individual's resources to manage the stressful event (Lazarus & Folkman, 1984; Haley et al., 2014).

**VP4: Monotonic Increase of Intensity of Stressful Event and Negative Personality (Neurotic) Amplifies Future Negative Response for Emotional Focused Support.**

VP4≡ ∀γ: TRACE, ∀t1, t2: TIME, tb, te:TIME, ∀D1,D2, R1, R2:REAL
[state(γ,t1)|= has_value(stressor, V1) &
state(γ,t1) |= has_value(neurotic, V2) &
state(γ,t1) |= has_value(emotional_focused, R1) &
state(γ,t2) |= has_value(emotional_focused n, R2) &
tb ≤ t1 ≤ te & tb ≤ t2 ≤ te & t1 < t2 & V1 = 0.8 & V2 = 0.8 ] ⇒ R2 ≥ R1

Previous literature illustrates that the intensity of stressful event impacts the coping strategy an individual use when confronted with stress (Kammeyer- Mueller, Judge, & Scott, 2014). Individuals who believe that something can be done to resolve the problem (low intensity of stressful event) tend to use a more active or "engagement" coping strategy than people who appraise the situation as beyond their control

(Folkman, Lazarus, Dunkel-Schetter, DeLongis, & Gruen, 1986; Kalkan & Epli-koç, 2014). Thus, individuals with high intensity of stressful event likely use more emotional or "disengagement" coping strategies (low problem-focus) as a result of the lack of self-confidence to handle the situation in a more direct manner (Gooden, 2014).

### 6.4 Complexity Analysis of a Configuration Algorithm

The complexity analysis is used to evaluate the proposed algorithm in term of the computational execution time of each algorithm. It is reflected in the number of steps or basic operations performed in the worst case during a computation. Therefore, the complexity specifies the order of magnitude within which the algorithm will perform its operations. The complexity is described in *Big O* notation (with a capital letter O), also called Landau's symbol. This concept is widely used in complexity theory, computer science, and mathematics to describe the asymptotic behaviour of functions and it tells how fast a function grows or declines. The big-O expressions do not have constants or low-order terms. This is because, when *N* gets large enough, constants and low-order terms don't matter (a constant-time algorithm will be faster than a linear-time algorithm, which will be faster than a quadratic-time algorithm). Table 6.3 shows the complexity of each statement in the proposed algorithm.

Universiti Utara Malaysia

Table 6.3

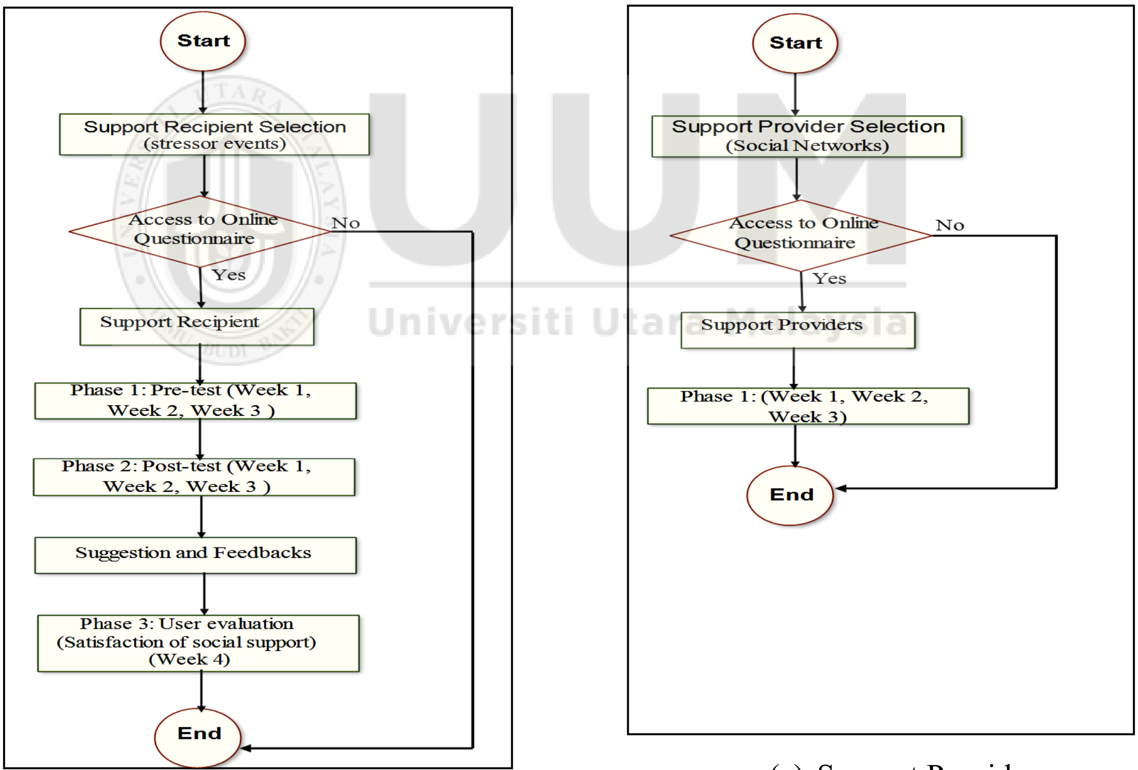
*The complexity of Configuration Priority Algorithm.*

| **Steps of Priority Selection** | **Time Complexity** |
|---|---|
| *Pa*, such that $0 \leq Pa \leq 1$ | *O(1)* |
| *Nv*, such that $0 \leq Nv \leq 1$ | *O(1)* |
| *i*, such that $1 \leq i \leq n$ | *O(1)* |
| *t*, such that $t \leftarrow 1$ | *O(1)* |
| While (*t<=numStep && (Sr>0* \|\| *Sp>0)* | *O(n)* |
| Then $P_{se} \leftarrow (Se / (We+Se)) * 100$ | *O(1)* |
| $P_{we} \leftarrow (We / (We+Se)) * 100$ | *O(1)* |
| Pc ← (Func_recp + Func_prov)/2 | *O(1)* |
| Then InfoSupp (Ir,Ip,Bl) | *n.O(1)* |
| EmotSupp (Er,Ep,Bl) | *n.O(1)* |
| InstSupp (Nr,Np,Bl) | *n.O(1)* |
| CompSupp (Cr,Cp,Bl) | *n.O(1)* |
| Select_Next_Provider_Prority (i, n) | *n.O(1)* |
| Select i | *O(1)* |
| *t← t +1* | *O(1)* |

The notation of *n*.O(1) refers to the algorithm executes n times for each statement that executes O(1). So, the time complexity of *n*.O(1) is equal to O(*n*). Therefore, the total time for the configuration algorithm is equivalent to the summation of all execution time are O(*n*). From the summation result, it shows that the proposed algorithm is a time linear complexity. Thus, it means that the computational effort to run the algorithm is proportional to *n* and time grows linearly as input size increases. Also, this is often the best possible (most efficient) case for time complexity where all the data must be examined. These loops process the input by a constant factor of $n$ and thus can be described as a linear problem.

### 6.5 Validation

The study made use of both descriptive and questionnaire research approaches to validate the computational models based on Madigan et al (2015). Thirty groups of graduate students in UUM (University Utara Malaysia) were selected based on their social support networks. Each group has five respondents, one respondent refers to support recipient and four respondents refer to support providers.




(b) Support Recipient

(a) Support Providers

*Figure 6.7.* Validation Phase Flowchart.

Moreover, the validation stages were implemented in three stages with two types of individuals in the same social network.

As well as a first stage is called pre-test was performed to measure the stress of support recipient (without any support provider). Later, after three weeks (post-test) was conducted. The third stage determined the satisfaction of the social support related to user evaluation. Figure 6.7 below gives an overview of the implementation process.

The questionnaire was given on the target recipient and provider in simple, clear and easy to understand manner also helps the user to be more receptive to the questions (see Appendix IX). The pre-test and post-test stages used three questionnaires namely; Personality Test, DASS (The Depression, Anxiety and Stress Scale), and Social Support. A detailed explanation of the descriptive analysis of the experiment is reported in Sub-section 6.4.1 while Sub-section 6.4.2 presents the data analysis for all three cases.

Universiti Utara Malaysia

### 6.5.1 Respondent's Background

A descriptive analysis of the implementation of the prototype on the thirty groups is discussed in this section. The responses of the respondents at two stages were collected and analysed. Details of each stage scenario are given in the following sections and a summary of the respondents' background which was obtained from the questionnaire distributed to the respondents is presented in Table 6.4.

Table 6.4

*Summary of Respondent's Background*

| Respondents | Educational Level | Age | Gender | Monthly Income Rm |
|---|---|---|---|---|
| Amal | Ph.D. | 25-34 | Female | 1000-2000 |
| Noor | Ph.D. | 25-34 | Female | <1000 |
| Ahmad | Degree | 25-34 | Male | 2001-3000 |
| Sana | Ph.D. | 25-34 | Female | <1000 |
| Mohammad | Diploma | 25-34 | Male | 3001-4000 |
| Lyn | Master | 25-34 | Female | <1000 |
| Reina | Degree | 25-34 | Female | <1000 |
| Dave | Diploma | 25-34 | Male | 1000-2000 |
| Simon | Ph.D. | 25-34 | Male | <1000 |
| Dora | Master | 25-34 | Female | 3001-4000 |
| Hafiza | Ph.D. | 25-34 | Female | <1000 |
| Wael | Master | 25-34 | Male | 2001-3000 |
| Pal | Army | 25-34 | Male | 3001-4000 |
| Weer | Ph.D. | 25-34 | Male | >4000 |
| Amreet | Ph.D. | 25-34 | Female | 1000-2000 |
| Amani | Ph.D. | 25-34 | Female | 1000-2000 |
| Elham | Degree | 25-34 | Female | <1000 |
| Asma | Ph.D. | 25-34 | Female | 1000-2000 |
| Salma | Master | 25-34 | Female | 2001-3000 |
| Tamer | Master | 25-34 | Male | 2001-3000 |

Universiti Utara Malaysia

For the first stage, the respondents' background was analyzed for the different thirty groups that accessible to the online questionnaire. Four socio-demographic characteristics, gender, age, and educational level, and monthly income.

### 6.5.2 Data Description

After the questionnaire was administered to obtain respondents preferences, the support provision begins. First, the process to convert the value from the questionnaire to the prototype was done as seen in Table 6.5. Sample of results of respondent's social support networks is provided in next subsections.

Table 6.5

*Conversion Values*

| **Options** | **Values** |
|---|---|
| 1) Strongly agree | 0.9 |
| 2) Agree | 0.7 |
| 3) Disagree | 0.4 |
| 4) Strongly disagree | 0.1 |

As well as, the results of instantaneous, temporal, and external factors are converted as follow: $Val(x) = \begin{cases} \text{Low}, & x < 0.5 \\ \text{High}, & x \geq 0.5 \end{cases}$

**Results for Amal's Social Support Network**

This section shows the personality attributes and characteristics of social support related to group one from both individual's recipient Amal and providers, Noor, Sana, Ahmad, and Mohammad. The result showed that Amal needs more informational support than others support. This high informational support returns directly to the high value of both her conscientiousness and personality attributes. Figure 6.8 shows the average of informational support can be provided for three weeks from her providers.

Universiti Utara Malaysia

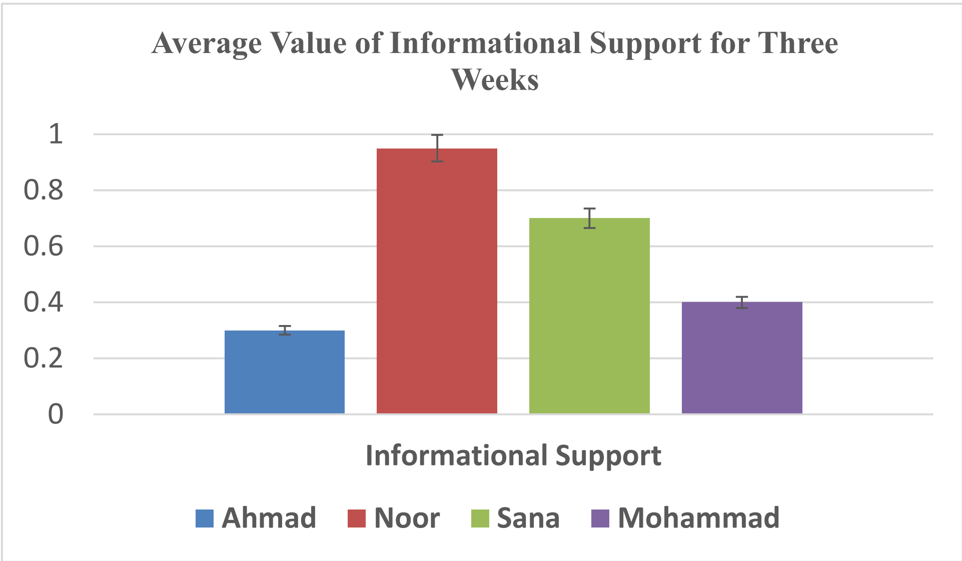



*Figure 6.8.* Average of Informational Support in Group One for Three Weeks.

Figure 6.8 shows the average value of the informational support of each provider in three weeks. In this case, Noor provides the highest informational support value follows by Sana. Thus, the configuration algorithm has selected both Noor and Sana to help Amal (informational support) as seen in Figure 6.9. This finding is consistent with (Knoll, Burkert, & Schwarzer, 2014; Thoits, 2011).

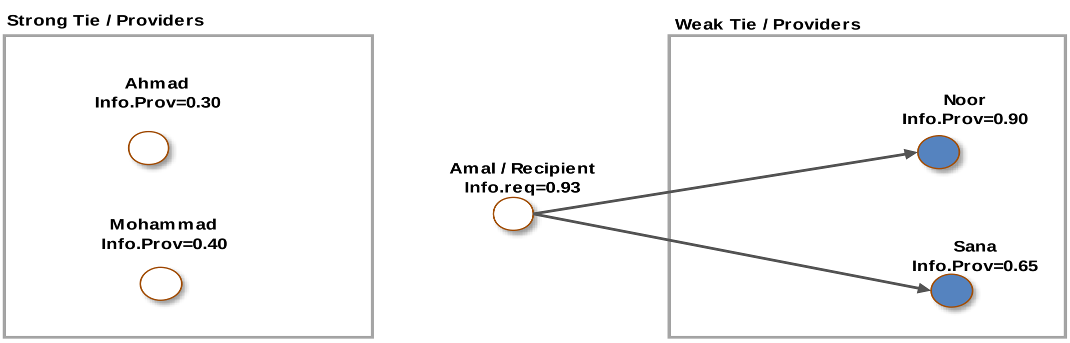



*Figure 6.9.* Informational Support of Amal.

Based on the support given, Figure 6.10 shows the relationship between information support provided for three weeks and stress level.

