Ergonomics design on the work stress outcomes

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Abstract

Theoretical explanation and empirical research on work stress conducted by the scholars in the field shows that it is an unignorable workplace problem. Most of the researchers agree that work stress is caused by the workstation design or workplace environment. An optimal workstation design is where the workplace environment supports the needs of the workers and where a worker operates in a conducive environment to the individual's abilities. It is important for organization to match the work place environment and the individual who performs the tasks. This is the goal of ergonomics. The discussion of ergonomics workstation design in this paper inclusive of working chairs, work area design, acoustic, lighting, working hours and humidity level. The stress outcomes include somatic complaints, fatigue, job dissatisfaction and intention to quit. This paper presented a study on 35 manufacturing operators in one multinational electronic company. Multiple regression analysis indicated that 62.9% of the variance in stress outcomes is accounted by the independent variables i.e., chair, work area, acoustics, lighting, working hours and humidity. Chair/office seating, working hours and humidity were found to have significant relationship with the outcomes of work stress. Work area design, acoustics and lighting, however were found not significant. This finding supports a better evaluation of policies' development of workplace ergonomics by management. In the long term such action taken by management authorities to enhance workplace ergonomics would produce benefits for the institution in terms of minimizing the outcomes of work stress.

Introduction

An optimal workstation design is where the workstation environment supports the needs of the workers and where a worker operates in a conducive environment to the individual's abilities. This can be materialized if organizations able/successfully to match the work processes with the individual who performs the tasks. This is the goal of ergonomics. Ergonomics is the science of designing the job to fit the worker, rather than physically forcing the worker's body to fit the job. Workstation design from an ergonomics perspective can effectively enhance productivity and minimize stress through the interaction between the various system components (Dempsey *et al*., 2004). If work station did not ergonomically design, workers may exposure to undue physical stress, strain, and overexertion, including vibration, awkward postures, forceful exertions, repetitive motion and heavy lifting. Employees who report discomfort and stress at work will have their productivity affected, because being too hot, too

cold, too draughty or harassed through lack of privacy or distraction will affect their ability to perform their work properly (Leaman, 1995). These conditions lead to workplace hazards, poor workers' health, disabilities, and reduction of workers' productivity and products' quality. Furthermore, work injuries have been suggested associate psychological distress, decreased participation in daily living activities and negative effects on family well-being (Kirsh and McKee, 2003).

Derived from the Greek words *ergo* (work) and *nomos* (natural laws), ergonomics literally means the laws of work. According to Rowan and Wright (1995), ergonomics refers to the complex relationship between workers and their work that permeates in 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 well-being of the workers. Wilson (1995) simplifies the definition by saying that ergonomics is the practice of learning about human characteristics and then using that understanding to improve people's interaction with the environments. In a nutshell, ergonomics encompasses the relationship between humans, machines systems, job design and the work environment. By approaching work practices (stretching, reaching, or sitting) from an ergonomically correct point of view, a worker actually becomes stronger, healthier and more productive. If management does not address ergonomics discomfort, a worker will act on a subconscious level, adapting his/her behavior to lighten the pain. When someone adapts behavior to avoid pain, it generally becomes both performance and safety issue.

Most of the researchers agree that work stress is caused by the work design and workplace environment. Smith (1994) stated stress as what happens when the body does not adjust to some new or additional internal or external stimulus. 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 many ways, from lowering resistance to illnesses and depriving them of sleep, to interfering with their concentration so that more injuries and accidents occur. Measures of distress can be psychological (anxiety, depression, irritability), physiological (high blood pressure, high muscle tension levels), or behavioural (poor work performance, accidents, sleep disturbances, substance abuse).

Based on the discussions above, stress is an unignorable workplace problem. The interaction between work environment and work station design will contribute to the work stress outcomes. According to De Croon *et al.* (2005), the work station design may directly or indirectly result in physiological and psychological reactions such as crowding stress (psychological state of inadequacy of space), occupationally induced fatigue, job satisfaction decrement and increased levels of blood pressure. In addition, the long term reactions include decreased performance, and negative health outcomes, such as psychosomatic health complaints including chronic fatigue, burnout and musculoskeletal disorders (De Lange *et al*. 2002; Sluiter *et al*. 2003). The ignorance of the stress outcomes in organizations will have negative effects workers' quality and productivity. This has attracted researchers to find

alternatives to reduce work stress outcomes in organization. Many research have shown positive effects in reducing work stress by applying ergonomic principles in workplaces, machine design, job design, environment, and facilities design (Burri and Helander, 1991; Resnick and Zanotti, 1997; Rayan, 1989).

