ERGONOMICS MEASUREMENT TOOL: A SURVEY FROM PUBLIC SECTORS EMPLOYEES

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Abstract

Ergonomic is a branch of science that focuses on the design of task or job, work equipment and work space and adapts the job and/or the equipment to fit the worker. The suitability of work equipment and work space with employees by considering also the capabilities with the limitations of the employees to ensure the fitness achieved. This design process takes into account the ability of human physiology and psychology. Thus, the aim of the survey was to validate the ergonomic checklist to develop ergonomic measurement scale to measure relationship with employees' perception on ergonomics problem at the workplace influence employees' body discomfort. 184 employees from the public sector were selected to participate as respondents. Results showed that this study has confirmed the acceptable internal consistency of the constructs demonstrated. The validity in assessing the measurement was confirmed by the instrument. Further work is needed to investigate the dimension of ergonomic risk factors to ensure that the instrument has valid outcome measures.

Introduction

New millennium with new technologies requires employees to spend their time at the workplace and dealings in all sorts of equipment, tools, work methods, tasks and the working in their work place and thus leads to injuries and accidents. [1] affirmed that "Globalization and the spread of new technology are generating new types of work organization and thereby new patterns of exposure to the risks of occupational accidents and diseases". This new problem is known as ergonomic problem. Ergonomic comes from the Greek word "ergon", which stands for "work", while "nomos" represents "natural laws", thus, ergonomic denotes to the "laws of work" [2]. In other words, ergonomic is "the science of adapting the job and/or the equipment to fit the worker"[3].

Organization bear higher costs due to ergonomic problems and employees' morale may also suffer. Previous researches findings showed some contributing factors to this new problem such as in vibration, environmental factors, repetitive motions, pressure points forceful exertion and awkward postures, [4]. Ergonomic is a means that organizations may be able to utilize it to avoid injuries in the workplace. This can be done by adjusting the any task to fit the person rather than asking the employees adjusting themselves into the work. Ergonomic improvement generates a safer and healthful work environment and some of the benefits organizations include the following; productivity and work quality increased, the turnover and absentee reduced, including in boosting their morale.

Besides, the workplace ergonomic issues have been highlighted in the safety and health legislation [5]. The third objective in the 1994 Occupational Safety and Health Act states "to promote the work environment for employees that conform to the requirements of their physiological and psychological" is a special focus on the ability of ergonomic to improve the safety and health of employees. Issues related to handling heavy loads in the workplace is also referred to in section 12 under the Factories and Machinery Act 1967 which states "no person can be employed to lift, carry and remove a heavy burden that can cause injury to his body.

Consequently, ergonomic tackles vital issue in innovation of additional action required to eliminate or reduce the risks associated with musculoskeletal disorder (MSD) [6]. Thus, ergonomic support from employers has shown improving trend toward the safe and healthy working environment [1].

The survey's aim was to validate the ergonomic checklist to develop ergonomic measurement scale to measure employees' perception on ergonomic problem at the workplace. Reliability of the tool was also examined.

2.0 Literatures Review

According to the International Ergonomic Association 2010, ergonomic would concentrate on the design of work in everyday life situation focusing on human. It cover over the unhealthy, unsafe and the uncomfortable parts or in the daily inefficient situation at work that was avoidable in taking into consideration of the physical and psychological capabilities including the limitation of the workers. These are several factors that play roles in ergonomic, namely:

- Posture involving Body Movement, including in the stand, sit, pull, push and lift position at work.
- Information including their Operation, such as retrieving information visually or by means of senses in using the control panel and the computer displays.
- Noise from vibration, illumination, climate and chemical substances that are part of the environmental factors
- Task and Jobs, which includes appropriateness of task and level of interest in jobs.

The study conducted by [7]had shown that in the optimize workspace design to support individual or group work, that provide ergonomic information in training to employees, greatly lowered the business process times including the associated compensation costs of the company. It is also indicated that for those who was given ergonomic training intervention have a positive and significant effect on the job control, sense of community, ergonomic climate, business process of time and cost efficiency, communication and collaboration, work-related musculoskeletal discomfort and environmental satisfaction [7]

Talking about cost incurred due to the musculoskeletal problems in the organization, a research by [8]showed that claims by the workers were increased when the training program was introduced first, but assessed through the pre-intervention period these claims, average cost, was considerably reduced. This aligned toward the rate of MSD injury whereby the rates dropped dramatically in the early year of the training but increased in the couple of years after the training program which showed that awareness and the information about the MSD was increased among the workers.