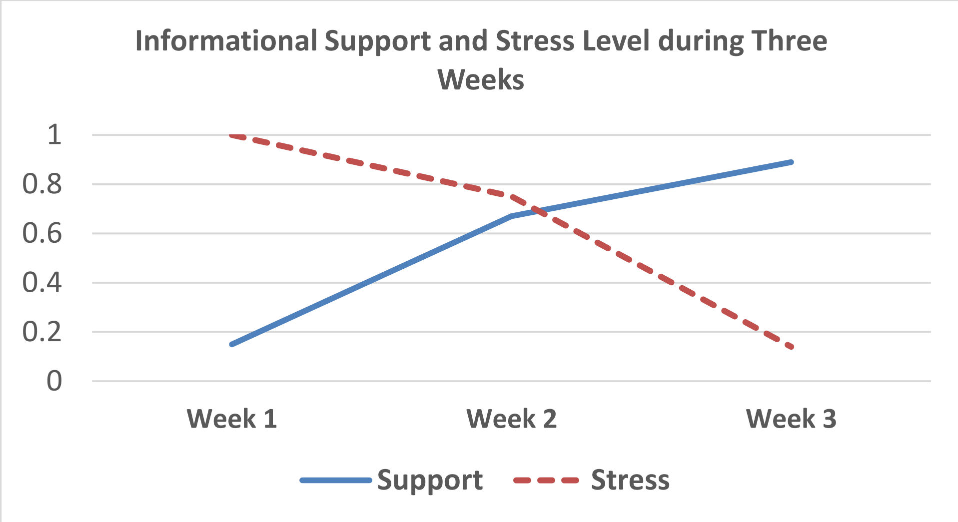



*Figure 6.10.* Informational Support and Stress Level of Amal after Three Weeks.

Figure 6.10 shows that in Week 1 when the informational support was low thus caused the high level in stress. In Week 2, as the amount of informational support is increasing, the observed stress level is decreasing.

Universiti Utara Malaysia

**Results for Lyn's Social Support Network**

In this section, the results for the second group is discussed. The results have shown that Lyn needs more emotional support as she has slightly higher neurotic personality. Figure 6.11 shows the average of emotional support can be provided for three weeks from her providers.

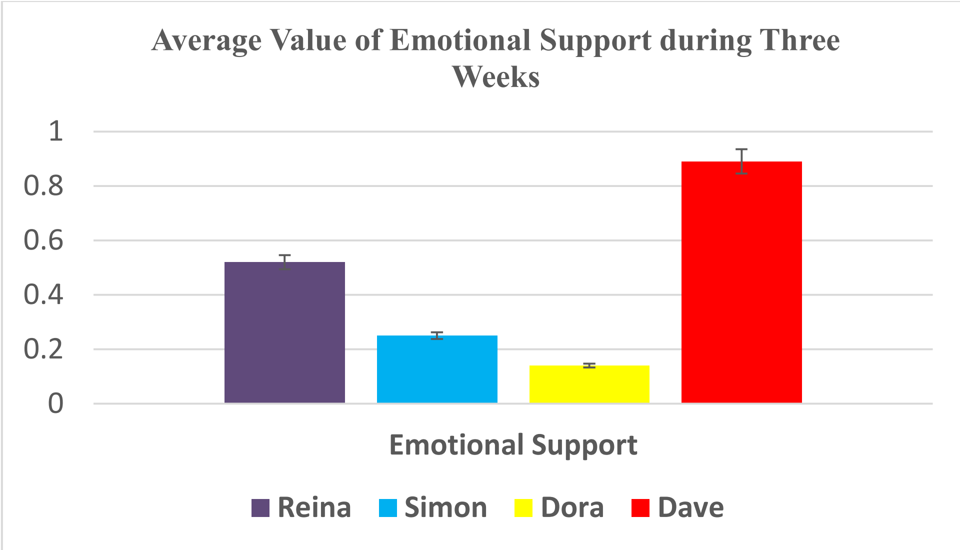



*Figure 6.11.* Average of Emotional Support in Group Two for Three Weeks.

Besides, Figure 6.11 shows the average value of emotional support for each provider within three weeks. In this case, Dave has capable to provide the highest value of emotional support compared to others. To reduce the burdening effect on Dave alone, the configuration algorithm has selected both Dave and Reina to help this Lyn (as seen in Figure 6.12). Furthermore, the results obtained from this study has shown Dave and Reina are members in Lyn's strong social network tie. This finding was found to be consistent with (Haines & Beggs, 2016; Lauritz, Preez, Cassimjee, & Ghazinour, 2015).

Universiti Utara Malaysia

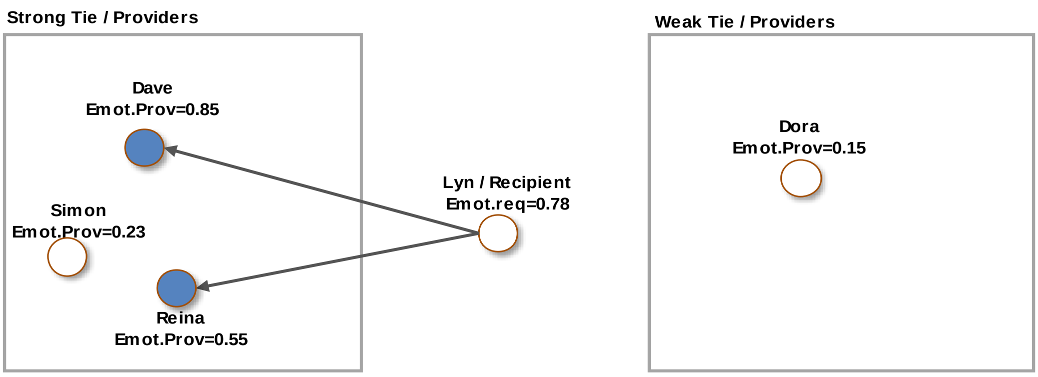



*Figure 6.12*. Emotional Support of Lyn.

Figure 6.13 shows the effects of the provided support within the observed periods.

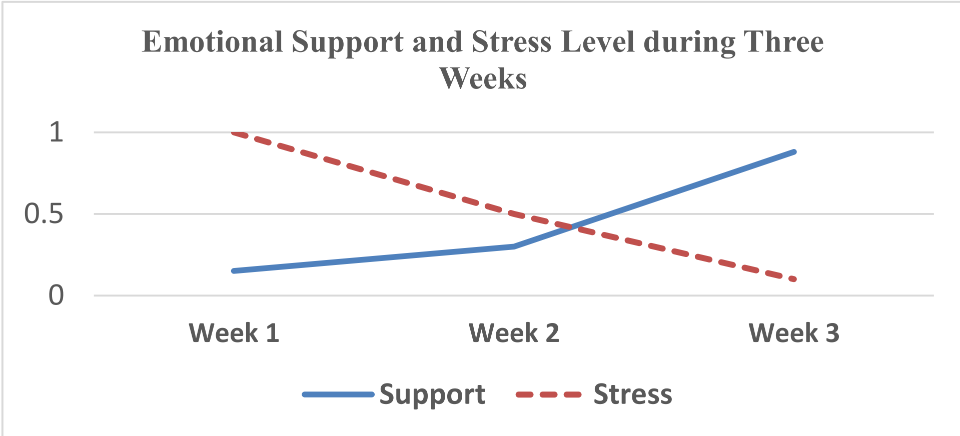



*Figure 6.13.* Emotional Support and Stress Level for Lyn after Three Weeks.

Figure 6.13 shows that in Week 1 when the emotional support is low, the stress level is observed as high. However, as the support has been given, the stress level is declining over the observed period.

**Results for Hafiza's Social Support Network** This group addresses the support exchange for companionship. This high companionship support returns directly to a high value of extraversion personality and emotional experience. Figure 6.14 shows the average of informational support can be provided for three weeks from her providers.

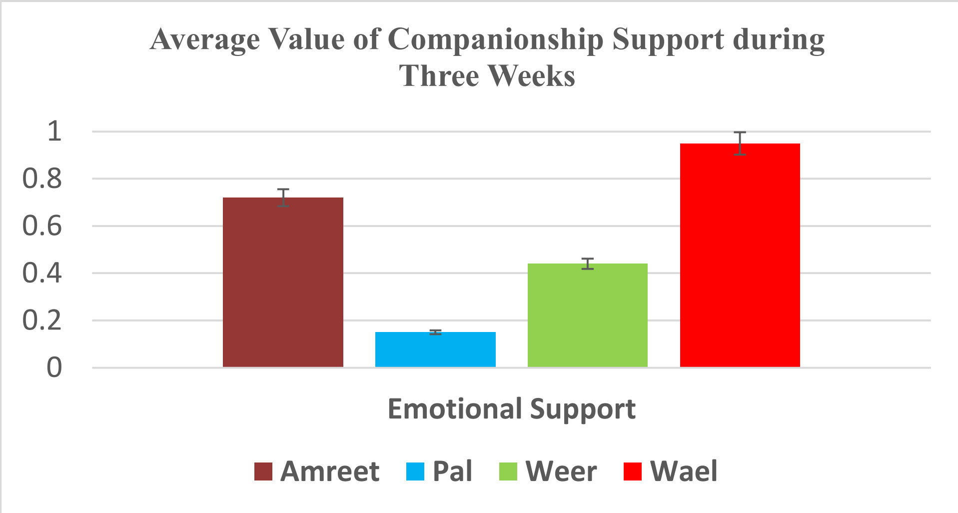



*Figure 6.14.* The average of Companionship Support in Group Three for Three Weeks.

Figure 6.14 shows the average value of companionship support of each provider within three weeks. In this condition, Wael provides the highest companionship support and followed by Amreet (see Table 6.10). Thus, the configuration algorithm has selected both Amreet and Wael to Hafiza in providing the companionship support she needed. This companionship selection is consistent with these previous findings (Dodson et al., 2016; Mohamed & Baqutayan, 2015).

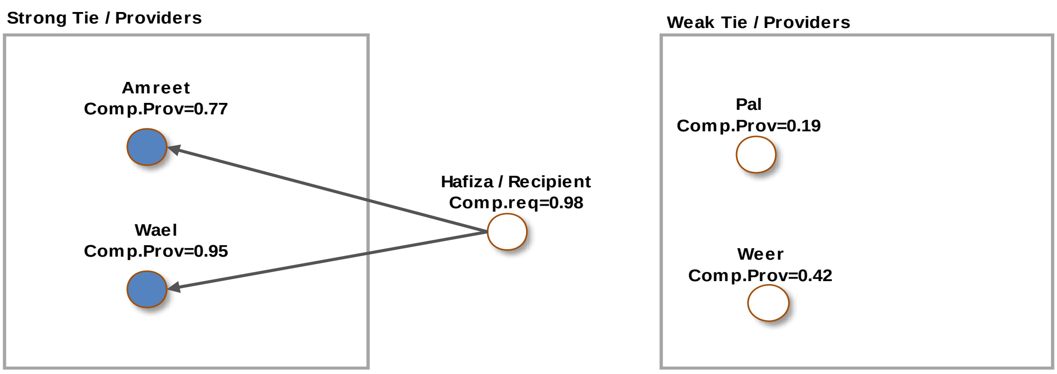



*Figure 6.15.* Companionship Support of Hafiza.

Figure 6.16 shows the effects of companionship support over the recipient's stress level.

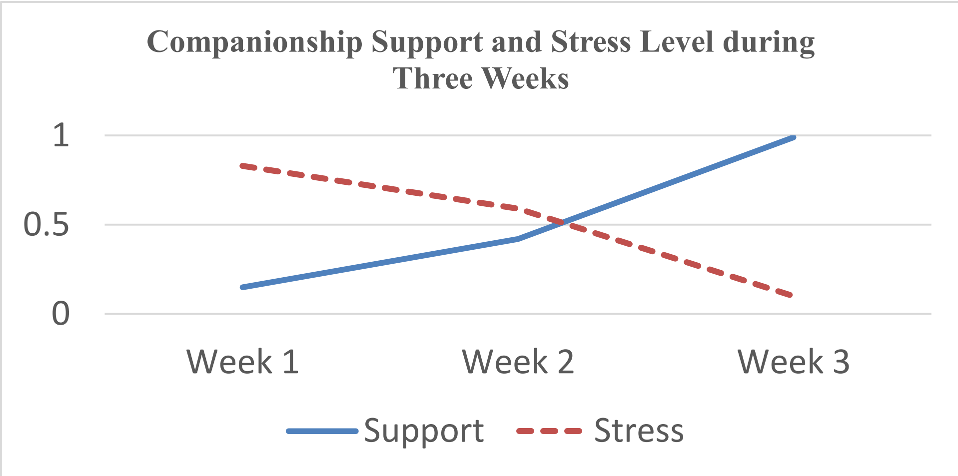



*Figure 6.16.* Companionship Support and Stress Level of Support Recipient after Three Weeks.

Universiti Utara Malaysia

Table 6.6 summarizes all groups with their assigned social support and their social support networks.

Table 6.6

*The Social Support Assignment for Thirty Groups.*

| **Recipient** | **Social Support Networks** | **Assigned Social Support** |
|---|---|---|
| Group 1 | Amal: Noor, Ahmad, Sana, Mohammad | Informational Support |
| Group 2 | Lyn: Sana, Mohammad, Reina, Simon | Emotional Support |
| Group 3 | Hafiza: Wael, Pal, Weer, Amreet | Companionship Support |
| Group 4 | Amani: Elham, Asma, Salma, Tamer | Instrumental Support |
| Group 5 | Weer: Noor, Ahmad, Simon, Reina | Informational Support |
| Group 6 | Amreet: Hafiza, Noor, Ahmad, Weer | Emotional Support |
| Group 7 | Simon: Elham, Asma, Salma, Tamer | Instrumental Support |
| Group 8 | Asma: Dave, Dora, Reina, Simon | Companionship Support |
| Group 9 | Sana: Noor, Ahmad, Weer, Amreet | Informational Support |
| Group 10 | Noor: Wael, Pal, Weer, Amreet | Emotional Support |
| Group 11 | Lyn: Dave, Dora, Reina, Simon | Emotional Support |
| Group 12 | Amani: Ahmad, Sana, Reina, Tamer | Instrumental Support |
| Group 13 | Amal: Reina, Simon, Sana, Mohammad | Informational Support |
| Group 14 | Hafiza: Noor, Ahmad, Weer, Amreet | Companionship Support |

| | | |
|---|---|---|
| Group 15 | Weer: Noor, Ahmad, Simon, Amreet | Informational Support |
| Group 16 | Amreet: Simon, Noor, Ahmad, Weer | Emotional Support |
| Group 17 | Simon: Noor, Ahmad, Salma, Tamer | Instrumental Support |
| Group 18 | Asma: Dave, Ahmad, Reina, Amreet | Companionship Support |
| Group 19 | Sana: Reina, Simon, Weer, Amreet | Informational Support |
| Group 20 | Noor: Wael, Pal, Ahmad, Simon | Emotional Support |
| Group 21 | Amal: Noor, Reina, Sana, Amani | Informational Support |
| Group 22 | Lyn: Dora, Ahmad, Reina, Simon | Emotional Support |
| Group 23 | Hafiza: Wael, Simon, Weer, Amreet | Companionship Support |
| Group 24 | Amani: Elham, Reina, Sana, Tamer | Instrumental Support |
| Group 25 | Weer: Dora, Asma, Simon, Reina | Informational Support |
| Group 26 | Amreet: Salma, Tamer, Ahmad, Weer | Emotional Support |
| Group 27 | Simon: Elham, Ahmad, Dave, Tamer | Instrumental Support |
| Group 28 | Asma: Asma, Salma, Reina, Simon | Companionship Support |
| Group 29 | Sana: Salma, Tamer, Weer, Amreet | Informational Support |
| Group 30 | Noor: Wael, Ahmad, Reina, Dora | Emotional Support |

### 6.5.3 User Evaluation

This section evaluates the level of satisfaction for the recommended support within assigned social support members. The evaluation components adapted from Sarason Social Support Questionnaire (Short Form) SSQSR. SSQSR consists of 6 elements of two parts as seen in Appendix IX. Table 6.7 shows the percentage of satisfied elements according to recipient individuals.

