A FORMAL MODEL FOR ANALYZING MANAGER'S PERFORMANCE DURING STRESS

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Abstrak

Pengurus yang terdedah kepada tekanan mempunyai risiko mengambil keputusan yang tidak mencukupi, yang akan memberi kesan kepada tahap prestasi mereka. Menjejaskan boleh menjadi sama ada positif atau negatif, bergantung kepada persepsi individu pada stres. Ramai yang tidak mencukupi kajian konvensional telah dijalankan untuk menganalisis hubungan rumit tekanan dan prestasi. Oleh itu kajian ini memperkenalkan model formal menyokong prestasi pengurus 'semasa tekanan. Model ini boleh dimuatkan ke dalam agen pintar atau robot yang boleh digunakan untuk menyokong pengurus. Metodologi yang digunakan untuk meneroka proses kognitif manusia semasa tekanan terdiri daripada empat fasa: pengenalpastian ciri-ciri tempatan dan bukan tempatan, konsep model ini harta, perasmian, dan penilaian. Persamaan yg memuji-muji telah digunakan dalam memformalkan hartanah. Model yang dibangunkan telah disimulasikan dengan memohon kepada senario yang berbeza. Analisis matematik telah digunakan untuk penilaian model. Hasil kajian menunjukkan bahawa model yang formal dapat menunjukkan kesan tahap yang berbeza tekanan pada prestasi pengurus.

Kata kunci: model formal, prestasi pengurus, tekanan, tekanan dan hubungan prestasi

Abstract

Managers who are exposed to stress have the risk of taking insufficient decisions, which will affect their performance levels. The affect could be either positive or negative, depending on the individual's perception on stress. Many inadequate conventional studies have been conducted for analyzing the complicated relationship of stress and performance. Hence this study introduces a formal model supports managers' performance during stress. This model can be encapsulated within an intelligent agent or robots that can be used to support managers. The methodology was used to explore human cognitive processes during stress consisted of four phases: identification of local and non-local properties, conceptualization of the model of these properties, formalization, and evaluation. Deferential equations have been used in formalizing the properties. The developed model has been simulated by applying it to different scenarios. Mathematical analysis has been used for the evaluation of the model. Results showed that the formal model was able to show the effects of different levels of stress on managers' performance.

Keywords: formal model, managers' performance, stressors, stress and performance relationship

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LIST OF ABBREVIATIONS

EU-OSHA	European Agency for Safety and Health at Work
KPI	Key Performance Indicators
CO's	Correctional Officers
JDR	Job Demand Resources Model
COR	Conservation of Resources Theory
HSE	Health and Safety Executive
BERT	Rational Emotive Behavioural Therapy

CHAPTER ONE
INTRODUCTION

1.1 Introduction

This chapter briefly explains the study background, problem statement, objectives, significance and scope of the study.

1.2 Background of the Study

Researchers and practitioners have paid more concern and focus on studying managerial stress and stress management. Implications of stress on individual and organization can no longer be studied or treated solely as the problem of individual manager. Stress has affects on the adjustment of individual with others which in turn can affect production and performance of the whole organization. Potential negative effects of stress are being realized by organizations, stress affects organizations in terms of lower motivation, decreased performance levels as well as physical and mental illness which are beyond cause of stress (Menon & Akhilesh, 1994). Stress emerges in situations when individuals face circumstances that they appraise as demanding or exceeding their resources and endangering their well-being (Lazarus & Folkman, 2011; Rani et al. 2013; Ramezani et al., 2013).

Up to fifty million Europeans complained about stress at work reported by European Agency for Safety and Health at work, stress results in costs of forty billion Euros in both health care and time (EU-OSHA, 2003; 2015). Additionally, 19% and 30% of general working employees are suffering from workplace stress and burnout (Cooper & Mrshall, 1976; Bourbonnais, Malenfant, Vézina, Jauvin, & Brisson, 2005; Dewa, McDaid, & Ettner, 2007). Work stress is the psychological negative stress or strain that appears as a result of both individual as well as organizational stressors in the work (Cooper & Mrshall, 1976; Cullen, Link, Wolfe & Frank, 1985). Burnout in the work is characterized by feelings of exhaustion which is one of the consequences of long term stress; there are plenty of other consequences just to mention cynicism, detachment, ineffectiveness and lack of personal accomplishment (Maslach, Schaufeli, & Leiter, 2001). Both job stress and burnout can affect employees' organizational commitment and leads to lower productivity (Maslach et al., 2001).

Health is a very complex concept which involves many dimensions such as individual's physical, social, occupational, spiritual, intellectual and emotional well-being (Nelson & Simmons, 2003). Hans Selye (1975) defined stress as a reaction of individual's body that can occur in all dimensions of human's health in response to a taxing. Responses to stress can be physiological and / or psychological in nature (Colligan & Higgins, 2005). Stress responses are appraised through the behavioral and physical reactions of an individual which take place as a result of psycophysiological responses one has towards demanding (Weinberger, Schwartz & Davidson, 1979). The use of the term stress has become common in society, where in lay terms it is used to depict a negative reaction to variety of stressors. Strain is another term which is used interchangeably with stress in academic researches (LeFevre, Kolt & Matheny, 2003).

Concepts of stress and health are attended by organizations as significant factors for employees (Kelloway & Day, 2005). The focus of many organizational and industrial researches on workplace noticed the increase in the levels of work related stress (Cryer, McCraty & Childre, 2003). Researchers had identified general organizational stressors related to organizational (change, culture etc.), occupational (uncertainty of job, role issue etc.) and personality (physical health, work-life etc.) factors (Murphy, 1995). Organizations are working actively in order to achieve competitive advantage and lives of individuals get busier, these stressors implication increases which in turn illustrates the rising levels of work stress.

The recent concentrate on employee's health and specifically in work stress is not arbitrary; organizations are realizing that the stress can have important organizational outcomes. Workplace distress has significant affect on the organization; it can increase turnover and absenteeism and decrease performance (MacDonald, 2003). In a health care industry it has been seen that stress decreases performance. Patients have been found to receive insufficient medical care by distressed doctors and patient deaths have also been related to high levels of distress (Firth-Cozen & Greenhalgh, 1997; Charatan, 1999). Consequences of this stress are not limited to organizations but it goes beyond that to influence individuals and society. The American Institute of Stress (2000) has reported that stress costs United States of America more than $300 billion every single year in health care, stress decreasing treatment and missed

work. Medibank Private Limited (2008) has stated that Australian economy suffers from work stress costs which reach to $14.81 billion a year. It is clear that organizations are interested in monitoring stress and its effects on employees and push towards creating positive work conditions and environments where possible. Past research has primarily concentrated on the negative stress aspects. This is expected given the documented implications of stress on well-being, health and performance. However the positive movement of psychology proposes that, research focus should be directed to positive well -being health and growth instead of concentrating on human pathology (Seligman & Csikszentmihaiyi, 2000). Selye (1973, 1974) has argued that stress is unavoidable and it is a part of human's life, and that stress has positive outcomes as well as negative outcomes. Appropriately negotiating, stress can carry positive results, it can be energizing, motivating and stimulating the employees as new accomplishments achieved and abilities are extended (Quick, Nelson, & Quick, 1990).

Stress is like the spices of work, and it is a part of any profession, it is effects on job performance can occur in either way based on how it has been experienced and perceived. Individuals perceive and experience the same stress levels differently which leads to different performance levels amongst employees in the workplace (Singh, 2009).

Previous studies of stress have primarily focused on the affects and causes of distress on employee. Recently researches are advancing into investigating new territory, exploring the positive stress side. Eustress is the good side of stress, it arouses employees and creates positive feelings and motivations of fulfillment (Selye, 1975). Selye (1975) had proposed a holistic model incorporates negative (distress) and positive (eutress) stress sides. Negative and positive stress are different constructs and can impact individuals concurrently, therefore understanding only one side of them is insufficient in order to manage stress and its implications. The inclusion of positive stress enables more comprehensive analysis of how stress affects individuals as well as organizations (Course & Cover, 2012).

Many decisions must be taken during stress, and many decision situations elicit stress responses themselves. Thus, stress and decision making are intricately connected,

and their relation is not limited to the behavioral level, they are related also on the neural level, the brain parts that underlie intact decision making are parts that are sensitive to stress-induced changes (Starcke & Brand, 2012).

Formal model or known as computational model provides a means of risk-free exploration in complex, critical, costly, time-consuming, or rare situations, a constructed computational model is capable of simulating certain key behaviors' in the selected domain of interest. For example, in a neuroscience domain, theoretical neuroscientists use computational modelling to help explain and understand the mechanisms of cognition. This means developing explicit mathematical models of the processes that go on in the brain when we perceive, act, learn, think or remember certain tasks. Despite the development of powerful brain imaging machines and software that allow scientists to investigate into greater details of our brain activities, these technologies still fall short to explain the detailed interaction between all of those activities involved (Conrad, Hubold, Fischer & Peters 2009). Thus, such use of computational and formal models is regarded as a tool for internal and external investigation of cognition within brain activities, and it can be useful in simplifying complicated relations including human function processes.

1.3 Problem Statement

In the working environment, performance is affected by stress. Employees under low stress levels may not meet the required commitment to perform at their best levels, while those under high stress levels are unable to focus or perform sufficiently. The relationship between stress and performance is complicated (Crampton, Hodge, Mishra & Price, 1995). In addition, .Yao, Fan, Guo & Li (2015) stated that, even though some researches have studied negative and positive effects of stress on employee's performance. These studies were just confined to theoretical development and conceptual models. Furthermore, there is a lack of empirical research on stress affects and performance. Moreover, Lo, Thurasamy & Liew (2014) has mentioned that Malaysian managers suffering from job stress is not a new issue and it is still an issue.

As previously mentioned, stress effects can be either positive or negative. However human's body are unable to distinguish between them (Cavanagh, 1988).Whether

stress is negative or positive depends upon how individuals react and perceive it (Castleman, 1991). For instance, success on the career can create great feelings of stress. Braham (1988) mentioned that one out of five managers affected by such stress feelings and he calls that as "success syndrome". Nevertheless, studies that have explored the implications of stress responses and stress exposure on decision making performance are rarely conducted compared to the numerous studies that have explored performance of memory under stress (Starcke & Brand, 2012). Moreover, Rodham and Bell (2002) have stated that research of stressors and manager's stress are limited, the estimation of the ability of manager's to control their work even during critical periods and potential stressors might be one of the reasons behind the less attention on such research.

There are multiple psychological theories that have deliberated stressors, stress, and how employee response to stress. However, the direct use of psychological theories for building and designing support systems is insufficient, since computerized programs requires encoding which is not supported by Psychological models and theories. Reasoning methods about them are unstructured, therefore, a formal method is required for reasoning such unstructured situations. A computational model has been found to be useful in formulating ideas and beneficial in identifying underlying assumption supported with well-specified rules for manipulations. Intelligent system is a set of procedures implemented by computers, which combines knowledge of experts with methods of reasoning, and conceptualizing theoretical mathematics that is translated into simulations of experiments, thus, a proper mechanism to support constricting the underlying infrastructure of intelligent system is represented in developing a formal model, intelligent system then can be usefully used to support managers during stress (Ali, 2014).

Although previous studies have explained the improvement of manager's performance during stress, less focus has been given to illustrate and explore the same concept using computational models; As a result, the development of a human model offers great solutions to the acquisition of complicated human functioning process (Treur, 2011). Where human models requires computational model which in turn includes the formalization of conceptual relationships. As has been mentioned previously formalization is the key for the development of support systems.

1.4 Research Questions

The main research questions of this study are:

- What are the local (Internal) and non local (External) properties and their relationship that influence stress and performance levels of managers?
- How a conceptual model can be used to understand the relationship between stressors, stress and manager's performance?
- How a formal model can be used in analyzing relationship of stressors, stress and manager's performance?

1.5 Research Objectives

The main objective of this study is to develop a formal model that analyzes manager's performance during stress. Sub objectives are:

- To identify local (Internal) and non local (External) properties that cause stress.
- To design a conceptual model of manager's performance during stress.
- To develop and evaluate a formal model that simulates relations of stressors and manager's performance during stress.

1.6 Scope of the Study

This study focuses on developing a formal model which represents the relations between stressors, stress and the performance of managers. Managers have been chosen because of the important role that they play in the organizations. Managers' performance can affect the entire organization production and can lead to the success or the failure of the institutions.

1.7 Significance of the Study

Human models implementation provides an important technical development to the complex process of human functioning (Treur, 2011). Psychological theories are descriptive in nature and its descriptions about manager's performance during stress can be translated to causal-mechanistic phase that illustrates the connections between a set of observed phenomenon (D'Mello & Franklin, 2011). Human model are beneficial to be used as foundation for designing an intelligent support system, that is able to predict the optimum level of performance as well as providing the support for

managers during critical situations, and assisting them in taking the right action even during high stress circumstances (Aziz, Klein& Treur, 2009). The development of human agent model and support systems requires formal model to be build first in order to be programmed, and translated into a computer understandable relations. This model can be used as underlying foundation within robots or virtual agents that simulate human behavior. As a consequence, the model can be useful for new psychologists to obtain more understanding pertaining to stress through simulating many situations on digital environments.

This study can help managers to learn how to cope with stress, recognizes stressors, to assist managers to determine what strategies can be used, and help them to control stress affects and improve their performance as well as their quality of life.

The study can be useful for the development of inclusive human resource management, to support the optimum working life through finding solutions on handling stress, and decreasing stress among employees in general and managers in specific.

1.8 Summary

This chapter introduces the background of the study, presents the research problem and objectives. Briefly, this study aims to develop a formal model to be used in analyzing manager's performance during stress. The model is to be implemented as a foundation to design an intelligent software agent that can predict and support managers performance and decision making process. Accordingly, this kind of model gives many benefits to psychologists by simulating various conditions on digital environments.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

This chapter discusses important concepts related to stress, as well as concepts affected by stress such as job performance. Then, the chapter reviews related models of stress and performance It also presents theories related to stress and performance, and illustrate psychological models that are related to the effects of stress on performance. Finally, the chapter covers several past studies factors that have studied stress effects and outcomes on performance.

2.2 Important Concepts Related to Stress

This section introduces important concepts related to and affected by stress.

2.2.1 Job Performance

Performance is considered as the employees' achievements and outputs acknowledged by the organization (Robbins & Coulter, 1996). Job performance comprised of a combination of skills, effort and work nature, where skill refers to the employee's knowledge and capacity, effort refers to the action bringing motivation for task completion and nature of work conditions refer to the level that these conditions are accommodated and how they facilitate the output of the employee (Kazmi, Amjad & Khan, 2008). In addition, job performance is able to develop flexible working surroundings, provide training, and enhance technological skills in the production sectors to ensure that employees are convenience, and to ensure that the employee's are effective in that they contribute towards job performance. In this regard, job performance is described as the employee's involvement and the level to which they can achieve performance by tackling workplace issues. The organizational rewards provided to the employees can be in the form of financial rewards like bonuses, and increased salary, or the non-financial rewards like vacation benefits, acknowledgement of certificate for a specific employee achievement, job satisfaction or achievement of high performance through motivation. In this regard, Giga and Hoel (2003) contended that job performance is a measure of an individual's performance of the job assigned, and it is more optimal in organizations that provide

employee rewards for job well done, and those that ensure high employee job satisfaction in the workplace.

Moreover, Cascio (2006) demonstrated the importance of job management's adoption of key performance indicators (KPI) to measure employees' job performance to ensure that employees are aware of what the organization expects from them in terms of job task achievements. Also, Mahmod, Hussain, Hannan and Muhammad (2010) noted that top factors influencing employee performance and bringing about employee stress are heavy workload and time pressure – in other words, employees are required to achieve their tasks in a limited period and this exposes them to workplace stress.

The enhancement of employee performance has been a topic of greater focus from the practitioners and researchers groups (Madsen, John & Miller, 2005). In this regard, the Merriam Webster Online Dictionary (2010) provided that performance is the task execution via the doing of action. This definition matches the definition provided by Carson, Cardy and Dobbins (1991) and Ilgen and Favero (1985) who described performance as the work-related behaviours and the borne results. Similarly, Campbell, Dunnette, Lawler and Weick (1970) described job performance as something that has a distinctive nature. It refers to the employees' behavior, no matter what the behavior outcomes is, where the outcome has a key role in distinguishing performance from outcomes (Cambell & Campbell, 1988). Covered under behavior, performance encapsulates notable actions and non-notable ones like thought processes and decision making – the entirety of which is covered under the individual employees' control.

The measurement of job performance can be conducted by noting the collaboration of three main factors namely skills, struggle and work environment, where the skills are considered as the individual's education, know-how and the specialties on the job, and struggle is considered to be the enthusiasm level towards goal achievement. Lastly, work environment is considered to be the level to which the working environment contributes to the employee's performance of the job close to the expected standards (Kazmi, Amjad & Khan, 2008). According to researchers, stress influences the employee's life in various ways, with the top effect influencing the

employee's efficiency while working. The efficiency of the employee is gauged via the workplace performance.

In other words, job performance can be considered as the individual productivity (both quantitative and qualitative) in job aspects. It largely depends on the office atmosphere, work settings and the employee's social connections and interactions (Coetzer & Rothman, 2006).

2.2.2 Managers Performance

On the basis of traditional management theory, managers should attempt to establish simplicity and order in the workplace (Caulkin, 1995). Managers are often skilled in using traditional plan, direction, and control over their functions. They also posses know-how on how to plan for the future, select optimum results based on predictions, and steer the organization towards desired results. Due to the technological development and proliferating market competition, in today's businesses, the current milieu of managers have changed. They are now required to manage complicated adaptive supra-systems comprised of individuals that are complex adaptive units that forms a complex adaptive system that covers periods of order, complication and chaos in its cycle. Nonlinear outcomes are expected owing to the systems inclusion of both positive and negative feedback methods. Traditional planning, directing and controlling are no longer applicable. It is pertinent for management to expect complex as well as chaotic periods and to consider them as a normal course of events. Managers are made aware of that the organizational systems are deterministic and that both planning and control are effective methods to be employed. Under this premise, chaotic periods are considered to reflect inefficient management. In terms of organizational members, they perceive the chaos as outside of the norm, and this contributes to their anxiety and stress levels (Green & Twigg, 2014).

Managers who are healthy in terms both physically and mentally are expected to bring about productive and competitive firms (Quick, Macik-Frey & Cooper, 2007). In other words, managers need to possess the energy to facilitate an effective working environment for their subordinates and to employ sound leadership strategies (Andersen, Tonnesen & Agnadottir, 2002).

In the most current job-situations, there exists increasing level of mental demands as opposed to physical demands (Siegrist, Starke, Chandola, Godin, Marmot, Niedhammer & Peter, 2004). In this regard, the manager's job situation is linked to his family life (Geurts & Demerouti, 2003) in a way that if a manager experience imbalance in work and family life, it may lead to adverse circumstances that would negatively affect the organization, the individual and even the family (Boyar, Maertz Jr., Pearson & Keough, 2003). Past authors (e.g. Frankenhaeuser et al., 1989; Lundberg, Mardberg & Frankenhaeuser, 1994; Bjorklund, Lohela-Karlsson, Jensen & Bergstrom, 2013) evidenced that the managerial level of the organization may have a potential affect on the stress perception as well as its determinants – this holds also holds true with coping with conflicts (Bernin et al., 2003). Added to this, empirical evidence shows that some professionals are more susceptible to stress more than others, and this includes managers of a restaurant chain (Parker & DeCotiis, 1983).

2.2.3 Stress and Performance during Stress

Stress is among the top well-known concepts that is commonly seen and heard often. Despite its extensive use in various contexts, it is challenging to pinpoint an accurate description of the concept. The pioneer researcher, Hans Selye, dedicated this work on this vital issue. In fact, stress has been one of the top interests focused on by researchers after World War II (Newton & Fineman, 1995). However, although it has been increasingly viewed as an environmental stimulus that affects individuals (Kahn, Wolfe, Quinn, Snoek & Rosenthal, 1964), Seyle (1956) described stress as the reaction of the individual to an environment force affecting the performance of the individual. Job stress can immobilize the individual as it threatens the functional of families and the performance of the individual. Every organization has its own stress sources with different levels and it influences the job performance of its workers (Thangiyah, 2012). Several researchers revealed that factors of job-related stress are connected to variables such as role ambiguity, role conflict, employee performance and satisfaction as well as work overload, achievement need, and the effectiveness of the organization (Dunnettee, 1976). Hans Selye, a known biologist, have contributed to the stress idea and among his most popular modern theories regarding psychological stress was published in his 1956 book entitled "The Stress of Life". Literature dedicated to stress shows that Selye was the pioneering researcher

to coin the term 'stress' when explaining the physical and psychological answer to adverse conditions reactions. He expounded the stress concept through the use of bad stress known as conditions of stress and good stress known as eustress. Meanwhile, distress is a negative stimulator that adversely influences the cerebral and corporeal health of the employee and it has a negative influence on the performance of the employee (Salami, Ojokuku & Ilesanmi, 2010). Distress lowers the performance of the employee while eustress stems from the Greek word "Eu", which refers to good or positive. Positive stress boosts the achievement of individuals and allows them to tackle difficulties. The level of insist is fundamental to Seyle's distress clarification (Le Fevre, Matheny & Kolt, 2003). He examined the physiological response to stress, as a distracted reaction of the body to something that negatively affects it. According to Seyle, stressor brings about a stress response. In this regard, the employee's ability to manage their emotions and other's emotions will contribute to their ability to handle on the job physiological and psychological stresses. Consequently, this may lead to greater job performance at work (Bar-On, 1997; Gillespie, Walsh, Winefield, Dua & Stough, 2001; Spector & Goh, 2001).

2.3. Stress and Performance Models

This section reviews some models which are related to stress and performance during stress.

2.3.1 Stressors

There are five primary categories of job stress in the organization according to the model proposed by Cooper and Marshall (1976). The model has been employed to various employee contexts such as social workers (Johnson & Cooper, 2003), and police officers, nurses and firemen (Johnson et al., 2005). The model encapsulates factors that are job-intrinsic, organizational role, career development, work relationships, organizational structure as well as organizational climate. In a related study, Finney, Stergiopoulos, Hensel, Bonato and Dewa (2013) made use of Cooper and Marshal's model in their categorization of stressors. First, stressors that are job-intrinsic – these are factors that contribute to the complexity of the worker's duties. In their study, they included correctional officers (CO's). This category also relates to factors contributing to workload (French & Caplan, 1972; Cooper & Marshall, 1976; Moon & Maxwell, 2004). Second, stressors that are related to role ambiguity

and role conflict (Cooper & Marshall, 1976), where the former occurs when the employee is faced with unclear duties and expectations (Cullen, Link, Wolfe & Frank, 1985; Castle & Martin, 2006; Castle, 2008) while the latter occurs when conflicting demands are experienced by the employee (Cooper & Marshal, 1976). This is evident through the CO's expectation to exercise professionalism within a system rife with bureaucratic issues (Cullen et al., 1985). For instance, CO's should uphold security via informal interactions with inmates that may not adhere with the established correctional facility rules (Cullen et al., 1985). The third category comprises of stressors that are work-specific and includes factors influencing the employee's future in the organization such as promotion, job security and ambition (Cooper & Marshal, 1976). Meanwhile, the fourth category covers work relationships that describe interactions between employee and subordinates, co-workers and supervisors (Cooper & Marshall, 1976). Organizational structure comprises of the employee's degree of latitude in decision making, organizational politics and organization-staff communication (Cooper & Marshall, 1976), the categories illustrated in Figure 2.1.