Due to musculoskeletal problems in the organization, stress among workers will increase and affect the productivity and their performance. Linked Stress to psychosocial factors and can related toward musculoskeletal complaints [9].

Ergonomic perspective of workstation design will set the creation of interaction of the various components in the system and this can lower stress and increase productivity [10]. Hence, workplace that is not ergonomically design, the workers are expose to physiological and psychological strains.

A research by [11] indicated that 62.9% of stresses outcomes are accounted by variables the condition and environment of the workplace. The work station design interaction with work environment can cause impact toward stress workplace. According to [12], physiological and psychological results impact are cause by work station design.

Furthermore, a study by [13] disclosed that factors like “work station”, “job control”, “job demand”, “physical environment”, “break time” and “social support” have an impact on “body regions’ discomfort”.

Based on, 2003, [14], reported musculoskeletal illness and conditions have seriously affected millions of people globally. In a year, around 10, 000 Malaysians, workplace computer users had suffered upper limb injuries in the upper limb. Hence, the [15]is addressing the urgent need in promoting workplace ergonomic. A research by [15]found that 61.4% of computer used workers who had severed bodily strain and pain whereas 70.6% had their eye-sight strain.

3.0 Methodology

This research used survey design, i.e., where researcher attempts to correlate one variable to another [16]. This design was chosen, for only the reasonable time period is needed for the researcher to collect all the completed responses. Besides, of it been cost effective[17]. Cross-sectional was conducted in the survey. The sampling design for this population was convenience sampling. The study has used non-probability sampling due to its subjective nature and because it is extremely useful when the researcher has limited resources, time and workforce [18]. [17]suggested that sample size and sampling design are very crucial as proper sampling design helps to draw conclusion that would be generalized to the population [19]. 184 respondents from selected public sector in region of the northern part of Malaysia. Analysis performed was on gender, age, ethnic group, and education level. The gender composition showed that 47.8%% were male respondents, while 52.2% were female. The composition of the highest age group was from 25-29 years which is 37.5% while the lowest was from less than 20 years group which was only 1.1%. The Malay were ranked as the largest number of respondents at 75.5%, followed by Indian 15.8%, Chinese 7.6% and others with 1.1%. In relation to academic background, respondents with a college degree were the most with 50%.

Self-administered questionnaires was used in the study shown in the data collection (refer Table 1). Survey questionnaire was distributed to the chosen respondents. The survey consisted of two sections: demographic and eight respective variables from human factors like “body posture” and work environment which include “job control”, “job demand”, “tools”, “work station”, “physical work environment”, “break time” and “social support” that have relationship with body discomfort.

Table 1

Instrument of the study

Variable	Item	Scale	Source
"Body posture"	11	1 = "Strongly Disagree" to 6 = "Strongly Agree"	checklist
"Workstation"	7		
Job control"	10		
"Job Demand"	7		
"Tools"	6		
"Break Time"	9	0 = "Never" to 4 = "Always"	
"Work Environment"	9		
"Social Support"	6		
"Body Discomfort" (from neck – foot)	20	1= "slightly uncomfortable" 2 = "moderately uncomfortable" 3= "very uncomfortable" 4= "not applicable"	Cornell Musculoskeletal Discomfort Questionnaires (CMDQ)

Statistical Package for Social Science (SPSS) version 23, was used in the data analysis. In accepting a 5 percent chance in rejecting the null hypothesis, the level of significance (or type I error) of 0.05 was used in the study. Analysis of data used factor analysis for construct validity while 12 experts validated the suitability of the survey, that was content validity. The experts were chosen based on their knowledge and understanding with the topic. A priori of analysing exploratory factor analysis and not pursuing confirmatory factor analysis was decided for this study.

4.0 Findings and discussion

4.1 Comment from Expert

Table 2 illustrates the feedback from twelve experts for the 65 items of independent variables. Through comments of on suitability, the modification of items were made. The perception of some item were clear and significant but certain adjustment was needed for they were lengthy.