Hypotheses development

Chairs/office seating

The physical problems associated with prolonged use of office seating do not end with the odd twinge discomfort. However, they can easily extend to repetitive strain injury (RSI) causing chronic or permanent damage (Beckett, 1995). In terms of everyday office use, an ergonomic chair is one which not only allows the user to complete tasks, but also actively facilitate the tasks. The work chair shall be stable and allow the operator or user moves easily and sits in a comfortable position. Furthermore, the seat shall be adjustable in height and tilt. To maximize comfort when leaning backwards, the seat should remain stationary and the feet remain flat on the floor, so as not to inhibit circulation (Beckett, 1995). For a chair to be ergonomic, it has to have at least vertically adjustable. The ergonomic chair will affect the workers performance through minimization of fatigue and stress (Cook *et al*., 2004).

Work area design

Taking ergonomics concern for work area design will decrease the problems of work stress (Tarcan *et al*., 2004). Tarcan *et al.* pointed out that if the organization doesn't provide a good working environment to employees such as buying the best-fitting apparatus, furniture and tools, the risk of becoming ill related to the workplaces will increase. Epidemiological studies proved that ergonomically work station design such as the improvement of work area will minimize the outcomes of work stress (Aaras *et al*., 2001).

Acoustics

Office acoustics also affect the outcomes of work stress (Melamed *et al*., 1992). Exposure to occupational noise, that is, unwanted sound, has been linked with variety of adverse effects upon well-being and obvious relationship with hearing loss (Leather *et al.*, 2003). Noise exposure has been found to be associated with a range of work stress outcomes such as cardiac problems, sickness-related absenteeism, self reported fatigue and psychological distress (McDonald, 1989; Cuesdan *et al*., 1977). Most of the researchers agreed that the sources of noise in the organizations come from telephone ringing, piped-in background music, office machines, people talking and street noise.

Lighting

There is a significant relationship between the lighting systems and work stress outcomes in organizations (Sutton and Rafaeli, 1987). Workplace lighting contributes to the increase of workers capability and fatigue minimization (Wojcikiewicz, 2003). This premise has been supported by Aaras *et al*. (2001) and Leather *et al*. (2003). They stated that low level of lighting will cause eye strains and increase work stress. It is however, difficult to make specific statement about the best level of lighting since their appropriateness depends heavily on the nature of a task (Sutton and Rafaeli, 1987). However there is agreement among scholars that high level of glare, lack of natural light, and level of lighting that are too low for a given task can have negative effects on work stress outcomes (Sutton and Rafaeli, 1987).

Negative relationship has been found by Oldham and Rotchford (1983) between darkness and employees' reactions including job satisfaction and well-being.

Working hours

Working long hours without proper rest will increase the stress level and contribute to industrial accidents. Iacovides *et al*. (2003) stated that the longer working hours will cause the work stress outcomes. In the long term it will affect the workers' health, whereas in the short term, it will cause accidents (Savery and Luks, 2000). Clark (2002) pointed out that there are several internal factors that affect the work stress in organization and among them is longer working hours.

Humidity

Air quality is a very important factor determining organizational comfort level. Indoor air quality has a direct impact on health problems and leads to uncomfortable workplace environments (Czubaj, 2002; Shiaw-Fen Ferng, 2002; Wilson, 2001). A good indoor air quality will improve production quality and help to minimize the outcomes of work stress (Martin, 1999). Research in ergonomics field has demonstrated the negative effects of hotness and coldness and extreme temperature with work performance (Ellis, 1982) while others have linked the air quality on fatigue and moods (Nelson *et al.*, 1984). Griffitt (1970) also stated that uncomfortable temperature or air quality has significant effect on the outcomes of work stress.

The objective of this paper is to examine ergonomic factors that contribute to the outcomes of work stress. Data were collected from 35 manufacturing operators in electronics companies. The work station design variables consists of chair/work seating, work area design, acoustics, lighting, working hours and humidity, whereas the work stress outcomes variables comprise of somatic complaints, fatigue, job dissatisfaction and intention to quit.

The research hypotheses

Seven hypotheses were developed and tested in this study. They are:

H1: There is a significant relationship between chair/office seating of the organizations and the outcomes of work stress.

H2: There is a significant relationship between work area design of the organizations and the outcomes of work stress.

H3: There is a significant relationship between acoustic systems of the organizations and the outcomes of work stress.

H4: There is a significant relationship between lighting systems of the organizations and the outcomes of work stress.

H5: There is a significant relationship between working hours of the organizations and the outcomes of work stress.

H6: There is a significant relationship between humidity level of the organizations and the outcomes of work stress.

H7: There is a significant relationship between the ergonomics work station design and the outcomes of work stress.

Methodology

The data was obtained from 35 respondents through questionnaires. The respondents were operators in a multinational electronic company in Petaling Jaya. Respondents were given 15 to 20 minutes to complete the questionnaire.