Table 6.7

*The Percentage of Elements in Satisfaction of Assignment Social Support.*

| **Recipient** | **Percentage (%)** |
|---|---|
| Group 1 | 81.66 |
| Group 2 | 85.63 |
| Group 3 | 88.33 |
| Group 4 | 90.54 |
| Group 5 | 82.55 |
| Group 6 | 92.66 |
| Group 7 | 81.66 |
| Group 8 | 90 |
| Group 9 | 88.33 |
| Group 10 | 93.56 |
| Group 11 | 87.66 |

| | |
|---|---|
| Group 12 | 85 |
| Group 13 | 89.33 |
| Group 14 | 90 |
| Group 15 | 85 |
| Group 16 | 86.33 |
| Group 17 | 90 |
| Group 18 | 81.66 |
| Group 19 | 93.56 |
| Group 20 | 87.66 |
| Group 21 | 83.41 |
| Group 22 | 89.33 |
| Group 23 | 91.52 |
| Group 24 | 85 |
| Group 25 | 81.66 |
| Group 26 | 85 |
| Group 27 | 88.33 |
| Group 28 | 90 |
| Group 29 | 93.56 |
| Group 30 | 87.66 |

Table 6.7 shows the average value for the satisfaction of social support provision and assignment. Generally, the average of satisfied support in all recipient is above 80 %. Therefore, it shows that the proposed solution provides a meaningful support assignment to capture certain needs among social network members.

Universiti Utara Malaysia

### 6.6 Summary

Detailed explanations on the model's evaluation are carried out in this chapter which was explored in two different stages namely verification and validation. The verification process was conducted using mathematical verification and temporal traces language. The results obtained from these two analyses show that the model is consistent with the literature. Furthermore, the validation is carried out using descriptive analysis whereby based on the model external factors. The results have shown that respondents were satisfied with the results of an automated social support assignment.

# CHAPTER SEVEN

# CONCLUSION

## 7.1 Introduction

This chapter is organized as follows: Section 7.1 summarizes the conclusions based on achieved objectives, while the study implication is presented in Section 7.2. Later, Section 7.3 discusses the limitations of this study. Finally, Section 7.4 shows how future works can be proposed based on this study.

## 7.2 Revisiting the Objectives

UUM Universiti Utara Malaysia

As presented in Chapter One, there are four objectives serve as a foundation for this study, namely;1) identifying the important factors in the recipient-provision process by developing a computational model for recipient-provision process, 2) integration the dynamics support provision task among selected members in line with their resources and preferences, 3) development of a configuration algorithm to cater real-time social support, and 4)evaluation the developed models and configuration algorithm.

**Research Objective #1:**

*To represent factors from psychology related to aspects on stress, and social support recipient and provider using a computational model.*

The first research objective is to determine support recipient and provider factors that reflect the seeking and giving social support based on. Based on related theories

(Cognitive Motivational Relational Theory (CMR), Transactional Stress Theory (TS), Broaden-and-Build Theory (BB), Coping Theory (CO), Support Network Preference theory (SNP), Behavioural Self-Regulation Model (BSR), Weak Tie/Strong Tie Support Network(WST), Stress Buffering Theory (SB), Attachment Theory (AT)), there are 26 factors were involved in the dynamics of social support recipient  As for the social support provision part, there are 28 factors were involved. those factors were based on related theories in Altruistic Personality Theory (AP), Self-Verification Theory(SV), Self-Determination Theory (SD), Reciprocity Theory (RP), Double ABCX Theory (DABCX), Cognitive Motivational Relational Theory (CMR), Transactional Stress Theory (TS), Coping Theory (CO), Support Network Preference theory (SNP), Behavioural Self-Regulation Model (BSR), Stress Buffering Theory (SB), Attachment Theory (AT), Empathy–Altruism Theory (EA), and  Strength of Tie Theory (ST).

Universiti Utara Malaysia

Table 7.1

*Summary of Research Objective #1*

| Model | Theory | Description | Figure |
|---|---|---|---|
| *Support Recipient* | Cognitive Motivational Relational Theory (CMR), Transactional Stress Theory (TS), Broaden-and-Build Theory (BB), Five-Factor Model (FFM), Behavioural Self-Regulation Model (BSR), Coping Theory (CO), Support Network Preference Theory (SNP), Weak Tie/Strong Tie Support Network (WST), Stress Buffering Theory (SB), | From these theories, key factors and its interplays are identified to determine the seeking support process that it is grouped into four categories: stress event, coping strategies, support requested preferences, and network tie preferences to identify the types of requested social support. | Figure 4.1<br>Figure 4.2<br>Figure 4.3<br>Figure 4.4<br>Figure 4.5 |

Table 7.1 Continued.

| | | | |
|---|---|---|---|
| *Support Provider* | Altruistic Personality Theory (AP), Five Factor Model (FFM), Self-Determination Theory (SD), Reciprocity Theory (RP), Cognitive Motivational Relational Theory (CMR), Transactional Stress Theory (TS), Coping Theory (CO), Support Network Preference theory (SNP), Behavioural Self-Regulation Model (BSR), Weak Tie/Strong Tie Support Network (WST), Empathy–Altruism Theory (EA), Double ABCX Theory (DABCX), Broaden-and-Build Theory (BB), Self-Verification Theory (SV), Stress Buffering Theory (SB), Attachment Theory (AT), Strength of Tie Theory (ST). | The interplays in support provider are determined form those theories that is grouped into three main components namely; coping strategies, adaptation concepts, and support provision preferences. | Figure 4.6<br>Figure 4.7<br>Figure 4.8<br>Figure 4.9 |

**Research Objective #2:**

*To integrate support recipient and provider models to address the dynamics of social support exchange.*

The second research objective determined the utilized social support based on social support activities. The obtained factors related to their corresponding theories were expressed in formal specifications for the computational model's development phase. All six integrated factors based on Sociometer theory (SO), General Adaption Syndrome Model (GAS), and Stress Buffering Theory (SB) theories were summarized in Table 4.14

Universiti Utara Malaysia

**Research Objective #3:**

*To develop a configuration algorithm to assign support among selected members within their resources and preferences.*

The third research objective aims to determine the sequence of the process in selecting the support provider(s) from social recipient's social network. The study presented five major requirements needed (tie's preferences, long-term stress, support receipt preferences, function in social networks, and support provision preferences) as a building block to design a configuration model. Furthermore, there are an additional set of constraints were introduced such as like preference number of providers, level of accepted for requested and provided support, and a level of accepted burden.

**Research Objective #4:**

*To evaluate the appropriateness of the integrated configuration algorithm with the social support networks.*

The last objective is dedicated to evaluate the developed models in two stages. First, the verification analysis using mathematical and automated verification methods was performed. In mathematical verification, four cases evaluated in term of its stability as stated in Section 6.2.1. The advantage of implementing the stability or equilibrium analysis is to show how the model stabilizes under certain conditions despite the presence of a small disturbance in the model. On the other hand, five different empirical cases in provision process were selected from the literature and each case was formalized and analysed using Temporal Trace Language (TTL) to achieve automated verification which confirmed the logical verification of the developed formal model which was discussed in Section 6.2.2. The second evaluation stage was done by external validation using human experiment based on a descriptive approach. This was to assert the logic correctness of the proposed model by employing thirty respondents as presented in Chapter Six. The findings from both approaches are coherent with the observed cases in the literature.

Table 7.2

*Summary of Study Findings*

| Objective | Method | Outcome | Chapter |
|---|---|---|---|
| To represent factors from psychology related to aspects on stress, and social support recipient and provider using a computational model. | Critical literature review of theories, models and related previous empirical studies within psychological stress and social support. Computational modelling process | Recipient and provider factors were identified. Computational Model | Chapter 4 |
| To integrate support recipient and providers models to address the dynamics of social support exchange. | Requirements and constraints. Computational modelling process. | Integrated Computational Model. | Chapter 4 |
| To develop a configuration algorithm to assign support among selected members within their resources and preferences. | Priority selection model Random selection model | Configuration algorithm | Chapter 4 |
| To evaluate the appropriateness of the integrated configuration algorithm with the social support networks. | Simulation, verification (using mathematical and automated analysis) and validation (using human experiment based on user-centred approach) | Verified and validated model. | Chapter 5, and 6. |

Universiti Utara Malaysia

## 7.3 Implication of the Study

The implication of this study can be viewed in three different ways. Firstly, this study has explicitly shown the computational process involved in psychological stress and social support as related to seeking and giving support. Hence, this study has been able to explore computational analysis in explicit comprehension of how seeking and giving support process can be obtained at different case conditions which shows the incoherent and unstable nature of support recipient and provider individuals behaviour as suggested by West (2009). Thirdly, the study explicitly shows the psychological stress can be reduced after the algorithm process that assigning utilized needed social support. These three mentioned implications significantly contribute to the knowledge of designing and developing successful behaviour of support recipient and provider interventions. In addition, the high point of this study is to enable designers in intelligent stress management systems to know to integrate social support-based concepts as one of the mechanisms in addressing support of a person with cognitive related stress. From this foundation, the developed models could be extended to provide social support for people with different cognitive dysfunctional such as anxiety, post-traumatic disorders, and unipolar depression.

## 7.4 Limitation of the Study

The developed computational models and configuration algorithm have been successfully performed on a single recipient to many support providers based on specific social support requirements. Therefore, the study did not cover every aspect of human behaviour mechanism whereas only stress and social support phenomena were focused. This is because human behaviour is as a result of complex interplaying factors that comprise of socio-demographic, cognitive, biological and environmental factors.

Although, the study made use of a user-centered approach for validation, the implementation of human-based (non-intrusive) sensing technologies, and an interactive agent simulation environment.

## 7.5 Future Work

There is still further work enveloped in this study which can apply to other various domains. This section will discuss these potential further works in four different subsections as apply to other areas.

### 7.5.1 Integration with Social Media Platforms

The presented model can be a basis to develop a human-aware or socially aware software application that can provide support in the social interaction, for example, by including a smart social media application helping in monitoring the states of the members of the network and giving signals when somebody's stress levels are becoming too high. Additionally, it could be interesting to expand the model to cope with a network containing a significant number of members. Thus, various seeking and providing support process models can be built together to provide support for complicated behaviour or/and the management of healthcare interventions for both individual and societal levels. This integration of various models can be achieved either by endogenous or exogenous components. Likewise, it can be modelled by the same functionalities at various abstraction levels which will aid complex behaviour analysis or provide desire support for related intervention.

### 7.5.2 Many-to-Many Social Support Assignment

The configuration algorithm described in this study has been successfully performed to guarantee many (providers) to one (recipient) assignment of social support. In the future, this limitation could be extended to directly applicable to many providers and many recipients in social support networks. In such a context, persons who are connected in a social network can provide support to their friends who are facing stress and receive support as well when it is necessary.

### 7.5.3 Integration with an Agent System

This study simulation result depicts various individual' case conditions as discussed in Chapter Six which were used to evaluate the developed computational models. Besides, these individual 'case conditions can be integrated with human-like embedded interactive agents or sociable robot to simulate further social environment conditions to rigorously evaluate the developed computational model. This will be useful in the predictions of various behavioural personalities of a human within a defined social environment to further understand the mechanism of psychological stress and social support process. Also, it will strengthen the position of predictions such as the boundary conditions which is based on complex interactions with the social environment.

Universiti Utara Malaysia

# REFERENCES


Abraham, C., & Michie, S. (2018). A taxonomy of social support techniques used in interventions. *Health psychology*, *27*(3), 379.

Adams,G. (2017). Perceptions of Social Support Availability and Coping Behaviors. *Psychiatric Rehabilitation Journal*, *56*(25), 33–45.

Adams, J., Giles, E. L., McColl, E., & Sniehotta, F. F. (2016). Carrots, social support and health behaviours: a framework for documenting the complexity of financial incentive interventions to change health behaviours. *Health psychology review*, *8*(3), 286-295.

Adelman, M. B., Parks, M. R., & Albrecht, T. L. (2017). Beyond Close Relationships: Support in Weak Ties. In T. L. Albrecht & M. B. Adelman (Eds.), *Communicating Social Support* (pp. 162–147).

Adner, R., Polos, L., Ryall, M., & Sorenson, O. (2018). The case for formal theory. *Academy of Management Review*, 34, 201–208.

Agarwal, N. (2018). Wireless infrastructure setup strategies for healthcare Indian Institute of Management Kozhikode. *The Journal of Cardiovascular Nursing*, *3*(9), 5–18.

Ahn, H. Il, & Picard, R. W. (2017). Measuring affective-cognitive experience and predicting market success. *IEEE Transactions on Affective Computing*, *5*(2), 173–186. http://doi.org/10.1109/TAFFC.2017.2330614.

Aktas, A., & Sertel-Berk, H. O. (2017). Social Support Reciprocity in Terms of Psychosocial Variables in Care Taking and Care Giving Processes of Spinal Cord Injury Patients and their Care Givers. *Procedia - Social and Behavioural Sciences*, *20*(5), 564–568. http://doi.org/10.1016/j.sbspro.2015.09.076

Albrecht, K., & Martin, M. (2016). Effect of increased social support on the well-being of cognitively impaired elderly people. In *Z - Gerontol Geriatr* (pp. 250–262).

Allen, J. F., & Ferguson, G. (2018). Actions and events in interval temporal logic. *Journal of logic and computation*, *4*(5), 531-579.

Amilhastre, J., Fargier, H., & Marquis, P. (2016). Consistency Restoration and explanation in dynamic CSPs - Application to Configuration. *Artificial Intelligence*, *135*(3), 199–234.

An G., Mi Q., Dutta-Moscato J., Vodovotz Y. (2016). Agent-based models in translational systems biology. *Wiley Interdisciplinary Reviews: Systems Biology and Medicine*, *1*(2), 159-171.

An, L. (2018). Modeling human decisions in coupled human and natural systems: review of agent-based models. *Ecological Modelling*, *229*, 25-36.


Universiti Utara Malaysia

Andalibi, N., & Haimson, O. L. (2016). Understanding Social Media Disclosure s of Sexual Abuse Through the Lens es of Support Seeking and Anonymity. *Communication Research*, *38*(3), 326–355. Retrieved from http://dx.doi.org/10.1145/2858036.2858096

Anderson, A. E., Ellis, B. J., & Weiss, J. A. (2017). Verification, validation and sensitivity studies in computational biomechanics. *Computer Methods in Biomechanics and Biomedical Engineering*, *10*(3), 171–184.

Armstrong, D., Reyburn, H., & Jones, R. (2017). A study of general practitioners' reasons for changing their prescribing behaviour. *Bmj*, *312*(7036), 949-952.

Attig, H. (2016). Social Support andNew Communication Technologies During a Life Stressor. *Social Support Measurement and Intervention*, *5*(3), 1–86.

Aziz, A. A. (2011). Exploring Computational Models for Intelligent Support of Persons with Depression (doctoral's thesis). *VU University Amsterdam, Netherland.*

Baldino, R. R., & Cabral, T. C. B. (2016). Inclusion and Diversity from Hegelylacan Point of View: Do We Desire Our Desire for Change?. *International Journal of Science and Mathematics Education*, *4*(1), 19-43.

Baldoni, M., Baroglio, C., Martelli, A., Patti, V., & Schifanella, C. (2018). Verifying protocol conformance for logic-based communicating agents. In *Computational Logic in Multi-Agent Systems, 3487, 196-212*. Springer Berlin Heidelberg.