Table 2

Expert Feedback

Expert	Items/ Questions	Comments
	"The tools selected can limit or minimize exposure to excessive vibration, force, bending or twisting the wrist, finger pinch grip, and problem with trigger finger."	Sentence too long
	"I decide my own task changes." "I am able to choose or change my methods work."	Have the same meaning.
	Body regions	Too many questions. For example "how often did you experience ache, pain, discomfort"
	"My work atmosphere is comfortable." "I find my work environment is good"	Have the same meaning.
	Overall items	The questions should be divided into each section.
	"When I work my head is bended."	The word 'bended' could be 'bending'
	Health section: "muscular pain in your arms or legs", "neck pain", "shoulder soreness", "stiff or sore wrist", "pain in hands/fingers"	Certain questions in health section are similar to body regions questions.
	'During the past two years, I had pain or complaints in body regions, left hand and right hand'.	Too long time to memorize. Maybe can change to 'during the past' only or 'during the past six months'
	Overall items	Divide the items into each sections because respondents will feel bored for answering many questions without separating it.
	" In working, for long hours I was sitting in one position" "For more than two hours per day I sit with lifted shoulders"	Quite the same sentence
	Overall items	Too many questions
	"I wear gloves to anti-vibration when I use vibrated tool while performing work task"	The Likert scale can be "Yes" or "No" for this question

4.2 Exploratory Factor Analysis (EFA)

The data was analyzed using principal axis factoring, specifying with eight factor solutions, with Varimax rotations on the data gathered. A priori standard was set according to number of factors extracted, i.e. 8 factors. This technique is practical when a study tries to test a theory or replicate another study [20]. To consider factor analysis, the sample must be 100 or greater or a minimum of five-to-one ratio between case and variable [4, 20] The minimum level of factor loadings must be more than ± .30, loadings of ± .40 is significant and loadings of ± .50 or greater are most significant [20]. However, sample size plays a major role in determining significant factor loadings. Loadings between 0.40 to 0.45 is considered significant for a sample size of 150 to 200 [20]

An examination of the Kaiser-Meyer Olkin (KMO) measure of sampling adequacy for this survey was greater than .60 and the Bartlett's test of sphericity was significant. The anti-image correlation matrix demonstrated that all measures of sampling

adequacy (MSA) were above the acceptable level of .50. Therefore, it was suggested that the sample was factorable (KMO = 0.767). The results of a Varimax rotation of the solution are shown in Table 3.

Table 4 shows the factor analysis of the 65 items for the independent variables; demonstrated eight factors of the rotated solution. This solution described 7.925% of the variance and included 7 items loaded onto Factor 1 which is labeled as “work station”. 6 items out of 10 items loaded onto Factor 2 and labeled as “job control” and accounted for 7.148 % of the variance. In this factor, four items less than 0.5 were removed.

Factor 3 consisted of 5 out of 7 items which related to “job demand” while only two items like “I work under extensive work pressure” and “ At work I speed to finish my task on time” were deleted because of low factor loading which were less than 0.5 and this factor accounted for 5.540% of the variance.

6 items loaded onto Factor 4 and four items less than 0.5 were eliminated; e.g. “In work I perform repetitive tasks”, “I exercise on my own (during work hours) to help relieve pain and discomfort caused by working at the workstation”, “ I find my work environment good”. Factor 4 with only 2 items were labeled as “social support” with 4.727% of the variance.

11 items were loaded onto Factor 5 and labeled as “body posture”, nine items less than 0.5 were deleted; e.g “When I key my hand in placed in a straight line with my lower arm” and “The handle tools that I use extends past my palms” and left only two items in this factor. This solution explained 4.388% of the variance and nine items loaded onto Factor 6 which is labeled as “break time”. Five items less than 0.5 were deleted, e.g “After two hours I take a break for 10 minutes”. Thus, only 4 items left in this factor.

Six items loaded onto Factor 7 which was labeled as “tools” and accounted for 4.279 % of the variance. In this factor, four items less than 0.5 were removed; like “For more than two hours per day I sit with lifted shoulders”, “I perform job task without computer”, “There is available fresh air in my work”, and “The tools selected can limit or minimize exposure to excessive vibration, force, bending or twisting the wrist, finger pinch grip and problem with trigger finger”. Thus, only two items were left.

