Jurnal Pengurusan 37(2013) 125 - 131

Ergonomics and Stress at Workplace: Engineering Contributions to Social Sciences

(Ergonomik dan Stres di Tempat Kerja: Sumbangan Kejuruteraan untuk Sains Sosial)

Zafir Mohd Makhbul
Nor Liza Abdullah
Zizah Che Senik
(Faculty of Economics and Management, Universiti Kebangsaan Malaysia)

ABSTRACT

The present study explores ergonomic workstation factors to explain work stress outcomes. Proportionate stratified random sampling method is utilized to collect data from 500 production operators. The production operators are employees of 11 manufacturing electronics organizations that joined Malaysian International Chamber of Commerce and Industry (MICCI). The data samples are based upon self-administered questionnaires. Following data analysis, ergonomically designed workstations are proven to be a significant strategy to help organizations minimize work stress outcomes. Additionally, the multiple regression analysis shows that ergonomic workstation element collectively has significant relationship with work stress outcomes.

Keywords: Ergonomics; stress; workstation environment; production operators

ABSTRAK

Kajian ini meninjau faktor stesen kerja ergonomik yang dapat menerangkan stres di tempat kerja. Kaedah pensampelan rawak berstrata digunakan untuk mengumpul data daripada 500 operator pengeluaran. Mereka ini adalah pekerja di 11 buah syarikat pengeluar barangan elektronik yang menjadi ahli kepada Badan Antarabangsa Perniagaan dan Industri Malaysia (MCCI). Responden telah diminta untuk menjawab soal selidik secara kendiri. Daripada analisis data, stesen kerja yang direka bentuk dengan ciri-ciri ergonomik merupakan strategi yang signifikan dalam membantu organisasi meminimumkan kesan stres di tempat kerja. Tambahan pula, analisis regresi berbilang juga menunjukkan setiap elemen stesen kerja ergonomik secara kolektif mempunyai hubungan yang signifikan dengan kesan stres di tempat kerja.

Kata kunci: Ergonomik; stres; persekitaran stesen kerja; operator pengeluaran

INTRODUCTION

Stress occurs in almost all organizations. However, stress is often ignored and considered an unimportant issue by employers (Loveday 2012). Smith (1994) stated stress as what happens when the body does not adjust to some new or additional internal or external stimulus. In conjunction with this statement, Ket de Vries (1979) pointed out that stress is a result of the imbalance between the demands of the environment and the ability of the individual to adapt. The nature and effects of stress might be best understood by saying that some environmental variables (stressors), when interpreted by the individual (cognitive interpretation), may lead to stress (Dua 1994). Whatever interpretations given by the scholars or researchers, the experience of stress in the workplace has undesirable consequences both for the health and safety of individuals and well being of their organizations. Work stress can affect workers in any number of ways, from lowering resistance to illnesses and depriving them of sleep, to interfering with their concentration so that more injuries and accidents occur.

According to Tarcan et al. (2004), an effective ergonomic process can minimize stress at the workplace. Derived from the Greek words *ergo* (work) and *nomos* (natural laws), ergonomics literally means the laws of work. According to Rowan & Wright (1995), ergonomics refers to the complex relationship between workers and their work that permeates every aspect of the workplace. Originally defined by Bernadino Ramazinni (1633-1714), an Italian physician credited as the founder of occupational medicine, it is only recently that ergonomics has attracted widespread attention. Ergonomics defined by Fernandez (1995), is the design of the workplace, equipment, machine, tool, product, environment, and system, taking into consideration the human's physical, psychological, biomechanical, and psychological capabilities, and optimizing the effectiveness and productivity of work systems while assuring the safety, health, and wellbeing of the workers. In a nutshell, ergonomics encompasses the relationship between humans, machines systems, job design and the work environment. Tarcan et al. (2004) and Jamieson and Graves (1998) also posit that an ergonomically designed workstation is one of the strategies that companies can utilize to minimize work stress. Thus, in the process of designing a workstation, ergonomic factors shouldalso be taken into account (Yeow & Sen 2003; Khan et al. 2005). If an organization fails to apply the ergonomic principles at the workplaces, it could lead to emotional depression, physical exhaustion, and

waning productivity and products quality (Shikdar & Sawaqed 2003; Shahraki & Nooh 2011). Despite the fact that ergonomics can significantly impact occupational safety and health, little attention and consideration is given to ergonomics when designing work environments (Ahasan & Imbeau 2003; Shikdar & Sawaqed 2003; Zafir & Fazilah 2007).