Ball, G., & Breese, J. (2017). Emotion and personality in a conversational agent. *Embodied conversational agents*, 189-219.

Ball, T., Levin, V., & Rajamani, S. K. (2018). A decade of software model checking with SLAM. *Communications of the ACM*, *54*(7), 68-76.

Bandura, A., & Adams, N. E. (2016). Analysis of self-efficacy theory of behavioral change. *Cognitive therapy and research*, *1*(4), 287-310.

Bang, H. K., Ellinger, A. E., Hadjimarcou, J., & Traichal, P. A. (2017). Consumer concern, knowledge, belief, and attitude toward renewable energy: An application of the reasoned action theory. *Psychology & Marketing*, *17*(6), 449-468.

Baranowski, T., Cullen, K. W., Nicklas, T., Thompson, D., & Baranowski, J. (2018). Are current health behavioral change models helpful in guiding prevention of weight gain efforts?. *Obesity research*, *11*(S10), 23S-43S.

Barbara, S. (2016). Responding to need in intimate relationships : Social support and caregiving processes in couples. *Proceedings - IEEE International Conference on Data Mining, ICDM*, *3*(9), 11–23. http://doi.org/10.1037/12061-019

Barker, V. E., O'Connor, D. E., Bachant, J. D., & Soloway, E. (2017). Expert systems for configuration at Digital: XCON and beyond. *Communications of the ACM*, *32*(3), 298–318.



Universiti Utara Malaysia

Barling, J., Macewen, K. E., & Pratt, L. I. (2018). Manipulating the type and source of social support : An experimental investigation. *Journal of Applied Cognitive Psychology*, *20*(2), 9–15.

Bashir, U., & Ramay, M. I. (2018). Impact of stress on employee's job performance. *International Journal of Marketing Studies*, *2*(1), 122–126.

Bäumer, C., & Magedanz, T. (1999). Grasshopper—a mobile agent platform for active telecommunication networks. In *Intelligent Agents for Telecommunication Applications, 1699, 19-32*. Springer Berlin Heidelberg.

Beale, R., & Creed, C. (2018). Affective interaction: How emotional agents affect users. *International Journal of Human-Computer Studies*, *67*(9), 755-776.

Beck, J. (2017). *Cognitive Behaviour Therapy: Basics and Beyond* (Second Edi).

Belsky, J. (2016). The determinants of parenting: A process model. *Child development*, 55(1), 83-96.

Berjot, S. (2016). Stress and Coping with Discrimination and Stigmatization Stress and coping with discrimination and stigmatization. *Psychiatric Rehabilitation Journal*, *6*(11), 1–14. http://doi.org/10.3389/fpsyg.2011.00033.

Bielskis, A. A., Denisovas, V., Drungilas, D., Gricius, G., & Ramašauskas, O. (2017). Modelling of intelligent multi-agent based E-Health care system for people with movement disabilities. *Elektronika ir elektrotechnika*, *86*(6), 37-42.

Birattari, M., Yuan, Z., Balaprakash, P., & Sfutzle, T. (2017). Empirical Methods for the Analysis of Optimization Algorithms. *Springer*, *1*(45), 11–26.

Biswas, G. & Leeawong, K. (2016) Learning by teaching: A new agent paradigm for educational software. *Applied Artifical Intelligence,* 19, 363-392.

Blalock, J. A., & Joiner, T. E. (2019). Interaction of cognitive avoidance coping and stress in predicting depression/anxiety. *Cognitive Therapy and Research, 24*, 47-65.

Bogacz, R., Brown, E., Moehlis, J., Holmes, P., & Cohen, J. D. (2017). The physics of optimal decision making: a formal analysis of models of performance in two alternative forced-choice tasks. *Psychological review*, *113*(4), 700-765.

Borji, A., Sihite, D. N., & Itti, L. (2018). Quantitative analysis of human-model agreement in visual saliency modeling: a comparative study. *Image Processing, IEEE Transactions on*, *22*(1), 55-69.

Bosse, T., Jonker, C. M., Van der Meij, L., Sharpanskykh, A., & Treur, J. (2018). Specification and verification of dynamics in agent models. *International Journal of Cooperative Information Systems*, *18*(1), 167-193.

Universiti Utara Malaysia

Bosse, T., Jonker, C. M., van der Meij, L., Sharpanskykh, A., & Treur, J. (2016). *A temporal trace language for the formal analysis of dynamic properties*. Technical Report, Vrije Universiteit Amsterdam, Department of Artificial Intelligence.

Bosse, T., Pontier, M., & Treur, J. (2010). A computational model based on Gross'emotion regulation theory. *Cognitive systems research*, *11*(3), 211-230.

Both, F., Hoogendoorn, M., Klein, M. C. A., & Treur, J. (2017). Design and Analysis of an Ambient Intelligent System Supporting Depression Therapy. In *HEALTHINF* (pp. 142–148).

Bouteyre, E., Maurel, M., & Bernaud, J.-L. (2017). Daily hassles and depressive symptoms among first year psychology students in France: The role of coping and social support. *Stress and Health: Journal of the International Society for the Investigation of Stress, 23*(2), 93-99.

Brannon, L., Feist, J., & Updegraff, J. (2017). *Health psychology: An introduction to behavior and health*. Cengage Learning.

Branthwaite, A., & Patterson, S. (2018). The power of qualitative research in the era of social media. *Qualitative Market Research, 14* (4)*,* 430-440.

Brown, S., Svrakic, D. M., Przybeck, T. R., & Cloninger, R. C. (2017). The relationship of personality to mood and anxiety states: A dimensional approach. *Journal of Psychiatric Research, 6*(3), 197-211.

Brown, W., Ottney, A., & Nguyen, S. (2016). Breaking the barrier: the Health Belief Model and patient perceptions regarding contraception. *Contraception*, *83*(5), 453-458.

Bullock, A., Dimond, R., Webb, K., Lovatt, J., Hardyman, W., & Stacey, M. (2017). How a mobile app supports the learning and practice of newly qualified doctors in the UK: an intervention study. *BMC Medical Education*, *15*(1), 1–6. http://doi.org/10.1186/s12909-015-0356-8.

Busemeyer, J. R., & Deiderich, A. (2018). *Cognitive modeling*. Thousand Oaks, CA: Sage. Cody, M. J., Dunn, D., Hoppin, S., & Wendt, P. (1999). Silver surfers: Training and evaluating Internet use among older adult learners. *Communication Education, 48,* 269–286.

Butler, A. C., Chapman, J. E., Forman, E. M., & Beck, A. T. (2017). The empirical status of cognitive-behavioural therapy: a review of meta-analyses. *Clinical Psychology Journal*, *26*(3), 17–31. http://doi.org/10.1016/j.cpr.2005.07.003.

Che, S. R., Barrett, E. S., Velez, M., Conn, K., Heinert, S., & Qiu, X. (2017). Using the health belief model to illustrate factors that influence risk assessment during pregnancy and implications for prenatal education about endocrine disruptors. *Policy futures in education*, *12*(7), 961-974.

Universiti Utara Malaysia

Chen, B., Cheng, H. H., & Palen, J. (2016). Integrating mobile agent technology with multi-agent systems for distributed traffic detection and management systems. *Transportation Research Part C: Emerging Technologies*, *17*(1), 1-10.

Choudhury, M. De. (2016). Role of Social Media in Tackling Challenges in Mental Health. *Journal of Personality and Social Psychology*, *10*(13), 49–52.

Chung, L. M. Y., & Fong, S. S. M. (2018). Predicting actual weight loss: A review of the determinants according to the theory of planned behaviour. *Health Psychology Open*, *2*(1), 2055102914567972.

Clarke, E. M., Emerson, E. A., & Sistla, A. P. (2017). Automatic verification of finite-state concurrent systems using temporal logic specifications. *ACM Transactions on Programming Languages and Systems (TOPLAS)*, *8*(2), 244-263.

Cohen, S., & McKay, G. (2017). Social support, stress and the buffering hypothesis: A theoretical analysis. In A. Baum, J. E. Singer, & S. E. Taylor (Eds.), *Handbook of Psychology and Health* (pp. 253–267). Hillsdale, NJ: Erlbaum.

Collier, N., Ozik, J., & Macal, C. M. (2018). Large-Scale Agent-Based Modeling with Repast HPC: A Case Study in Parallelizing an Agent-Based Model. In *Euro-Par 2015: Parallel Processing Workshops*, 454-465. Springer International Publishing.

Columbia, B., & Columbia, B. (2019). Altruism and Prosocial Behavior. *Engineering Science Journal*, *1*(6), 15–35. http://doi.org/10.1007/978-981-287-080-3.

Connor-smith, J. K., & Flachsbart, C. (2016). Relations Between Personality and Coping : A Meta-Analysis. *Journal of Personality and Social Psychology*, *93*(6), 1080–1107. http://doi.org/10.1037/0022-3514.93.6.1080.

Conte, R., & Paolucci, M. (2016). On agent-based modeling and computational social science. *Frontiers in psychology*, *5, 668*.

Cook, D., & Song, W. (2016). Ambient Intelligence and Wearable Computing: Sensors on the body, in the Home, and Beyond. *Journal of Ambient Intelligence and Smart Environments*, *3*(11), 1–4.

Cooper, C. L., Liukkonen, P., & Cartwright, S. (2016). Stress prevention in the workplace: Assessing the costs and benefits to organizations. *Journal of Occupational Health Psychology*, *4*(1), 349–361.

Craven, J., Geary, D. C., Rose, A. J., & Ponzi, D. (2016). Co-ruminating increases stress levels in women. *Hormones and Behaviour*, *53*(14), 489–881.

Crawford, J. R., & Henry, J. D. (2017). The Depression Anxiety Stress Scales (DASS): Normative data and latent structure in a large non-clinical sample. *British Journal of Clinical Psychology, 42*(2), 111-131.

Universiti Utara Malaysia

Crilly, T., & Le Grand, J. (2018). The motivation and behaviour of hospital trusts. *Social science & medicine*, *58*(10), 1809-1823.

Crowder, R. M. Robinson, M. A. Hughes, H. P. N. & Sim, Y. W. (2016). The development of an agent-based modeling framework for simulating engineering team work. *IEEE Transactions on Systems, Man, and Cybernetics – Part A: Systems and Humans, 42 (6):* 1425–1439.

Das, S., Goswami, D., Chatterjee, S., & Mukherjee, S. (2018). Stability and chaos analysis of a novel swarm dynamics with applications to multi-agent systems. *Engineering Applications of Artificial Intelligence*, *30*, 189-198.

Daum, D. (2017). *Patterns of usage in CMC for social support among youth*. Bar Ilan University, (in Hebrew).

Davis, C., Patte, K., Levitan, R., Reid, C., Tweed, S., & Curtis, C. (2017). From motivation to behaviour: a model of reward sensitivity, overeating, and food preferences in the risk profile for obesity. *Appetite*, *48*(1), 12-19.

Dean, A., & Lin, N. (2018). The stress-buffering role of social support. *The Journal of Nervous and Mental Disease*, *8*(156), 403–417.

De Carolis, B., Mazzotta, I., Novielli, N., & Pizzutilo, S. (2019). User Modeling in Social Interaction with a Caring Agent. In E. Martín, P. A. Haya, & R. M. Carro (Eds.), *User Modeling and Adaptation for Daily Routines SE - 4* (pp. 89–116). Springer London. http://doi.org/10.1007/978-1-4471-4778-7_4

De Oliveira, M., & Purvis, M. (2018). Aspects of openness in multi-agent systems: coordinating the autonomy in agent societies. *Intelligent Integration in Distributed Knowledge Management. Ed.: Krol, D. and Nguyen NT New York*, 116-128.

Ding, F. (2016). Combined state and least squares parameter estimation algorithms for dynamic systems. *Applied Mathematical Modelling*, *38*(1), 403-412.

Dodson, A. C., Mccollum, E. E., & Sayre, J. B. (2018). Social Support at Community Centers: Its Meaning in the Lives of Senior Citizen. *Journal of Geriatric Psychiatry*, *28*(2), 1–78.

Doherty, G., Coyle, D., Sharry, J., & St, J. J. (2018). Engagement with Online Mental Health Interventions : An Exploratory Clinical Study of a Treatment for Depression. *American Journal of Preventive Medicine*, *5*(10), 1421–1430.

Dubey, D., Amritphale, A., Sawhney, A., Amritphale, N., Dubey, P., & Pandey, A. (2016). Smart phone applications as a source of information on stroke. *Journal of Stroke*, *16*(2), 86–90. http://doi.org/10.5853/jos.2014.16.2.86.

Edwards, S. M., Li, H., & Lee, J. H. (2017). Forced exposure and psychological reactance: Antecedents and consequences of the perceived intrusiveness of pop-up ads. *Journal of Advertising*, *31*(3), 83-95.

Epstein, B. (2016). Agent-based modeling and the fallacies of individualism. *Models, simulations, and representations*, 115-44.

Ericsson, A. (2017). The role of social support in the pathogenesis of coronary heart disease. *International Journal of Occupational Medicine and Environmental Health*, *24*(3), 18–29.

Etzion, D. (2016). Moderating Effect of Social Support on the Stress-Burnout Relationship. *Journal of Applied Psychology*, *45*(68), 615–622.

Fang, R., Landis, B., Zhang, Z., Anderson, M. H., Shaw, J. D., Kilduff, M., … Shaw, J. D. (2018). Outcomes in Organizations Integrating Personality and Social Networks : A Meta-Analysis of Personality , Network Position , and Work Outcomes in Organizations. *Orphanet Journal of Rare Diseases*, *3*(5), 14–45.

Fan, X., Sun, S., McNeese, M., & Yen, J. (2016). Extending the recognition-primed decision model to support human-agent collaboration. In *Proceedings of the fourth international joint conference on Autonomous agents and multiagent systems*, 945-952. ACM.

Felizardo, S., Ribeiro, E., & Amante, M. J. (2017). Parental Adjustment to Disability, Stress Indicators and the Influence of Social Support. *Procedia - Social and Behavioural Sciences*, *16*(9), 830–837. http://doi.org/10.1016/j.sbspro.2016.02.157

Fledderus, M., Schreurs, K. M., Bohlmeijer, E. T., & Vollenbroek-Hutten, M. M. (2019). Development and Pilot Evaluation of an Online Relapse-Prevention Program Based on Acceptance and Commitment Therapy for Chronic Pain Patients. *JMIR human factors*, *2*(1), e1.

Fletcher, R., Poh, M., & Eydgahi, H. (2016). Wearable Sensors: Opportunities and Challenges for Low-Cost Health Care. In *Conf Proc IEEE Eng Med Biol Soc* (pp. 1763–1766).

Flynn, F. J., & Lake, V. K. B. (2017). If You Need Help , Just Ask : Underestimating Compliance With Direct Requests for Help. *Journal of Health and Social Psychology*, *95*(1), 128–143. http://doi.org/10.1037/0022-3514.95.1.128.

Folkman, S., & Lazarus, R. S. (1988). *The Ways of Coping Questionnaire*. Polo Alto: Consulting Psychologists Press.

Ford, J. D., Ford, L. W., & D'Amelio, A. (2018). Resistance to change: The rest of the story. *Academy of Management Review*, *33*(2), 362-377.