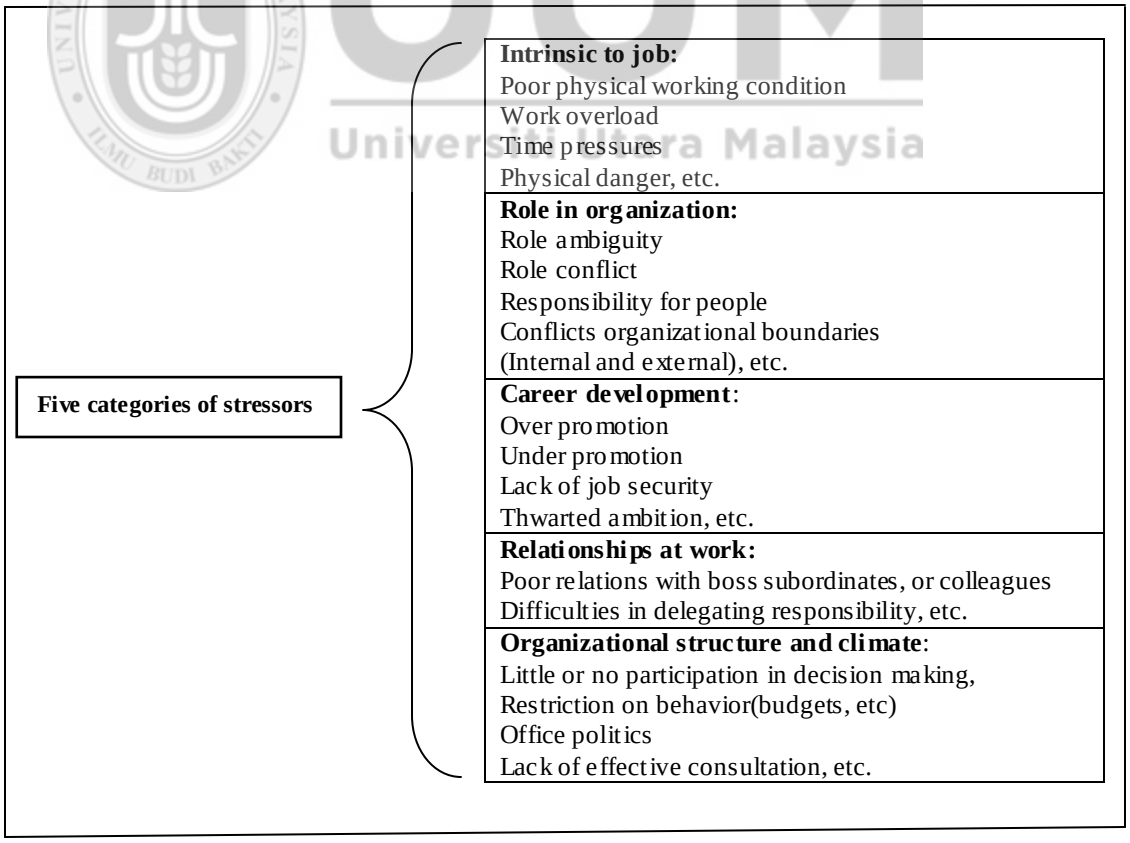

Figure 2.1: Five categories of stressors (Cooper & Marshall, 1976).

Similarly, Sutherland and Cooper (2000) proposed five categories of potential stress (occupation and psychosocial stress). In addition they also brought forward other potential stressors like live events causing stress such as home, family and demands, matrimonial problems, and job-family conflicts in terms of demands (Sutherland & Cooper, 2000).

Furthermore, Cooper (1983) proposed a summarized work stress sources which are six in number; job conditions (quantitative and qualitative work overload, people's decisions, physical danger, and techno stress), role stress (role ambiguity, sex bias and sex-role stereotypes), interpersonal factors (poor work and social support systems, lack of management concern for the worker, political rivalry, jealousy and anger), career development (under-promotion, over-promotion, job security, frustrated ambitions), organizational structure (rigid and impersonal structure, political issues, insufficient supervision or training, non-participative decision making), home-work interface (spill-over, lack of spousal support, marital conflict, stress stemming from dual career).

In a related study, Beehr, Jex, Stacy and Murray (2000) revealed a relationship between occupational stressors and employee's performance in an organization and its influence on the employee's psychological well-being, while Jamal (2007) examined the relationship between job stress and job performance between managers and employees (blue-collar in particular). Job stress can be attributed to the unsecured working environment perceived by the individual.

Furthermore, job performance can be measured through the combination of skills, struggle and work environment. In this context, skills refer to the individual's education, know-how and job specialization, struggle refers to the enthusiasm degree towards goal achievement and lastly, work environment refers to the level to which the working atmosphere assists the performance of the job based on standards (Kazmi, Amjad & Khan, 2008).

Despite the fact that the psycho-social job aspects-health/well-being of workers relationship has been evidenced in literature (Dollard & Metzer, 1999), only a few studies have been dedicated to the impact of specific job performance stressors.

According to the center of the good governance (2006), stressors can be categorized into two namely external psychological stressors and internal psychological stressors. In this regard stress that occurs in the organization is generally referred to as specific organizational characteristics and employee behavior that may cause employee stress. Organizational stressors include bureaucratic processes, perceived lack of support from the community and leaders, and lack of career development opportunities in the organization (Stinchcomb, 2004; Burke & Mikkelsen, 2006). On the other hand, inconsistent discipline procedures and management style and lack of administrative support have been cited to be features of organization stress (Toch, Bailey & Floss, 2002).

Meanwhile, Cooper and Marshall (1978) categorized potential stressors into environmental, organizational and personal stressors. Added to this, job demands are often classified into challenge job stressors and hindrance job stressors, with the latter referring to unpleasant, undesirable and excessive factors present in the workplace, which influences the individual's goal achievement related to a specific job (e.g. role conflict, role overload, and role ambiguity) - such factors are considered as the negative job demands aspects (Judge, Erez & Bono, 1998). Challenge job stressors are on the other hand described as stressors having the potential to promote the personal growth and career development of the employee and it covers factors such as high workload, time limitation and various responsibilities. These are considered as positive stressors because of their potential to provide the employee with rewards (Cohen-Charash & Spector, 2001).

Finney, Stergiopoulos, Hensel, Bonato & Dewa (2013) have viewed the stressors that have been studied by a number of researchers. Table 2.1 shows those studies and their findings.

Table 2.1:

Stressors and findings

Reference	Stressors	Outcomes
Armstrong & Griffin (2004)	Role problems (6 items, Hepburn & Knepper, 1993) Perceived intrinsic rewards (6 items, Mottaz, 1981) Quality of supervision (7 items, Saylor 1981) Organizational support (3 items, Eisenberger et al., 1986)	Job stress
Moon & Maxwell (2004)	Work overload (5 items, validated) Supervisory support (5 items, validated)	Job stress
Castle & Martin (2006)	Working overtime (1 item) Inmate overcrowding (1 item) Levels of staffing (1 item) Training prior to employment (1 item) Role problems (5 items, not validated) Opportunity for promotion (not reported) Salary (1 item, annual salary) Supervisory support (6 items, Cullen et al. 1985) Administrative strengths (10 items, Saylor, 1984)	Job stress
Griffin (2006)	Quality of supervision (7 items, Saylor 1981) Organizational support (3 items, Eisenberger et al., 1986)	Job stress
Neveu (2007)	Participation (3 items, validated) Skill utilization (4 items, validated) Professional worth (4 items, validated)	Burnout

Table 2.1 Continued

Castle (2008)	Role problems (5 items, not validated) Opportunity for promotion (not reported) Supervisory support (not reported) Administrative strengths (not reported)	Job stress
Taxman & Gordon (2009)	Organizational justice (13 items, Sweeny & McFarlin, 1997)	Job stress
Summerlin et al. (2010)	Levels of staffing (1 item, PSQ-Org, McCreary & Thompson, 2006) Daily operational tasks (PSQ-Org, McCreary & Thompson, 2006) Work-related activities outside of correctional facility (PSQ-Org, McCreary & Thompson, 2006) Style of leadership (PSQ-Org, McCreary & Thompson, 2006)	Job stress

As Table 2.1 showed there are numerous stressors that cause stress. Stressors include environment related stressors, organization related stressors and personal stressors.

2.3.2 Job Demand-Resource Model (JDR model)

This model reflects a theory relating to work stress in order to explain the manner in which job features can promote employee burnout (Demerouti, Bakker, Nachreiner & Schaufeli, 2000), and it is an offshoot from conservation of resources theory (COR). According to this model, job demands that are often considered as stressors are the job aspects relating to the organization, physique and society – these need sustained effort. Such physical or psychological effort pressures the individual. Job resources, on the other hand, are protecting factors that mitigate the demands or assist the individual in how to cope with demands. These resources can be organizational, social or physical (e.g. job design, support from supervisor or safety equipment).

The model posits that inadequate organizational resource contributes to the demands on the job, where job demands positively relate to employee distress. The model has been validated in the sectors of health and community services and the connections between resources, demands and distress have been evidenced by Gelsema, van der Doef, Akerboom & Verhoeven (2005). They categorized job demands into work demands and emotional demands – with the former being factors like load/pressure, responsibility, operational hindrances, and work-home interference and the latter being lack of job control, lack of support, rewards, role, interpersonal conflicts and organizational inequality. Both categories' relationships with stress were highlighted. The model stresses that it is important for organizations to provide the required resources to employees for job and task completion and for the minimization of demands and steering clear of distress. The JDR model is depicted in Figure 2.2.

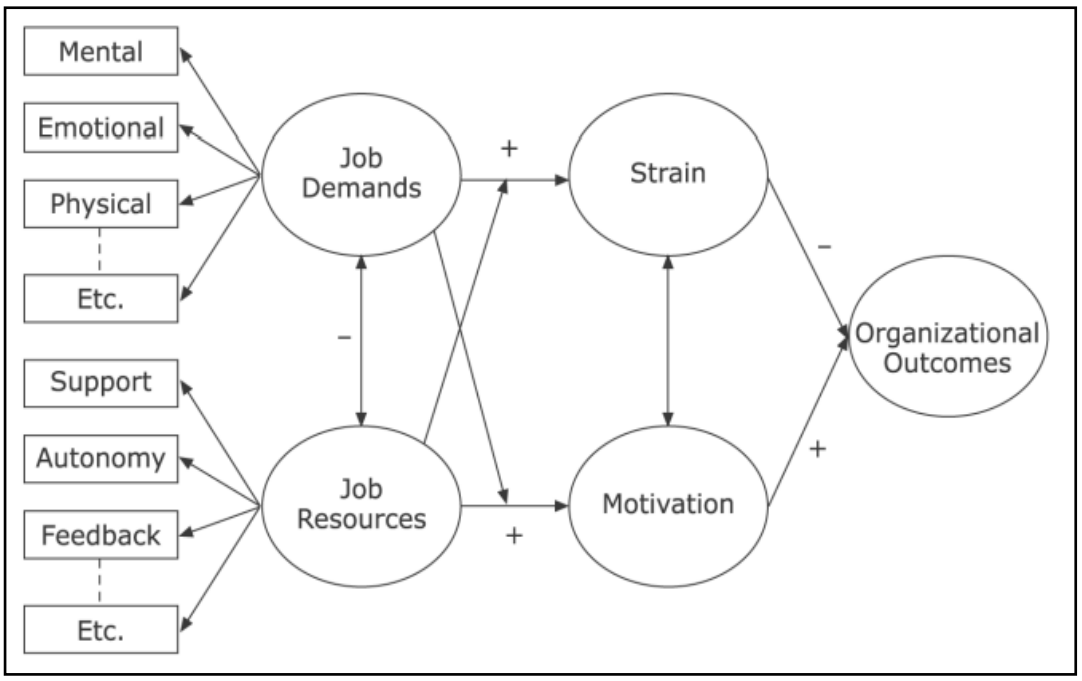

Figure2.2: Job Demand-Resource Model (Bakker & Demerouti, 2007)

2.3.3 Model of Work Stress

Palmer, Cooper and Thomas (2001) proposed a simple model of stress that is advocated by the Health and Safety Executive (HSE, 2001) publication that sheds light on the relationships between the dangers that are stress related, the exhibitions of the organization and individuals, and the results. According to the HSE (2001) it is important to examine and address the seven main dangers that can lead to employee stress. The theory is depicted in Figure 2.3. The hazards are demand (exposure to issues like workload, patterns of work and work environment like work volume and complexity, shift work and unrealistic deadlines), control (individual say and involvement in the how work is done like control balanced against demands, and lack of autonomy), support (encouragement, sponsorship, and resources provided by the organization, line management and colleagues like training for core job functions), relationships (promotion of positive working to steer clear of conflict and handling unacceptable behavior like bulling and harassment and conflicts), role (individual's understanding of their role and the guarantee of the organization as to no conflicting roles like vague job descriptions), change (how large/small organizational change is managed and communicated throughout the organization like how the staff understand the necessity of change, staff communication and useless fears). The HSE stresses on mitigating or eliminating dangers and not merely

on providing stress management courses or training (Palmer et al., 2001; HSE, 2004).

However this model focuses only on one side of the factors that lead to stress and its outcome, it ignores the existence of factors that can reduce the effects of these hazards, the job resources that has been indicated in JDR model that feed the motivations of employee, these resources can exist at the same time with demands in the organizations (Muse & Stamper, 2007).

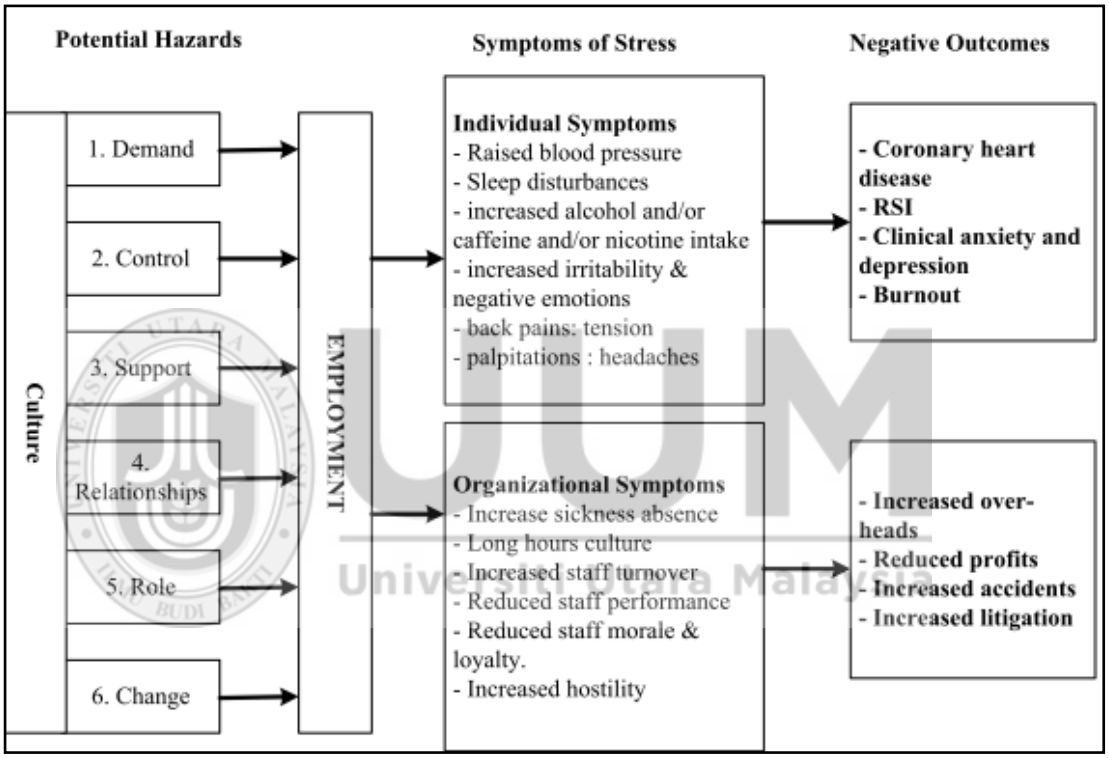

Figure2.3: Model of Work stress (Palmer et al, 2003)

2.3.4 The Cognitive-Transactional Model

Lazarus (1966; 2006), Lazarus and Folkman (2011) conceptualized the cognitive-transaction model in their effort to explain the relationships between work demands, stress responses and results. The model is depicted in graph in Figure 2.4. According to the model, job demands are considered by the employee either as threat or a challenge at the onset. It depends on the employee whether or not the tools and abilities are available at the second consideration. These judgments may lead to stress and such stress influences multiple results at the individual and organizational level.

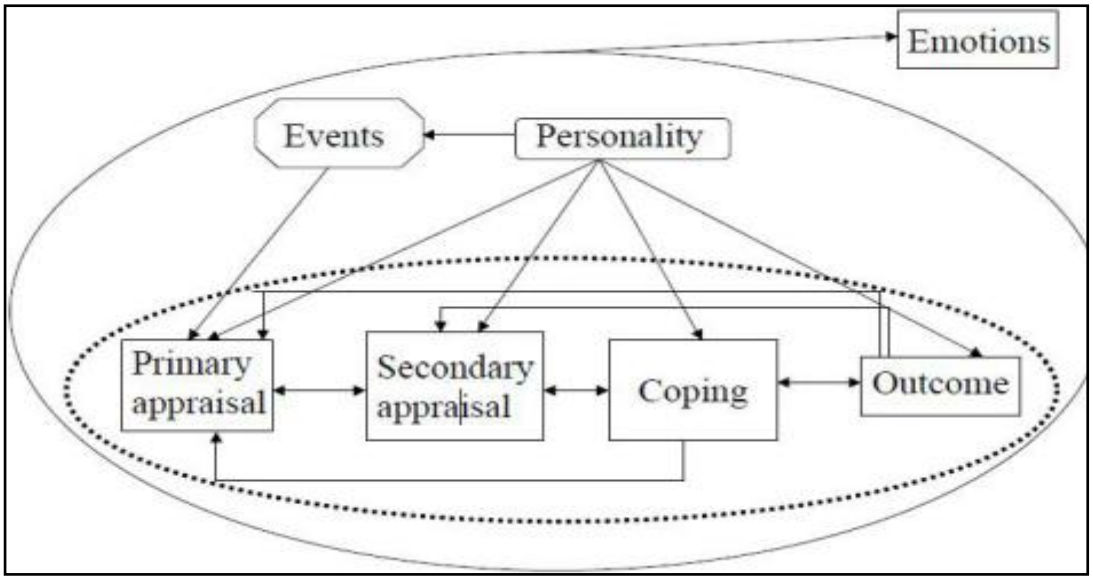

Figure2.4: Cognitive-Transactional Model of Stress (Lazarus 1966, 2006; Lazarus & Folkman, 2011).

The steps of appraisal in the model highlight the fact that stress stems from the individual's perception of a demand (Gardner, Fletcher & McGowan, 2006). Specifically, individuals perceive a demand either as a threat, a challenge or inconsequential (Cooligan & Higgins, 2005) indicating that a deadline may be perceived by an employee as distressing, but it may be perceived by another as challenging and motivating. Added to this, individuals also feel the demands in varying stress levels (LeFevre, Kolt & Matheny, 2006). For instance, an employee may consider a tight deadline to be stressful but only experience slight worry while another may consider it to be extremely distressing, which could lead to chronic anxiety. The secondary appraisal entails the perception of the individual of whether or not he is able to cope with the demand. In this regard, Schwarzer and Knoll (2003) explained some tangible methods that individuals can employ in stress coping.

Coping refers to an effort to manage or overcome demands and critical events that are challenging, threatening, harmful or beneficial to an individual (Lazarus, 1991). It has been often classified as either emotional or task-focused (Gonzalez-Morales, Peiro, Rodriguez & Greenglass, 2006). The first coping classification attempts to minimize the negative feelings and moods related while the latter coping classification works towards reducing or removing the demand. Individuals vary in their coping approach (Gardner & O'Driscoll, 2007). Such variations in coping perceptions and strategies largely depend on the individual and hence, they stem

from experience and individual characteristics (Beasley, Thompson & Davidson, 2003; Karademas & Kalantzi-Azizi, 2004).

Moreover, psychological capital has been reported to be negatively associated with the levels of distress and this supports the notion that personality influences the levels of stress (Avey, Luthans & Jensen, 2009). Also, there are other personality variables that have been evidenced to influence the interpretation of the individual of a demand (primary appraisal) (Avey et al., 2009), and the coping strategies employed to handle the demands (secondary appraisal) (Garnder & O'Driscoll, 2007). Hence, it can be stated that organizational factors coupled with individual differences influence perceived demands, consequent stress and behavioral reactions (Course & Cover, 2012).

2.4 Theories related to Stress and Performance

This section reviews theories related to stress and performance during stress

2.4.1 Cannon-bard Theory of Emotion

According to Cannon (1927), an individual experiencing physiological stress (e.g. a heart attack) may also experience psychological stress (e.g. mental illness) at the same time. This premise was extended by Mueller and Maluf (2002) after which they established a physical stress theory. Their theory posits that level of the physical stress of the individual reflects his predictable biological reaction to it. To clarify, an individual who has the habit of mitigating the level of his physical stress will be more adept at experiencing a positive biological response in comparison to a counterpart who often suffers from a high level of physical stress. This control may result in higher performance on the job (Hsieh et al., 2004; Gillespie et al., 2001; Slaski & Cartwright, 2002).

2.4.2 Self-Efficacy Theory

Bandura's (1977) self-efficacy theory proposes that a high efficacious individual, who is convinced of his ability to conduct a specific course of action, will not invoke adverse cognitive feelings and thoughts. This theory is applied in an occupational stress model, which evidences that if an individual is confident of using his abilities

in handling job stressors, this may lead to higher job performance (Nikolaou & Tsaousis, 2002; Wetzel et al., 2006).

2.4.3 Inverted-U Theory of Stress

This theory concentrates on the relationship between stress and performance and is depicted in the diagram (Figure 2.5). It posits that when an individual experiences little pressure to conduct a significant task, little incentive is present to concentrate all efforts and attention to achieving it. This holds true when there are more urgent, more interesting tasks that also need completion. With the increase in pressure, the realm of best performance is entered and this will allow the individual to concentrate on the job and perform well – on the condition that the pressure is just enough to pressure on focusing rather than disruption. With increasing stress, distractions, difficulties, anxieties and negative perceptions also increase and inability to perform the action arises. Highly-stressed individuals will insist on following a course of action although other superior alternatives are at hand. This explains why people who are anxious put their best foot forward when they experience little additional stress, whereas calm people require more pressure to achieve better performance. The theory is represented by Figure 2.5.