Work stress is a negative emotional and physiological state that employees suffer from when faced with adverse work conditions beyond their control. It can also be an outcome of employee's negative perception of his/her work environment. Stress can be caused by environmental conditions, stimuli and events, which are referred to as stressors. In relation to the work environment, elements of inappropriate physical infrastructure can be considered stressors, such as lighting; humidity system; work area design; and acoustics systems. As stated by Sutton and Rafaeli (1987), extreme heat, dim lighting and congested works area could be associated with stress in the workplace. Such phenomena are especially apparent in manufacturing industries where production operators work in shift systems that may lead to chronic stress problems. Thus, it is important to increase awareness of the importance of ergonomic design as a mechanism to reduce stress, particularly in production facilities. Research that aims to explicate the relationship between ergonomics and performance would definitely assist the manufacturing sector to take advantage of the principles of ergonomics in maximizing work performance (Yeow & Sen 2003).

This phenomenon is also evident in Malaysia, which depends highly on its manufacturing industries. Between 1999 and 2003, the manufacturing sector in Malaysia reported the highest number of industrial accidents compared to other industries (Khan et al. 2005; Zafir & Fazilah 2007) and it is apparent that blue collar workers are more exposed to work-related health risks than white collar and professional workers (Cooper & Williams 1991). The frequent health risks faced by blue collar workers principally relate to exposure to chemical substances and dust; psychological work stress; and ergonomic related problems (Liang & Xiang 2004). In addition, blue collar workers are exposed to noise, air pollution, physical burdens, unsatisfactory shiftwork, long working hours, poor social interaction in the workplace and bad relationships with superiors (McLean 1974). With all these possibilities, incidence of stress is likely to occur and hence, the evaluation of stress is of considerable importance.

The focal point of the present research is to examine the relationship between factors relating to ergonomic workstation components (human, machine, work area, and environment) and work stress. The objective of the present research is to identify the significant factors among ergonomic workstation variables that contribute to stress in organizations.

LITERATURE REVIEW

The concern among researchers to identify significant relationships between organizational factors and work stress escalates as stress becomes a major factor affecting productivity (Wilson 2000). Sharpley et al. (1996) conclude that extreme and unremitting exposure to stress lessens the competency of individuals to perform at work. Since ergonomics are now a theme in management research, on the use of ergonomic design as a mechanism to reduce stress in work place has become more legitimate. However, research on the application of ergonomics as a mechanism to mitigate stress is still sparse, especially in the Malaysian context, since knowledge and awareness on the importance of ergonomic concepts are still minimal (Shahnavas 1996; Lee 2005; Zafir & Fazilah 2007; Zafir et al. 2011).

When designing workstations, the main variables of ergonomic considerations involve the human, in regards to body posture and health; the machine, in terms of tools suitability and maintenance; the work area, which includes, but is not limited to, working chair and work area design; and the work environment, which includes factors such as humidity, acoustics, lighting, shiftwork and working hours.

Tarcan et al. (2004) suggest that body posture can lead to work stress. For example, prolonged static movement can reduce blood flow to tendons, which is likely to cause fatigue and strain (Wojcikiewicz 2003). Another example is stress resulting from frequently working with hands above shoulder level (Dahlberg et al. 2004). Additionally, stress related to body posture may be triggered by neck, shoulder, arm, thigh, and knee problems (Magnusson & Pope 1998).