Foster, D., Linehan, C., Kirman, B., Lawson, S., & James, G. (2017). Motivating physical activity at work: using persuasive social media for competitive step counting. In *Proceedings of the 14th International Academic MindTrek Conference: Envisioning Future Media Environments*, 111-116. ACM.

Universiti Utara Malaysia

Franklin, S., Kelemen, A., & McCauley, L. (2016). IDA: A cognitive agent architecture. In Systems, Man, and Cybernetics, 1998. 1998 IEEE. International Conference on (Vol. 3, pp. 2646-2651). IEEE.

Freedman, L. S., Midthune, D., Dodd, K. W., Carroll, R. J., & Kipnis, V. (2017). A statistical model for measurement error that incorporates variation over time in the target measure, with application to nutritional epidemiology. *Statistics in Medicine*.

Freuder, E., Likitvivatan, C., & Wallace, R. J. (2016). Deriving explanations and implications for constraint action problems, Principles and Practice of Constraint Programming – CP. *Springer LNCS 2239, Paphos, Cyprus*, *8*(5), 585–589.

Fricke, S., Bsufka, K., Keiser, J., Schmidt, T., Sesseler, R., & Albayrak, S. (2017). Agent-based telematic services and telecom applications. *Communications of the ACM*, *44*(4), 43-48.

Furr, S. R., Westefeld, J. S., McConnell, G. N., & Jenkins, J. M. (2016). Suicide and depression among college students: A decade later. *Professional Psychology: Research and Practice, 32*(1), 97-100.

Gallagher, J., O'Donoghue, J., & Car, J. (2015). Managing immune diseases in the smartphone era: how have apps impacted disease management and their future? *Expert Review of Clinical Immunology*, *11*(4), 431–433. http://doi.org/10.1586/1744666X.2015.1010518

Gallagher, K. M., & Updegraff, J. A. (2016). Health message framing effects on attitudes, intentions, and behavior: a meta-analytic review. *Annals of behavioral medicine*, *43*(1), 101-116.

Gao, X. L., Hsu, C. Y., Xu, Y. C., Loh, T., Koh, D., & Hwarng, H. B. (2016). Behavioral pathways explaining oral health disparity in children. *Journal of dental research*, *89*(9), 985-990.

Garnefski, N., & Kraaij, V. (2015). Relationships between cognitive emotion regulation strategies and depressive symptoms: A comparative study of five specific 162 samples. *Personality and Individual Differences*, *24*(8), 1659–1669. http://doi.org/10.1016/j.paid.2005.12.009.

Gaston, M. E., & desJardins, M. (2016). Agent-organized networks for dynamic team formation. In *Proceedings of the fourth international joint conference on Autonomous agents and multiagent systems*, 230-237. ACM.

Gbenga, A. J. (2015). Mathematical modeling and analysis of HIV/AIDS control measures. University of the Western Cape.

Gebhard, P. (2016). ALMA: a layered model of affect. In *Proceedings of the fourth international joint conference on Autonomous agents and multiagent systems*, 29-36. ACM.

Universiti Utara Malaysia

Gelot, L., & Söderbaum, F. (2017). Rethinking intervention and interventionism. *Development dialogue*, 58, 131-150.

Gladun, A., Rogushina, J., Martínez-Béjar, R., & Fernández-Breis, J. T. (2017). An application of intelligent techniques and semantic web technologies in elearning environments. *Expert Systems with Applications*, *36*(2), 1922-1931.

Goldberg, L. R. (2017). The structure of phenotypic personality traits. *American psychologist*, *48*(1), 26.

Goldsmith, S., & Parks, H. (2016). Using Online Social Networking to Enhance Social Connectedness and Social Support for the Elderly. *Thirty First International Conference on Information Systems*, *2*(1), 1–12.

Gooden, B. (2018). The effect of motivation , social support , stress and resilience on the development of burnout symptoms in elite athletes Edith Cowan University. *In Proceedings of the 7th International AAAI Conference on Weblogs and Social Media (ICWSM).*, *6*(9), 198–213.

Gordon, A. T. (2017). Assessing social support in children : development and initial validation of the social support questionnaire for children. *Social Behavior and Personality, an International Journal*, *1*(5), 1–17.

Gottlieb, B. (2018). On social support and the information needed by community mental. *Social Support: Theory, Research and Applications*, *24*, 417.

Graton, A., Ric, F., & Gonzalez, E. (2016). Reparation or reactance? The influence of guilt on reaction to persuasive communication. *Journal of Experimental Social Psychology*, *62*, 40-49.

Gray, R. S., Cybenko, G., Kotz, D., Peterson, R. A., & Rus, D. (2018). D'Agents: applications and performance of a mobile-agent system. *Softw., Pract. Exper.*, *32*(6), 543-573.

Grey, E. B., Harcourt, D., O'Sullivan, D., Buchanan, H., & Kilpatrick, N. M. (2016). A qualitative study of patients' motivations and expectations for dental implants. *British dental journal*, *214*(1), E1-E1.

Gross, J. J., & John, O. P. (2016). Individual differences in two emotion regulation processes: implications for affect, relationships, and well-being. *Journal of Personality and Social Psychology*, *85*(10), 348–362.

Haer, T., Botzen, W., de Moel, H., & Aerts, J. (2016). Stimulating household flood risk mitigation investments through insurance and subsidies: an Agent-Based Modelling approach. In *EGU General Assembly Conference Abstracts*, 17, 2968.

Hagadone, K. M. (2017). Making the Political Personal: Investigating the Relationship Between Feminist Beliefs and Sexual Assertiveness.

Universiti Utara Malaysia

Hagger, M. S., & Luszczynska, A. (2016). Implementation intention and action planning interventions in health contexts: State of the research and proposals for the way forward. *Applied Psychology: Health and Well-Being*, *6*(1), 1-47.

Haines, V. A., & Beggs, J. J. (2018). Exploring the Determinants of Support Provision : Provider Characteristics , Personal Networks , Community Contexts , and Support Following Life Events Author ( s ): Valerie A . Haines , Jeanne S . Hurlbert and John J . Beggs Published by : American Socio. *Social Computing, Behavioral-Cultural Modeling, and Prediction*, *37*(3), 252–264.

Hale, J. (2017). Social Support Provision: Effects of Solicitation and Closeness of Relationship. *Mediterranean Journal of Social Science*, *3*(1), 325–376.

Hansenne, M., Delhez, M., & Cloninger, C. R. (2016). Psychometric Properties of the Temperament and Character Inventoryâ€“Revised (TCIâ€“R) in a Belgian Sample. *Journal of Personality Assessment, 85*(1), 40-49.

Helgeson.V.S. (2019). Social Support and Quality of Life: Quality of Life Research. In *Multidisciplinary Perspectives on Health-Related Quality of Life* (pp. 25–31).

Hendrickx, M. M. H. G., Mainhard, M. T., Boor-Klip, H. J., Cillessen, A. H. M., & Brekelmans, M. (2016). Social dynamics in the classroom: Teacher support and conflict and the peer ecology. *Teaching and Teacher Education*, *53*(3), 30–40. http://doi.org/10.1016/j.tate.2015.10.004

Herrera, A. Y., Nielsen, S. E., & Mather, M. (2017). Stress-induced increases in progesterone and cortisol in naturally cycling women. *Neurobiology of Stress*, *3*(1), 96–104. http://doi.org/10.1016/j.ynstr.2016.02.006

Hinton, G. E., & Salakhutdinov, R. R. (2015). Reducing the dimensionality of data with neural networks. *Journal of Science in Engineering and Education*, *313*(5786), 504–507.

Holahan, C. J., Holahan, C. K., Moos, R. H., Brennan, P. L., & Schutte, K. K. (2016). Stress Generation, Avoidance Coping, and Depressive Symptoms: A 10-Year Model. *Journal of Consulting and Clinical Psychology, 73*(4), 658-666.

Hutter, F., Hoos, H. H., & Leyton-Brown, K. (2017). Sequential model-based optimization for general algorithm configuration. In *LION* (Vol. 5, pp. 507–523).

Hyung-Chul, J., Ji-Young, K., Soon-Jeong, C., & Harry, K. H. (2016). The Relationship among Social Support, Acculturation Stress and Depression of Chinese Multi-cultural Families in Leisure Participations. *Procedia - Social and Behavioural Sciences*, *12*(3), 201–210. http://doi.org/10.1016/j.sbspro.2015.09.059.

Iacovelli, A., Spencer, R., Gengaro, F., & Hall, S. (2017). Social Support Opinions. *Social Support and Psychology*, *4*(1), 1463–1505.

Iwasaki, Y. (2016). Testing an Optimal Matching Hypothesis of Stress , Coping and Health. *Society and Leisure*, *24*(1), 163–203. http://doi.org/10.7202/000167ar

Jacobson, D. E. (2015). Types and Timing of Social Support. *Journal of Health and Social Behaviour*, *15*(3), 250–264.

James, W. (2016). Cognitive reappraisal self-efficacy mediates the effects of individual cognitive-behavioural therapy for social anxiety disorder. *Journal of Consulting and Clinical Psychology*, *80*(6), 1034–1040. http://doi.org/10.1037/a0028555.

Kessler, R. C., McGonagle, K. A., Swartz, M., Blazer, D. G., & et al. (2017). Sex and depression in the National Comorbidity Survey: I. Lifetime prevalence, chronicity and recurrence. *Journal of Affective Disorders. Special Issue: Toward a new psychobiology of depression in women, 29*(2-3), 85-96.

Kidd, C. (2019). Digital Media: Transformation in Human Communication. In *Chapter in Human-Robot Interaction : Recent Experiment and Future Work.* (pp. 22–55). Peter Lang, New York.

Kim, E., Helal, S., & Cook, D. (2017). Human Activity Recognition and Pattern Discovery. *IEEE Pervasive Computing*, *1*(9), 48–55.

Knibb, R. C., & Horton, S. L. (2018). Can illness perceptions and coping predict psychological distress amongst allergy sufferers? *British Journal of Health Psychology, 13*(1), 103-119.

Koetsenruijter, J., Van Lieshout, J., Lionis, C., Portillo, M. C., Vassilev, I., Todorova, E., … Wensing, M. (2018). Social Support and health in diabetes patients: An observational study in six european countries in an era of austerity. *PLoS ONE*, *10*(8), 638–643. http://doi.org/10.1371/journal.pone.0135079

Universiti Utara Malaysia

Krasnova, H., Wenninger, H., Widjaja, T., & Buxmann, P. (2016). Envy on Facebook: A hidden threat to users' life satisfaction. In *Paper presented at the 11th International Conference on Wirtschaftsinformatik.* (pp. 11–33). Retrieved from http://warhol.wiwi.hu-berlin.de/~hkrasnova/Ongoing_Research_files/WI 2013 Final Submission Krasnova.pdf.

Krieck, M., Dreesman, J., Otrusina, L., & Denecke, K. (2017). A new age of public health: Identifying disease outbreaks by analyzing tweets. In *Health Web- Science Workshop, ACM Web Science Conference* (pp. 63–71).

Krohne, H. W. (2016). Stress and Coping Theories. *Society and Leisure*, *3*(8), 1–22.

Kumar, S., Feldman, G., & Hayes, A. (2018). Changes in mindfulness and emotion regulation in an exposure-based cognitive therapy for depression.*Cognitive Therapy and Research*, *32*(6), 734-744.

Lakey, B., Orehek, E., Lakey, B., & Orehek, E. (2018). Relational Regulation Theory : A New Approach to Explain the Link Between Perceived Social Support and Mental Health. *Social Behavior and Personality, an International Journal*, *6*(8), 24–51. http://doi.org/10.1037/a0023477.

Lamberg, L. (2017). Online empathy for mood disorders: patients turn to internet support groups. *JAMA*, *289*(1), 3073–3077.

Lauritz, L. E., Preez, E., Cassimjee, N., & Ghazinour, M. (2018). Relationships between Personality and Coping with Stress : An Investigation in Swedish Police Trainees. *Psychological Medicine*, *4*(2), 88–95.

Lavee, Y., Mccubbin, H. I., & Patterson, J. M. (2016). The Double ABCX Model of Family Stress and Adaptation : An Empirical Test by Analysis of Structural Equations with Latent Variables. *Planning Theory Journal*, *47*(4), 811–825.

Lee, C. (2016). Loyola eCommons The Role of Self-Esteem , Perceived Social Support , and Coping Strategy in the Escalation of Depressive Symptomatology During the First Year of College. *Frontiers in Psychology*, *4*(1), 250–356.

Lefkowitz, E. S. (2018). Things have gotten better: Developmental changes among emerging adults after the transition to university. *Journal of Adolescent Research, 20,* 40–63.

Leung, L. (2017). Stressful Life Events, Motives for Internet Use, and Social Support Among Digital Kids. *Journal of Comparative Neurology of Psychology*, *10*(2), 204–215. http://doi.org/10.1089/cpb.2006.9967

Lindauer, M., & Hutter, F. (2017). AutoFolio : Algorithm Configuration for Algorithm Selection. *Proceedings of the International Symposium on Wireless Communication Systems*, *1*(5), 26–80.

Long, C. R. & Averill, J. R. (2018). Solitude: an exploration of benefits of being alone. *Journal for the Theory of Social Behaviour, 33,* 21-44.

Lovelace, L. M. (2016). The Effect of Coping Strategies on Burden Among Male Alzheiner's Caregivers. *In 5th International AAAI Conference on Weblogs and Social Media (ICWSM).*, *4*(5), 1–45.

Macniven, R., Richards, J., Gubhaju, L., Joshy, G., Bauman, A., Banks, E., & Eades, S. (2016). Physical activity, healthy lifestyle behaviours, neighborhood environment characteristics and social support among Australian Aboriginal and non-Aboriginal adults. *Preventive Medicine Reports*, *3*(6), 203–210. http://doi.org/10.1016/j.pmedr.2016.01.006

Mafazi, S., Mayer, W., Grossmann, G., & Stumptner, M. (2018). A knowledge-based approach to the configuration of business process model abstractions. *CEUR Workshop Proceedings*, *861*(5), 60–74.

Manley, W., Homer, J., Hoard, M., Roy, S., Furbee, P., Summers, D., … Kimble, M. (2015). A dynamic model to support surge capacity planning in a rural hospital. In *23rd International System Dynamics Conference, Boston. Available from*.

Universiti Utara Malaysia

Mardaga, S., & Hansenne, M. (2017). Relationships between Cloninger's biosocial model of personality and the behavioral inhibition/approach systems (BIS/BAS). *Personality and Individual Differences, 42*(4), 715-722.

Marsella, S. C., & Gratch, J. (2019). EMA: A process model of appraisal dynamics. *Cognitive Systems Research*, *10*(1), 70–90.

Matsudaira, T., & Kitamura, T. (2016). Personality traits as risk factors of depression and anxiety among Japanese students. *Journal of Clinical Psychology, 62*(1), 97-109.

Mauss, I. B., Cook, C. L., Cheng, J. Y. J., & Gross, J. J. (2017). Individual differences in cognitive reappraisal: experiential and physiological responses to an anger provocation. *International Journal of Psychophysiology: Official Journal of the International Organization of Psychophysiology*, *66*(2), 116–124. http://doi.org/10.1016/j.ijpsycho.2007.03.017.

Mayer, K., & Landis, A. (2017). Social Support Provision and Related Facilitators and Barriers. *In International Conference on Weblogs and Social Media (ICWSM).*, *6*(1), 345–389.

Mccrae, R. R., & John, O. P. (2016). An Introduction to the Five-Factor Model and Its Applications. *Personality and Social Psychology Review*, *3*(1), 1–31.