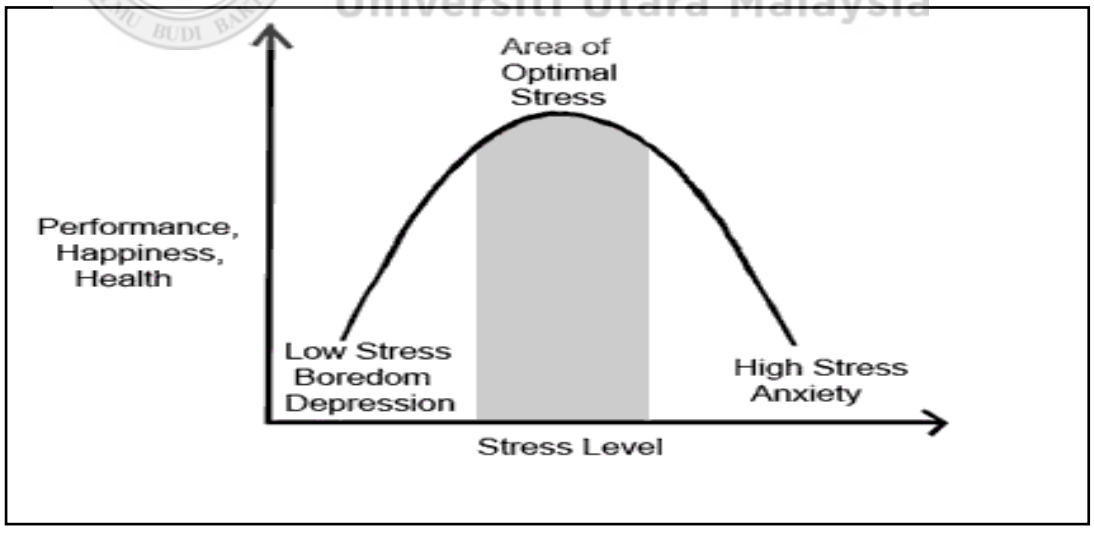

Figure 2.5: Inverted-U Theory of Stress (Yerkes & Dodson, 1908)

2.5 Computational Modeling

The concept of computational modeling refers to a process of simulating a set of processes that have been observed in the natural world in order to gain profound

understanding of these processes and to predict the outcome of natural processes by given a specific set of input parameters. These models are priceless since they permit researchers to study and having revision on complete relations that may perhaps not be arranged out by virtuously experimental approaches, and to create approximations that cannot be made without difficulty by extrapolating from the existing data (Ellner & Guckenheimer, 2011).

Frequently, computational model is providing a means of undisruptive exploration in multifaceted, critical, costing, rare situation or time-consuming. A constructed computational model is accomplished of simulating certain key behaviors in the particular area of interest and concern. For instance, in a neuroscience field, theoretical neuroscientists apply computational modeling to help in understanding and explain the mechanisms of cognition. This means developing clear mathematical models of the processes which go on in the brain when we act, think, perceive, learn or remember certain tasks. In spite of the evolution of software and influential brain imaging machines that permit scientists to investigate into broader detailed of our brain activities, these technologies still unable to describe the detailed interaction between all of those activities involved. As a result, using of computational models has seemed as an instrument for external and internal investigation of cognition within brain activities.

2.5.1 Computational Psychology

The study of human mind and behavior in both applied and academic point to definition of psychology (Farrell & Lewandowsky, 2010). Research in psychology is looking for explaining and understanding theoretical framework of emotion, thought, and behavior.

Generally, human psychological processes are extremely complicated to understand only based on behavior observations, particularly when the underlying grounding theory of the observed circumstances is not completely understood (Scassellati, 2002). In addition, because of the complexity of the human mind, and its impact in behavioral flexibility, it produces a restricted decision that solely computational modeling can show the process and its interactions. Moreover computational modeling can be more valuable in term of intensity of process details and granularity

of input-output interactions, which are fundamentally useful to illustrate the level of cognitive functions.

In recent years, computational models are often used as tools for understanding human cognitive functions and behaviors (Both, Hoogendoorn, Klein, & Treur, 2008; Ting, Zhou, & Hu, 2010). The models have been used to investigate the fundamental nature of various cognitive functionalities and psychology through the ongoing detailed comprehension by assigning identical computational models of representations and mechanisms. Moreover, this computational way that have been used to model cognitive functionalities of human is called cognitive modeling. According to (Ali, 2014) cited (Detje, Dörner, &Schaub, 2003) cognitive modeling is "a method to study the human mind**.**

Cognitive Models try to explain the structure and the processes of the human mind by building them. A model of human cognition should mirror human mental activities, human errors, slips and mistakes. Cognitive modelers try to understand how the human memory works, how the human memory is structured to reflect reality, how the human memory is used for the organization of behavior. The scope of cognitive modeling is widened beyond cognition to more general and more complicated forms of psychological processes which include social, emotional and motivational factors". It has demonstrated that computational models have succeeded to simulate related behaviors in specific domains of interests by assigning the corresponding computational processes onto cognitive functions to produce executable computational models by which the detailed simulations are performed. Results from the simulations are used to justify that the models offer good explanations of the cognitive mechanisms pertinent to the corresponding domains of interest.

2.5.2 Computational Models related to Psychological Models

The intelligent agent technology is invaluable in maximizing analysis, decision making ability as well as interactions. In order to create a supportive human agent application, it is important to include a dynamic model of the human portraying the way how he may experience cognitive vulnerability or to maintain a healthy well-being into the application (Aziz & Klein, 2010). A maintained progressive model of

cognitive vulnerability therefore needs to be developed and as such Aziz and Klein (2010) presented the basis of an intelligent ambient agent application that assists individuals with their cognitive vulnerability with the help of Rational Emotive Behavioral Therapy (REBT). The model's three components are environment, inferential feedback and formation. The model represents the dynamic interactions between environmental feedback and individuals who possess negative thought formation at the onset of relapse and the depression recurrence.

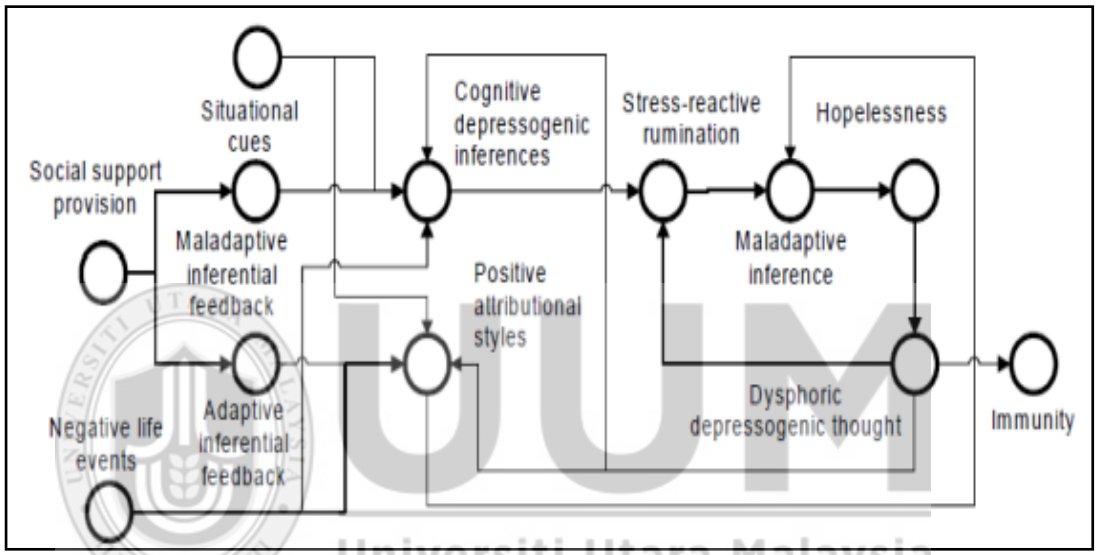

Figure2.6: Domain Model in Cognitive Vulnerability (Aziz & Klein, 2010).

Both, Hoogendoorn, Klein, and Treur (2008) have developed a formal model of mood dynamics, to simulate the dynamics in the mood of persons, and in more especially, whether they develop longer periods a undesired moods, as in depressions. The main concepts and relations involved in this model are extracted from psychological theories about unipolar depressions and represented in a formal model of the aspect of mood and depression (as has illustrated in Figure 2.7). It supposed that each situation has a value of emotion, which represents the extent to which a situation is experienced as something positive.

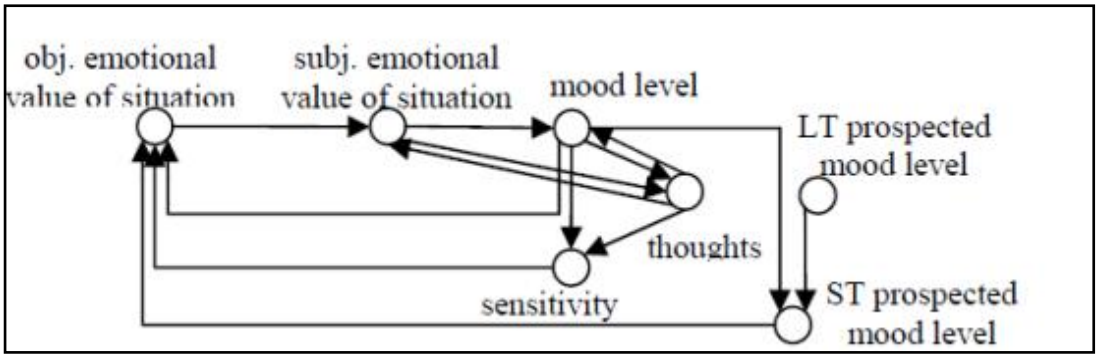

Figure2.7: Model of Mood Dynamics (Hoogendoorn, Klein, & Treur, 2008)

Table 2.2 introduces related computational models in cognitive and psychology with the respect on its underlying techniques.

Table 2.2:

Studies of Computational Model

Author	Year	Title	Technique
Lik Mui et. al.	2002	A Computational Model of Trust and Reputation	First Order logic
Gebhard	2005	ALMA – A Layered Model of Affect Integrated Neural Processes for	Rule Base
Paul Cisek	2006	Defining Potential Actions and Deciding between Them: A Computational Model	Differential Equation
Amy (Wenxuan) Ding	2007	Modeling the Psychosocial Effects of Terror or Natural Disasters for Response Preparation	Differential Equation
Aziz et. al.	2009	Design of an intelligent support agent model for people with a cognitive vulnerability	Differential Equation
Ting et. al.	2010	A Computational Model of Situation Awareness for MOUT Simulations	Differential Equation and Fist order logic
Fiemke Both, Mark Hoogendoorn, Michel C.A. Klein, and Jan Treur	2010	Computational Modeling and Analysis of The rapeutical Interventions for Depression	Differential Equation

Table 2.2 Continued

Naze and Treur	2011	A Computational Agent Model for Post-traumatic stress disorder	Differential Equation and Fist order logic
Bosse et. Al	2011	.Incorporating Human Aspects in Ambient Intelligence and Smart Environments	Rule Base
Azizi Ab Aziz	2011	Exploring Computational Models for Intelligent Support of Persons with Depression	Differential Equation
Jan Treur	2011	Dreaming Your Fear Away: a Computational Model for Fear Extinction Learning During Dreaming	Differential Equation
Ahmad and Zaid	2012	A Mood Driven Computational Model for Gross Emotional Regulation Paradigm	Differential Equation
Dilhan J. Thilakarathne, Jan Treur	2013	A computational cognitive model for intentional inhibition of actions.	Symbolic frame Work
Jeffrey B. Vancouver, Justin M. Weinhardt , Ronaldo Vigo	2014	Change one can believe in: Adding learning to computational models of self-regulation	Rule base
Jan Treur	2014	Displaying and Regulating Different Social Response Patterns: A Computational Agent Model	Differential Equation
Dilhan J. Thilakarathne and Jan Treur	2014	Modelling the dynamics of emotional awareness	Differential Equation
Tibor Bosse, Rob Duell , Zulfiqar A. Memon , Jan Treur , C. Natalie van der Wal	2015	Agent-Based Modelling of Emotion Contagion in Groups	Differential Equation
Dilhan J. Thilakarathne and Jan Treur	2015	Modeling intentional inhibition of actions	Differential Equation

Table 2.2 Continued

Fiemke Both, Mark Hoogendoorn, Michel C.A. Klein, Jan Treur	2015	A generic computational model of mood regulation and its use to model therapeutically interventions	Differential Equation
Altaf H. Abro, Michel C.A. Klein, Adnan R. Manzoor, S. Amin Tabatabaei, Jan Treur	2015	Modeling the effect of regulation of negative emotions on mood	Differential Equation

Different techniques have been used in developing computational models. However, differential equation technique is the most used one in designing computational models.

2.6 Evaluation in Computational Modeling

In order to evaluate the formal model (computational model), mathematical verification technique used to verify the correctness and stability of the model (Both, Hoogendoorn, Klein, & Treur, 2008; Ting, Zhou, & Hu, 2010).

2.6.1 Mathematical Verification

Mathematical analysis is one of the important aspects to determine in which stable situation for the proposed model are possible. Equilibria are analyzed that may occur under certain conditions. The equilibria describe situations in which a stable situation has been reached and these equilibria conditions are interesting to be discovered, it is possible to explain equilibria conditions using knowledge from the theory or problem that is modeled. In addition, the existence of reasonable equilibrium is also an indication for the correctness of the model. Moreover, if the dynamic of the system is described by differential equation, then the equilibria can be estimated by setting a derivation (or all derivatives) to zero. ne important thing to be noted, an equilibria condition is considered stable if the system always returns to it after small disturbance.

For instance, using this autonomous equation,

$$dy/dx = f(y) \qquad \text{Eq2.1}$$

The equilibria or constant solution of this differential equation are the roots of the equation

$$f(y) = 0 \qquad \text{Eq2.2}$$

2.7 Summary

This chapter has identified the approaches to be used for developing a formal model for analyzing manager's performance during stress it has also reviewed the past studies that have considered job performance. The job demands resources model, which is usually designated JDR as well as job stress and performance have been discussed with reference to manager's profession besides a set of concepts related to stress and it's affects on performance. Finally, the relationships between various variables have been assessed to include the relationship between job demand, job resources job performance and stress, the relationship between job stress and job performance. Referring to previous studies we can conclude that JDR model argues that while job demands hinder employees from performing better at the workplace, job resources are functional in achieving work goals. While JDR has contributed much to explaining job performance (Akkermans, Brenninkmeijer, Blonk, & Koppes, 2009), previous studies have generally considered job demands or job resources singly or separately. To date fewer studies have looked at the differential effects of each factor in determining job performance. Such theoretical knowledge is warranted as both factors do not occur in isolation at work, rather they are perceived to exist simultaneously and each has a different role in impacting job performance.

According to JDR and COR theory, when job demands and resources are present at work, they can lead to various types of physiological as well as psychological response, or even emotional response such as stress. JDR model asserts specifically that when these factors are not favourably perceived, this will lead to a stressful situation, and hence impair job performance. On the other hand Model of work stress does not follow the same approach of JDR model, rather it only focuses on specified hazards that lead to stress, this model encourages organizations on eliminating these dangers to avoid its outcomes, dislike JDR model it does not look to the resources that leads to motivation. Cognitive transactional model focuses on the reaction of

individuals towards stress, and the differences on the perceiving of stress from one to another, each of the models and theories that have been presented in this chapter focuses on various angle of stress and its effects on performance, these theories and concepts will be used in developing the conceptual model in order to achieve the second objective of the present study.

CHAPTER THREE
METHODOLOGY

This chapter describes the research methodology adapted from (Aziz, 2010) for this study. Figure 3.1 shows the phases involved:

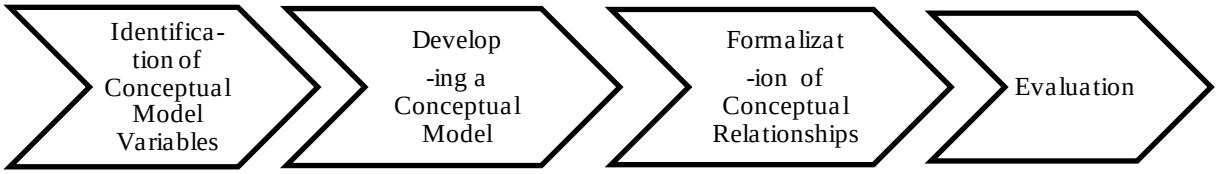

Figure 3.1: Research Methodology

The methodology consists of four phases; the phases are further elaborated in the coming sections. Table 3.1 illustrates the activities of this methodology as well as the deliverables of each phase.

Table 3.1

Methodology Activities

Phase	Activity	Technique	Objective	Milestone (Deliverable)
Identification of conceptual model variables	Identifying stressors Identifying stress levels Identifying performance levels	Literature review	Identifying stressors among managers	Stressors, Stress levels and Performance levels. First objective has been achieved
Developing a conceptual model	development of conceptual model structure	Literature review and experts evaluation	Developing a conceptual model	Evaluated conceptual model. Second objective has been achieved
Developing a formal model	Model development Programming Simulation	Differential equations	Developing a formal model	Formal model. Third objective partly achieved
evaluation	Verification	Mathematical verification	Developing formal model evaluates conceptual relationships	Evaluated formal model. Third objective achieved

The following sections explain the phases:

3.1 Phase I - Identification of Conceptual Model Variables (Local and non local properties).

In this phase local (internal) and non local (external) properties have been identified based on past literatures. The outputs of this phase were:

(i) a set of external properties and

(ii) a set of internal properties

Local (internal) properties are the stress factors that represent internal factors to the managers where these factors are dependent on the psychology of the person and it contributes directly or indirectly to stress. As a consequence affects the performance either positively or negatively. Non local (external) properties are the stress factors in which are external to the managers and it affect the level of stress which would lead to changes on the performance levels. For the sack of clarity, the properties have been represented in tow sets as instantaneous properties, and temporal properties. Stress can be caused by environmental, organizational, and individual variables (Matteson & Ivancevich, 1999; Cook & Hunsaker, 2001).

Centre for Good Governance (2006) has stated that individuals can be affected by external and internal stressors; in addition these two categories have physical and psychological sources. Physical external stressors involve unpleasant conditions of environment, for instance high temperature, low temperature, and pain. However, physical internal factors involve symptoms such as inflammation and infection. External psychological stressors are factors such as poor working conditions and conflicting relationships. While internal psychological stressors defined as the most harmful stressors, since it's not easy to resolve them once individual is in stressful situation, these stressors include fearing about things that may happened or not, and the status of stress would continue as long as the individual still worrying about it.

3.2 Phase II - Developing a Conceptual Model.

Based on the properties (stressors) identified in Phase I a conceptual model structure has been developed. The model represents the combination of internal and external properties and the output stress weather short term stress or long term stress, properties such as burnout, exhaustion and fatigue. Stress affects the performance of

managers it whether increase or decrease depends on how individuals perceive stress. These conceptual relationships constructed on this phase.

3.3 Phase III- Formalization of Conceptual Model.

The conceptual model that has been constructed in phase II was formalized in this phase. Formalization has been done using differential equations technique. This phase aims to construct an executable model of the dynamics of the process.

3.4 Phase IV- Evaluation

In this phase, the formalized model has been evaluated using Mathematical analysis technique. Mathematical analysis is used to ensure that the equilibria points for the constructed model were developed accordingly. Further explanation of this phase covered in Chapter Four.

3.5 Summary

This chapter presents the research methodology stages which involved four phases; identification of local (Internal) and non local (External) properties, developing conceptual model, formalization of conceptual relationships, and evaluation. All of these phases were conducted in order to achieve the objectives of the study. The outcome of the first phase was a list of local and non local properties that affects stress and performance. These factors were formally presented using differential equations to be in term of executable dynamic properties in order to generate simulation traces. Four main simulation scenarios have been used to represent simulation results. Mathematical analysis has been used in the evaluation phase. An insight explanation is covered in Chapter Four.

CHAPTER FOUR
FORMAL MODEL DESIGN

This chapter introduces the detailed steps and processes that were followed in designing the formal model, and deliverables of methodology phases presented in details.

4.1 Identified Properties and their Relations

The deliverables of the first phase of the methodology is a set of identified properties, these properties are the variables of the conceptual model, the main concept of the proposed model adopted from JDR model, JDR model included negative resources represented in demands(Jd), and positive resources represented in resources(Jr), according to Bakker and Demerouti (2007) ,

> *"Job demands refer to those physical, psychological, social, or organizational aspects of the job that require sustained physical and/or psychological (cognitive and emotional) effort or skills and are therefore associated with certain physiological and/or psychological stress. Examples are a high work pressure, an unfavourable physical environment" (p. 312)*

Bakker and Demerouti (2007) have studied and introduced another important related concept, that is demands as job stressors, according to their study,

> *"Job resources refer to those physical, psychological, social, or organizational aspects of the job that are either/or functional in achieving work goals, reduce job demands and the associated physiological and psychological stress and stimulate personal growth, learning, and development" (p. 312)*

Demerouti, Bakker, Nachreiner and Schaufeli (2001) had introduced the concept of job buffer (*Jb*), job buffer is the factor that reduces the affects of job demands through job resources, buffering is a cognitive process that varies from an individual to another, social support (*Sc*) has been considered and discussed in many studies, Bakker and Demerouti (2007) had introduced the concept of social support as the relations of an individual either strong/weak ties represented in the family, or strong/weak ties represented in organization's network, social support is an important concept was studied by Cohen and Wills (1985) as a resources that positively improves individual's well being, as a consequence, it reduces stress, and positively contributes to performance. Environmental stressors (*En*) are factors from the

surrounding of individuals, these stressors includes; noise, heat and workload (Demerouti, Bakker, Nachreiner & Schaufeli, 2001). However, environmental stressors has been identified as a single concept in this study, to avoid bias selection, where it could encapsulate many concepts, environmental stressors were found to be related to high levels of stress, and negative impact on individuals performance Bakker and Demerouti (2007). Organizational factors (*Of*) includes organizational support, represented in rewards, career opportunities financial and incorporeal support, it was defined as factor that contributes to stress levels, and has a noticeable correlation with individual's accomplishment, these factors would affect cynical behaviors (*Cy*), and improves motivation, in addition it improves the confidence of individuals and creates satisfactory feelings (Bakker & Demerouti, 2007), it is valuable to mention that, In this study, the focus on external resources because there is no general agreement regarding which internal resources can be considered stable or situation independent, which can be changed by adequate job design. Organizational factors could also include job control, potential for qualification, participation in decision making, and task variety. Social resources refer to support from colleagues, family, and peer groups (Demerouti, Bakker, Nachreiner & Schaufeli, 2001). Personality is another important concept that regularly was been mentioned, personality includes five main concepts, that had been defined in previous literature. However, the personality variable that has received the most attention with respect to stress and coping is neuroticism (Gunthert, Cohen & Armeli, 1999), in this study it is represented in negative personality factor (*Np*), negative personality lead to a noticeable decrease of self efficacy (*Se*) as stated by Judge, Jackson, Shaw and Rich (2007). Furthermore, Martin (2007) has found that self efficacy mediates the relation between negative personality and performance, negative personality was found to be related coping strategies and appraisal (Gunthert, Cohen & Armeli, 1999).

