

Workplace Ergonomics and Employees' Health: A Case Study at Automotive Manufacturer

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Abstract— Employees' health (either physiological or psychological) could have significant effects on organizational productivity and competitiveness. Unhealthy employees incline to be absent and have high sick and hospitalization leaves. Recent statistics from Social Security Organizations of Malaysia indicate that the number of occupational diseases reported has increased every year from 2005 (194 cases) to 2014 (3002 cases). The number of Musculoskeletal Disorder (MSD) and occupational stress are also rising at alarming rate. Poor workplace ergonomics is claimed as one of the major contributors to the declining of employees' health. Despite its importance, study on the effect of workplace ergonomics on employees' health is still very limited. Thus, this paper aimed to identify the effects of workplace ergonomics (in terms of indoor air quality, lighting, furniture and tools, acoustics, building general environment) on employees' health (physiological or psychological). A cross sectional survey participated by 171 employees of an automotive manufacturer revealed that all elements of workplace ergonomics have significant correlations with employees' health ($p < 0.05$) with indoor air quality has the strongest coefficient of 0.688. Regression analysis shows that workplace ergonomics explained 51.8% variance in employees' health with only indoor air quality is retained as significant contributor. This finding implies the importance of workplace ergonomics on employees' health and that safety and health issues need to be incorporated in organizational strategic directions to ensure the organizational sustainability.

Keywords— Workplace Ergonomics; Employees' Health; Automotive Industry

I. INTRODUCTION

Concerns over employees health has heightened recently as statistics on employee's health has shown an upward trend. According to statistics from the Social Security Organizations of Malaysia, the number of occupational diseases has increased from 194 cases in 2005 to 3002 cases in year 2014. Similarly, the number of Musculoskeletal Disorder (MSD) reported was 10 cases in 2005 but has increased to 675 in 2014. In terms of mental health, the number of mental illness cases is reported to be climbing every year [1]. A survey by Jobstreet found that more than 60% of respondents reported that their work as extremely and very stressful. These various statistics are compelling evidence that employees' health (physiological and psychological) in Malaysia is indeed deteriorating and might have serious implications to employee productivity [2], organizational competitiveness [3] and national productivity [4]. Unhealthy employees not only tend to have higher absenteeism either from sick leaves of medical leaves but also might not be able to give full commitment to their works [5].

There are many potential contributors to employees' health ranging from individual health statuses, organizational factors [6], and environmental and societal factors (). However, among these factors, organizational factors such as workplace ergonomics have received significant attention since it is claimed to have positive effects on MSDs [7], stress level [8], and job performance [9]. Despite global recognition of ergonomic issues, related studies on ergonomics has received less attention in Malaysia [10]. Thus, this paper intends to bridge this empirical gap in the existing ergonomics literature by investigating the effects of workplace ergonomics and employees' health among employees working in automotive company.

II. LITERATURE REVIEW

Ergonomics as a concept is initially introduced by Jastrzebowski in 1850s in his book titled *The Science of Work*. It is generally defined as a study of fit between tools and workplace designs and their respective users to ensure that tasks could be carried out efficiently and safely [11]. According to International Ergonomics Association (2015), ergonomics could be categorized into physical, cognitive and organizational ergonomics. Physical ergonomics refers to human anatomical, anthropometric, physiological and biomechanical characteristics as they relate to physical activity. Posture, material handling, repetitive movements, musculoskeletal disorders, workplace layout, safety and health are subsets of physical ergonomics. Cognitive ergonomics is related to mental processes such as perception, attention, and reaction as it involves human interaction and other elements in a system. It includes mental workload, decision making, human-computer interaction, work stress and training.

Organizational ergonomics, on the hand, focuses on optimization of subsystems such as organizational structure, mission and processes. This involves communication, human resource management, work design, working hours and teamwork, new work paradigm, virtual organization and quality management. Evidently, the concept of ergonomics has evolved to be multi-faceted, multi-dimensional at varying levels [12]. At workplace, ergonomic optimizes the human-machine-environment interface to provide balance between worker characteristics and task demand to improve productivity and reduce health complaints. In this paper, the focus shall be on organizational ergonomics or more specifically the work environment fit. In line with this contention, this paper focuses on the five environmental interface of workplace which include indoor air quality, lighting, acoustics, furniture and tools and building environment [13]–[15].