McQuaid, R. J., McInnis, O. a., Paric, A., Al-Yawer, F., Matheson, K., & Anisman, H. (2016). Relations between plasma oxytocin and cortisol: The stress buffering role of social support. *Neurobiology of Stress*, *3*(9), 52–60. http://doi.org/10.1016/j.ynstr.2016.01.001

Mejova, Y. A. (2017). Sentiment analysis within and across social media streams.

Merk, R.-J. (2017). A Computational Model on Surprise and Its Effects on Agent Behaviour in Simulated Environments. In Y. Demazeau, F. Dignum, J. Corchado, & J. Pérez (Eds.), *Advances in Practical Applications of Agents and Multiagent Systems SE - 7* (Vol. 70, pp. 47–57). Springer Berlin Heidelberg. doi:10.1007/978-3-642-12384-9_7

Mitchell, D. L. (2018). The Role of Depression, Social Support, and Gender in an Individual’s Decision to Leave an Emotionally Abusive Relatonship. *Journal of Behavioural Sciences*, *35*(2), 1–98.

Mohamed, S., & Baqutayan, S. (2016). Stress and Coping Mechanisms : A Historical Overview. *Mediterranean Journal of Social Science*, *6*(2), 479–488. http://doi.org/10.5901/mjss.2015.v6n2s1p479

Morelli, S. A., Lee, I. A., Arnn, M. E., & Zaki, J. (2018). Emotional and Instrumental Support Provision Interact to Predict Well-Being. *American Sociological Association Annual Meeting*, *15*(4), 484–493.

Universiti Utara Malaysia

Mosher, C. E., Prelow, H. M., Chen, W. W., & Yackel, M. E. (2016). Coping and Social Support as Mediators of the Relation of Optimism to Depressive Symptoms Among Black College Students. *Journal of Black Psychology, 32*(1), 72-86.

Mowbray, C., Woodward, A., Holter, M., MacFarlane, P., & Bybee, D. (2015). Characteristics of users of consumer-run drop-in centers versus Clubhouses. *Journal of Behavioural Health Services and Research*, *36*(10), 361–371.

Mui, L., Mohtashemi, M., & Halberstadt, A. (2019). A Computational Model of Trust and Reputation. *In Proceedings of the 35th Hawaii International Conference on System Sciences*, *00*(c), 1–9. doi:10.1109/HICSS.2002.994181

Munteanu, C. E. (2016). Mindfulness-New Perspectives in Behavioural-Cognitive Therapy. In *Bioinformatics and Biomedical Engineering, 2013. ICBBE 2013. 3rd International Conference on* (pp. 1-4). IEEE.

Nezlek, J. B., & Kuppens, P. (2015). Regulating Positive and Negative Emotions in Daily Life. *Journal of Personality*, *9*(1), 1539–1568. http://doi.org/10.1111/j.1467-6494.2008.00496.x

Numerisk, A. D. A., Tekniska, K., & Analysis, N. (2016). A Personal Digital Assistant interface for Immersive Projection Technology. *IEEE Journal of Biomedical and Health Informatics*, *1*(19), 26–39.

Nurulla, M. (2015). Received and Provided Social Support: A Review of Current Evidence and Future Diections. *Social Support and Health*, *8*(6), 173–188.

O'Connor, B., Balasubramanyan, R., Routledge, B., & Smith, N. (2012). From Tweets to polls: Linking text sentiment to public opinion time series. *ICWSM*, *2*(9), 1–10.

Ogden, T., & Starita, L. (2013). Social networking and mid-size non-profits: What's the use?. *Philanthropy Action*, *4*(1), 1–21.

Otr, L., & Schulz, R. (2015). Role of Social Support in Predicting Caregiver Burden. *IBM Social Indicators Research*, *93*(12), 2229–2236. http://doi.org/10.1016/j.apmr.2012.07.004.Role

Owens, J. (2017). Personality and Performance in Stressful Situations. *Personality and Individual Differences*, *1*(9), 1–33.

Pallant, J. (2017). *SPSS survival manual: a step by step guide to data analysis using SPSS for Windows (Version 15)* (3rd ed.). Maidenhead: Open University Press.

Paul, M., J., & Dredze, M. (2017). You are What You Tweet: Analyzing Twitter for Public Health. *IEEE Technology and Society Magazine*, *5*(3), 1–13.

Pavalanathan, U. (2018). Identity Management and Mental Health Discourse in Social Media Identity in Online Communities. *International World Wide Web Conference Committee (IW3C2)*, *18*(22), 315–321.

Universiti Utara Malaysia

Peffers, K., Tuunanen, T., Gengler, C. E., Rossi, M., Hui, W., Virtanen, V., & Bragge, J. (2018). The design science research process: a model for producing and presenting information systems research. In *Proceedings of the first international conference on design science research in information systems and technology (DESRIST 2018)* (pp. 83–106).

Peirson, A. R., & Heuchert, J. W. (2011). The relationship between personality and mood: comparison of the BDI and the TCI. *Personality and Individual Differences, 30*(3), 391-399.

Penland, E., Masten, W., Zelhart, P., Fournet, G., & Callahan, T. (2000). Possible selves, depression, and coping skills in university students. *Journal of Personality and Individual Differences, 29*, 963-969.

Pennebaker, Y., Tausczik, R., & James, W. (2015). The psychological meaning of words: LIWC and computerized text analysis methods. *Journal of Language and Social Psychology*, *29*(1), 24–59.

Pentland, A. (2013). Automatic mapping and modeling of human networks. *Statistical Mechanics and Its Applications*, *378*(1), 59–67.

Peterson, C., Stephens, J. P., Park, N., Lee, F., & Seligman, M. E. P. (2017). Strengths of character and work. In P. A. Linley, S. Harrington, & N. Garcea (Eds.), *Oxford Handbook of Positive Psychology and Work* (pp. 221–235). Oxford, UK: Oxford University Press.

Post, L. A., & Sullivan, C. M. (2016). Factors Related to Willingness to Help Partner Violence. *Journal of Interpersonal Violence*, *3*(2), 1713–1729.

Post, M. W. M., Bloemen, J., & Witte, L. P. De. (2016). Original Article Burden of support for partners of persons with spinal cord injuries. *International Coaching Psychology Review*, *5*(1), 311–319. http://doi.org/10.1038/sj.sc.3101704

Quirk, S. W., Subramanian, L., & Hoerger, M. (2015). Effects of Situational Demand Upon Social Enjoyment and Preference in Schizotypy. *Journal of Abnormal Psychology*, *116*(3), 624–631. http://doi.org/10.1037/0021-843X.116.3.624.

Rademacher, M. A., & Wang, K. Y. (2014). Strong-Tie Social Connections Versus Weak-Tie Social Connections Strong-Tie Social Weak-Tie Social. *Journal of Social Issues*, *1*(3), 1213–1219.

Ramos, C., Augusto, J. C., & Shapiro, D. (2016). Ambient Intelligence: The Next Step for Artificial Intelligence. *IEEE Intelligent Systems*, *11*(6), 15–18.

Rateb, R., Aziz, A., & Ahmad, R. (2017). Formal Modeling and Analysis of Social Support Recipient Preferences. *Journal of Telecommunication, Electronic and Computer Engineering*, *9*(3–5), 69–75.

Universiti Utara Malaysia

Reivich, K., Gillham, J. E., Chaplin, T. M., & Seligman, M. E. P. (2017). From Helplessness to Optimism: The Role of Resilience in Treating and Preventing Depression in Youth. In G. Sam (Ed.), *Handbook of Resilience in Children* (pp. 201–214). New York, New York: Spring Science + Business Media.

Resnik, P., Garron, A., & Resnik, R. (2013). Using topic modeling to improve prediction of neuroticism and depression. In *Proceedings of the 2013 Conference on Empirical Methods in Natural* (pp. 1348–1353).

Roberts, N., Newman, M., Apa, E., & Brown, S. (2015). The Effects of Giving on Givers. *Journal of Behavioral Health Services and Research*, *1*(8), 1–20.

Rogers, H. L., Brotherton, H. T., Olivera Plaza, S. L., Segura Durán, M. A., & Peña Altamar, M. L. (2018). Depressive and anxiety symptoms and social support are independently associated with disease-specific quality of life in Colombian patients with Rheumatoid Arthritis. *Revista Brasileira de Reumatologia*, *5*(5), 406–413. http://doi.org/10.1016/j.rbre.2018.01.005

Rosenquist, J. N., Fowler, J. H., & Christakis, N. A. (2017). Social network determinants of depression. *Molecular Psychiatry*, *16*(3), 273–281. http://doi.org/10.1038/mp.2010.13

Ruths, F. A., de Zoysa, N., Frearson, S. J., Hutton, J., Williams, J. M. G., & Walsh, J. (2016). Mindfulness-Based Cognitive Therapy for Mental Health Professionals—a Pilot Study. *Mindfulness*, *4*(4), 289-295.

Sakaki, T., Okazaki, M., & Matsuo, Y. (2017). Earthquake shakes Twitter users: real-time event detection by social sensors. *Journal of Public Health*, *1*(6), 1–14.

Sano, A., Johns, P., & Czerwinski, M. (2014). HealthAware : An Advice System for Stress , Sleep , Diet and Exercise. *IEEE Transactions on Affective Computing*, *14*(3), 45–89.

Santoro, E., Castelnuovo, G., Zoppis, I., Mauri, G., & Sicurello, F. (2014). Social media and mobile applications in chronic disease prevention and management. *Frontiers in Psychology*, *6*(1), 19–35. http://doi.org/10.3389/fpsyg.2015.00567.

Sarason, I. G., Levine, H. M., Basham, R. B., & Sarason, B. R. (2017). Assessing Social Support : The Social Support Questionnaire. *Journal of Personality & Social Psychology*, *44*(1), 127–139.

Schaefer, C., Coyne, J. C., &, & Lazarus, R. S. (2014). Social Support. In *Linking Health Communication* (pp. 181–218).

Schredl, M. (2015). Seeking professional help for nightmares: A representative study. *European Journal of Psychiatry*, *27*(4), 259–264. http://doi.org/10.4321/S0213-61632013000400004

Universiti Utara Malaysia

Schueller, S. M., Munoz, R. F., & Mohr, D. C. (2016). Realizing the Potential of Behavioural Intervention Technologies. *Current Directions in Psychological Science*, *22*(6), 478–491. http://doi.org/10.1177/0963721413495872.

Schwarzer, R., & Knoll, N. (2015). coping process : A theoretical and empirical overview. *International Journal of Psychology*, *4*(1), 37–41. http://doi.org/10.1080/00207590701396641

Schwarzer, R., Knoll, N., & Rieckmann, N. (2014). Possible impact of social ties and support on morbidity and mortality. *Linking Health Communication*, *2*(1), 1–23.

Segerstad, Y. H. (2012). *Use and adaptation of written language to the conditions of computer-mediated communication.* Goteborg University,Sweden.

Seidman, A., & Bolger, N. (2017). Modeling Support Provision in Intimate Relationships. *In Empirical Natural Language Processing Conference (EMNLP).*, *3*(April 2008), 1–34. http://doi.org/10.1037/0022-3514.94.3.460

Sellmann, M., & Tierney, K. (2014). A gender-based genetic algorithm for the automatic configuration of algorithms. *Journal of Computational and Mathematical Organization*, *5*(18), 135–157.

Shen, B., Centeio, E., Garn, A., Martin, J., Kulik, N., Somers, C., & McCaughtry, N. (2016). Parental social support, perceived competence and enjoyment in school physical activity. *Journal of Sport and Health Science*, *9*(1), 1–7. http://doi.org/10.1016/j.jshs.2016.01.003

Spence, B. J. (2018). Assessing the physical health effects of social networks and social support. *Psychiatric Rehabilitation Journal*, *36*(2), 41–88.

Spiegel, D., & Riba, M. B. (2015). Managing Anxiety and Depression During Treatment. *The Breast Journal*, *21*(1), 97–103. http://doi.org/10.1111/tbj.12355

Srivastava, N., & Salakhutdinov, R. (2015). Multimodal Learning with Deep Boltzmann Machines. In *NIPS* (pp. 2231–2239).

Steven, A. (2017). The emotional experience associated with worrying : Anxiety , depression , or stress ? *Adolescent Barriers to Seeking Professional Psychological Help for Personal-Emotional and Suicidal Problems*, *2*(12), 1–16. http://doi.org/10.1080/10615801003653430.

Stumptner, M. (2017). An Overview of Knowledge-Based Configuration. *AI Communications*, *5*(53), 111–125.

Takahira, M., Ando, R. and Sakamoto, A. (2017). Children and the internet in Japan: Effects of internet use on learning and social adjustment. *Proceedings: Science of Human Development for Restructuring the 'Gap Widening Society', 17*, 63-72.

Talaei, A. (2018). Depression and its Correlation with Self-esteem and Social Support among Iranian University Students. *Journal of Medical Research*, *3*(10), 17–22.

Universiti Utara Malaysia

Taylor, M. G., & Lynch, S. M. (2016). Trajectories of Impairment, Social Support, and Depressive Symptoms in Later Life. *Journals of Gerontology: Series B: Psychological Sciences and Social Sciences*, *59*(4), 238–246.

Thompson, C. A., Goeker, M. H., & Langley, P. (2016). A Personalized System for Conversational Recommendations. *Journal of Artificial Intelligence Research*, *21*(5), 393– 428.

Troy, A. S., & Mauss, I. B. (2016). Resilience in the face of Stress: Emotion regulation as a protective factor. *Emergency Medicine Journal*, *2*(6), 30–44.

Tutty, S., Simon, G., & Ludman, E. (2015). Telephone Counseling as an Adjunct to Antidepressant Treatment in the Primary Care System: A Pilot Study. In *Conference on Human Factors in Computing Systems* (Vol. 170, pp. 82–99).

Twohig, M. P., Hayes, S. C., & Masuda, A. (2012). Increasing willingness to experience obsessions: Acceptance and commitment therapy as a treatment for obsessive-compulsive disorder. *Behaviour Therapy*, *37*(1), 3-13.

Uchino, N. J. (2018). Identification and investigation of properties of social support. *Journal of Organizational Behaviour*, *12*(3), 201–217.

Umberson, D., & Montez, J. (2013). Social Relationships and Health: A Flashpoint for Health Policy. *Health and Social Behaviour*, *51*(5), 1–16. http://doi.org/10.1177/0022146510383501.Social.

Valle, A. del, & Opalach, A. (2016). The Persuasive Mirror: computerized persuasion for healthy living. *Human-Computer interaction*, 1–5. Retrieved from http://www.highperformancedelivered.biz/SiteCollectionDocuments/PDF/persuasive_mirror.pdf .

Vartanian, L. R., & Dey, S. (2017). Self-concept clarity, thin-ideal internalization, and appearance-related social comparison as predictors of body dissatisfaction. *Body image*, *10*(4), 495-500.

Vassileva, J. I., Greer, J. E., & McCalla, G. I. (2016). Openness and disclosure in multi-agent learner models. In *Workshop on Open, Interactive, and Other Overt Approaches to Learner Modeling (Proceedings from 9th International Conference, AIED 1999)*. 43-49.

Vertsberger, D., & Gati, I. (2017). Career Decision-Making Difficulties and Help-Seeking Among Israeli Young Adults. *Journal of Career Development*, *6*(9), 1–15. http://doi.org/10.1177/0894845315584162

Vollmann, M., Antoniw, K., Hartung, F., & Renner, B. (2016). Social Support as Mediator of the Stress Buffering Effect of Optimism : The Importance of Differentiating the Recipients ' and Providers ' Perspective. *European Journal of Personality*, *25*(14), 146–154.