Satisfaction (*Sa*) is a pleasurable or positive emotional state resulting from the appraisal of one's job or job experience, satisfaction contributes to motivation (*Mv*), in addition it has been found to be related to reducing the impact of stress and burnout (Khalatbari, Ghorbanshiroudi & Firouzbakhsh, 2013; Yeh, 2015). Dissatisfaction (*Ds*) is the opposite concept of satisfaction; therefore it is relations are the contrast of satisfaction. Job strain (*Js*) is related concept to stress (Demerouti,

Bakker, Nachreiner & Schaufeli, 2001), it was defined as a high psychological demand resulted on low decision latitude at work, which would lead to short term exhaustion (*Sx*), and later long term exhaustion (*Lx*) and eventually causes burnout (*Br*) in a long view, later will affect short term performance (*Sp*), and Long term Performance (*Lp*) in the cumulative perspective (Ahola, Honkonen, Kivimäki, Virtanen, Isometsä, Aromaa, & Lönnqvist, 2006). An unavoidable related concept is fatigue researchers describe it as tiredness, weariness, malaise, exhaustion, lack of energy and impairment in memory or concentration (Christley, 2010; Evengae et al., 1999). These conditions have effect on how the person feels about self daily activities, family care, and relationships with others (Christley, 2010). An individual suffers from short term fatigue (*Sf*) as result of feeling exhausted which would eventually result on long term fatigue (*Lf*) in the long affect (MacDonald, 2003).

When facing a stressed event, an individual appraises two kinds of appraisals; the primary and the secondary. The primary appraisal is made to evaluate person's well being. At first, the situation can be appraised either as threat or challenge. This process will determine individuals' emotion perception; negative or positive emotion (Folkman, 1984). Negative emotion is related to perceiving harm and threat, and positive emotion is attributed to perceiving challenge. Secondly, a person evaluates whether he or she has the resources to deal with the stressors. It is commonly related to the emotional attribution, where a positive emotion results in acceptance (*Ap*), while the negative emotion triggers holdback (*Hb*) (Aziz, Klein, & Treur, 2011). Later, it will lead to the problem (*Pf*) and emotion focused coping (*Ef*). A problem focused coping is associated with rational efforts to get the problem solved, while emotion-focused coping strategies entail efforts to regulate the emotional consequences of stressful events (Marsella & Gratch, 2003). All these strategies can be proven useful, but many individuals feel that in a long run, emotion focused coping is associated with outcomes that people found unsatisfactory, where it leads to short term stress (*Ss*) that can eventually causes long term stress (*Ls*) (Folkman, 1984).

4.2 List of the Properties

From previous section and as stated in literature reviews, properties with significant relations to stress and performance was identified, Table4.1 shows a list of local/nonlocal instantaneous properties, their formal presentation in the formalized model, and their descriptions.

Table 4.1
Instantaneous Properties

NO	Property	Formal Representation	Description
1	Environment stressors	*En*	Refers to factors from the surroundings of individual
2	Job strain	*Js*	high psychological demands resulted on low decision latitude at work
3	Social support	*Sc*	Any kind of assistance and encouragement for individual during stressful event
4	Cynicism	*Cy*	represents the cognitive aspect of hostility and is defined as cynical and mistrustful attitudes and the tendency to interpret other's actions as offensive
5	Motivation	*Mv*	voluntary uses of high-level self-regulated learning strategies, such as paying attention, connection, planning, and monitoring
6	Job resources	*Jr*	refer to physical, psychological, social, or organizational aspects of the job
7	Job demands	*Jd*	refer to those physical, psychological, social, or organizational aspects of the job that require sustained physical and/or psychological (cognitive and emotional) effort or skills and are therefore associated with certain physiological and/or psychological costs.
8	Satisfaction	*Sa*	a pleasurable or positive emotional state resulting from the appraisal of one's job or job experience
9	Dissatisfaction	*Ds*	A negative emotional state resulting from job experience
10	Self efficacy	*Se*	Individual's beliefs about his/her capabilities to produce designated levels of performance that exercise influence over events that affect their lives

Table 4.1 Continued			
11	Acceptance	*Ap*	Individuals' condition when they are trying to face the stressful event in a trial to change the situation
12	Holdback	*Hb*	The opposite case of acceptance when individuals give up and no longer trying to face a stressful event
13	Emotional focus coping	*Ef*	Refers to an entail efforts of an individual to control the emotional consequences of stressful event (thinking rather than acting)
14	Problem focus coping	*Pf*	Refers to an interpersonal efforts of a human to adjust the situation as well as rational efforts to have the problem solved
15	Short term stress	*Ss*	How human body respond to any kind of stressful situation that happens instantaneously
16	Short term exhaustion	*Sx*	A state of extreme physical or mental tiredness that happens occasionally
17	Short term fatigue	*Sf*	A physical and/or mental exhaustion such as swollen lymph nodes, sore throat, and muscle weakness etc.
18	Negative personality factor	*NP*	It is an enduring tendency to negative traits states. Such as Neuroticism, anger, etc.
19	Job buffer	*Jb*	Reduces the negative impact of stressors
20	Short term job performance	*Sp*	The instantaneous performance level

Previous Table shows instantaneous properties, Table4.2 shows identified temporal properties along with their formal presentation and descriptions.

Table 4.2
Temporal Properties

No.	Property	Formal Representation	Description
1	Burnout	*Br*	The result of a significant accumulation of work-related stress.
2	Long term stress	*Ls*	How human body respond to any kind of stressful situation that happens for a long perio

Table4.2 Continued

3	Long term exhaustion	*Lx*	A state of extreme physical or mental tiredness that happens for a long period.
4	Long term fatigue	*Lf*	A disabling fatigue that lasts at least one month
5	Long term Job performance	*Lp*	The cumulative level of performance

4.3 Conceptual model of manager's performance during stress

Based on previous sections, and previous literature reviews, the structure of the conceptual model relations has been designed, the relations of identified properties were explained in section 4.1 used in designing the model, Figure4.1 shows the conceptual model of manager's performance during stress.

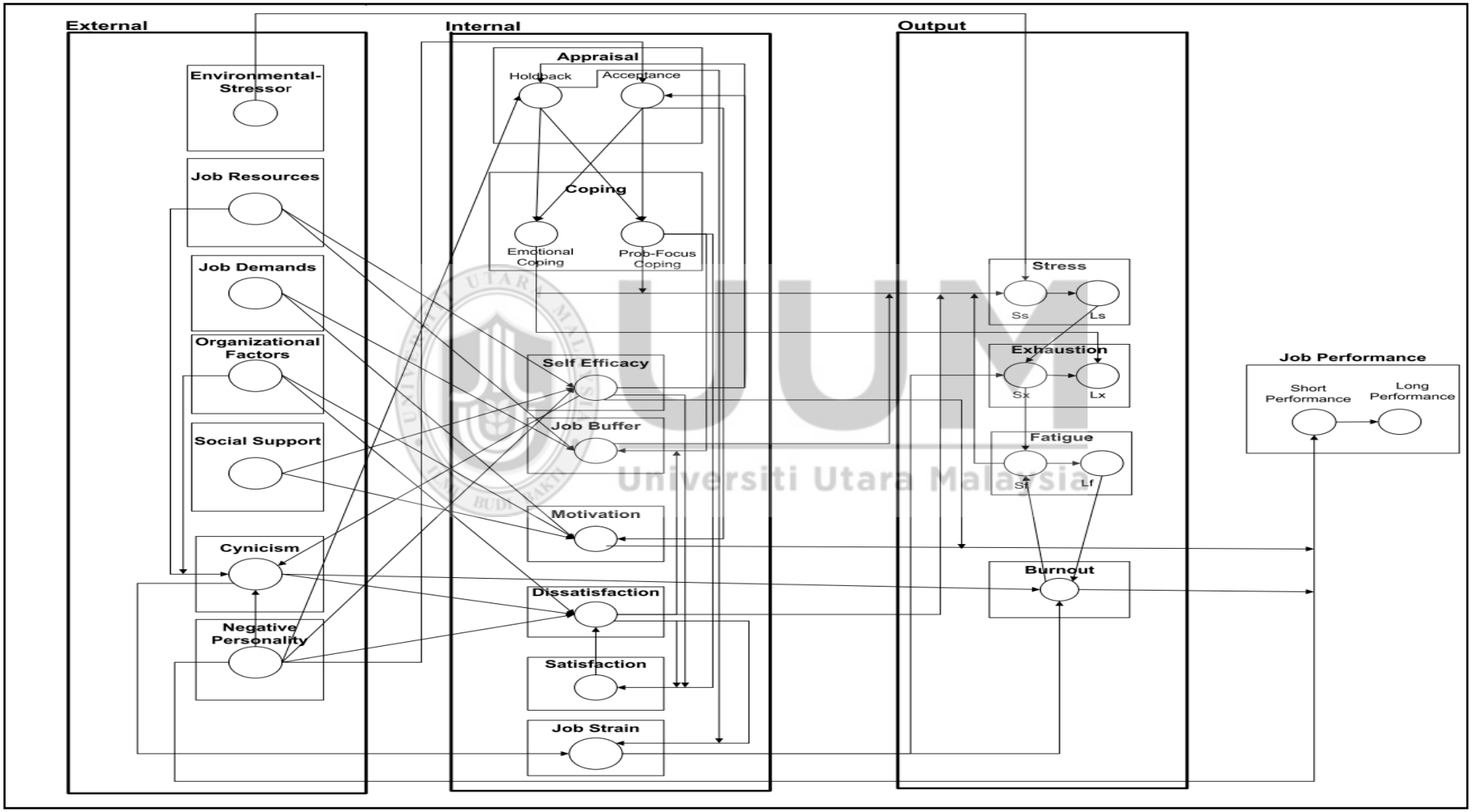

Figure 4.1: Conceptual model structure of manager's performance during stress

4.4 Formal Model Design

Formalization has been done using differential equations technique. Formalization aims to construct an executable model of the dynamics of the process. The following sections present the formalized model, each of the properties details with a list of different conditions is described in the following section, different conditions are used to indicate the expected patterns in the simulation based on previous literatures

It is worthy to mention that, in the formalised model equations there are a number of parameter's used, parameters declared based on their positions on each equation, there are different types of used parameters; Table4.3 shows used parameters along with their type and declaration.

Table 4.3
Parameters declaration

Parameter	Type	Value
α_{se}	Regulator	0.5
β_{jb}	Regulator	0.5
ω_{js}	Weightage	0.3
ω_{cy}	Weightage	0.25
γ_{sa}	Regulator	0.5
α_{ds}	Regulator	0.5
μ_{mv}	Regulator	0.5
ω_{s}	Weightage	0.5
κ_{ss}	Regulator	0.5
Υ_{ss}	Regulator	0.5
ω_{sx}	Weightage	0.5
α_{sf}	Regulator	0.5
η_{sp}	Regulator	0.5
θ_{lx}	Contribution	0.01
λ_{br}	Regulator	0.3
ω_{br}	Weightage	0.3

4.4.1 Instantaneous Local Properties

This section introduces the formalization of instantaneous properties which include the twenty factors listed in phase I

1. Self Efficacy

Self efficacy is a local property, that has been defined as Individual's beliefs about his/her capabilities to produce designated levels of performance that exercise influence over events that affect their lives. Table 4.4 shows the properties in which contribute to self efficacy.

Table 4.4

Contributed properties to self efficacy

No.	Property	Presentation
1	Social support	Sc
2	Negative personality	Np
3	Job resources	Jr

Figure 4.2 represents Self Efficacy relations; the mathematical equation of self efficacy provided in Eq4.1

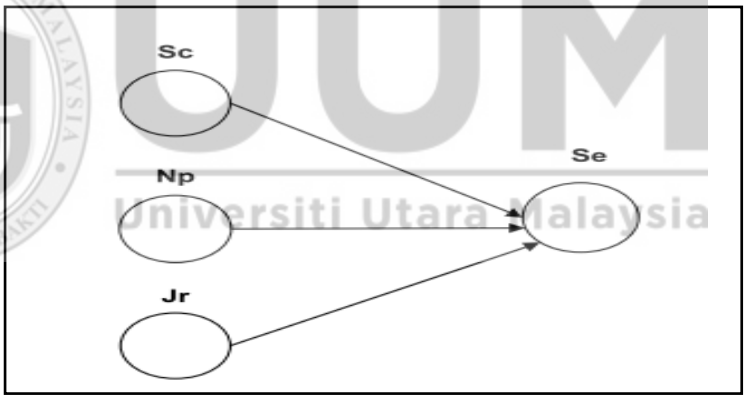

Figure 4.2: Self Efficacy

$$Se(t) = [\alpha_{se}.Sc(t) + (1 - \alpha_{se}).Jr(t)].\big(1 - Np(t)\big) \quad \text{Eq4.1}$$

The input for this equation is three elements which are Sc,Np, and Jr. Se is the output of this equation. Se occurs when Sc and Jr are triggered and also Negative personality should be triggered. Parameter α is used to control or regulate the equation. Table 4.5 illustrates the effect on Se when the input conditions are changed.

Table4.5

Different conditions of self efficacy

Conditions	Local dynamics Properties	Self Efficacy value	Description
Condition1	Sc high Jr high Np high	Se low	Se is high when Sc and Jr are high , Np will negatively affect Se.
Condition2	Sc high Jr low Np high	Se low	
Condition3	Sc high Jr high Np low	Se high	

2 Job Buffer:

Job buffer has been defined as the factor that buffers the effects of job demands on job resources. Table 4.6 shows the properties in which contribute to job buffer.

Table4.6

Contributed properties to job buffer

No.	Property	Presentation
1	Job demand	Jd
2	Dissatisfaction	Ds
3	Job resources	Jr
4	Problem focus	Pf

Figure 4.3 represents job buffer relations. In addition, Eq4.2 shows the mathematical equation of job buffer

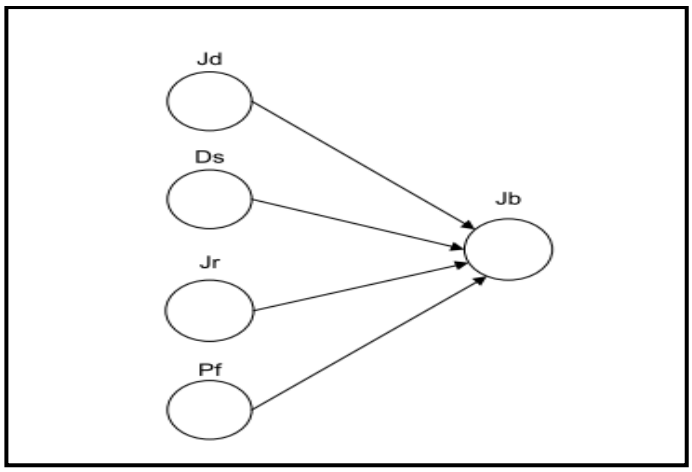

Figure4.3: Job Buffer

$$Jb(t) = \left[\beta_{jb} . Jr(t).(1 - Jd(t)\right] + \left[\left(1 - \beta_{jb}\right).Pf(t).\left(1 - Ds(t)\right)\right] \quad \text{Eq4.2}$$

The input for this equation are four elements which are Jd, Ds, Jr and Pf. Jb is the output of this equation. Parameter β is used to control and regulate the equation. Table 4.7 illustrates the effect on Jb when the input conditions are changed.

Table4.7

Different condition of job buffer

Conditions	**Local dynamics Properties**	**Job buffer value**	**Description**
Condition1	Jd high Ds high Jr high Pf high	Jb low	Jb is low whenever one of Jr,Jd or Pf and Ds is low otherwise its high.
Condition2	Jd high Ds low Jr low Pf high	Jb high	
Condition3	Jd high Ds low Jr low Pf low	Jb low	

3 Job Strain :

Job strain is a non local property, which has been defined as high psychological demands resulted on low decision latitude at work .Table 4.8 shows the properties which contribute to job strain

Table4.8

Contributed Properties to Job Strain

No.	Property	Presentation
1	Hold back	Hb
2	Cynicism	Cy
3	Dissatisfaction	Ds

Figure 4.4 represents job strain relations, and Eq4.3 presents the mathematical equation of job strain

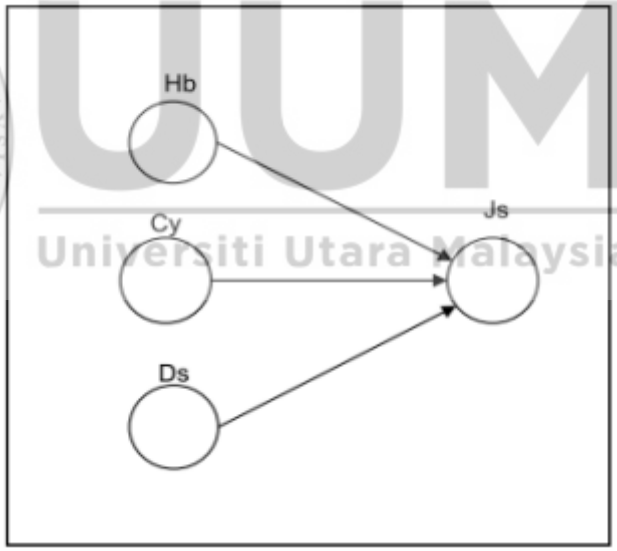

Figure4.4: Job Strain

$$Js(t) = \omega_{js1} . Hb(t) + \omega_{js2} . Cy + \omega_{js3} . Ds(t) \quad \text{Eq4.3}$$

Where $\sum_{3}^{i=1} \omega_{js} = 1$

The input for this equation are three elements which are Hb, Cy and Ds, the parameter ω is used to regulate the equation, Table 4.9 illustrates the effect on Js when the input conditions are changed.

Table4.9

Different conditions of job strain

Conditions	Local dynamics Properties	Job strain value	Description
Condition1	Hb high Cy high Ds high	Js high	Js is high when one of Hb, Cy or Ds is high .
Condition2	Hb high Cy low Ds high	Js high	
Condition3	Hb low Cy low Ds low	Js low	

4 Cynicism

Cy defined as the representation of the cognitive aspect of hostility and is defined as cynical and mistrustful attitudes and the tendency to interpret other's actions as offensive. Table 4.10 shows the properties in which contribute to cynicism.

Table4.10

Contributed properties to cynicism

No.	Property	Presentation
1	Job resources	Jr
2	Negative personality	Np
3	Organizational factors	Of
4	Self efficacy	Se
5	Problem focus coping	Pf

Figure 4.5 represents cynicism relations, the mathematical equation of job strain as shown in Eq4.4

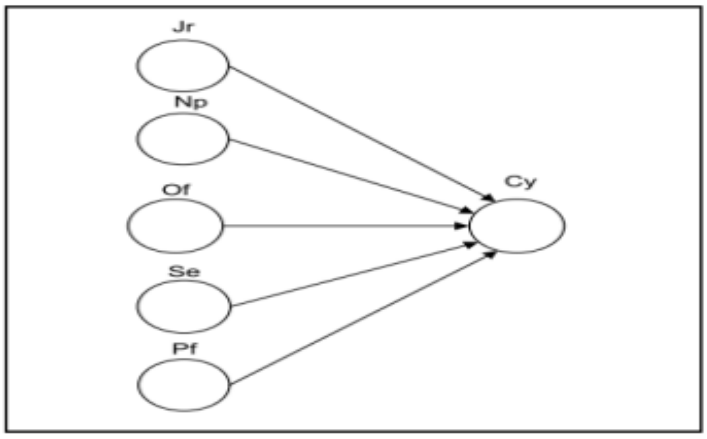

Figure4.5: Cynicism

$$Cy(t) = Np(t).\left[1 - \left(\omega_{cy1}.Jr(t) + \omega_{cy2}.Of(t) + \omega_{cy3}.Se(t) + \omega_{cy4}.Pf(t)\right)\right] \quad \text{Eq4.4}$$

Where $\sum_{4}^{i=1} \omega_{cy} = 1$

Cy is measured by Np, Jr, Of, Se and Pf. The contributions of these variables are distributed by using regulator parameter ω. Table 4.11 shows the effect on Cy when the input conditions were manipulated.

Table4.11

Different conditions of cynicism

Conditions	Local dynamics Properties	Job buffer value	Description
Condition1	Jr high Of high Se high Pf high Np high	Cy high	Cy is high whenever Np is high , and vice versa
Condition2	Jr low Of low Se low Pf high Np high	Cy high	

Table4.11Continued

Condition3	Jr high
	Of high
	Se high
	Pf high
	Np low
	Cy low

5 Acceptance:

Acceptance is a local dynamic property which refers to individuals' perception when they are facing stressful circumstances. Individuals often are trying to change the situation by appraise it as a challenge (that means, high level of acceptance). Table 4.12 shows the properties in which contribute to Acceptance

Table4.12
Contributed Properties to Acceptance

No.	Property	Presentation
1	Self efficacy	Se
2	Negative personality	Np

Figure 4.6 represents acceptance relations, the mathematical equation of acceptance as shown in Eq4.5

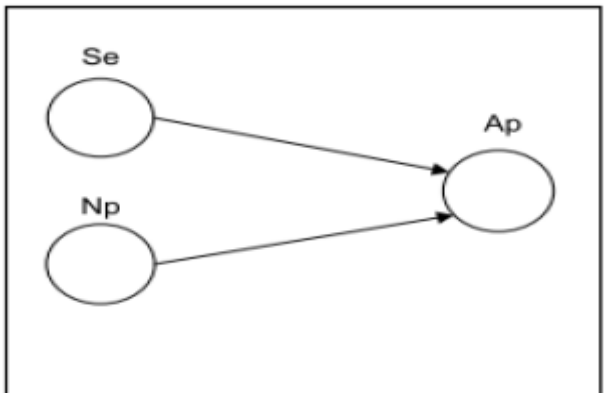

Figure4.6: Acceptance

$$Ap(t) = Se(t).\big(1 - Np(t)\big) \qquad \text{Eq4.5}$$

Ap is triggered by two ingredients which are Se and Np. Differential equation of acceptance has two inputs Se and Np. The output is acceptance. Table 4.13 illustrates the effect on acceptance when the input conditions are changed.

Table4.13
Different Conditions of Acceptance

Conditions	Local dynamics Properties	Acceptance value	Description
Condition1	Se high Np high	Ap low	Ap is high when Se is high , and vice versa.
Condition2	Se low Np high	Ap low	Yet when Np is high it negatively effects Ap
Condition3	Se high Np low	Ap high	

6 Holdback :

Holdback is the opposite condition with previous local dynamic property (acceptance). It is a negative evaluation or appraisal to the stressful circumstances, that's mean, individuals will give up and not trying to change the situation. Table 4.14 shows the properties in which contribute to Holdback

Table4.14
Contributed Properties to Holdback

No.	Property	Presentation
1	Self efficacy	Se
2	Negative personality	Np

Figure 4.7 represents holdback relations, the mathematical equation of holdback as shown in Eq4.6

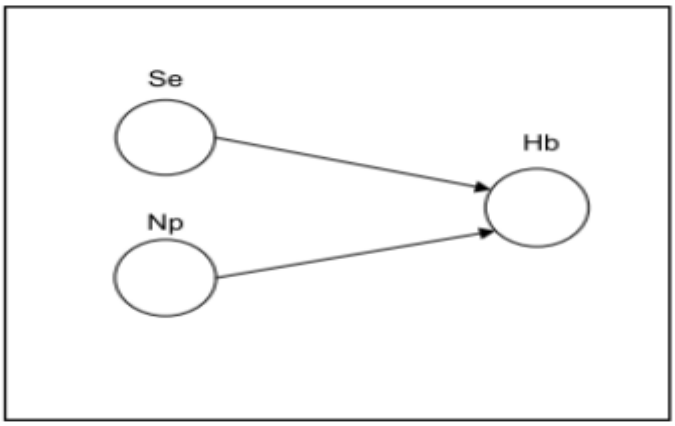

Figure4.7: Holdback

$$Hb(t) = Np(t).(1 - Se(t)) \quad \text{Eq4.6}$$

It is triggered by two ingredients which are negative personality Np and self efficacy Se. Table 4.15 illustrates the effect on holdback when the values of Se and Np are changed.