In relation to machines, research demonstrates that injuries at the workplace occurred because of tools used by employees in performing their tasks (Wickens, Lee, Liu & Becker 2004). Pain and stress could be minimized, as well as the work environment being made more comfortable, if minor adjustments of the tools are introduced, such as table, chair, machine, and other apparatus (Wojcikiewicz 2003). For example, chairs used by workers to perform their tasks fulfil three principal functions: increasing individual effectiveness; minimizing fatigue and stress at the workplace; and fitting the body posture (Wojcikiewicz 2003). However, adjustable chairs and chairs with armrests will help to minimize strains on the neck, shoulder and arm muscles (Cook et al. 2004). An ergonomic chair will not only allow employees to perform their tasks, but also aids in the quicker completion of tasks and, most importantly, minimizes work stress (Beckett 1995). This is further supported by epidemiology research that acknowledges the importance of the physical environment of the ergonomic workstation in miminimizing stress, including factors such as lighting, anthropometry control and improving work conditions (Aaras et al. 2001).

Extreme factors in the working environment can also act as stressors. For example extreme heat in the workplace

creates mental depression and affects work performance (Clark 2002). On the other hand, extreme cold impedes mental abilities and eventually leads to absenteeism and non-performance (Smith et al. 2000). It is common for workers to complain about discomfort resulting from extreme environments and the failure of the employer to address these complaints may lead to job dissatisfaction (Leaman 1995). Work stress resulting from uncomfortable workstation environments should be avoided because it affects workers' abilities to perform well and thus affect productivity levels. Another common stressor in the work environment is extreme noise, a variable that is more prevalent in stress issues among blue collar workers (Melamed et al. 1992; Leather et al. 2003). Noise from the telephone ringing, piped-in background music, loud telephone conversations and typewriters affects the ability of employees to focus on performing tasks. Fairbrother and Warn (2003) conclude that minimizing noise levels will definitely reduce work stress. In addition to noise, Sutton and Rafaeli (1987) find that appropriate lighting also plays an important role in minimizing work stress. The findingis supported by Aaras et al. (2001) and Leather et al. (2003),who suggest that high levels of glare and minimum lighting can cause eye strain and lead to stress in the workplace.

Another stressor related to work environment is shiftwork (Kundi 2003). 20 to 30 percent of workers dislike shift system because it causes insomnia, problems in the digestive system and impedes mental functions that will all ended with stress (Costa 2003). Iacovides et al. (2003) find that long working hours can cause acute stress in the workplace. Long working hoursand insufficient rest can result in chronic fatigue (Ahasan 2002), and, expectedly, extreme fatigue will lead to stress (Savery & Luks 2000; Tucker 2003). Both chronic fatigue and stress are also a contributing factor to accidents at the workplace (Savery & Luks 2000).

Based on the review of extant research, the present paper hypothesizes that:

H_1 The human variables and work stress are significantly related.
H_2 The machine variables and work stress are significantly related.
H_3 The work design variables and work stress are significantly related.
H_4 The environment variables and work stress are significantly related.
H_5 The combination of ergonomics factors significantly affects work stress.

METHODOLOGY

Approximately 51,000 production operators work for multinational electronic manufacturing companies that are registered with Malaysian International Chamber of Commerce and Industry (MICCI). The sample utilized in the present study is obtained through a proportionate stratified random sampling method. The multinational companies are located in industrial areas in Penang, Wilayah Persekutuan, Selangor, Malacca and Johor. Krejcie and Morgan's (1970) table is utilized to determine the sample size. According to the table, once the population reaches 50,000, 381 of them must be drawn as the sample of the study. Due to the significant size of the population being examined in the present research, 500 samples are obtained in an effort to minimize sampling error.