Factor 8 consisted of nine items and related to “work environment”. Five items like “The air inside the office is too cold” and “I gaze at the computer screen” were removed because factor loadings were less than 0.5 and this factor accounted for 4.168 % of the variance. Only 4 items left in this factor.

Overall, eight factors were confirmed, that were “work station”, “job control”, “job demand”, “social support”, “body posture”, “break time”, “tools”, and “work environment”.

Table 3

Factor analysis for the items in the independent variables (N = 184)

Item	Factor loading
Factor 1: Workstation	
“My desk (table) at work has suitable height”	0.620
“I can adjust my chair height”	0.558
“When I use the mouse device, my arm is supported by the table”	0.636
“The chair I use during work supports my lower back”	0.544
“My keyboard is placed directly in front of me”	0.714
“The screen is placed directly in front of me”	0.812
“I have enough space to work at my office”	0.673

Percentage of variance explained	7.925
Cronbach's Alpha (7 items)	0.902
Factor 2: Job Control	
"I decide how to perform my job task"	0.704
"I decide my own task changes"	0.682
"I determine the time and speed job tasks"	0.714
"My work develops my abilities"	0.648
"In my work I learn new things"	0.556
"I have to be creative in my work"	0.480
Percentage of variance explained	7.148
Cronbach's Alpha (6 items)	0.836

Item	Factor loading
Factor 3: Job Demand	
"I find it difficult to finish my task on time"	0.704
"I take extra hours to finish my job tasks"	0.685
"I have no enough time to finish my job task"	0.759
"I find my work tasks difficult"	0.717
"I have too many job tasks"	0.650
Percentage of variance explained	5.540
Cronbach's Alpha (5 items)	0.867
Factor 4: Social Support	
"If I made mistake in my work task I find support from my colleges"	0.642
"If I made mistake in my work task I find support from supervisors"	0.700
Percentage of variance explained	4.727
Cronbach's Alpha (2 items)	0.807
Factor 5: Body Posture	
"Head is twisted towards the left or right"	0.640
"Trunk is twisted towards the left or right"	0.592
Percentage of variance explained	4.503
Cronbach's Alpha (2 items)	0.816
Factor 6: Break Time	
"I can plan my work breaks"	0.644
"I can divide my work time"	0.629
"I alternate in my body posture"	0.685
"I alternate in my job task"	0.719
Percentage of variance explained	4.388

Cronbach's Alpha (4 items)	0.824
Factor 7: Tools	
"I wear gloves to anti-vibration when I use vibrated tool while performing work task"	0.578
"There is regular cleaning and maintenance of machines and equipment"	0.538
Percentage of variance explained	4.279
Cronbach's Alpha (2 items)	0.762

Item	Factor loading
Factor 8: Work Environment	
"The air inside the office is too dry"	0.577
"In the office there is unwanted air"	0.564
"My work place is too bright"	0.563
"The computer screen reflects the office lights"	0.510
Percentage of variance explained	4.168
Cronbach's Alpha (4 items)	0.671

4.3 The Reliability of the Instrument

Reliability test was used to test the degree level of stability and consistency of the questionnaires. It measures the degree of freedom of data errors and therefore yields a consistence result. Cronbach's Alpha was used to indicate how well the items in the instruments are positively correlated to one another. Table 5 illustrated Cronbach's Alpha for the instrument. The Cronbach's alpha for all the variables were in the range of 0.671 to 0.954. A lenient cut-off of 0.60 is common in exploratory research; the generally agreed upon lower limit for alpha is 0.70 [20] and many researchers require a cut-off of 0.80 for a "good scale" [10]. Thus, the Cronbach's alpha coefficient of the instrument was above the acceptable level of 0.60. The result shows that it can be accepted because of the high reliability [20].

Table 5

Cronbach's Alpha

No.	Variable	Item	Cronbach's alpha
1.	"Body regions' discomfort"	60	0.954
2.	"Body Posture"	2	0.816
3.	"Workstation"	7	0.902
4.	"Job Control"	6	0.836
5.	"Job Demand"	5	0.867
6.	"Tools"	2	0.762
7.	"Work Environment"	4	0.671
8.	"Break Time"	4	0.824
9.	"Social Support"	2	0.807

Based on the factor analysis findings, a conceptual framework as Figure 1 was developed for further testing.