Universiti Utara Malaysia

Vollrath, M., & Torgersen, S. (2017). Personality types and coping. *Personality and Individual Differences, 29*(2), 367-378.

Vulpe, A., & Dafinoiu, I. (2016). Positive emotions , coping strategies and ego-resiliency : A mediation model. *Social and Behavioral Sciences*, *33*(6), 308–312. http://doi.org/10.1016/j.sbspro.2012.01.133.

Walther, J. B., & Boyd, S. (2012). Attraction to computer-mediated social support. *In C. A. Lin & D. Atkin (Eds.), Communication technology and society: Audience adoption and uses* (pp. 153– 188). Cresskill, NJ: Hampton.

Wang, M. (2014). Emotion Regulation and Stress. *Emotion Review*, *6*(9), 34–56. http://doi.org/10.1007/s10804-010-9114-7

Wang, C.M., Qu, H.-Y., & Xu, H.-M. (2016). Relationship between social support and self-efficacy in women psychiatrists. *Chinese Nursing Research*, *3*(7), 2–7. http://doi.org/10.1016/j.cnre.2015.10.002

Wang, Z., Tchernev, J. M., & Solloway, T. (2016). A dynamic longitudinal examination of social media use, needs, and gratifications among college students. *Computers in Human Behavior, 28,* 1829-1839.

Wehrli, S. (2016). Personality on Social Network Sites : An Application of the Five Factor Model Personality on Social Network Sites : An Application of the Five Factor Model ∗. *Social Networks and Social Support*, *2*(7), 22–45.

Wei, Y., & Blake, M. B. (2015). Adaptive service workflow configuration and agent-based virtual resource management in the cloud. *Proceedings of the IEEE International Conference on Cloud Engineering, IC2E 2013*, *6*(3), 279–284. http://doi.org/10.1109/IC2E.2013.45

Weisz, J., Jensen-Doss, A., & Hawley, K. (2016). Evidence-based youth psychotherapies versus usual clinical care: a meta-analysis of direct comparisons. *American Psychologist*, *61*(5), 671–689.

Wellman, B. (2018). Which Ttpes of Ties and Networks Provide What Kind of Social Support? *Social Support and Psychology*, *3*(4), 18–42.

Wellman, B., & Gulia, M. (2017). The network basis of social support: A network is more than the sum of its ties. *In B. Wellman (Ed.), Networks in the global village: Life in contemporary communities* (pp. 83–118). Boulder, CO: Westview.

Wellman, J. S., & Wilson, J. S. (2015). Social Support Networks for Literacy Engagement among Culturally Diverse Urban Adolescents by Social Support Networks for Literacy Engagement among Culturally Diverse Urban Adolescents. *Journal of School Psychology*, *18*(42), 1–30.

Universiti Utara Malaysia

Wijndaele, K., Matton, L., Duvigneaud, N., Lefevre, J., De Bourdeaudhuij, I., Duquet, W., et al. (2017). Association between leisure time physical activity and stress, social support and coping: A cluster-analytical approach. *Psychology of Sport and Exercise, 8*(4), 425-440.

Williams, A., & Taylor, J. (2016). Resolving accountability ambiguity in nonprofit organizations. *International Journal of Voluntary & Nonprofit Organizations*, *24*(1), 559–580. http://doi.org/10.1007/s11266-012-9266-0.

Wong, J. G. W. S., Cheung, E. P. T., Chan, K. K. C., Ma, K. K. M., & Tang, S. W. (2016). Web-based survey of depression, anxiety and stress in first-year tertiary education students in Hong Kong. *Australian and New Zealand Journal of Psychiatry, 40*(9), 777-782.

Yamaguchi, N., Nakajima, N., Okada, S., & Yuri, K. (2016). Effects of aging on stress-related responses of serotonergic neurons in the dorsal raphe nucleus of male rats. *Neurobiology of Stress*, *3*(1), 43–51. http://doi.org/10.1016/j.ynstr.2016.01.002

Yang, D., Dong, M., & Miao, R. (2018). Development of a Product Configuration System with an Ontology-based Approach. *Computer-Aided Design*, *40*(6), 863–878.

Zaumseil, M., & Schwarz, S. (2015). Understandings of Coping : A Critical Review of Coping Theories for Disaster Contexts. *Cognitive Therapy and Research*, *6*(8), 45–55. http://doi.org/10.1007/978-1-4614-9354-9

Zhang, Y., Tang, J., Sun, J., Chen, Y., & Rao, J. (2018). MoodCast: Emotion prediction via dynamic continuous factor graph model. *IEEE International Conference on Data Mining, ICDM, 1*(3), 1193–1198. http://doi.org/http://doi.org/10.1109/ICDM.2010.105.

Zheng, J. (2018). Social Media, Social Support and Solitude among College Student Honors. *Journal of Applied Social Psychology*, *33*(1), 1–28.

Zhou, D., Luo, J., Silenzio, V., Zhou, Y., Hu, J., Currier, G., & Kautz, H. (2017). Tackling Mental Health by Integrating Unobtrusive Multimodal Sensing. *International Journal of Computer Vision*, *2*(8), 36–52.

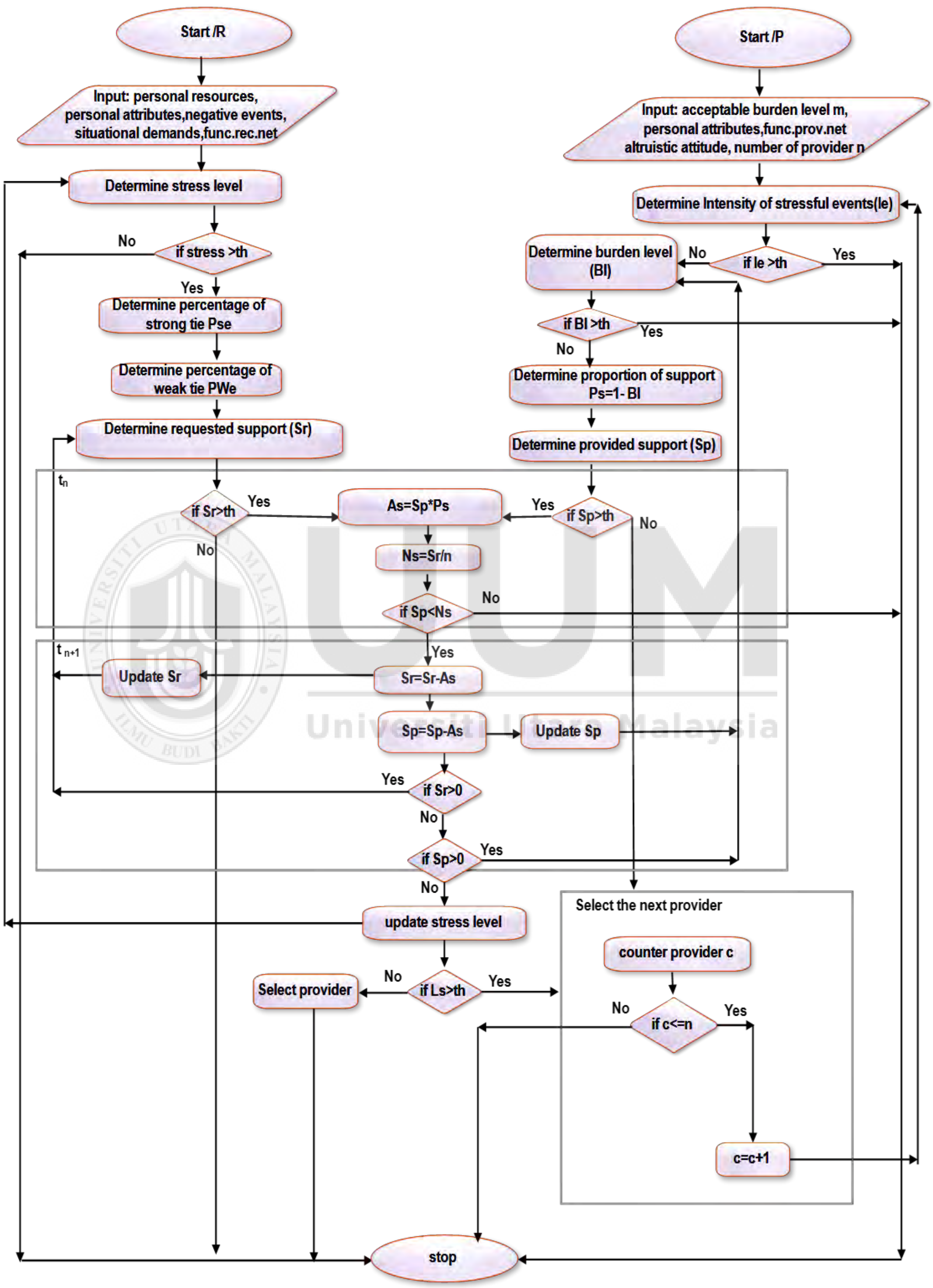
Zhou, K.-N., Li, H.-X., Wei, X.-L., Li, X.-M., & Zhuang, G.-H. (2016). Relationships between perceived social support and retention patients receiving methadone maintenance treatment in China mainland. *Chinese Nursing Research*, *5*(2), 12–32. http://doi.org/10.1016/j.cnre.2015.12.001.

Zorn, T., Grant, S., & Henderson, A. (2015). Strengthening resource mobilization chains: developing the social media competencies of community and voluntary organizations in New Zealand. *Voluntas: International Journal Of Voluntary & Nonprofit Organizations*, *24*(3), 666–687. http://doi.org/10.1007/s11266-012-9265-1.

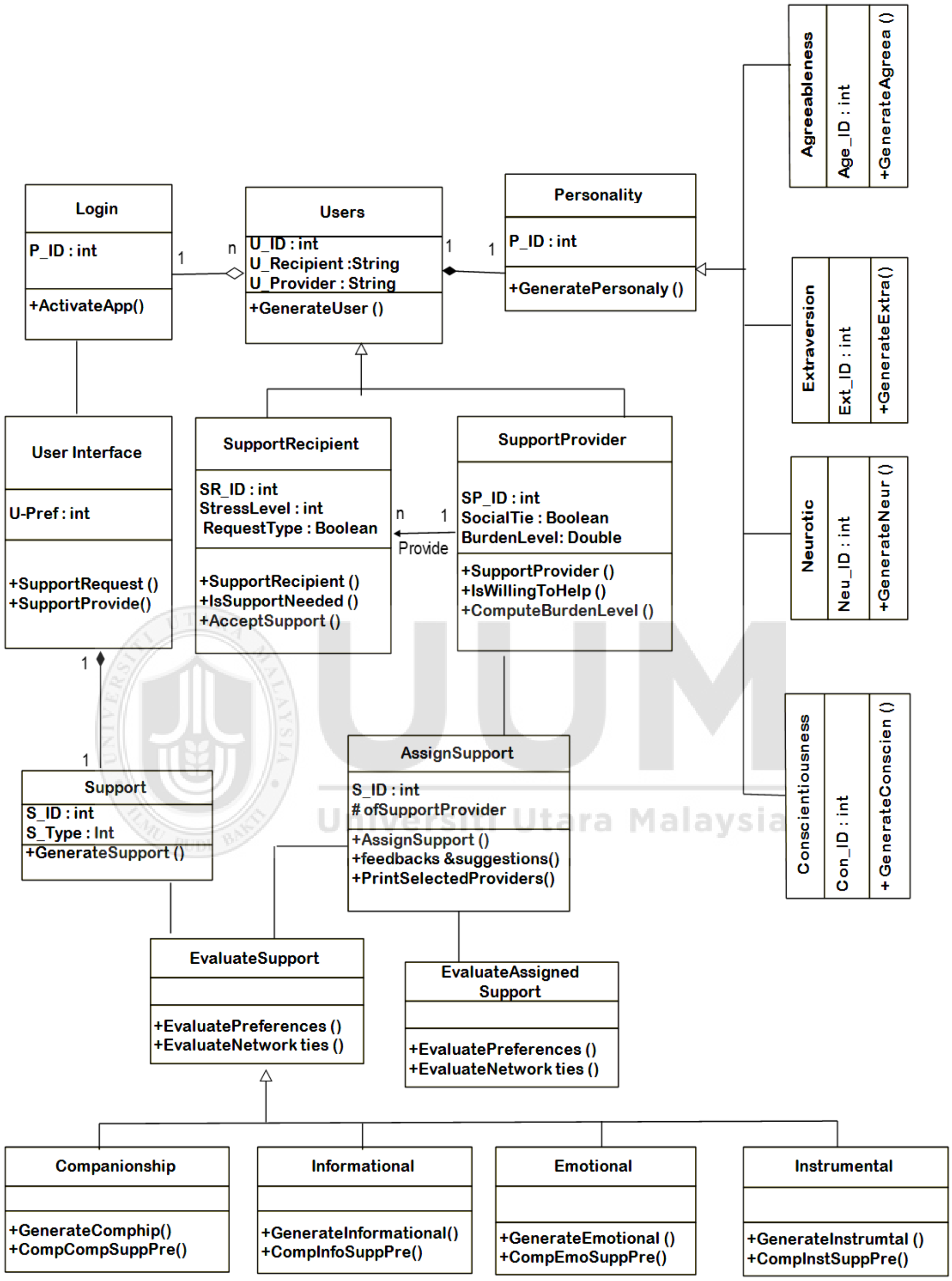
Universiti Utara Malaysia

# APPENDICES

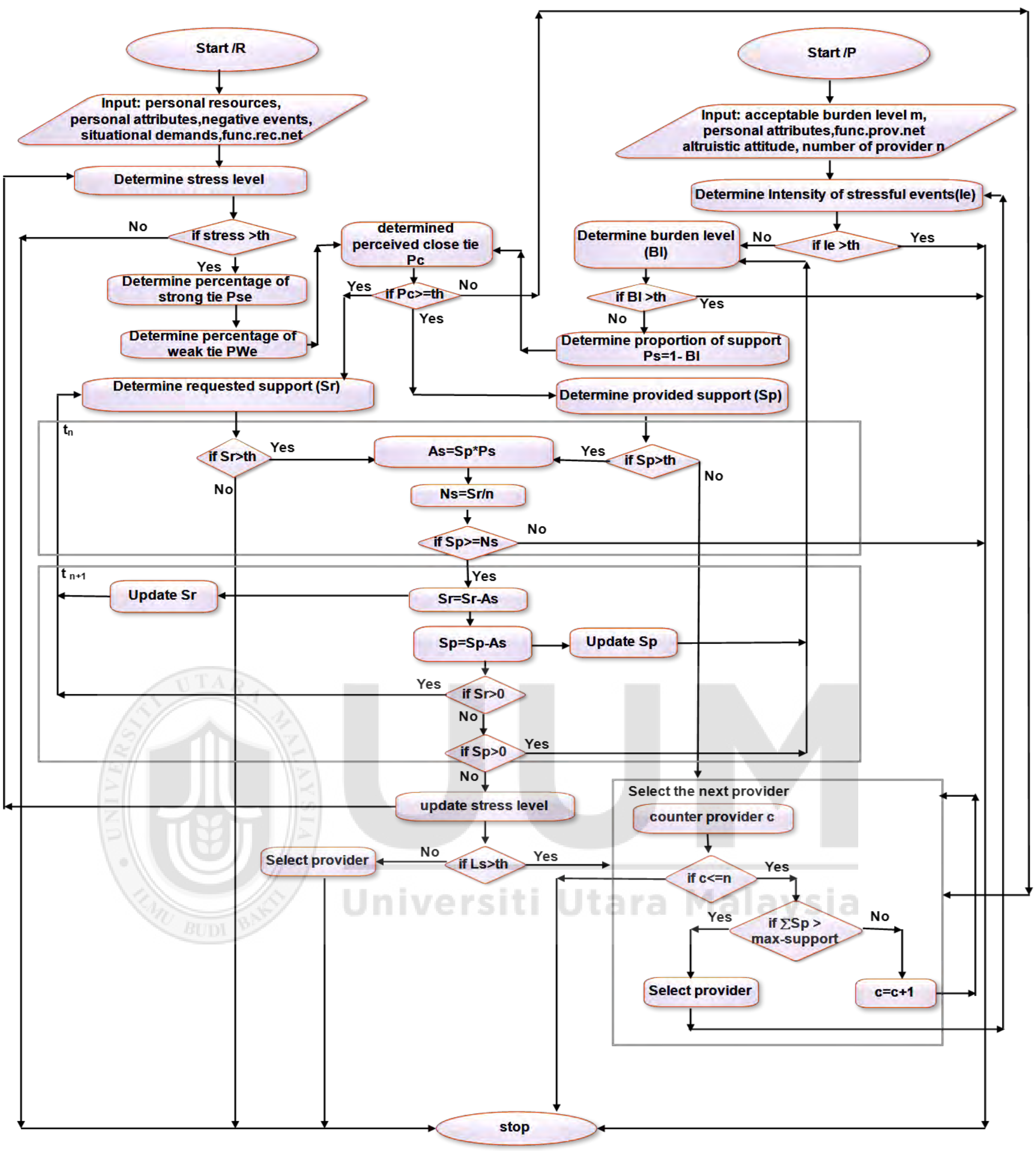
## Appendix I: FLOW IN RANDOM SELECTION MODEL