Data for the present study was collected via questionnaire distributions. The questionnaires were developed based upon extant research related to ergonomics and work stress. New items are also added in the measurement to strengthen the research and achieve the research objectives. The items use a 5-point Likert

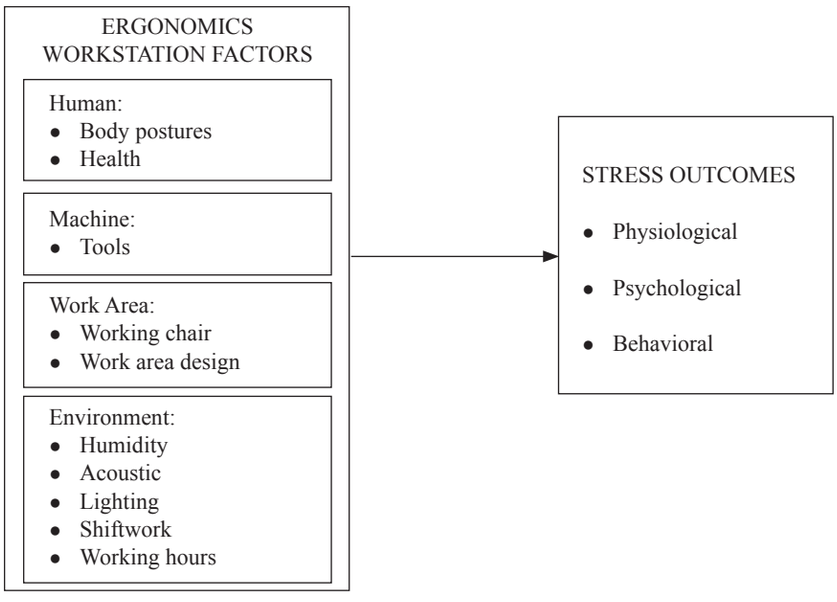

FIGURE 1. Research Model

scale, ranging from (1) strictly disagree to (5) strictly agree. The questionnaire consisted of positive and negative statements, with the negative statements being recoded accordingly.

The questionnaires divided into several sections. Section 1 includes items related to ergonomic workstation factors. These items were adapted from House and Rizzo (1972), Brief and Aldag (1976), Lemasters and Atterbury (1996), Hedge and Erickson (1997), Tate, Whatley and Clugston (1997), Miles (2000), Hilderbrant et al. (2001), Nag and Nag (2004) and Tarcan et al. (2004). Section 2 includes physiological, psychological and behavioral items, which are modified from the works of Karasek (1979), Ekman and Ehrenberg (2002) and Mearns et al. (2003).

DATA ANALYSIS AND RESULTS

Table 1 depicts the comprehensive analysis of the respondents' background. The majority of the respondents are women (81.6%), which are expected because manufacturing production operators in Malaysia are predominantly female. The analysis also demonstrates that more than 80% of the employees are engaged in shiftwork, which is a principal area of concern in the present study. In terms of working hours, the majority (90.6%) of employees work between 46 to 65 hours per week, which involves working a maximum of 11 hours per day in a 6 day work week.

TABLE 1. Respondents' Demographic Information

	Frequency	%
Gender		
Male	92	18.4
Female	408	81.6
Age		
< 25 years old	188	37.6
26 – 30 years old	132	26.4
31 – 35 years old	64	12.8
36 – 40 years old	53	10.6
41 – 45 years old	49	9.8
> 46 years old	14	2.8
Education Attainment		
LCE/SRP/PMR	96	19.2
MCE/SPM	316	63.2
HSC/STPM	41	8.2
Diploma	47	9.4
Shiftwork		
Yes	421	84.2
No	79	15.8
Total of working hour per week		
36 hours – 45 hours	29	5.8
46 hours – 55 hours	323	64.6
56 hours – 65 hours	130	26.0
66 hours – 75 hours	13	2.6
76 hours – 85 hours	5	1.0

Table 2 illustrates the reliability and item loading for each variable. Factor loading for each construct demonstrate that it is acceptable as the value for every loading exceeds 0.30. (Field 2003; Aron et al. 2005). Although values lower than 0.4 are considered low, the result is negligible due to the large sample size (Guadagnoli & Velicer 1988).