Table4.15
Different Conditions of Holdback

Conditions	Local dynamics Properties	holdback value	Description
Condition1	Np high Se high	Hb low	Hb is high when Np is high , and its low when Np
Condition2	Np low Se high	Hb low	is low. Se negatively effects Hb
Condition3	Np high Se low	Hb high	

7 Emotional Focus

The concept of emotional focus coping refers to associated endeavours to control the emotional consequences of potential stressful event (thinking rather than behaving to change individual –environment relationship). The occurrence of emotional focus is determined according to the level of holdback (Hb), and

acceptance (Ap). Emotional focus will be chosen if there is high level of holdback. Table 4.16 shows the properties in which contribute to emotional focus

Table4.16
Contributed Properties to Holdback

No.	Property	Presentation
1	Acceptance	Ap
2	Holdback	Hb

Figure 4.8 represents emotional focus relations, the mathematical equation of emotional focus as shown in Eq4.7

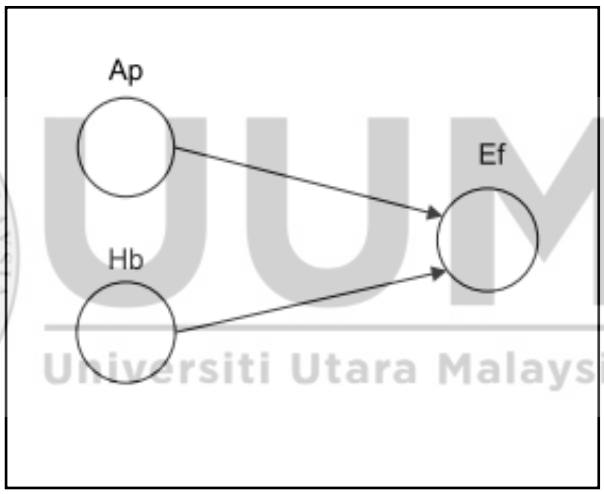

Figure 4.8: Emotional Focus

$$Ef(t) = Hb(t).\big(1 - Ap(t)\big) \qquad \text{Eq4.7}$$

Table 4.17 illustrates the conditions of problem focus when inputs values are changed.

Table4.17

Different Conditions of Emotional Focus

Conditions	Local dynamics Properties	Emotional focus value	Description
Condition1	Hb high Ap high	Ef low	Ef is high when Hb is high , and its low when Hb is
Condition2	Hb low Ap high	Ef low	low and Ap high .Ap has negative impact on Ef.
Condition3	Hb high Ap low	Ef high	

8 Problem Focus:

Problem focus coping strategy refers to interpersonal endeavours to change the stressful situation as well as rational efforts to get the problem solved (the opposite of holdback, acting rather than thinking). It is triggered by two factors which are acceptance (Ap) and Holdback (Hb). High level of acceptance will increase the level of problem focus coping; otherwise, it will decrease (high level of holdback). Table 4.18 shows the properties in which contribute to problem focus

Table4.18

Contributed Properties to Problem Focus

No.	Property	Presentation
1	Acceptance	Ap
2	Holdback	Hb

Figure 4.9 represents problem focus relations, mathematical equation of problem focus as shown in Eq4.8

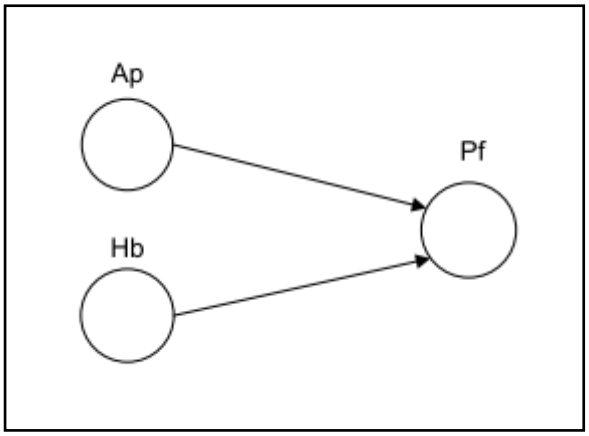

Figure4.9: Problem Focus

$$Pf(t) = Ap(t).(1 - Hb(t)) \quad \text{Eq4.8}$$

Table 4.19 illustrates the conditions of problem focus when inputs values are changed.

Table4.19
Different Conditions of Problem Focus

Conditions	Local dynamics Properties	Job buffer value	Description
Condition1	Ap high Hb high	Pf low	Pf is high when Ap is high, and its low when Ap is low. However Hb has negative impact on Pf even when Ap is high.
Condition2	Ap low Hb high	Pf low	
Condition3	Ap high Hb low	Pf high	

9 Satisfaction

Satisfaction has been defined as a pleasurable or positive emotional state resulting from the appraisal of one's job or job experience, Sa trigged by three components which are Pf, Se, and Ds as illustrated in Figure 4.9. Table 4.20 shows the properties which contribute to satisfaction

Table4.20

Contributed Properties to Satisfaction

No.	Property	Presentation
1	Problem focus coping	Pf
2	Self efficacy	Se
3	Dissatisfaction	Ds

Figure 4.10 represents satisfaction relations; mathematical equation of satisfaction is as shown in Eq4.9

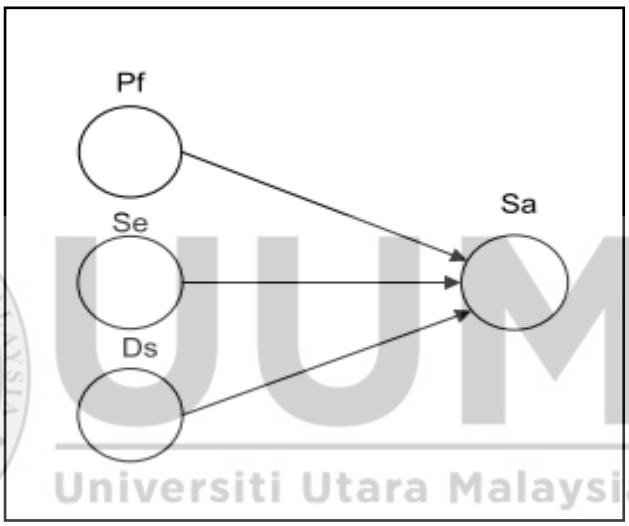

Figure4.10: Satisfaction

$$Sa(t) = [\gamma_{sa}.Pf(t) + (1-\gamma_{sa}).Se(t)].\big(1-Ds(t)\big) \quad \text{Eq4.9}$$

Table 4.21 shows the affects of manipulating the values of the components.

Table4.21

Different Conditions of Satisfaction

Conditions	Local dynamics Properties	Satisfaction value	Description
Condition1	Pf high Se high Ds high	Sa low	Sa is low when Ds is high, and vice versa.
Condition2	Pf low Se high Ds high	Sa low	
Condition3	Pf high Se high Ds low	sa high	

10 Dissatisfaction :

Dissatisfaction is a negative emotional state resulting from individual's experience. Ds triggered by the existence of four properties which are Cy, Np, Of and Sa Table 4.22 shows the properties which contribute to dissatisfaction

Table4.22

Contributed Properties to Dissatisfaction

No.	Property	Presentation
1	Cynicism	Cy
2	Negative personality	Np
3	Satisfaction	Sa
4	Organizational factors	Of

Figure 4.11 represents dissatisfaction relations; mathematical equation of dissatisfaction is as shown in Eq4.10

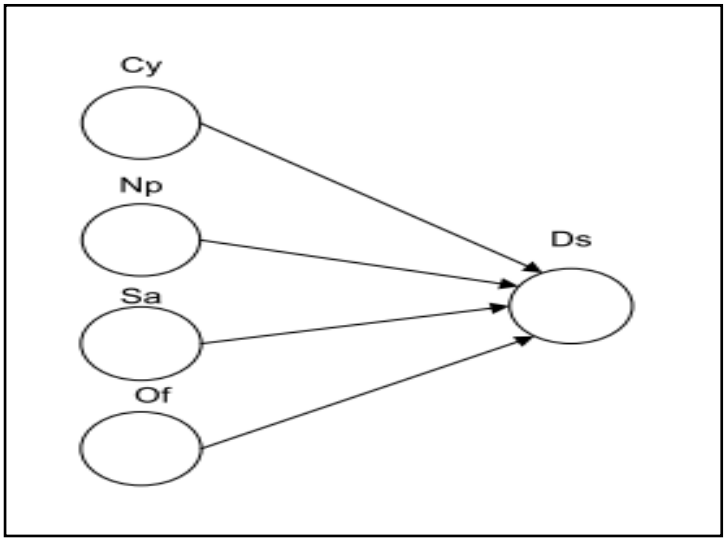

Figure4.11: Dissatisfaction

$$Ds(t) = [\alpha_{ds}.Cy(t) + (1-\alpha_{ds}).Np(t)].\left[1 - \begin{pmatrix} \eta_{ds}.Sa(t)) + \\ (1-\eta_{ds}).Of(t) \end{pmatrix}\right] \quad \text{Eq4.10}$$

Table 4.23 shows the affect when the values of the four properties manipulated.

Table4.23

Different Conditions of Dissatisfaction

Conditions	Local dynamics Properties	Dissatisfaction value	Description
Condition1	Cy high Np high Sa high Of high	Ds high	Ds is high when Cy and Np are high, or either one of them is high, and its low when both are low.
Condition2	Cy high Np high Sa low Of low	Ds high	

Table4.23Continued

Condition 3	Cy low	Ds low
	Np low	
	Sa high	
	Of high	

11 Motivation

Motivation defined as voluntary uses of high-level self-regulated learning strategies, such as paying attention, connection, planning, and monitoring, it is calculated by the contributions of four properties which are Ap, Jd, Sc, and Of. Table 4.24 shows the properties which contribute to motivation

Table4.24

Contributed Properties to Motivation

No.	Property	Presentation
1	Acceptance	Ap
2	Job demand	Jd
3	Social support	Sc
4	Organizational factors	Of

Figure 4.12 represents how motivation triggered by the contributed properties, mathematical equation of motivation is as shown in Eq4.11

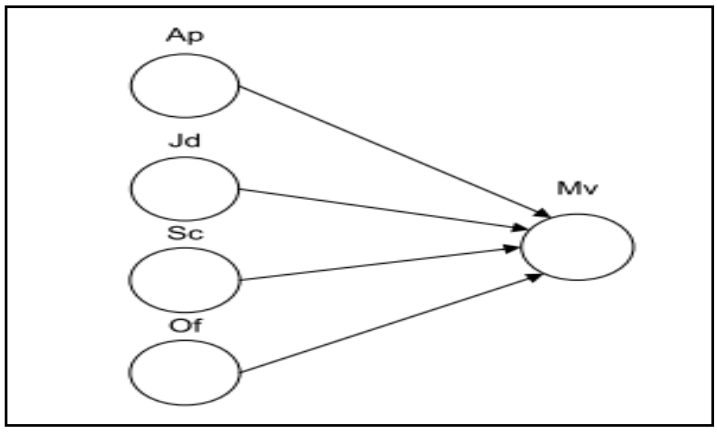

Figure4.12: Motivation

$$Mv(t) = \begin{bmatrix} \mu_{mv}.Sc(t) + \\ (1-\mu_{mv}).Ap(t) \end{bmatrix}.\left[1 - \left(Jd(t).(1-Of\ (t)\right)\right] \quad \text{Eq4.11}$$

The formulated equation of Mv as shown in Eq15, the values of the four properties regulated using μ parameter. Table 4.25 shows how Mv affected when manipulating the four properties.

Table4.25
Different Condition of Motivation

Conditions	Local dynamics Properties	Motivation value	Description
Condition1	Ap high Jd high Sc high Of high	Mv low	Mv is low when Jd and Of are high, or either one of them is high, and its high otherwise.
Condition2	Ap high Jd high Sc low Of low	Mv low	
Condition 3	Ap high Jd low Sc high Of low	Mv high	

12 Short term stress

Ss is defined as a reaction to a stressful event or any stimuli that disturbs physical or mental state of individuals instantaneously, short term stress can be triggered by six ingredients which are Sf, Jd, Ef, Pf, Ds and En. Table 4.26 shows the properties which contribute to short term stress

Table4.26
Contributed Properties to Sort Term Stress

No.	Property	Presentation
1	Environment stressor	En
2	Dissatisfaction	Ds
3	Problem focus coping	Pf
4	Emotional focus coping	Ef
5	Job demand	Jd
6	Sort fatigue	Sf

Figure 4.13 represents how short term stress triggered by the contributed properties, mathematical equation of short term stress is as shown in Eq4.12

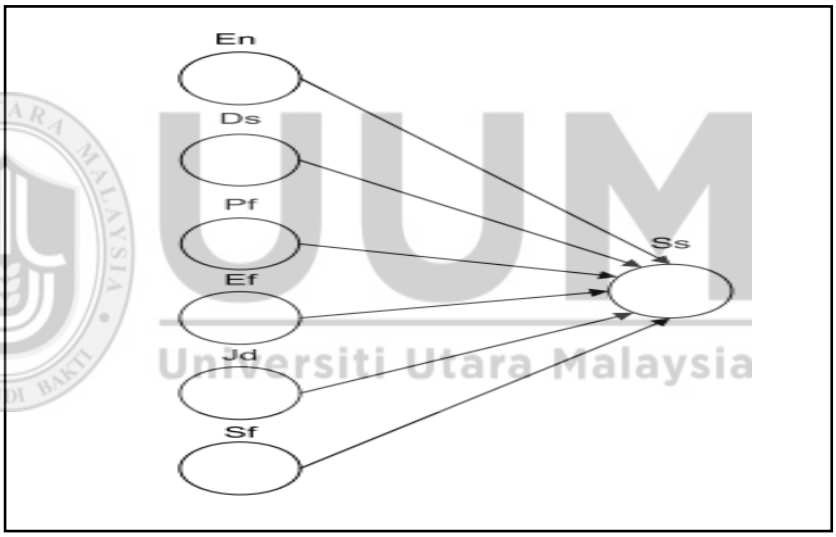

Figure4.13: Short term stress

$$Ss(t) = \begin{bmatrix} \omega_{s1}.En(t) + \\ \omega_{s2}.Sf(t) \end{bmatrix} . \left[1 - \begin{pmatrix} \kappa_{ss}.Jb(t)) + \\ (1 - \kappa_{ss} \end{pmatrix} . \begin{bmatrix} \Upsilon_{ss}.Pf(t) + \\ (1 - \Upsilon_{ss}).Ef(t) \end{bmatrix} \right] . (Ds(t)) \quad \text{Eq4.12}$$

The differential equation of Ss has six inputs and Ss is the output. Table 4.27 illustrates the conditions of Ss when inputs values are changed.

Table4.27

Different Conditions of Short Term Stress

Conditions	Local dynamics Properties	Short term stress value	Description
Condition1	En high Sf high Jb high Pf high Ef high Ds high	Ss low	Ss is high when Ds is low and vice versa.
Condition2	En high Sf high Jb high Pf high Ef high Ds low	Ss high	

13 Short term Exhaustion ,

It is a state of extreme loss of physical or mental abilities caused by tiredness or illness instantaneously. It is caused when Js or Ls exist. Table 4.28 shows the properties which contribute to short term exhaustion

Table4.28

Contributed Properties to Short Term Exhaustion

No.	Property	Presentation
1	Job strain	Js
2	Long stress	Ls

Figure 4.14 represents how short term exhaustion triggered by the contributed properties, mathematical equation of short term exhaustion is as shown in Eq4.13

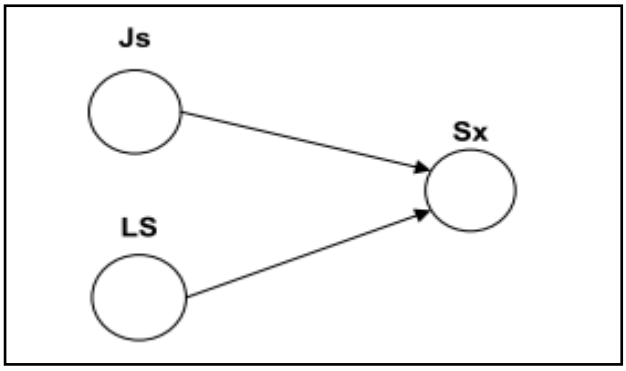

Figure4.14: Short Term Exhaustion

$$Sx(t) = \omega_{sx1} . Js(t) + \omega_{sx2} . Ls(t) \qquad \text{Eq4.13}$$

Sx has been expressed as a mathematical equation as shown in Eq11.Sx is measured by Js, and Ls. The contributions of these variables are distributed by using regulator parameter ω. Table 4.29 shows the effect on Short term exhaustion when the input conditions were manipulated.

Table4.29
Different Conditions of Short Term Exhaustion

Conditions	Local dynamics Properties	Short term exhaustion value	Description
Condition1	Js high Ls high	Sx high	Sx is low when both Js and Ls are low, otherwise its high
Condition2	Js high Ls low	Sx high	
Condition 3	Js low Ls low	Sx low	

14 Short term Fatigue:

Fatigue is defined as a feeling of lack of energy and motivation in term of physical, mental or both. Sf has two local properties which are Sx and Br. Table 4.30 shows the properties which contribute to short term fatigue

Table4.30
Contributed Properties to Short Term Fatigue

No.	Property	Presentation
1	Short term Exhaustion	Sx
2	Burnout	Br

Figure 4.15 represents how short term fatigue triggered by the contributed properties, mathematical equation of short term fatigue is as shown in Eq4.14

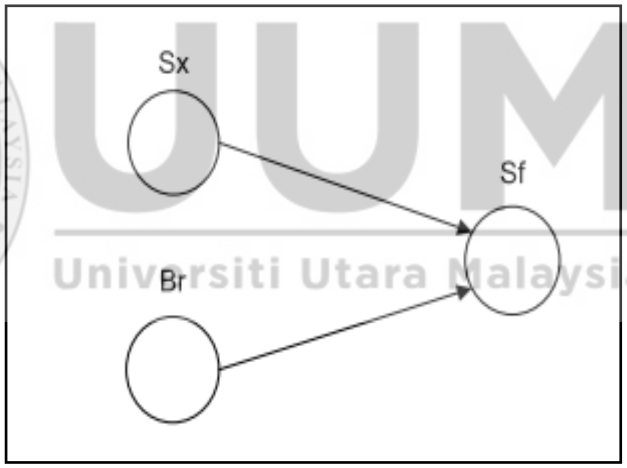

Figure4.15: Short Term Fatigue

$$Sf(t) = \alpha_{sf}.Sx(t) + \left(1 - \alpha_{sf}\right).Br(t) \quad \text{Eq4.14}$$

Sort term fatigue has been expressed as a mathematical equation as shown in Eq4.14.Its calculated using the combination of Sx and Br. Table 4.31 shows the effect on Sf when the input conditions were manipulated.

Table4.31

Different Conditions of Short Term Fatigue

Conditions	Local dynamics Properties	Job buffer value	Description
Condition1	Sx high Br high	Sf high	Sf is low when both Sx and Br are low,
Condition2	Sx high Br low	Sf high	otherwise its high
Condition 3	Sx low Br high	Sf low	

15 Short term Performance:

Short term performance is the instantaneous performance level, it is measured by the contribution of Se, Mv, and Br. Table 4.32 shows the properties which contribute to short term performance

Table4.32

Contributed Properties to Short Term Performance

No.	Property	Presentation
1	Self efficacy	Se
2	Motivation	Mv
3	Burnout	Br

Figure 4.16 represents how short term performance triggered by the contributed properties, mathematical equation of short term performance is as shown in Eq4.15

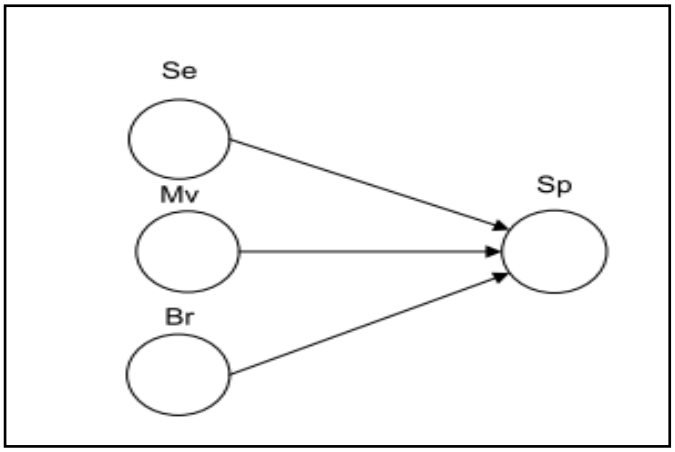

Figure4.16: Short Term Performance

$$Sp(t) = \left[\eta_{sp}.Se(t) + \left(1 - \eta_{sp}\right).Mv(t)\right].\left(1 - Br(t)\right) \quad \text{Eq4.15}$$

The formulated equation of Sp as shown in Eq4.15. Parameter η has been used to regulate the values of the three contributed properties. Table 4.33 shows the changing value of Sp when the values of the contributed properties manipulated

Table4.33
Different Conditions of Short Term Performance

Conditions	Local dynamics Properties	Short term performance value	Description
Condition1	Se high Mv high Br high	Sp low	Sp is low when Br is high. Br negatively effects Sp.
Condition2	Se high Mv high Br low	Sp high	

4.4.2 Temporal Properties

This section introduces the formalization of long term relationships

1. Long term Exhaustion:

Long term exhaustion is a state of extreme loss of physical or mental abilities caused by tiredness or illness for a long period. It is caused when Sx persists for a long period and when Ef exists for a time. Figure4.17 shows how long term exhaustion triggered by short term exhaustion and emotional focus, however emotional focus contribution is cumulative minimal contribution towards long term exhaustion.