## Appendix II: CLASS DIAGRAM



## Appendix III: FLOW IN PRIORITY SELECTION MODEL



Appendix IV: **ONLINE QUESTIONNAIRE**

**"Dynamic Support Model for Social Support Assignments"**

[redacted]

You are asked to participate in a research study conducted by Roqia AL-Shorman, doctoral candidate, Azizi Ab Aziz, *Ph.D*., and Rahayu Ahmad, *Ph.D.*, from School of Computing at Universiti Utara Malaysia (UUM). The result of this survey will be used as apart in the doctoral thesis for Roqia AL-Shorman. You were selected as a participant in this study because you have indicated that you are ready to provide feedback which is appreciated in designing configuration model. You should read the provided information below and ask questions about anything you don't understand before proceeding to participate. Your participation in this research is completely unpaid and you are free to decide whether to join or terminate at any point of the experimental period.

- **PURPOSE OF THE STUDY**

The main goal of this experimental study is to evaluate the first prototype of social support assignment by determining the seeking and providing social support types and finally choose the appropriate providers from your social networks that can help you based on your request. It was developed to support stressed individuals. The obtained results of this experiment will help to validate to what extend the designed model is accepted and useful to help stressed individuals.

- **CONFIDENTIALITY**

Any information that is obtained in connection with this questionnaire and that can be identified with you will remain confidential and will be used only for research purpose.

**SECTION A: DEMOGRAPHIC DETAILS**

**Please mark (√) in the appropriate place provided.**

1. Please indicate your gender?

☐ Male ☐ Female

2. Which of the following age categories do you belong to:

☐ <24 ☐ 25 - 34 ☐ 35 - 44

☐ > 45

3.Please identify your educational level?

☐ Ph.D. ☐ Master ☐ Diploma

☐ Undergraduate/ degree ☐ Others, Please state…………………

UUM
Universiti Utara Malaysia

4. Monthly income/ pocket money in ringgit Malaysia (**RM**/**MYR**)

☐ < 1000 ☐ 1000 -2000 ☐ 2001- 3000 ☐ 3001- 4000

☐ > 4000

5. What is the relationship between you and recipient (Just for support providers)?

☐ Parents ☐ Sister ☐ Brother

☐ Wife/Husband ☐ Close friend ☐ Friend

## SECTION B: SEEKING SOCIAL SUPPORT

**Instructions:**

This scale is made up of a list of statements each of which may or may not be true about you. For each statement circle "strongly agree" if you are sure it is true about you and "agree" if You think it is true but are not absolutely certain. Similarly, you should circle "strongly disagree" if you are sure the statement is false and "disagree" if you think it is false but are not absolutely certain.

1. I see myself as dependable, self-disciplined.
   A) Strongly agree B) Agree C) Strongly disagree D) Disagree
2. I see myself as anxious, easily upset.
   A) Strongly agree B) Agree C) Strongly disagree D) Disagree
3. I see myself as open to new experiences, complex.
   A) Strongly agree B) Agree C) Strongly disagree D) Disagree
4. I see myself as reserved, quiet.
   A) Strongly agree B) Agree C) Strongly disagree D) Disagree
5. I see myself as extraverted, enthusiastic.
   A) Strongly agree B) Agree C) Strongly disagree D) Disagree
6. I see myself as sympathetic, warm.
   A) Strongly agree B) Agree C) Strongly disagree D) Disagree
7. I see myself as disorganized, careless.
   A) Strongly agree B) Agree C) Strongly disagree D) Disagree
8. I see myself as calm, emotionally stable.
   A) Strongly agree B) Agree C) Strongly disagree D) Disagree
9. I see myself as someone who is a reliable worker.
   A) Strongly agree B) Agree C) Strongly disagree D) Disagree
10. I see myself as conventional, uncreative.
    A) Strongly agree B) Agree C) Strongly disagree D) Disagree

Universiti Utara Malaysia

11. I see myself as someone who makes plans and follows through with them.
   A) Strongly agree B) Agree C) Strongly disagree D) Disagree

12. If I needed an emergency loan of RM100, there is someone (friend, relative, or Acquaintance) I could get it from.
   A) Strongly agree B) Agree C) Strongly disagree D) Disagree

13. If I were sick, I could easily find someone to help me with my daily chores.
   A) Strongly agree B) Agree C) Strongly disagree D) Disagree

14. It would be difficult to find someone who would lend me their car for a few hours.
   A) Strongly agree B) Agree C) Strongly disagree D) Disagree

15. If I wanted to have lunch with someone, I could easily find someone to join me.
   A) Strongly agree B) Agree C) Strongly disagree D) Disagree

16. If I needed a ride to the airport very early in the morning, I would have a hard time finding someone to take me.
   A) Strongly agree B) Agree C) Strongly disagree D) Disagree

17. I found it hard to wind down
   A) Strongly agree B) Agree C) Strongly disagree D) Disagree

18. I tended to over-react to situations
   A) Strongly agree B) Agree C) Strongly disagree D) Disagree

19. I found myself getting agitated
   A) Strongly agree B) Agree C) Strongly disagree D) Disagree

20. I am as good at doing things as most other people are.
   A) Strongly agree B) Agree C) Strongly disagree D) Disagree

21. I feel that I can share my most private worries and fears with.
   A) Strongly agree B) Agree C) Strongly disagree D) Disagree

22. I don’t often get invited to do things with others.
   A) Strongly agree B) Agree C) Strongly disagree D) Disagree

Universiti Utara Malaysia

23. I see myself as someone who is full of energy.
A) Strongly agree B) Agree C) Strongly disagree D) Disagree

24. I see myself as someone who is inventive.
A) Strongly agree B) Agree C) Strongly disagree D) Disagree

25. I see myself as someone who tends to be organized.
A) Strongly agree B) Agree C) Strongly disagree D) Disagree

26. I found it difficult to relax.
A) Strongly agree B) Agree C) Strongly disagree D) Disagree

27. I had a major financial crisis.
A) Strongly agree B) Agree C) Strongly disagree D) Disagree

28. I felt that I was using a lot of nervous energy.
A) Strongly agree B) Agree C) Strongly disagree D) Disagree

29. A close family member died (e.g. parent, brother, etc).
A) Strongly agree B) Agree C) Strongly disagree D) Disagree

30. I felt that I was rather touchy.
A) Strongly agree B) Agree C) Strongly disagree D) Disagree

31. I was intolerant of anything that kept me from getting on with what I was doing
A) Strongly agree B) Agree C) Strongly disagree D) Disagree

32. I see myself as critical, quarrelsome.
B) Strongly agree B) Agree C) Strongly disagree D) Disagree

Universiti Utara Malaysia

**SECTION C: PROVIDING SOCIAL SUPPORT**

1. I can give information to help understand a situation.
A) Strongly agree B) Agree C) Strongly disagree D) Disagree

2. I can give good advice about a crisis.
A) Strongly agree B) Agree C) Strongly disagree D) Disagree

3. I see myself as extraverted, enthusiastic.
A) Strongly agree B) Agree C) Strongly disagree D) Disagree

4. I see myself as critical, quarrelsome.
A) Strongly agree B) Agree C) Strongly disagree D) Disagree

5. I had a minor illness or injury like one needing a visit to a doctor or a couple of days off work.
   A) Strongly agree B) Agree C) Strongly disagree D) Disagree
6. There has been serious increase in arguments or problems with someone who lives at home.
   A) Strongly agree B) Agree C) Strongly disagree D) Disagree

7. I see myself as dependable, self-disciplined.
   A) Strongly agree B) Agree C) Strongly disagree D) Disagree
8. I studied for, or did, important exams.
   A) Strongly agree B) Agree C) Strongly disagree D) Disagree

9. I can listen to you when you need to talk.
   A) Strongly agree B) Agree C) Strongly disagree D) Disagree

10. I can confide in or talk to about yourself or your problems.
    A) Strongly agree B) Agree C) Strongly disagree D) Disagree

11. I take you to the doctor if you needed it.
    A) Strongly agree B) Agree C) Strongly disagree D) Disagree

12. I prepare your meals if you were unable to do it yourself.
    A) Strongly agree B) Agree C) Strongly disagree D) Disagree
13. I see myself as anxious, easily upset.
    A) Strongly agree B) Agree C) Strongly disagree D) Disagree
14. I have a good time with.
    A) Strongly agree B) Agree C) Strongly disagree D) Disagree

15. I can get together with for relaxation.
    A) Strongly agree B) Agree C) Strongly disagree D) Disagree

16. I can do things with to help you get your mind off things.
    A) Strongly agree B) Agree C) Strongly disagree D) Disagree

17. I show you love and affection.
    A) Strongly agree B) Agree C) Strongly disagree D) Disagree

18. I love and make you feel wanted.
    A) Strongly agree B) Agree C) Strongly disagree D) Disagree



UUM Universiti Utara Malaysia

19. If I wanted to have lunch with someone, I could easily find someone to join me

A) Strongly agree B) Agree C) Strongly disagree D) Disagree

20. I see myself as reserved, quiet.

A) Strongly agree B) Agree C) Strongly disagree D) Disagree

21. I see myself as sympathetic, warm.

A) Strongly agree B) Agree C) Strongly disagree D) Disagree

22. I see myself as disorganized, careless.

A) Strongly agree B) Agree C) Strongly disagree D) Disagree

23. I see myself as someone who is helpful and unselfish with others

A) Strongly agree B) Agree C) Strongly disagree D) Disagree

24. I see myself as calm, emotionally stable.

A) Strongly agree B) Agree C) Strongly disagree D) Disagree

25. I can be sympathetic and friendly.

A) Strongly agree B) Agree C) Strongly disagree D) Disagree

26. I see myself as someone who likes to cooperate with others.

A) Strongly agree B) Agree C) Strongly disagree D) Disagree

Universiti Utara Malaysia

27. I see myself as conventional, uncreative.

A) Strongly agree B) Agree C) Strongly disagree D) Disagree

28. I am sometimes respectful to others.

A) Strongly agree B) Agree C) Strongly disagree D) Disagree

29. I see myself as someone who is interested about many different things.

A) Strongly agree B) Agree C) Strongly disagree D) Disagree

30. I see myself as someone who has an active imagination.

A) Strongly agree B) Agree C) Strongly disagree D) Disagree

31. I see myself as someone who values artistic, aesthetic experiences.

A) Strongly agree B) Agree C) Strongly disagree D) Disagree

32. I often can present my abilities.
A) Strongly agree B) Agree C) Strongly disagree D) Disagree

**SECTION D: SATISFACTION WITH SOCIAL SUPPORT**

**Instructions:**

The following questions ask about people in your life who provide you with help or support. Each question has two parts. For the first part, list all the people you know, excluding yourself, who you can count on for help or support in the manner described. Write the person's initials and their relation to you (see example). Do not list more than one person next to each of the numbers beneath the question. For the second part, circle how satisfied you are with the overall support you have. If you have no support for a question, circle the words "No one," but still rate your level of satisfaction. Do not list more than nine people per question. Please answer all the questions the best you can. All your responses will be kept confidential.

1. Who can you really count on to be dependable when you need help?

No one 1.) 2.) 3.)

4.) 5.) 6.)

2. How satisfied?

6 - Very satisfied 5 - fairly satisfied 4 - a little satisfied
3 - a little dissatisfied 2 – fairly dissatisfied 1- very dissatisfied

3. Who can you really count on to help you feel more relaxed when you are under pressure or tense?

No one 1.) 2.) 3.)

4.) 5.) 6.)

4. How satisfied?

6 - Very satisfied 5 - fairly satisfied 4 - a little satisfied
3 - a little dissatisfied 2 – fairly dissatisfied 1- very dissatisfied



Universiti Utara Malaysia

5. Who accepts you totally, including both your worst and best points?

| | | | |
|---|---|---|---|
| No one | 1.) | 2.) | 3.) |
| | 4.) | 5.) | 6.) |

6. How satisfied?

| | | |
|---|---|---|
| 6 - Very satisfied | 5 - fairly satisfied | 4 - a little satisfied |
| 3 - a little dissatisfied | 2 – fairly dissatisfied | 1- very dissatisfied |

7. Who can you really count on to care about you, regardless of what is happening to you?

| | | | |
|---|---|---|---|
| No one | 1.) | 2.) | 3.) |
| | 4.) | 5.) | 6.) |

8. How satisfied?

| | | |
|---|---|---|
| 6 - Very satisfied | 5 - fairly satisfied | 4 - a little satisfied |
| 3 - a little dissatisfied | 2 – fairly dissatisfied | 1- very dissatisfied |

9. Who can you really count on to help you feel better when you are feeling down-in-the-dumps?

| | | | |
|---|---|---|---|
| No one | 1.) | 2.) | 3.) |
| | 4.) | 5.) | 6.) |

UUM Universiti Utara Malaysia

10. How satisfied?

| | | |
|---|---|---|
| 6 - Very satisfied | 5 - fairly satisfied | 4 - a little satisfied |
| 3 - a little dissatisfied | 2 – fairly dissatisfied | 1- very dissatisfied |

11. Who can you count on to console you when you are very upset?

| | | | |
|---|---|---|---|
| No one | 1.) | 2.) | 3.) |
| | 4.) | 5.) | 6.) |

12. How satisfied?

| | | |
|---|---|---|
| 6 - Very satisfied | 5 - fairly satisfied | 4 - a little satisfied |
| 3 - a little dissatisfied | 2 – fairly dissatisfied | 1- very dissatisfied |