TABLE 2. Loading for Each Construct for Construct Validity and Reliability

Constructs	Loading	α
Body posture	.38 – .65	.79
Health	.42 – .68	.73
Tools	.41 – .67	.86
Working chair	.70 – .81	.84
Work area design	.48 – .57	.70
Humidity	.31 – .67	.78
Noise/Acoustics	.48 – .57	.71
Lighting	.48 – .74	.75
Shiftwork	.58 – .72	.75
Working hours	.56 – .71	.77

Loading based on varimax rotation

MULTIPLE REGRESSION ANALYSIS

Table 3 presents the findings of the multiple regression analysis. The findings indicate that 38.4% of changes in the workplace stress outcomes are related to human; machine; work area; and environmental factors. In conjunction with this, Table 4 validates that the ergonomic factors examined significantly ($p < 0.01$) correlate to the workplace stress outcomes. This result supports H_5, which states that the combination of ergonomic workstation components significantly influences stress outcomes in the workplace.

TABLE 3. Multiple Correlation Coefficients and Other Statistics

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.620	.384	.381	.41429	1.905

TABLE 4. Summary of Hypotheses Testing, T-Value and Significant Level

Hypotheses	t	Sig.
H_1. Human – Stress	11.893	0.000**
H_2. Machine – Stress	0.391	0.696
H_3. Work area – Stress	-0.343	0.732
H_4. Environment – Stress	6.536	0.000**
H_5. Ergonomics workstation – Stress	5.761	0.000**

**$p < 0.01$

DISCUSSION

The multiple regression analysis on the major components of ergonomic workstation reveals that 38.4% of the changes in workplace stress outcomes are due to the relationship between stress and ergonomic factors, which include human; machine; work area; and environmental factors. Among the four major components, only human ($\beta = 0.459$) and environment ($\beta = 0.287$) factors are significantly related to stress, while machine and work area are not significantly related to workplace stress outcomes. The findings support H_1 and show that the human variable (health and body postures) has a significant relaitonship with workplace stress outcomes. The result is in accordance with Wickens et al. (2004), who find that the health level of employees is closely related to workplace stress outcomes.

The research findings also support H_4. Based on the findings, components of thework environment (such ashumidity, lighting, acoustics, shiftwork and working hours) play a siginificant role in stress outcomes. This finding is similar to Nag and Nag (2004) and Tarcan et al. (2004) who suggest that ergonomic workstations that address all of these issues could curb workplace stress problems. Additionally, Leaman (1995) and Clark (2002) agree that excessive organizational temperature could trigger mental depression and negatively affect work performance.

The findings also suggest that a good lighting system can minimize stress outcomes in the workplace, which is supported by the findings of several scholars' (i.e., Sutton & Rafaeli 1987; Aaras et al. 2001; Leather et al. 2003; Wojcikiewicz 2003). The significance of the relationship between work environment and work stress (H_4) also supports findings by Melamed et al. (1992), Fairbrother and Warn (2003), and Leather et al. (2003), who emphasize that acoustic systems play an important role in minimizing stress problems in the workplace. Furthermore, anumber of extant studies link shiftwork to workplace stress outcomes (Costa 2003; Kundi 2003). The findings in relation to H4 also support Savery and Luks (2000), Ahasan (2002), Clark (2002), Tucker (2003), and Iacovides et al. (2003). The aforementioned researchers argue that long working hours without proper breaks increase the likelihood of depression and bring about stress.

From the analysis, only two ergonomics workstation factors are significantly related to workplace stress outcomes: human and environmental factors. The findings do not support the existence of a relationship between machine (H_2) and work area (H_3); and stress. The findings of the present research contradicts those of Caplan et al. (1975) and Wojcikiewicz (2003), who propose that the machine factor of ergonomics are a significant contributor to stress outcomes in the workplace. The insignificant relationship maybe due to the nature of operators' jobs, which is highly routinized. In addition, production operators do not use computers or machines that are linked to stress at the workplace as described in the literature (Minter 1999).