In this study, the work station design was measured by six factors i.e., chair/office seating, work area design, acoustics, lighting, working hours, and humidity. All 57 items in the questionnaire have been adapted from Miles (2000), Nag and Nag (2004), Lemasters and Atterbury (1996), Hedge and Erickson (1997), House and Rizzo (1972), Tate *et al*. (1997), Brief and Aldag (1976), Ekman dan Ehrenberg (2002), Camman *et al*. (1979), Karasek (1979), Mearns *et al*. (2003) and Tarcan *et al*. (2004). Items were presented on a five-point Likert scale, from strongly agree to strongly disagree. Table 1 reports the Cronbach's alpha for each independent and dependent variables.

Table 1: Reliability analysis – scale (alpha)

Construct	Number of items	Cronbach's alpha
Chair/office seating	5	0.78
Work area design	5	0.75
Acoustics	4	0.80
Lighting	4	0.73
Working hours	3	0.70
Humidity	7	0.75
Stress outcomes	29	0.82

Before we do further analysis, all regression analysis should met its basic assumptions. One of the assumptions is that the data are from a normally distributed population. The rationale behind hypothesis testing relies on having normally distributed populations and so if this assumptions is not met then the logic behind hypothesis testing is flawed (Field, 2003). Table 2 shows the test of normality by using Kolmogorov-Smirnov test. This test tells us that the distribution of the sample is normally distributed ($p>0.05$).

Table 2: Tests of Normality

	Kolmogorov-Smirnov([a])		
	Statistic	Df	Sig.
Stress_Outcomes	.107	35	.200(*)

* This is a lower bound of the true significance.

[a] Lilliefors Significance Correction

Before the final analysis was performed, the assumptions for multiple regression analysis were examined. Based on the analysis conducted, we found that the data were normally distributed, linearity and homogeneity of variance were met and no threat of multi collinearity exist.

Data analysis

Descriptive statistics were presented to gain an understanding of the respondents' demographic factors.

Results

Table 3 provides the details of the respondents' demographic factors. The respondents were seven male and 28 female. The huge gender difference is normal for manufacturing operators. Their age ranges from 25 to late 40s. The oldest respondent was 45 years old. Most of the respondents education level were SRP and SPM. Almost 70% of the respondents have been working in the organization for 6 to 11 years.

Table 3: Respondents' Demographic Information

	Freq	%
Gender		
Male	7	20
Female	28	80
Age Category		
< 25	3	8.6
26 – 30	9	25.7
31 – 35	7	20.0
36 – 40	14	40.0
41 – 45	2	5.7
Education		
LCE/SRP/PMR	15	42.9
MCE/SPM	10	28.6
HSC/STPM	8	22.8
Diploma	2	5.7
Length of Services		
< 2 years	1	2.9
3 – 5 years	8	22.9
6 – 8 years	11	31.4
9 – 11 years	13	37.1
12 – 14 years	2	5.7
Gross Salary		
< RM1000	21	60
RM1000 – RM1500	8	22.9
RM1501 – RM2000	4	11.4
RM2001 – RM2500	2	5.7

Table 4 presents the mean and standard deviation of the respondents' perception towards the ergonomic work station design variables. Chair, work area, acoustics and working hours have moderate score (mean 3.1286 – 3.3200). Lighting has the highest mean score (3.73069). These finding suggest that most of the respondents are satisfied with the lighting system in the organization. However, the organizations should consider the humidity level which had been scored the lowest by the respondent (mean 2.7837).

Table 4: Descriptive Statistics

	Mean	Std. Deviation	N
Stress Outcomes	3.1537	.44	35
Chair	3.3200	.65	35
Work_Area	3.3086	.80	35
Acoustics	3.1286	.59	35
Lighting	3.4000	.50	35
Working Hours	3.3810	.71	35
Humidity	2.7837	.78	35

Table 5 shows the results of the multiple regression analysis.

Table 5: The values of the multiple correlation coefficient R and other statistics
Model Summary (b)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.793(a)	.629	.549	.29491	1.722

a Predictors: (Constant), Humidity, Lighting, Chair, Acoustics, Working Hours, Work Area

b Dependent Variable: Stress Outcomes

Table 6 indicates the ANOVA, which tests for a linear relationship between the independent and dependent variables. In this research, the value of F in the ANOVA table is significant beyond the 0.01 level i.e., support the seventh research hypotheses.

Table 6: The ANOVA for the regression
ANOVA (b)

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4.122	6	.687	7.899	.000(a)
	Residual	2.435	28	.087		
	Total	6.557	34			

a Predictors: (Constant), Humidity, Lighting, Chair, Acoustics, Working_Hours, Work_Area

b Dependent Variable: Stress_Outcomes

As shown in Table 7, three independent factors i.e., chair, working hours and humidity have a significant relationship towards the outcomes of work stress. Based on the analysis, only hypotheses 1, hypotheses 5 and hypotheses 6 were supported. Chair, working hours and humidity level were found to have a significant influence on the stress outcome.