A. Indoor Air Quality

Indoor air quality could negatively impact employee's physical health such as asthma exacerbation and respiratory allergies and complications [16]. Since employees spend more than eight hours per day working inside buildings, poor indoor air quality might not only contribute to higher medical costs but also reduced productivity. According to Wargoeki [4], improving indoor air quality could earn potential annual savings and productivity gains of at least 29 billion and reduction of absenteeism of USD400 per employee. Sundell [16], claim that indoor air quality is probably the most important aspects of environmental ergonomics but has been relatively overlooked. In the developing countries, indoor air quality is claimed to be major cause of allergies, other hypersensitivity reactions, airway infections, and cancers [16]. Bruce et al [17] who review the health effects of indoor air pollution in developing countries confirms this finding. Employees who are exposed to various types of pollutants including particles and gaseous (Yu et al. 2009; Bernstein et al. 2008) tend to increase their health risks which consequently affect their productivity and performance.

B. Lighting

Lighting studies has tended to compare the effects of artificial lighting and of natural lights on productivity and performance and to certain extent employees' health. Mills et al. [20], for example, conducted experiments on the effect of high correlated color temperature office lighting on well-being, functioning and work performance among employees of Standard Life Healthcare in UK. The high correlated color temperature office lighting is claimed to have higher amount of short wavelength and thus higher temperature. They found that subjects in the experimental group showed significant improvements not only in concentration but also in terms of fatigue and alertness. Another study by Dianat et al. [21] evaluates the implications of levels of illuminations and lighting conditions (lighting characteristics and disturbances) on employee satisfaction, job performance and safety and health using both survey and physical illumination measurements. Their study indicates that lighting not only vital to improve employee performance but their health as well.

C. Acoustics

Noise refers to unwanted sound, outside the comfortable hearing range of humans. In Malaysia, noise monitoring is governed by the Factories and Machinery Act 1967 [Act 139] P.U.(A) 1/89 Factories and Machinery (Noise Exposure) Regulations 1989 [22]. Noise originates from various sources such as workplace machineries, office equipment, appliances and electronic devices and could affect both the physiological and psychological comfort of employees (Stansfeld & Matheson 2003; Passchier-Vermeer & Passchier 2000). Studies have found that noise could influence productivity [25], employee concentration [26] and performance [27]. The consequences of noise on employee health have been well documented. It can range from mild effects of human fatigue, headache and irritation [26] to life-threatening consequences such as cardiovascular disease, endocrine and digestive reactions [28] and hearing loss [25].

D. Furniture and Tool Design

Incorporating key ergonomics principles and practices into the design and selection of furniture and equipment is key to minimizing the likelihood of musculoskeletal injuries and enhancing productivity. However, majority of empirical studies on the impact of furniture designs on health seems to focus on school [29], [30] and computer users [31]–[33]. Although there are substantial evidence that furniture and tools design affect employees health (especially musculoskeletal related illnesses), stress level and performance [34]–[36], a study done by Shojaei and Hamzavi (2013) found that physical interaction between employees and furniture such as tables and chairs with stress is not significant. This indicates the need to further pursue this interaction.

E. Building Environment

Building environment not only provides comfort but also contributes significantly to the safety and health of the employees. Badayai [14] claims that building environment could affect the stress level of employees while a study by Makhbul [13] found that building environment significantly related to health complaints from employees. Tarcan et al [15] in their qualitative inquiry among 362 employees in 25 hospital indicates similar finding that improving building environment could improve both employees and organizational performance.

All these studies lead to the formulation of hypothesis of this study which is there are significant relationships between workplace ergonomics (indoor air quality, lighting, furniture and tools, acoustics, building general environment) on employees' health (physiological or psychological).

III. METHODOLOGY

A. Data Collection and Sample

This is a quantitative case study at an automotive company located in Pasir Gudang, Johor Malaysia. Data was collected using self-administered questionnaires distributed to 175 employees from a total of 308 employees based on Krejcie & Morgan sampling size table [37]. Samples were derived by means of stratified sampling to ensure representative samples taken from various departments. However, only 171 questionnaires were returned resulting in 85.5% return rate. Majority of respondents was female (63.7%), with 55.6% of them below 30 years old, 61.4% had high school degree (SPM), and in average worked between 40-49 hours per week (48%).