Literature states that ergonomic chairs and comfortable work areas can minimize work stress (Sutton & Rafaeli 1987; Beckett 1995; Aaras et al.2001; Cook et al. 2004). However, the result for H_3 is not significant. This may be due to the fact that the job descriptions of production operators' jobs require them to move speedily, thus eliminating the need for comfort in the form of working area and chairs. Thus, chairs and work area that meet their minimum needs are more than sufficient.

Multiple regression analysis shows that all components and ergonomic workstation are significantly related to workplace stress outcomes. The analysis supports H_5 and this finding parallels extant studies, whose findings indicate that ergonomic workstations can minimize work stress (Beckett 1995; Miles 2000; Khan et al. 2005). The results in regards to H_5 support the findings of extant research that conclude that ergonomic workstations reduce stress and can assist organizations in increasing their productivity (Miles 2000; Clark 2002).

CONCLUSION

The findings of the present study have influential effects in regards to the organizational management. Management should assess each workstation factors being examined in the present study, as the assessment could assist in reducing the elements of existing work stations that result inwork stress outcomes. A thorough evaluation must be performed in relation to employees' health factors; work area design; shiftwork; humidity; and working hours, particularly since all variables have a significant relationship with workplace stress outcomes. An ergonomically designed working environment can reduce human resource problems, including fatigue, job dissatisfaction and intention to quit. To guarantee the success of such a strategy, management must ensure that the work environment suits the workers by matching human resources anthropometry distinctiveness and employee demands.

REFERENCES

Aaras, A., Horgen, G., Bjorset, H-S., Ro, O. & Walsoe, H. 2001. Musculoskeletal, visual and psychosocial stress in VDU operators before and after multidisciplinary ergonomic interventions. A 6 years prospective study – part II. *Applied Ergonomics* 32: 559-571.

Ahasan, R. & Imbeau, D. 2003. Who belongs to ergonomics? An examination of the human factor community. *Work Study* 52(3): 123-128.

Ahasan, R. 2002. Human adaptation to shift work in improving health, safety and productivity – Some recommendations. *Work Study* 51(1): 9-16.

Aron, A., Aron, E. N. & Coups, E.J. 2005. *Statistical for the behavioral and social sciences*. 3rd edition. New Jersey: Pearson Education, Inc.

Beckett, R. 1995. Are you sitting comfortably? *Facilities* 13(12): 26-27.

Brief, A. P. & Aldag, R. J. 1976. Correlates of role indices. *Journal of Applied Psychology* 61(4): 468-472.

Caplan, R. D., Cobb, S., French, J. R. P., Harrison, R. V. & Pinneau, S. R. 1975. *Job Demands and Worker Health: Main Effect and Occupational Difference*. Washington, DC: DHEW Publication (NIOSH), US Department of Health, Education and Welfare.

Clark, J. 2002. *Stress – A Management Guide*. United States: Spiro Business Guides.

Cook, C., Burgess-Limerick, R. & Papalia, S. 2004. The effect of wrist rests and forearm support during keyboard and mouse use. *International Journal of Industrial Ergonomics* 33: 463-472.

Cooper, C. L. & Williams, J. 1991. A validation study of the OSI on a blue-collar sample. *Stress Medicine* 7: 109-112.

Costa, G. 2003. Factors influencing health of workers and tolerance to shift work. *Theoretical Issues in Ergonomics Science* 4(3-4): 263-288.

Dahlberg, R., Karlqvist, L., Bildt, C. & Nykvist, K. 2004. Do work technique and musculoskeletal symptoms differ between men and women performing the same type of work tasks?. *Applied Ergonomics* 35: 521-529.

Dua, J. K. 1994. Job stressors and their effects on physical health, emotional health, and job satisfaction in a university. *Journal of Educational Administration* 32(1): 59-78.

Ekman, I. & Ehrenberg, A. 2002. Fatigue in chronic heart failure – Does gender make a difference? *European Journal of Cardiovascular Nursing* 1: 77-82.