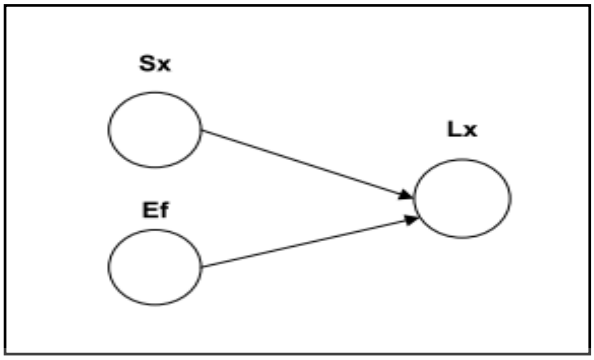

Figure4.17: Long Term Exhaustion

$$Lx(t+\Delta t) = Lx(t) + \beta_{lx}.\begin{bmatrix}(Sx(t) - Lx(t)) \\ +\theta_{lx}.Ef(t)\end{bmatrix}.Lx(t).(1 - Lx(t)).\Delta t \qquad \text{Eq4.16}$$

The contribution of Ef is regulated by parameter θ, and its contribution to Lx is minimal and cumulative. Lx can be expressed as a mathematical equation as shown above in Eq4.16, Table3.34 shows how changing conditions can affect long term exhaustion.

Table4.34

Different Conditions of Long Term Exhaustion

Conditions	Local dynamics Properties	Job buffer value	Description
Condition1	Sx high Ef high	Lx high	Lx is high when Sx is high otherwise its low.
Condition2	Sx low Ef high	Lx low	

2. Long term Stress:

Long term stress (Ls) is a physical and mental disturbance of individuals for a long period of time. It caused by high level of short term stress (Ss) and continues for

long period (accumulative exposure to Ss leads to long term stress). Figure 4.18 shows relation of long term stress with short term stress

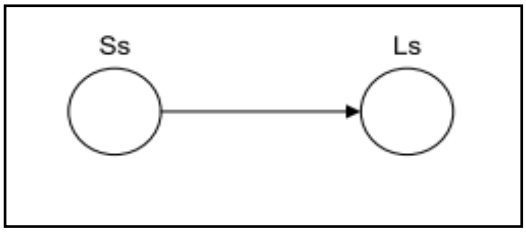

Figure4.18: Long Term Stress

$$Ls(t+\Delta t) = Ls(t) + \gamma_{ls}.\big(Ss(t) - Ls(t)\big).Ls(t).\big(1 - Ls(t)\big).\Delta t \qquad \text{Eq4.17}$$

Figure 4.18 explains how Ls will be triggered by short term stress. It can be represented in a mathematical equation as provided above in Eq4.18 where parameter γ .used to regulate the equation. The level of Long term stress will be increased or decreased over time depending on the level of short term stress. Long term stress will be in high level if there is considerable presence of short term stress. The changing process is measured in a time Interval between (t) and (t+Δt). Table 4.35 shows the conditions of Ls when the inputs values are changed.

Table4.35

Different Conditions of Long Term Stress

Conditions	Local dynamics Properties	Long term stress value	Description
Condition1	Ss high	Ls high	Ls is high when Ss is high
Condition2	Ss low	Ls low	otherwise its low.

3. Long term Fatigue

Long term fatigue is a feeling of lack of energy and motivation in terms of physical, mental or both for a long period. Lf is caused when Sf is high and persists for a long period. Lf can be expressed as a mathematical equation as shown in Eq4.18. Figure 4.19 shows the relation between long term fatigue and short term fatigue

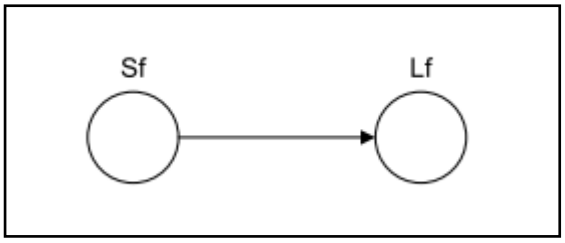

Figure4.19: Long Term Fatigue

$$Lf(t+\Delta t) = Lf(t) + \mu_{lf}.\big(Sf(t) - Lf(t)\big).Lf(t).\big(1 - Lf(t)\big).\Delta t \qquad \text{Eq4.18}$$

.Lf builds or reduces over time. When Sf is higher than Lf multiplied with the contribution factor, μ, then Lf increases. Otherwise, it decreases depending on its previous level and contribution factor. The change process is measured using time interval between t and t + Δt. Table 4.36 shows the effect on Lf when the input conditions were manipulated.

Table4.36

Different Conditions of Long Term Fatigue

Conditions	Local dynamics Properties	Long term fatigue value	Description
Condition1	Sf high	Lf high	Lf is high when Sf is high
Condition2	Sf low	Lf low	otherwise its low.

4. Long term Performance :

It is The cumulative value of performance, Lp is caused when SP is high and persists for a long period. Lp can be expressed as a mathematical equation as shown in Eq4.19. Figure4.20 represents the relationship between long term performance and short term performance

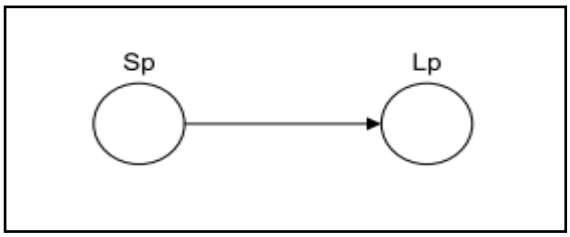

Figure4.20: Long Term Performance

$$Lp(t+\Delta t) = Lp(t) + \beta_{Lp}.\big(Sp(t) - Lp(t)\big).Lp(t).\big(1 - Lp(t)\big).\Delta t \qquad \text{Eq4.19}$$

The parameter β has been used to regulate the equation. Table 4.37 shows the effect on Lp when Sp altered.

Table4.37

Different Conditions of Long Term Performance

Conditions	Local dynamic Properties	Long term performance value	Description
Condition1	Sp high	Lp high	Lp is high when Sp is high
Condition2	Sp low	Lp low	otherwise its low.

5. Burnout :

Burnout is the result of a significant accumulation of work-related effort. Table4.38 shows the contributed properties to burnout

Table4.38

Contributed Properties to Burnout

No.	Property	Presentation
1	Job strain	Js
2	Cynicism	Cy
3	Long term fatigue	Lf

Figure 4.21 represents how burnout triggered by the contributed properties, mathematical equation of burnout is as shown in Eq4.20

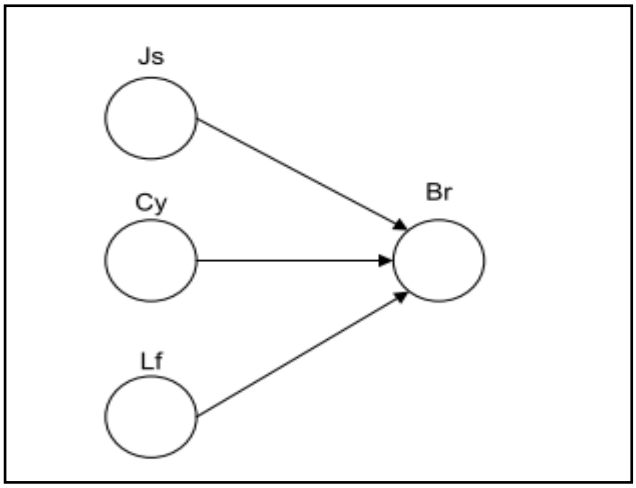

Figure4.21: Burnout

$$Br(t+\Delta t) = Br(t) + \lambda_{br}[Gr(t) - Br(t)].Br(t).\big(1 - Br(t)\big).\Delta t \qquad \text{Eq4.20}$$

*W*here:

$$Gr(t) = \omega_{br1}.Js(t) + \omega_{br2}.Cy(t) + \omega_{br3}.Lf(t) \qquad \text{Eq4.21}$$

Table 4.39 shows the affect of changing the values of contributed properties on Br.

Table4.39
Different Conditions of Burnout

Conditions	Local dynamics Properties	Burnout value	Description
Condition 1	Js high Cy high Lf low	Br high	Br is high when one of Js, Cy and Lf is high, and its low when all are low .
Condition 2	Js low Cy high Lf low	Br high	
Condition 3	Js low Cy low Lf low	Br Low	

4.5 Simulation

After formalizing the model, a simulation using MATLAB Programming Language was done, four main different scenarios has been used in the simulation. To be precise, the four scenarios have been classified based on two external properties which are environmental stressors and job demands. These two properties have been indicated to as stressor events in the simulation, the other external properties have been represented as positive resources which include job resources, organizational factors, and social support, the other part of the properties presented as negative resources which are cynicism and negative personality. The main four scenarios were high stressor event, low stressor event, moderate stressor event and high-low stressor event. Each one of the main four scenarios has 3 sub scenarios, where positive and negative resources were manipulated. Moreover, formal model simulation provides a deep understanding in the sequences of events through the time. In this phase, a simulator has constructed and designed using MATLAB Programming Language 2014. Table4.40 shows four main scenarios used in the simulation with their sub scenarios, 1 and 0 represent the values used in the simulation to indicate high and low levels respectively, 0.5 used to indicate moderate levels, such values used in modelling to predict levels (Vancouver, Weinhardt & Vigo, 2014)

Table4.40
Simulation Scenarios

No.	Scenario	Sub scenario
1	Case#1: High stress event	1.1: High stress event with high positive resources and low negative resources
		1.2: High stress event with high negative resources and low positive resources
		1.3: High stress event with moderate positive and negative resources
2	Case#2: Low stress event	2.1: Low stress event with high positive resources and low negative resources
		2.2: Low stress event with high negative resources and low positive resources

Table 4.40 Continued

		2.3: Low stress event with moderate positive and negative resources
3	Case#3:Moderate stress event	3.1: Moderate stress event with high positive resources and low negative resources
		3.2: Moderate stress event with high negative resources and low positive resources
		3.3: Moderate stress event with moderate positive and negative resources
4	Case#4:High-Low stress event	4.1: High-low stress event with high positive resources and low negative resources
		4.2: High-low stress event with high negative resources and low positive resources
		4.3: Moderate stress event with moderate positive and negative resources

All of these scenarios were coded and simulated, sample of the simulation code as shown in Figure4.22.

```
%Manager's Performance during Stress Simulation
%Part One
%Intializing all parameters to regulate the equations
      maxLimY = 1;
      minLimX = 0  ;
      Delta_t = 0.3;
      Alpha_se=0.5;
      Beta_jb=0.5;
      Gamma_sa=0.5;
      Alpha_ds=0.5;
      Eta_ds=0.5;
      Mu_mv=0.5;
%Part Two
%DECLARE VECTORS FoR ALL NODES and Set initial values to external factors

% External Factors
En= zeros(1,numStep);       % Environmental stressors
Jr= zeros(1,numStep);       % Job resources
Jd=zeros(1,numStep);        % Job demands
Of=zeros(1,numStep);        % Organizational factors
Sc=zeros(1,numStep);        % Social support
Cy=zeros(1,numStep);        % Cynicism
Np=zeros(1,numStep);        % Negative Personality


% Initializing temporal Factors
Ls(1)=0.5;
Lx(1)=0.5;
Lf(1)=0.5;
Br(1)=0.5;
Lp(1)=0.5;

  %Part Three
  % Executing the Model at time t=2
  for t = 2:numStep
      Se(t)=(Alpha_se*Sc(t)+(1-Alpha_se)*Jr(t))*(1-Np(t));      %Self Efficacy
      Jb(t)=(Beta_jb*Jr(t)*(1-Jd(t)))+((1-Beta_jb)*Pf(t)*(1-Ds(t)));  %Job Buffer
      Js(t)= Omega_js1*Hb(t)+Omega_js2*Cy(t)+Omega_js3*Ds(t);         %Job Strain
      Cy(t)=Np(t)*(1-(Wah1*Jr(t)+Wah2*Of(t)+Wah3*Se(t)+Wah4*Pf(t)));  %cynicism
      Ap(t)=Se(t)*(1-NP(t));                                          %Acceptance
      Hb(t)=Np(t)*(1-Se(t));                                          %HoldBack
    end
  % plotting graphs

  %Part Four
  % plotting graphs
  hold on
  t=1:numStep;
  subplot(2,1,1);
  y = plot(t, Ls,'k:',t, Lp, 'k-');
  xlabel('time steps');ylabel('levels');
  xlim([0 numStep]);ylim([minLimX maxLimY]);
  hold off;
  legend(y,'Long term Stress','Long term Performance')
```

Figure4.22: Sample of Simulation Code

As shown in Figure4.22 the simulation has been implemented in MATLAB Programming Language. The code has been divided into four sections, in the first part a number of parameters has been initialized, that were used to regulate the equations. The second part declares values to constant factors to be passed to the simulated equations, part three includes all equations and their processes, an initial

value has been declared to instantaneous and temporal properties. Lastly, the fourth part is plotting the graph to display simulation results, simulation results discussed, elaborated and presented precisely in Chapter Five.

4.6 Evaluation Technique

Mathematical analysis verification has been used as an evaluation technique, the evaluation used to ensure stability of the model at specific points; the following is an explanation on how mathematical analysis conducted.

Suppose we have a structured formal equation such as Eq1

$(y + \Delta t) = y(t) + \beta [b(t) - y(t)] . \Delta t$ Eq1

And

$b(t) = a(t) + [1 - c(t)]$ Eq2

$q(t) = b(t) + c(t)$ Eq3

Then $\lim_{\Delta t \to 0} \frac{(y+\Delta t) - y(t)}{\Delta t} = 0$

And $\frac{dy}{dx} = \beta [b - y]$ Eq4

Then $\beta [b - y] = 0$ where t variable is taken out.

Assuming $\beta = 1$ and $\beta \neq 0$

Then $b = y$ Eq5

Replacing Eq5 with Eq3

Therefore $q = y + c$

4.7 Summary

This chapter presents the formal model design stages which involved; formalization of conceptual relationships, simulation, and evaluation. All of these processes were elaborated in order to achieve the objectives of the study, factors identified as local

and nonlocal were mapped in the conceptual model, and formally presented using differential equations (formal model) in order to generate simulation traces. Four main simulation scenarios have been divided into 12 sub scenarios, 3 sub scenarios for each one of the main scenarios, scenarios used to represent results. Mathematical analysis was explained, a clarification example was included, an insight explanation is covered in Chapter Five.

CHAPTER FIVE

SIMULATION RESULTS AND VALIDATION

This chapter presents results of simulation, and mathematical analysis verification as validation technique.

5.1 Simulation Results

As mentioned in previous chapter, four different scenarios with variety of conditions have been simulated; simulation traces developed to provide an adequate insight for psychologists, results of each scenario are presented in the following sections.

Case #1: High stress event

Environmental stressors and Job demands are set to be in high values.

Case #1.1: High stress with high positive resources and low negative resources

The individual experiences a high stress represented by high environmental stressors, and high job demands. Moreover, the individual enjoys a high level of positive resources, represented by job resources, social support, and organizational factors. However, his/her negative resources are low represented by cynicism and negative personality. Table5.1 shows the values of input used in this scenario's simulation

Table5.1

Values of Case 1.1

Factor	Given Value
Environmental stressors(En)	1
Job demands(Jd)	1
Job resources(Jr)	1
Social support(Sc)	1
Organizational factors(Of)	1
Cynicism(Cy)	0
Negative personality(Np)	0

The result of running the simulation code of the scenario, the result obtained as shown in Figure 5.1

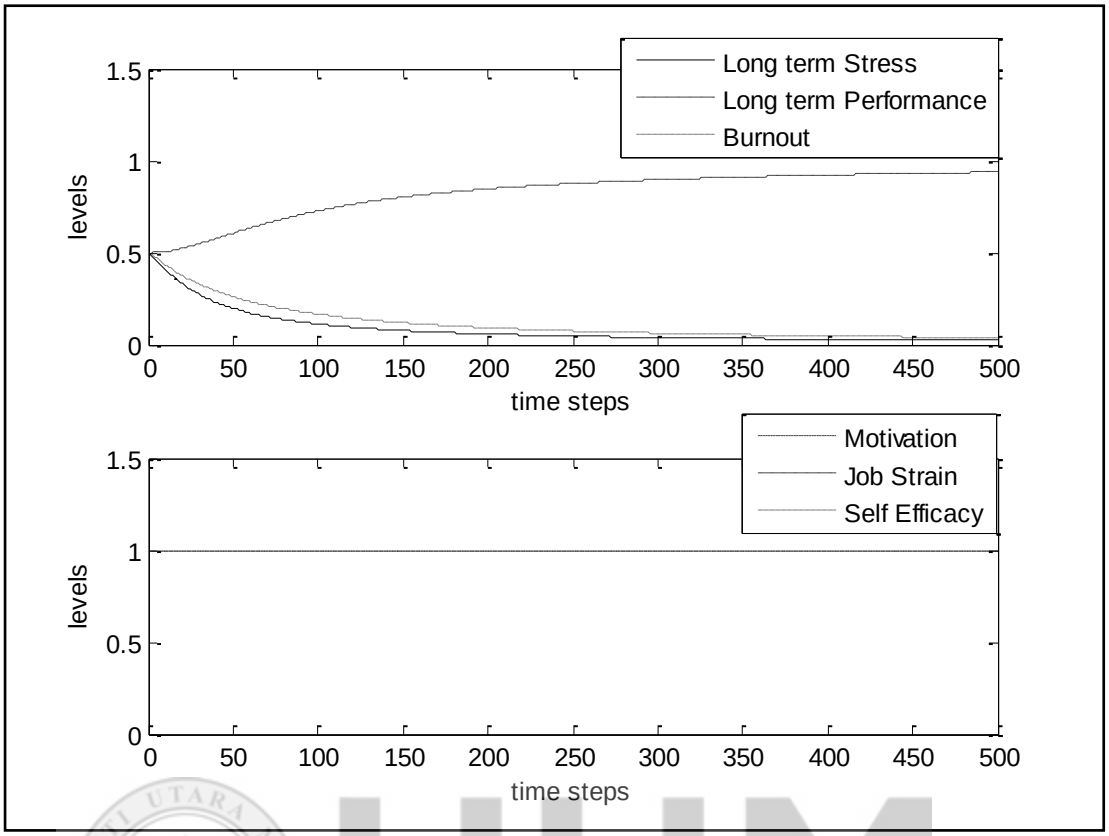

Figure 5.1: Simulation Result of Case1.1

As shown in the Figure, the two properties (Environmental stressors and Job demands) that leads to a stressed event have been set to high values, with having high positive properties and low negative properties. Having the job resources high and social support high with other positive factors, the negative effect of high job demands decreased (Bakker & Demerouti, 2007). The results presented show a high levels of performance, with decreased stress and burnout, in addition, the motivation level is high,with increasing levels of self efficacy.

Case #1.2: High stress event with high negative resources and low positive resources

In this scenario the two properties (Environmental stressors and Job demands) that leads to a stressed event have been set to high levels, with having high negative properties and low positive properties. Having job resources low and other positive factors too, in addition the negative properties are high, which leads to low motivation and increases the stress levels which in turn negatively affect performance (Bakker & Demerouti, 2007). Table 5.2 presents the conditions of this cas.

Table5.2
Given *Values of Case 1.2*

Factor	Given Value
Environmental stressors(En)	1
Job demands(Jd)	1
Job resources(Jr)	0
Social support(Sc)	0
Organizational factors(Of)	0
Cynicism(Cy)	1
Negative personality(Np)	1

The result of the scenario as shown in Figure 5.2

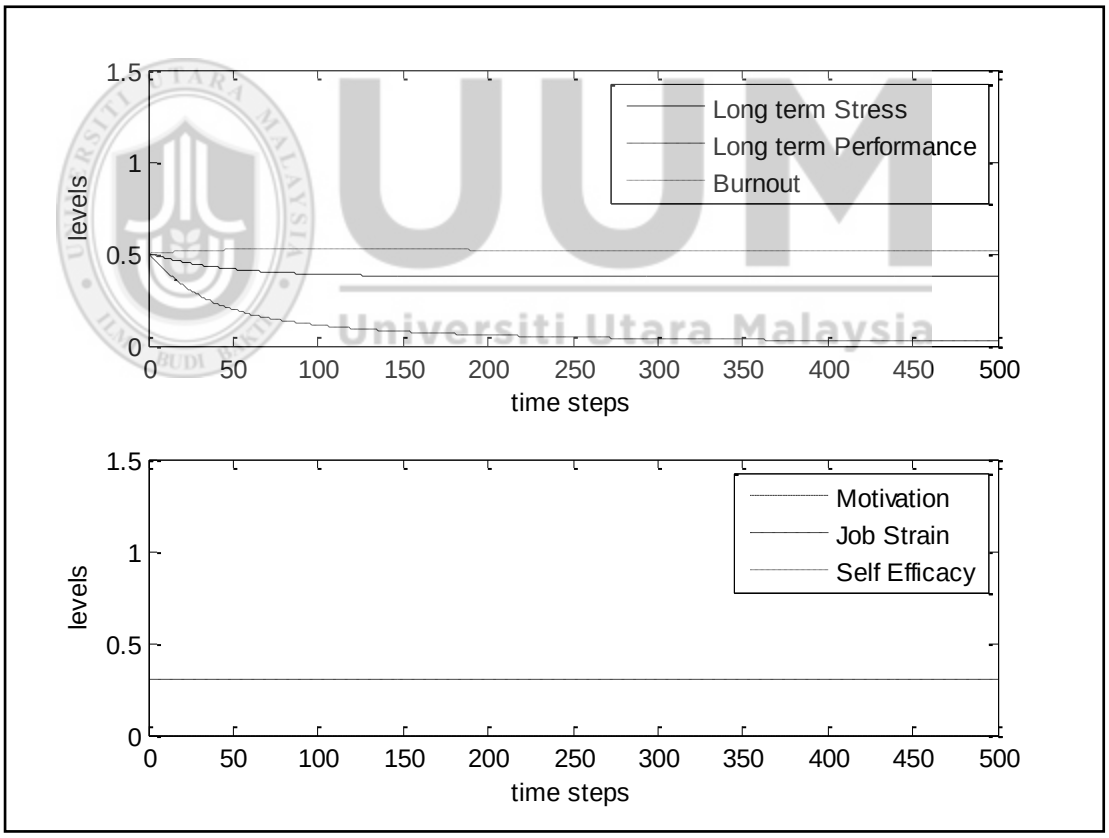

Figure 5.2: Simulation Result of Case 1.2

As can be seen from the Figure, the result shows decreasing level of performance, with having the levels of stress and burnout increasing. It's also worthy to notes that the motivation and self efficacy levels are very low with higher job strain values.

Case #1.3: High stress event with moderate positive and negative resources

In this case the positive properties such as job resources and social support are moderate. Moreover negative properties such as Negative personality and cynicism in high levels, with the high level of job demand and environmental stressor, the result shows low levels of stress, burnout and fatigue. However, motivation and self efficacy indicates low levels, which negatively affects performance levels. In this situation the result would depend on the individual's perception and reaction to stress (Beasley, Thompson & Davidson, 2003; Karademas, Kalantzi & Azizi, 2004; Course & Cover, 2012).

Table 5.3 shows the different given values in this case.