Table 7: The regression equation and associated statistics Coefficients(a)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	.917	.508		1.807	.082		
	Chair	.170	.082	.250	2.076	.047	.914	1.094
	Work Area	.124	.076	.227	1.635	.113	.688	1.454
	Acoustics	.018	.092	.025	.199	.844	.853	1.172
	Lighting	.000	.106	.000	-.001	.999	.893	1.120
	Working Hours	.162	.077	.261	2.103	.045	.859	1.164
	Humidity	.278	.075	.495	3.702	.001	.741	1.350

a Dependent Variable: Stress Outcomes

Discussions and conclusion

Ergonomics work station design is one of the alternatives to minimize the outcomes of work stress in organization. This can be achieved if the organizations try to match the workstation environment with the abilities of the individual who performs the task. Dempsey *et al.* (2004) and Wilson (1995) suggests that understanding the interaction between the various components such as man, work area, machine and environment can effectively enhance productivity and minimize stress. Work stress is a major contributor to the poor health and the stress experienced by the individual may cause strains and long-term negative effects. Researchers such as Linton (2004), De Lange *et al*. (2002), and Sluiter *et al*. (2003), stated that work stress has undesirable effect both for the health and safety of individuals and well-being of the organization. Most of the researchers such as Ket de Vries (1979), Smith (1994), and Dua (1994) agreed that work stress is caused by the work design and workplace environment. Stress is a result of the discrepancy between the demands of the environment and the ability of the individual to adapt it. The interaction between work environment or work station design will contribute to the work stress outcomes. The measures of work stress outcomes consist of physiological, psychological and behavior (De Croon, 2005; Cotton and Hart, 2003).

The analysis of mean and standard deviation for each factor of independent variables shows that the humidity has been scored the lowest as compared to the other factors whereas lighting has the highest score from the respondent. This finding suggests that organization should give attention to the humidity level. The ignorance of this environmental factors leads to workplace hazards, poor worker health, and will affect workers' productivity and products' quality (De Croon *et al.*, 2005).

Based on multiple regression analysis, 62.9% of the variance in stress outcomes is accounted by the independent variables such as chair, work area, acoustics, lighting, working hours and humidity. For the hypothesis 1, 5 and 6, the regression analysis support the research hypothesis, therefore we can conclude that there is a significant relationship for three variables (chair/office seating, working hours and humidity) and the outcomes of work stress. The result of hypothesis 1 supported the statements of Cook *et al*., (2004). The hypotheses 5 result supported Iacovides *et al.* (2003) and Clark (2002). They agreed that the longer working hours will affect the work stress outcomes. Hypotheses 6 supported Martin (1999) and Griffitt

(1970). They pointed out that a good indoor air quality will minimize the outcomes of work stress.

Hypotheses 2, 3 and 4, were not supported. Therefore we can't say that there is a significant relationship between work area design, acoustics and lighting and the outcomes of work stress in the organization. The result for hypothesis 2 contrary to the statements made by Tarcan *et al*. (2004) and Aaras *et al*. (2001). They proposed that ergonomically work area design will minimize the outcomes of work stress. Results for hypothesis 3 also do not support the statements made by Melamed *et al.* (1992), McDonald (1989) and Cuesdan *et al.* (1977). The result of this study align with the findings of Miller (1974), Hedge (1982), and McDonald (1989) who suggest that acoustics did not have any direct effect upon the outcomes of work stress. The efforts for decreasing the noise level are not necessary because of the high capability of human beings to adapt to difficult conditions.

The results for hypothesis 4 also in context to findings of Sutton and Rafaeli (1987), Aaras *et al*. (2001) and Leather *et al.* (2003). The contradictory on the findings might have caused by the nature of employees' task. It is difficult to make specific statements about levels of lighting since their appropriateness depends heavily on the nature of a task (Sutton and Rafaeli, 1987).

This research finding is restricted to the Malaysian workplace environment, where the awareness of workplace ergonomics is still low. The findings might be different if we tested the hypotheses in different countries. In general, the results also might be different if we increase the sample size and involve different industries. It is important to create awareness about the significance of ergonomics amongst Malaysian workforce. It will improve health and performance of workers and leads to higher organizational productivity. This study suggests that organization should pay higher attention as ergonomic factors namely chair, working hours and humidity. These factors were found to have significant effect on the outcome of stress. Ergonomic issues will continue even the best designed jobs if employees ignore proper handling of equipments or do not possess ergonomic-related knowledge. Improving ergonomics factors should be regarded as an investment and an office should provide a happy and conducive environment for work.

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