Fairbrother, K. & Warn, J. 2003. Workplace dimensions, stress and job satisfaction. *Journal of Managerial Psychology* 18(1): 8-21.

Fernandez, J.E. 1995. Ergonomics in the workplace. *Facilities* 13(4): 20-27.

Field, A. 2003. *Discovering statistics using SPSS for Windows: Advanced techniques for the beginner*. Great Britain: Sage Publications Inc.

Guadagnoli, E. & Velicer, W. 1988. Relation of sample size to the stability of component patterns. *Psychological Bulletin* 103: 265-275.

Hedge, A. & Erickson, W. A. 1997. A study of indoor environment and sick building syndrome complaints in air conditioned offices: Benchmarks for facility performance. *International Journal of Facilities Management* 1(4): 185-192.

Hildebrandt, V. H., Bongers, P. M. & van Dijk, F. J. 2001. Dutch musculoskeletal questionnaire: Description and basic qualities. *Ergonomics* 44: 1038-1055.

House, R. J. & Rizzo. 1972. Role conflict and ambiguity as critical variables in a model of organizational behavior. *Organizational Behavior and Human Performance* 7: 467-505.

Iacovides, A., Fountoulakis, K. N., Kaprinis, St. & Kaprinis, G. 2003. The relationship between job stress, burnout and clinical depression. *Journal of Affective Disorders* 75: 209-221.

Jamieson, D. W. & Graves, R. J. 1998. Determining ergonomic factors in stress from work demands of nurses. In *Contemporary ergonomics*, edited by M. A. Hanson, 162-166. London: Taylor & Francis.

Karasek, R. 1979. Job demands, job decision latitude and mental strain: Implications for job redesign. *Administrative Science Quarterly* 24: 285-308.

Kets de Vries, M. F. R. 1979. Organizational stress: A call for management action. *Sloan Management Review* 21(1): 3-14.

Khan, M. K. J., Abdullah, N. A. C. & Yusof, A. A. 2005. *Keselamatan dan Kesihatan Pekerjaan dalam Organisasi*. Selangor: Prentice Hall.

Kundi, M. 2003. Ergonomic criteria for the evaluation of shift schedules. *Theoretical Issues in Ergonomics Science* 4(3-4): 302-318.

Leaman, A. 1995. Dissatisfaction and office productivity. *Facilities* 13(2): 13-19.

Leather, P., Beale, D. & Sullivan, L. 2003. Noise, psychosocial stress and their interaction in the workplace. *Journal of Environmental Psychology* 23: 213-222.

Lee, L.T. 2005. Laporan tahunan Institut Keselamatan dan Kesihatan Pekerjaan (NIOSH).

Lemasters, G. K. & Atterbury, M. R. 1996. The design and evaluation of a musculoskeletal and work history questionnaire. In *Occupational ergonomics: Theory and Applications*, edited by Amit Bhattacharya & James. D. McGlothlin, 431-461. New York: Marcel Dekker, Inc.

Liang, Y. & Xiang, Q. 2004. Occupational health services in PR China. *Toxicology* 198: 45-54.

Loveday, A. 2012. Tackling stress at work. Occupational Health 64(3): 12-12

Magnusson, M. L. & Pope, M. H. 1998. A review of biomechanics and epidemiology of working postures: It isn't always vibration which is to blame. *Journal of Sound Vibration* 215(4): 965-976.

Makhbul, Z. M., Alam, S. S., Azmi, S. M. & Talib, N. A. 2011. Ergonomics and work stress issues in banking sector. *Australian Journal of Basic and Applied Sciences* 5(9): 1301-1309.

Makhbul, Z. M. & Hasun, F. M. 2007. Ergonomik dan stres di Malaysia: Implikasi terhadap teori, metodologi dan pengurusan. *Jurnal Pengurusan* 26(1): 99-130.

McLean, A. A. 1974. *Occupational Stress*. Springfield, Illinois: Thomas.