Table5.3
Values of case 1.3

Factor	Given Value
Environmental stressors(En)	1
Job demands(Jd)	1
Job resources(Jr)	0.5
Social support(Sc)	0.5
Organizational factors(Of)	0.5
Cynicism(Cy)	0.5
Negative personality(Np)	0.5

The result of simulation of the case provided below in Figure4.3

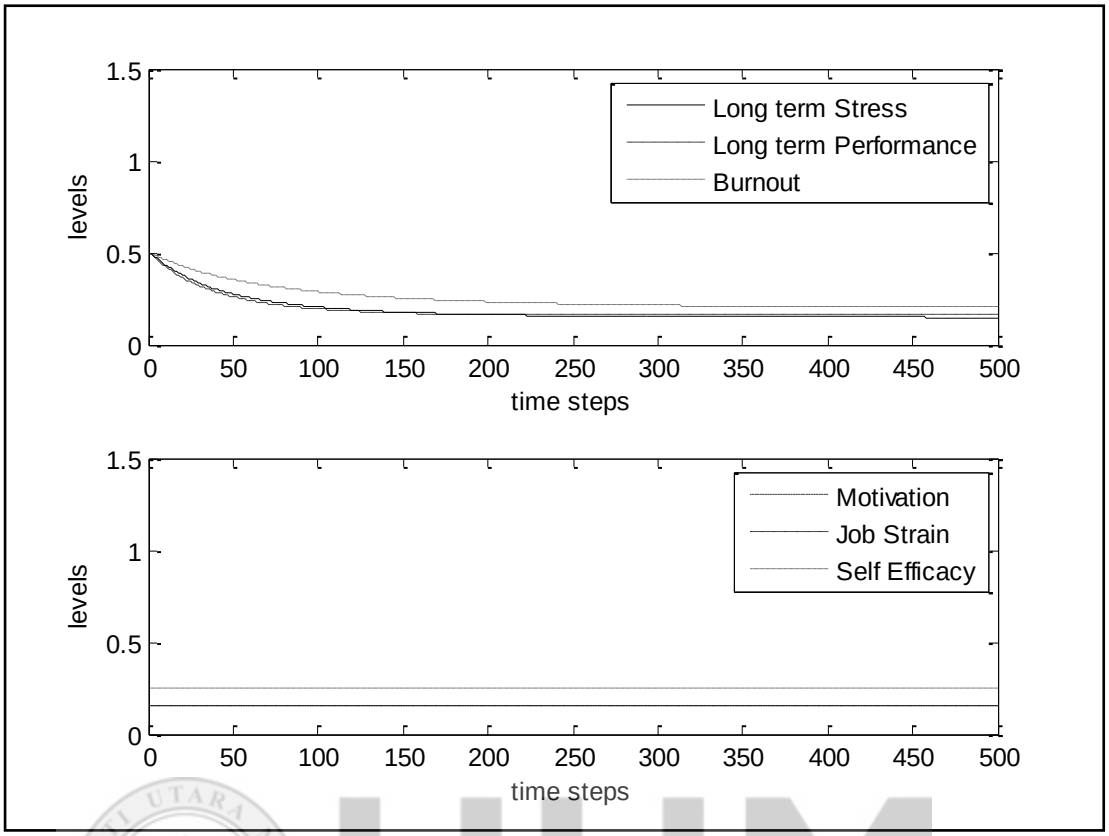

Figure 5.3: Simulation Result of Case 1.3

As the Figure show the level of motivation is very low, these low levels justify the decrease of performance level. As mentioned previously the results of the scenario highly depends on the individual's perception.

Case #2: Low stress event

Environmental stressors and Job demands are set to be in low levels.

Case #2.1: Low stress event with high positive resources, and low negative resources

In this scenario the two properties (Environmental stressors and Job demands) that leads to a stressed event has been set to low levels, with having high positive properties and low negative properties. Having job resources high and other positive factors too, in addition the negative properties are low, which leads to high motivation and reduces the stress levels which in turn positively affect performance (Thangiyah, 2012; Bakker & Demerouti, 2007). Table 5.4 presents the values given in this scenario, and Figure 5.4 shows the result of this case.

Table5.4

Values of Case 2.1

Factor	Given Value
Environmental stressors(En)	0
Job demands(Jd)	0
Job resources(Jr)	1
Social support(Sc)	1
Organizational factors(Of)	1
Cynicism(Cy)	0
Negative personality(Np)	0

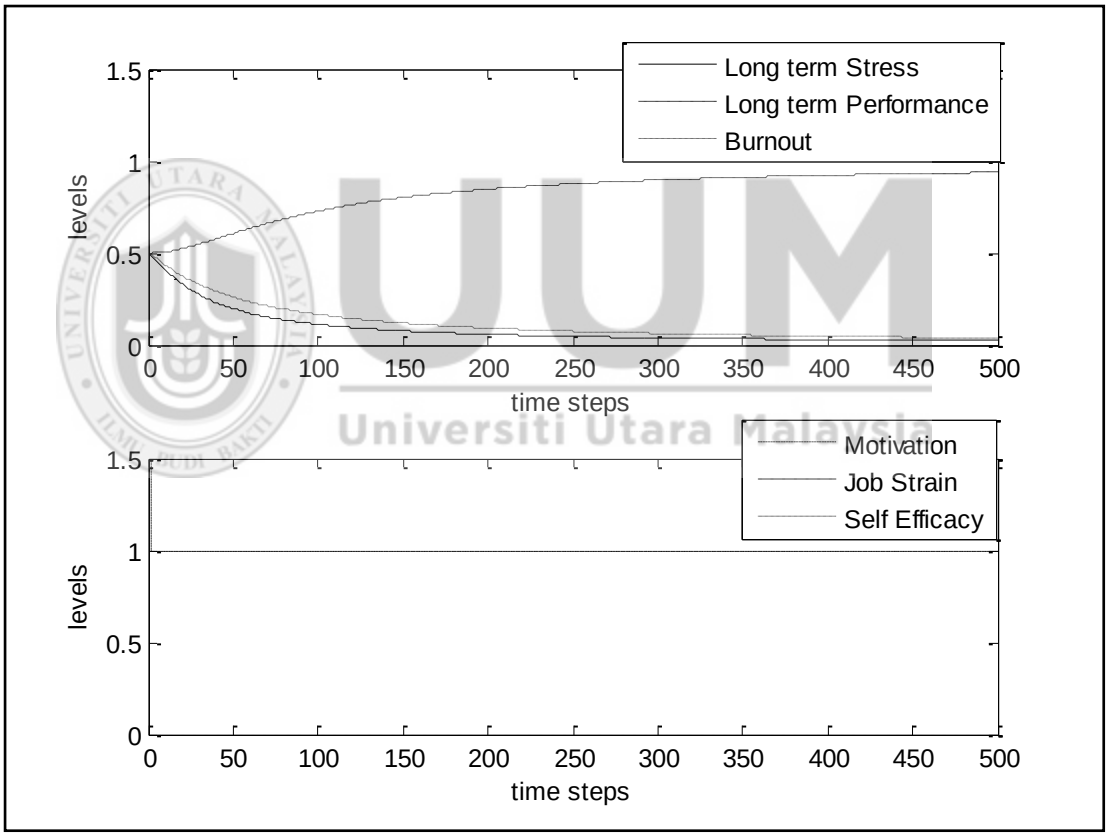

Figure 5.4: Simulation Result of Case2.1

The result shows low levels of stress, and that positively affects the levels of performance, which indicates high levels. Motivation and self efficacy levels are high while job strain levels are low.

Case #2.2: Low stress event with low positive resources, and high negative resources

This scenario simulates the situation of low stressors and low positive resources, the values of job resources and social support are low, negative personality and cynicism are high, Values stated for this case are shown in Table 5.5.

Table5.5
Values of Case 2.2

Factor	Given Value
Environmental stressors(En)	0
Job demands(Jd)	0
Job resources(Jr)	1
Social support(Sc)	1
Organizational factors(Of)	1
Cynicism(Cy)	0
Negative personality(Np)	0

The result of this case simulation illustrated in Figure 5.5 below.

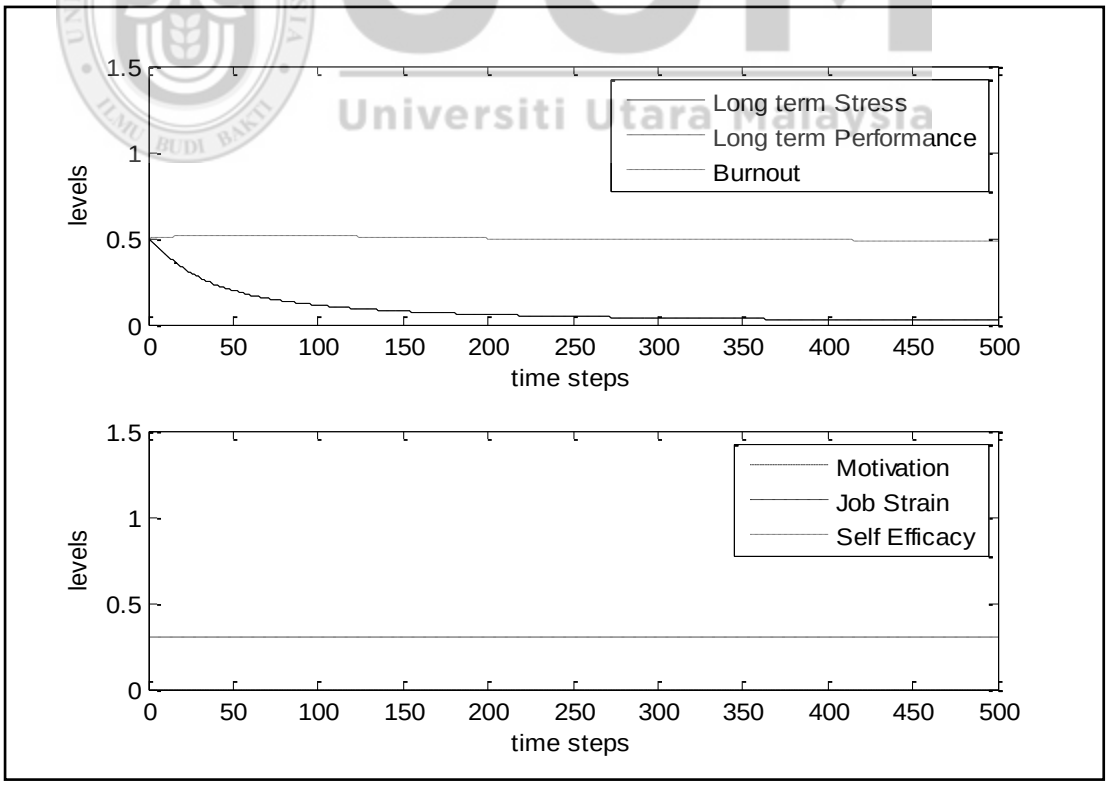

Figure 5.5: Simulation Result of Case 2.2

Result of this scenario presents low levels of performance; even though the stress level is low the performance is not high (Yerkes & Dodson, 1908). High levels of negative resources combined with low positive resources have lead to the negative impact on manager's performance.

Case #2.3: Low stress event with moderate positive and negative resources

Individual's positive and negative resources have been set to moderate values, as it is displayed in Table5.6 below.

Table5.6

Values of Case 2.2

Factor	Given Value
Environmental stressors(En)	0
Job demands(Jd)	0
Job resources(Jr)	0.5
Social support(Sc)	0.5
Organizational factors(Of)	0.5
Cynicism(Cy)	0.5
Negative personality(Np)	0.5

Simulation of this scenario displays low levels of stress and low levels of performance. The result of this scenario depends on the perception of the individual, and their personal reaction, it depends on how individuals control their emotions (Gardner, Fletcher & McGowan, 2006), as shown in Figure5.6

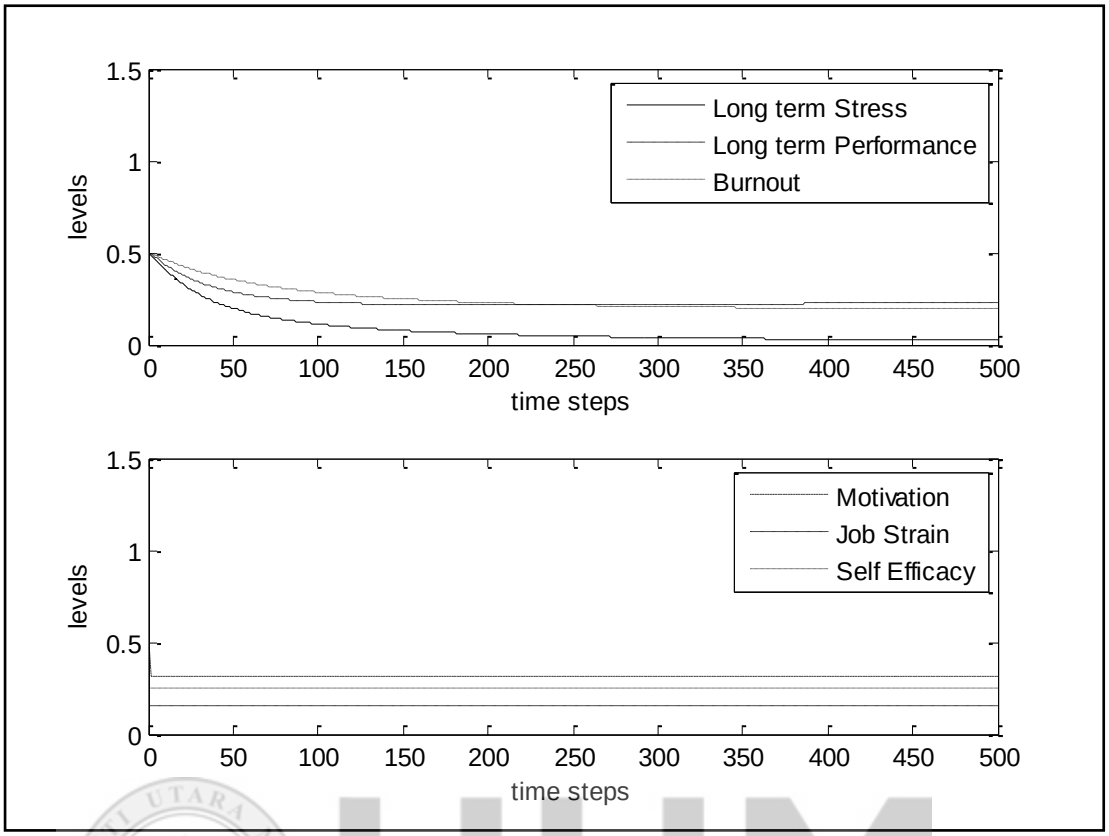

Figure5.6: Simulation Result Case 2.3

As the Figure show the level of motivation is very low, these low levels justify the decrease of performance level. As mentioned previously the results of the scenario highly depends on the individual's perception.

Case #3: Moderate stress event

The values of Environmental stressors and Job demands are set in moderate levels.

Case #3.1: Moderate stress event with high positive resources, and low negative resources

The case simulates moderate values of environmental stressor, and job demands, with high values of positive resources, low values of negative resources. Table 5.7 below shows given values in this case.

Table5.7
Values of Case 3.1

Factor	Given Value
Environmental stressors(En)	0
Job demands(Jd)	0
Job resources(Jr)	0.5
Social support(Sc)	0.5
Organizational factors(Of)	0.5
Cynicism(Cy)	0.5
Negative personality(Np)	0.5

Simulation result shows low levels of long term stress, burnout and fatigue, likewise performance level are high. the level of motivation and self efficacy properties are high which justify the low levels of stress (Nikolaou & Tsaousis, 2002; Wetzel et al., 2006). Furthermore, the performance levels are high at moderated circumstances of stressors (Yerkes & Dodson, 1908). Figure 5.7 presents the result.

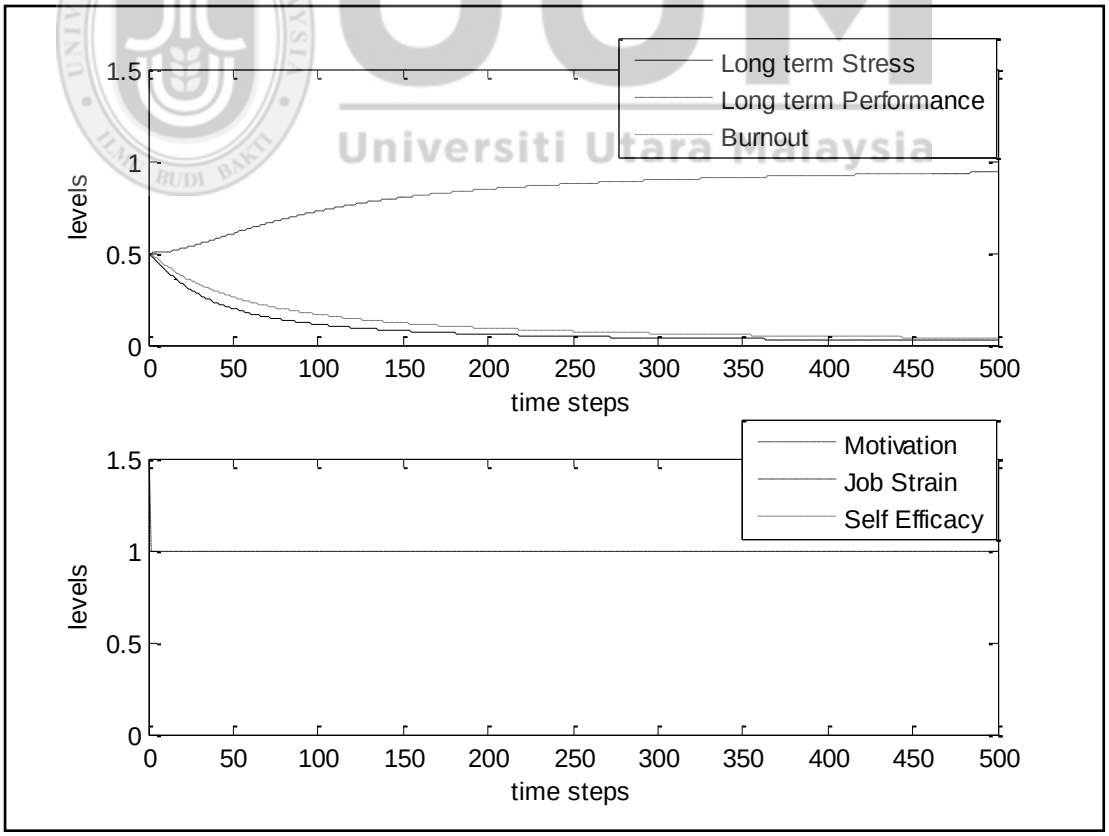

Figure 5.7: Simulation Result of Case 3.1

Result shows high levels of performance, where the stress levels are low. Motivation and self efficacy levels are high, which justifies the high levels of performance, job strain indicates low levels.

Case #3.2: Moderate stress event, low positive resources, and high negative resources

The values given in this case displayed below in Table5.8

Table5.8
Values of Case 3.2

Factor	Given Value
Environmental stressors(En)	0.5
Job demands(Jd)	0.5
Job resources(Jr)	0
Social support(Sc)	0
Organizational factors(Of)	0
Cynicism(Cy)	1
Negative personality(Np)	1

The result of this scenario shows low levels of performance and moderated level of stress, burnout and fatigue. Having the negative personality property high in addition cynicism property negatively affects the performance (Kumaresan, Nasurdin& Ramayah, 2004). The result also shows that individul in this scenario tends to use emotional focuse stratagy as a copnig stratagy which also negativly affects levels of performance in the comulative aspect (Gonzalez-Morales, Peiro, Rodriguez & Greenglass, 2006). Figure5.8 shows the result.

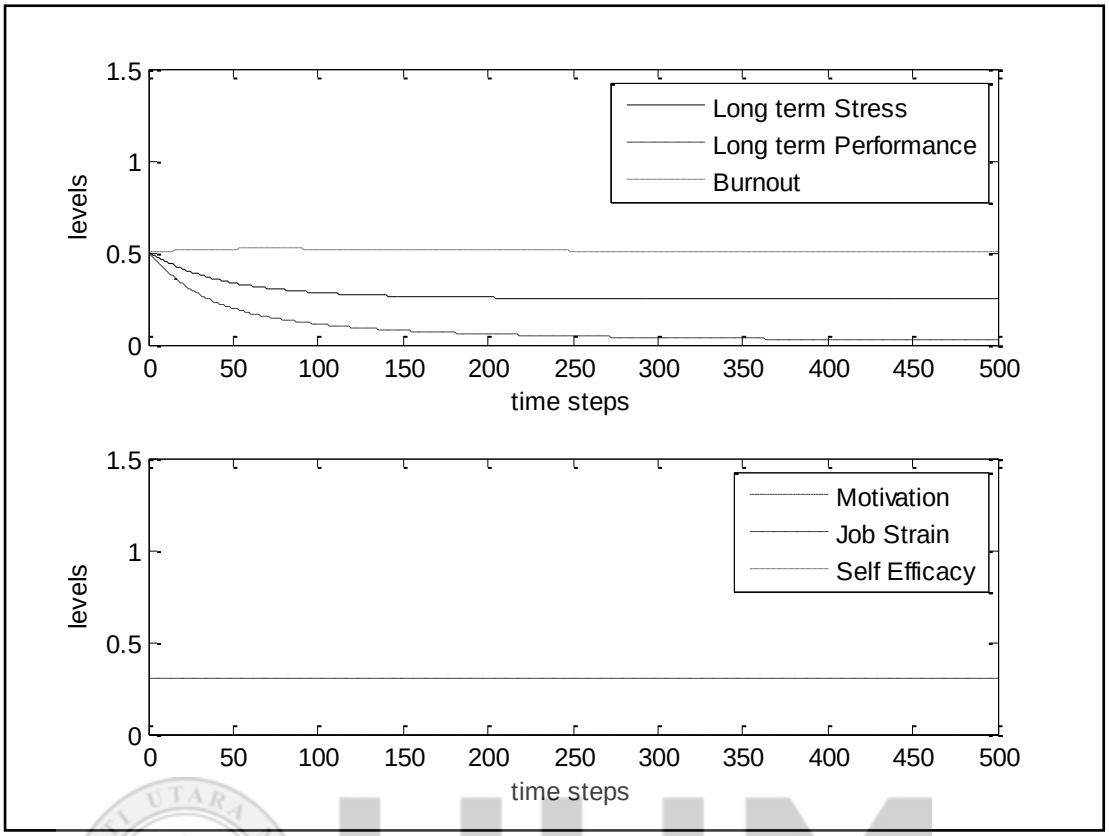

Figure5.8: Simulation Result of Case3.2

Result shows very low levels of motivation and self efficacy, these low levels have negative impact on job performance which can be seen in Figure 4.8 the levels of performance are decreasing.

Case #3.3: Moderate stress event, moderate positive and negative resources

This case simulates moderate environmental stressor and job demands values. Also values of positive and negative resources are set to moderate levels. Values given as shown in Table5.9

Table5.9

Values of Case 3.3

Factor	Given Value
Environmental stressors(En)	0.5
Job demands(Jd)	0.5
Job resources(Jr)	0.5
Social support(Sc)	0.5
Organizational factors(Of)	0.5
Cynicism(Cy)	0.5
Negative personality(Np)	0.5

Simulation shows, the levels of burnout and long term stress are low; however the stressors are in moderate levels. Result indicates low performance levels, even though the negative and positive properties are in moderate levels, the reaction on such scenario depends on the perception of the person and how they interpret the situation (Course & Cover, 2012). Figure 5.9 presents the result.