B. Measures

Workplace ergonomics which consists of indoor air quality, acoustics, lighting, furniture design and building environment were operationalized based on the work of Makhbul [13]. There are a total of 23 items measuring workplace ergonomics with Cronbach's coefficient alpha values ranged from 0.800 to 0.929 which showed high inter-item consistency (Nunnally, 1978). Exploratory factor analysis revealed Kaiser-Meyer-Olkin measure of sampling of 0.827, which is good (Hair et al, 2012). Bartlett's test of sphericity was significant at $\chi^2(253) = 1763.616, p < 0.05$. All item communalities were all above 0.5 which indicate that each item shared common variance with other items. Rotated component matrix revealed six categories of workplace ergonomics with Eigen value more than 1 and shared variance of 65.672%, confirming the initial conceptualization.

Employee health was divided into two sub dimensions of physiological and psychological health. There are a total of 14 items with Cronbach's coefficient alpha of 0.944. Exploratory factor analysis yielded Kaiser-Meyer-Olkin measure of sampling of 0.925, which is good. Bartlett's test of sphericity was significant at $\chi^2(91) = 1885.654, p < 0.05$ with all item loading exceeded 0.5. Rotated components yield two factors with shared variance of 67.804%. These values indicate that measurement of both constructs are reasonably reliable and valid.

IV. RESULTS AND DISCUSSION

Prior to testing of hypothesis, descriptive analysis in forms of measure of central tendency (mean) and measure of dispersion (standard deviation) was performed and shown in Table 1. The mean of workplace ergonomics ranged from 2.39 to 3.53 which indicate positive perception of employees on overall workplace ergonomics. Based on the mean alone, indoor air quality showed highest mean of 3.61(SD=0.75), followed by building environment, acoustics, furniture and lighting. These values indicate that most employees perceived that these workplace ergonomics factors are satisfactory. Indicators of employees health showed that majority of employees disagree on most symptoms related to either physiological or psychological health. This result is expected since the company has good ergonomics practices and exemplary safety and health conduct.

TABLE I. MEAN AND STANDARD DEVIATIONS

	<i>Mean</i>	<i>SD</i>
Workplace Ergonomics		
Indoor Air Quality	3.61	0.75
Lighting	3.25	0.93
Acoustics	3.53	0.68
Furnitures	3.52	0.87
Building Environment	3.53	0.84

Employee Health		
Physiological	2.41	0.88
Psychological	2.20	0.77

In terms of correlation, all workplace ergonomics factors were significantly correlated with both physiological and psychological health with indoor air quality has the strongest value as shown in Table II. However, when all these factors were regressed together as shown in Table III, only indoor air quality was found to be significantly influence the employee health (both physiological and psychological). Workplace ergonomics explained 51.8% of variance in employee health.

TABLE II. CORRELATION COEFFICIENTS

	Physiological	Psychological	Overall Employee Health
Indoor Air Quality	0.667**	0.656**	0.688**
Lighting	0.507**	0.436**	0.493**
Acoustics	0.441**	0.376**	0.427**
Furnitures	0.348**	0.282**	0.329**
Building Environment	0.417**	0.351**	0.402**

* $p < 0.05$

** $p < 0.001$

TABLE III. REGRESSION RESULTS

	Physiological Health			Psychological Health			Overall Health		
	B	SE B	β	B	SE B	β	B	SE B	β
Indoor Air Quality	0.611	0.075	0.523**	0.579	0.070	0.564**	0.595	0.067	0.564**
Lighting	0.121	0.078	0.080	0.067	0.072	0.080	0.094	.070	0.110
Acoustics	0.140	0.092	0.016	0.840	0.850	0.074	0.112	0.082	0.097
Furniture	0.044	0.069	0.043	0.014	0.064	0.016	0.029	0.062	0.032
Building Env.	0.069	0.083	0.065	0.045	0.077	0.048	0.057	0.074	0.060
R ²	0.504			0.454			0.518		
F	33.557			27.452			35.435		

** Significant at $p < 0.01$

V. CONCLUSIONS AND RECOMMENDATIONS

The finding of this research provides mixed supports to the existing body of knowledge. Only indoor air quality was found to influence employees' health either physiologically or psychologically but not with other factors. This implies that even when good ergonomics, safety and health principles are applied, Sick Building Syndrome might still exist and continuous monitoring of air quality is required. Proper understanding of workplace ergonomics may not only improve employee

performance but organizational competitiveness in a long run. As remarked by Fernandes et al. [38], proactive actions are imperative to prevent undesirable outcomes and to promote better quality life at work.

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