Mearns, K., Whitaker, S. M. & Flin, R. 2003. Safety climate, safety management practice and safety performance in offshore environments. *Safety Science* 41: 641-680.

Melamed, S., Luz, J. & Green, M. S. 1992. Noise exposure, noise annoyance and their relation to psychological distress, accident and sickness absence among blue-collar workers – The Cordis study. *Israel Journal Medical Science* 28(8): 629-635.

Miles, A. K. 2000. The ergonomics and organizational stress relationship. Unpublished PhD. Thesis, The Florida State University.

Minter, S. G. 1999. Too much stress? *Occupational Hazards* 61(5): 49-52.

Nag, A. & Nag, P. K. 2004. Do the work stress factors of women telephone operators change with the shift schedules?. *International Journal of Industrial Ergonomics* 33: 449-461.

Rowan, M. P. & Wright, P. C. 1995. Ergonomics is good for business. *Facilities* 13(8): 18-25.

Savery, L. K. & Luks, J. A. 2000. Long hours at work: Are they dangerous and do people consent to them? *Leadership & Organization Development Journal* 21(6): 307-310.

Shahnavaz, H. 1996. Making ergonomics a world-wide concept. *Ergonomics* 39(12): 1391-1402.

Shahraki, S. & Abu Bakar, N. 2011. The role of ergonomics in workforce productivity in services companies. *International Journal of Academic Research* 3(5): 204-210

Sharpley, C. F., Reynolds, R., Acosta, A. & Dua, J. K. 1996. The presence, nature and effects of job stress on physical and psychological health at a Large Australian University. *Journal of Educational Administration* 34(4): 73-86.

Shikdar, A. A. & Sawaqed, N. M. 2003. Worker productivity, and occupational health and safety issues in selected industries. *Computers and Industrial Engineering* 45(4): 563-572.

Smith, A., Thomas, M. & Whitney, H. 2000. After-effects of the common cold on mood and performance. *Ergonomics* 43(9): 1342-1349.

Smith, S. L. 1994. Combating stress. *Occupational Hazards* 56(3): 57-59.

Sutton, R. I. & Rafaeli, A. 1987. Characteristics of work stations as potential occupational stressors. *Academy of Management Journal* 30(2): 260-276.

Tarcan, E., Varol, E. S. & Ates, M. 2004. A qualitative study of facilities and their environmental performance. *Management of Environmental Quality: An International Journal* 15(2): 154-173.

Tate, U., Whatley, A. & Clugston, M. 1997. Sources and outcomes of job tension: A three-nation study. *International Journal of Management* 3: 350-358.

Tucker, P. 2003. The impact of rest breaks upon accident risk, fatigue and performance: A review. *Work & Stress* 17(2): 123-137.

Wickens, C. D., Lee, J., Liu, Y. & Becker, S. G. 2004. *An Introduction to Human Factors Engineering*. 2nd ed. New Jersey: Pearson Education, Inc.

Wilson, J.R. 2000. Fundamentals of ergonomics in theory and practice. *Applied Ergonomics* 31: 557-567.

Wojcikiewicz, K. 2003. Seven key factors for ergonomic workstation design. *Manufacturing Engineering* 131(1): 45.

Yeow, P. H. P. & Sen, R.N. 2003. Quality, productivity, occupational health and safety and cost effectiveness of ergonomic improvements in the test workstations of an electronic factory. *International Journal of Industrial Ergonomics* 32(3): 147-163.

Zafir Mohd Makhbul (corresponding author)
School of Management
Faculty of Economics and Management
Universiti Kebangsaan Malaysia
43600 UKM Bangi, Selangor
E-mail: zafir@ukm.my

Nor Liza Abdullah
School of Management
Faculty of Economics and Management
Universiti Kebangsaan Malaysia
43600 UKM Bangi, Selangor
E-mail: iza@ukm.my

Zizah Che Senik
School of Management
Faculty of Economics and Management
Universiti Kebangsaan Malaysia
43600 UKM Bangi, Selangor
E-mail: zizahcs@ukm.my