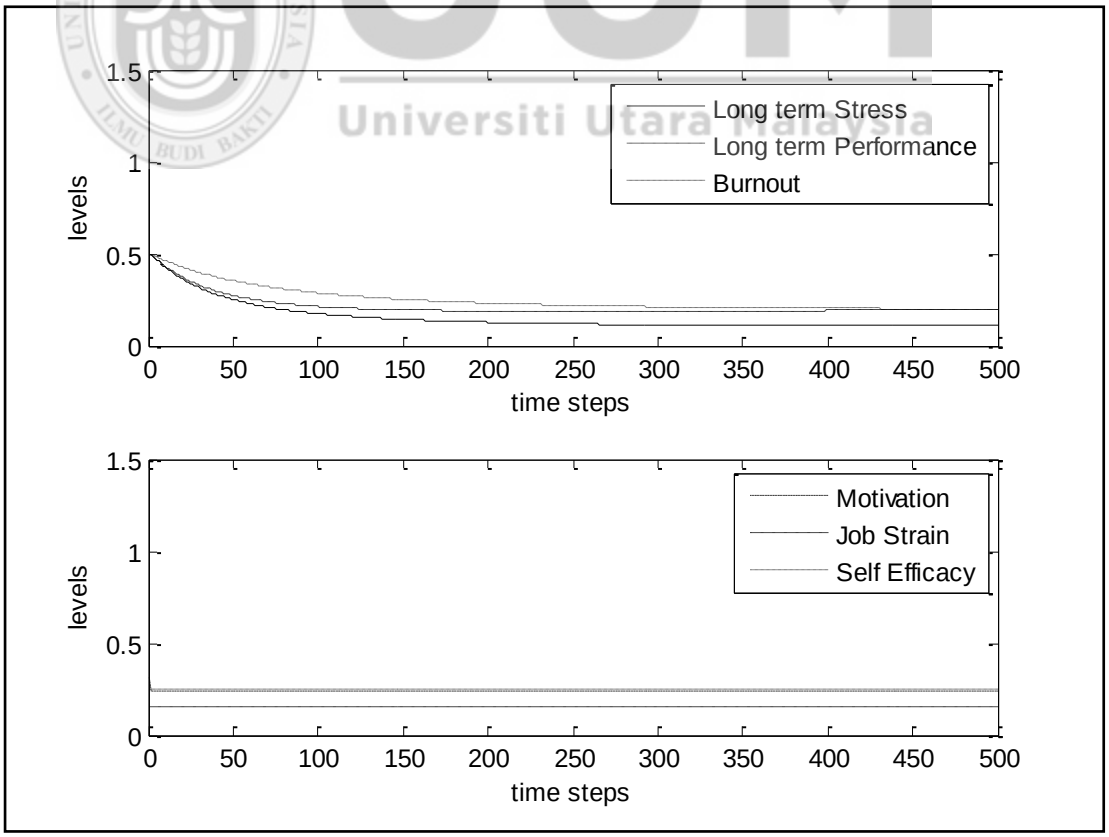

Figure5.9: Simulation Result of Case3.3

As the Figure show the level of motivation is very low, these low levels justify the decrease of performance level. As mentioned previously the results of the scenario highly depends on the individual's perception.

Case #4: High-low stress event

These cases combine the result of having high stress event and the condition changes at the middle of time steps, the following are the sub cases of this main case.

Case #4.1: High-low stress event with high positive resources and low negative resources

This case combines both high and low stress event represented by environmental stressor and job demands. High positive resources values were given, with having low negative resources; Table 5.10 shows the given values in this case.

Table5.10

Values of Case 4.1

Factor	Given Value
Environmental stressors(En)	1 at t=0 to 250 time steps, 0 at t=250 to 500
Job demands(Jd)	1 at t=0 to 250 time steps, 0 at t=250 to 500
Job resources(Jr)	1
Social support(Sc)	1
Organizational factors(Of)	1
Cynicism(Cy)	0
Negative personality(Np)	0

The result of this case indicates high performance levels with low burnout, and long term stress. Result also shows high motivation and self efficacy levels, the performance of individual were high even under high pressure, the high levels of positive resources justify the result of performance. Figure4.10 shows the simulation result.

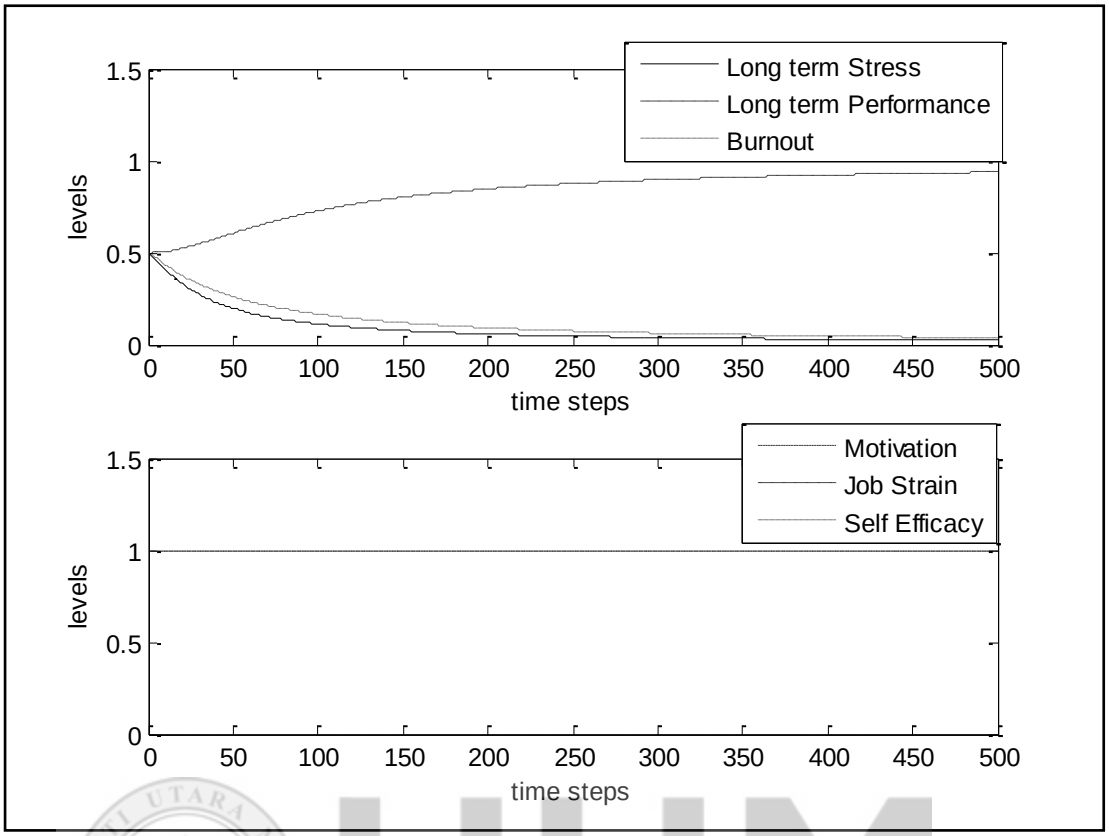

Figure5.10: Simulation Result of case 4.1

Result shows high levels of performance, while stress and burnout levels are low. Motivation and self efficacy levels are high, which contributes to the high levels of performance, job strain indicates low level.

Case #4.2: High-low stress event with low positive resources, and high negative resources

The case simulates both conditions high and low stress event, with low positive resources, however negative resources values are high. Table 4.11 shows the given values in this case

Table5.11
Values of Case 4.2

Factor	Given Value
Environmental stressors(En)	1 at t=0 to 250 time steps, 0 at t=250 to 500
Job demands(Jd)	1 at t=0 to 250 time steps, 0 at t=250 to 500
Job resources(Jr)	0
Social support(Sc)	0
Organizational factors(Of)	0
Cynicism(Cy)	1
Negative personality(Np)	1

The result of this scenario shows a changing long term stress levels, Result as shown in Figure 5.11

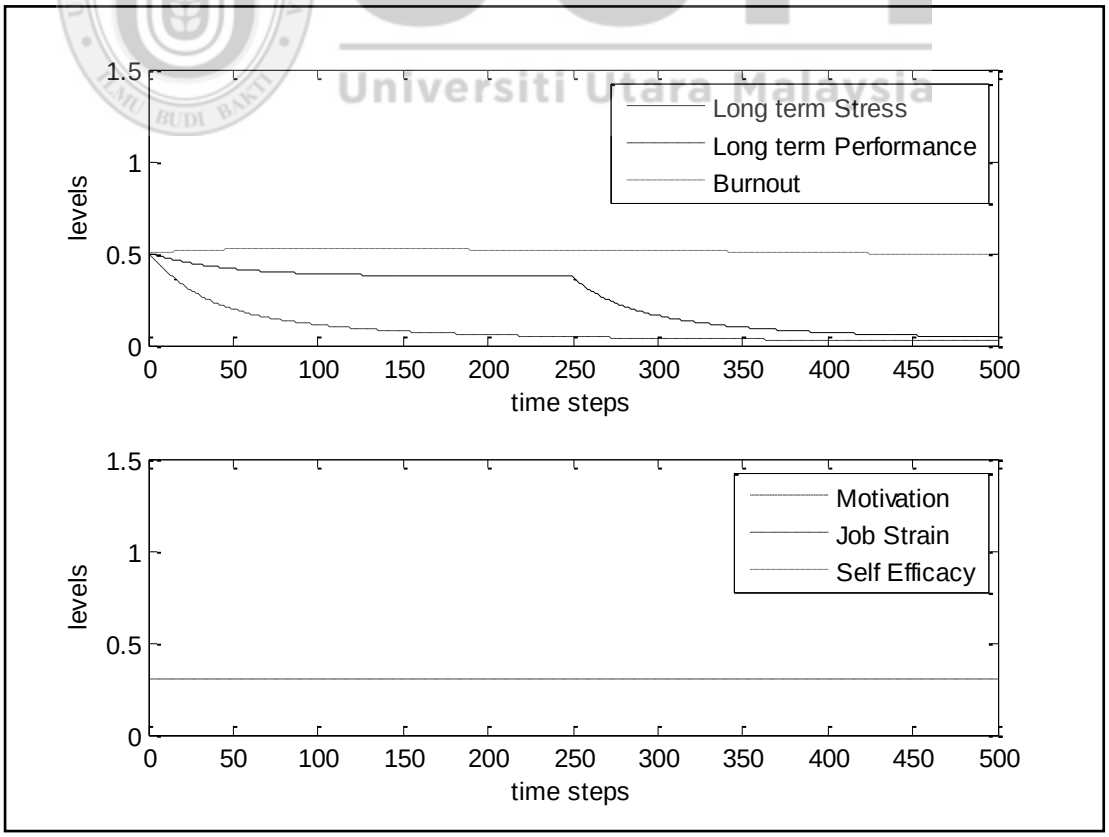

Figure5.11: Simulation Result of Case4.2

As it can be seen from the Figure motivation and self efficacy levels are low, the result was strongly affected by the high values of negative resources.

Case #4.3: High-low stress event with moderate positive and negative resources

In this case positive and negative resources were set in moderate values, with having both conditions; high and low stress event represented in environmental stressors and job demands properties. Table 5.12 shows the values given in this case.

Table5.12
Values of Case 4.3

Factor	Given Value
Environmental stressors(En)	1 at t=0 to 250 time steps, 0 at t=250 to 500
Job demands(Jd)	1 at t=0 to 250 time steps, 0 at t=250 to 500
Job resources(Jr)	0.5
Social support(Sc)	0.5
Organizational factors(Of)	0.5
Cynicism(Cy)	0.5
Negative personality(Np)	0.5

The result of this case shown in Figure 5.12

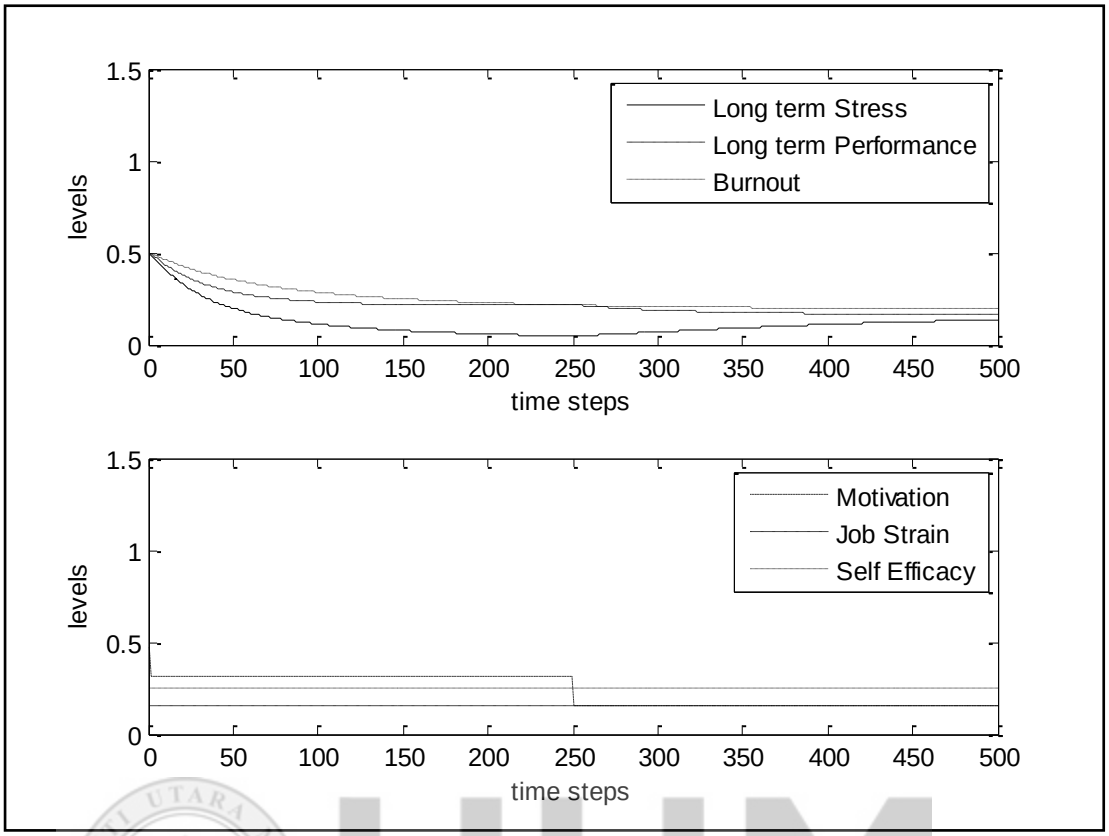

Figure5.12: Simulation Result of Case4.3

The result shows changing level of performance, and the other stress properties. The level of motivation was dropped at time step 250 which has affected the performance levels at the same time step value (250), the effects of the changing conditions highly depends on the individual's perception on stress.

5.2 Mathematical Verification

Mathematical verification is used to ensure the proposed model stability through giving constant values to contributed variables. In this method of evaluation the time reference is left out. It's worthy to mention that in this evaluation method all the exogenous variables are given constant values, and the parameters given a non zero value. By following all these assumptions of the formal analysis, the following could be concluded.

From Eq4.17:

$$Ls(t+\Delta t) = Ls(t) + \gamma_{ls}.\big(Ss(t) - Ls(t)\big).Ls(t).\big(1 - Ls(t)\big).\Delta t$$

$$\frac{dLs(t+\Delta t)-Ls(t)}{\Delta t}=\gamma_{ls}\big(Ss(t)-Ls(t)\big).Ls(t).\big(1-Ls(t)\big)$$

$$\frac{dLs(t)}{dt}=(Ss-Ls).Ls.(1-Ls)$$

While $\frac{dLs(t)}{dt}=0$ and $\gamma_{ls}=1$

Therefore Ss=Ls or Ls=0 or Ls=1

The value of Long term stress is either equal to short term stress or one or zero which is a constant value.

Case #1: Ls=1 Therefore from Eq4.13

$sx=\omega_{sx}.Js+\omega_{sx}$ Then the resulted expression is

Case #2: Ss=Ls Therefore from Eq4.13

$Sx=\omega_{sx}.Js+\omega_{sx}.Ss$

Case# 3: Ls=0 Therefore from Eq4.13

$Sx=\omega_{sx}.Js$

From Eq4.16 :

$$Lx(t+\Delta t)=Lx(t)+\beta_{lx}.\big[\big(Sx(t)-Lx(t)\big)\big].Lx(t).\big(1-Lx(t)\big).\Delta t$$

$$\frac{dLx(t+\Delta t)-Ls(t)}{\Delta t}=\beta_{lx}\big(Sx(t)-Lx(t)\big).Lx(t).\big(1-Lx(t)\big)$$

$$\frac{dLx(t)}{dt}=(Sx-Lx).Lx.(1-Lx)$$

While $\frac{dLs(t)}{dt}=0$ and $\beta_{lx}=1$

Therefore Sx=Lx or Lx=0 or Lx=1

The value of Long term exhaustion is either equal to short term exhaustion or one or zero which is a constant value.

From Eq4.18

$$Lf(t+\Delta t) = Lf(t) + \mu_{lf}.\left[\left(Sf(t) - Lf(t)\right)\right].Lf(t).\left(1 - Lf(t)\right).\Delta t$$

$$\frac{dLf(t+\Delta t) - Lf(t)}{\Delta t} = \mu_{lf}\left(Sf(t) - Lf(t)\right).Lf(t).\left(1 - Lf(t)\right)$$

$$\frac{dLf(t)}{dt} = (Sf - Lf).Lf.(1 - Lf)$$

While $\frac{dLs(t)}{dt} = 0$ and $\mu_{lf} = 1$

Therefore Sf = Lf or Lf=0 or Lf=1

The value of Long term fatigue is either equal to short term fatigue or one or zero which is a constant value.

Case#1: Lf = 1 From Eq4.20

$$Br(t+\Delta t) = Br(t) + \lambda_{br}\left[\left[\omega_{br}.Js + \omega_{br}Cy\right] - Br(t)\right].Br(t).\left(1 - Br(t)\right).\Delta t$$

Case# 2: Lf = Sf From Eq4.20

$$Br(t+\Delta t) = Br(t) + \lambda_{br}\left[\left[\omega_{br}.Js + \omega_{br}Cy + \omega_{br}.Sf\right] - Br(t)\right].Br(t).\left(1 - Br(t)\right).\Delta t$$

Case #3: Lf=0 From Eq4.20

$$Br(t+\Delta t) = Br(t) + \lambda_{br}\left[\left[\omega_{br}.Js + \omega_{br}Cy\right] - Br(t)\right].Br(t).\left(1 - Br(t)\right).\Delta t$$

From Eq4.20

$$\frac{dBr(t+\Delta t) - Br(t)}{\Delta t} = \lambda_{br}\left(Gr(t) - Br(t)\right).Br(t).\left(1 - Br(t)\right)$$

By following the assumptions therefore

Gr=Br or Br=0 or Br=1

The value of Burnout is either equal to Gr or one or zero which is a constant value.

Case #1: Gr=Br From Eq4.15

$$Sp(t) = \left[\eta_{sp}.Se(t) + \left(1 - \eta_{sp}\right).Mv(t)\right].\left(1 - Gr(t)\right)$$

Case# 2: Br=0 From Eq4.15

$Sp(t) = [\eta_{sp}.Se(t) + (1 - \eta_{sp}).Mv(t)]$

Case #3: Br=1 From Eq4.15

Sp=0

From Eq 4.1

$$Se(t) = [\alpha_{se}.Sc(t) + (1 - \alpha_{se}).Jr(t)].(1 - Np(t))$$

Se=0

[α_(se).Sc(t)+(1-α_se).Jr(t)].$(1 - Np(t)) = 0$

$\alpha_{se} = 0.5$ Therefore $0.5\ sc + 0.5\ Jr.(1 - Np)$

$\alpha_{se} = 1$

$Sc + Jr.(1 - Np) = 0$

$(1 - Np) = 0$ Therefore Np=1

Where $0.5Jr.(1 - Np) = -0.5Sc$

Then Np=1.

Which indicates that when negative personality value is high (1), that will lead to the low value of self efficacy (0).

5.3 Summary

This chapter discussed the simulation results of the study. Four main scenarios were simulated, and the scenarios were; high stress event with high positive resources, low stress event with high negative resources, moderated stress event with moderate positive and negative resources, high-low stress event. Each scenario has three sub scenarios, where the values of resources were manipulated; the chapter also presented the mathematical verification for the evaluation purpose.

CHAPTER SIX
CONCLUSION AND RECOMMENDATIONS

This study has included important issue of manager's performance during stress. According to what have been accomplished in the study this chapter summarizes the findings and the outcomes of the study, and presents limitations as well as future work.

6.1 Conclusion

In this study manager's performance and the effect of stress and stressors on performance have been discussed and introduced carefully. As Chapter One indicated the study aimed to achieve three main objectives; 1) Identifying local and non local dynamic properties that causes stress,2) designing a conceptual model of manager's performance during stress,3) develop and evaluate a formal model of manager's performance during stress, based on the results presented in Chapter Four, the objectives of this study have been achieved.

Based on previous literatures, findings in previous studies and adequate theories and models which answered the question (What are the local and non local properties that effect stress and manager's performance) a set of properties that are related to manager's performance during stress have been identified. The properties are; Environmental stressors, Job strain, Social support, Cynicism, Motivation, Job resources, Job demands, Satisfaction, Dissatisfaction, Self efficacy, Acceptance, Holdback, Emotional focus coping, Problem focus coping, Short term stress, Short term exhaustion, Short term fatigue, Negative personality, Job buffer, Short term performance. Based on these identified properties the first objective was achieved. Using the identified set of properties from the first objective, the conceptual model structure has been designed. Base on that the second objectives of the study have been achieved.

Third objective of the study have been achieved through the formalization of the conceptual model. From the second objective, differential equations technique was used for the formalization of the relations. Simulation traces has been generated to

simulate various scenarios and condition, furthermore, evolution technique has been used that is; mathematical analysis, to evaluate the proposed model stability and ensure the correctness of the model as explained in chapter Four.

6.2 Limitation of the study

The study presented a formalized model designed based on cognitive theories and model. However, the neurology aspect was not involved. The study have introduced the manager's performance and how it is effected during stress, However gender variations have not been considered in this study. Male and female manager's differences need to be considered and in studying the effects of stress on performance.

6.3 Future work recommendation

There are various areas where further research is required. The evaluation techniques such as mathematical analysis and automated verification ensure the internal validation of the model. However, the model should be implemented and impeded into a robotic program which will ensure the real world applicability of the model. This will achieve the fundamental goal of the study, which is providing the support to the manager's and improve their performance quality.

The personal perception of individual's and their personal interpretation of stress events are critical factor. This factor has a significant effect on determining the resulted stress and performance. This factor needs to be studied in future work. In addition, motivation has a great impact on the performance, therefore motivation should be deeply considered includes its sub classifications and their impact on stress.

6.4 Summary

The chapter has concluded the outcomes of this study, and summarized the findings. This chapter has included the limitation of the study and presented the main points that could be included in the future study. Furthermore, a recommendation for future work and the needed studies were introduced in this chapter.

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