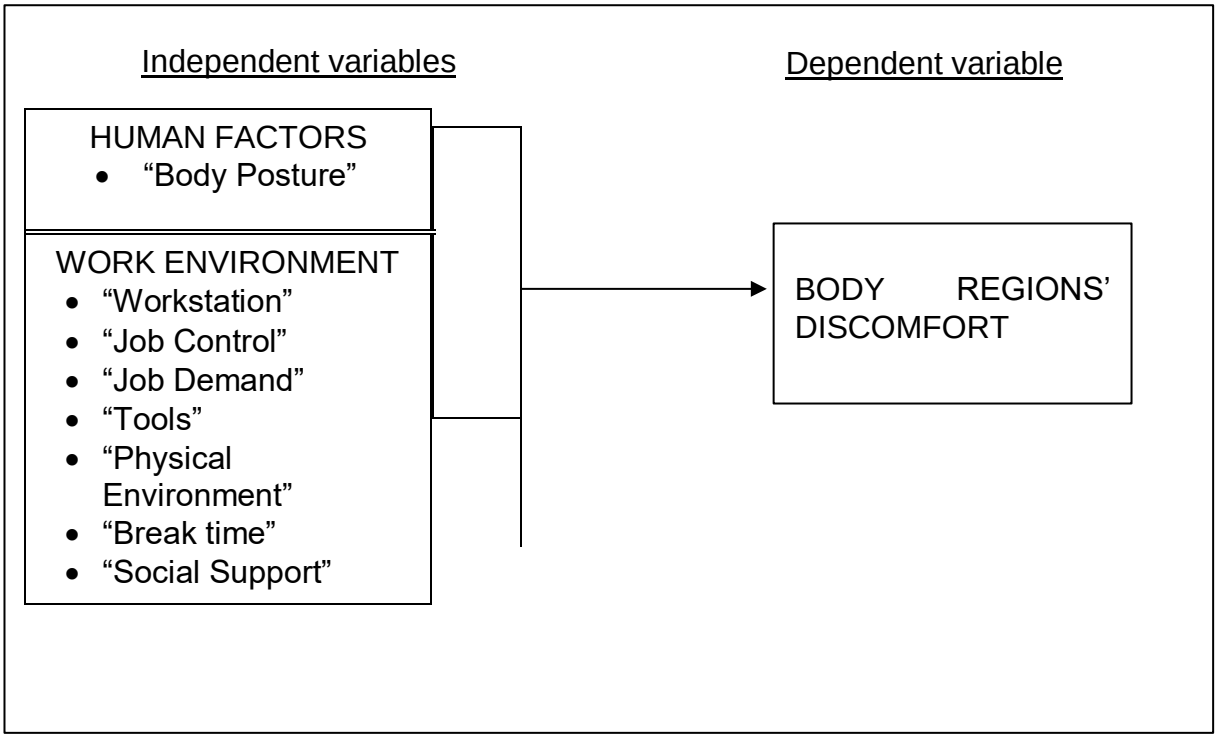

Figure 1. The Conceptual Framework

4.4 Discussion

.

There are eight variables denotes in this ergonomic articles. It shows that "break time", "workstation", "job control", "job demand", "social support", "body posture", "tools", and "work environment" may have a relationship with body discomfort. The internal consistency reliability coefficient was in the range of .671 to .954. The results revealed that the measurement constantly assesses what it is intended to measure [21]. Content validity defines to what extent a single item in a measure relate its meaning with the underlying theoretical concept. Even though the assessments were subjective, the content validity was ascertained to persistent procedures [22]. The results of the factor analysis permit this study to refine the instrument measurement to enhance its usability and validity. All the scales revealed reasonable validity in determining how well the concept is defined by the measure [20]. Even though some factors are different from previous study on ergonomic tools, the items in each factor were able to indicate the conceptual definition of the underlying construct.

4.5 Limitation and Future Research

For research purposes, the model presents some insights into the components related to ergonomic measurement scale that might influence body discomfort, which gives the basis for future research in any settings. Although this study did not examine all the potential variables that might be reflected on the body discomfort, it presents initial inquiry into the significance of exploring the phenomenon from various job position perspectives as an attempt to denote the relationship between these factors with body discomfort. Nevertheless, there are some limitation in the study, proposing the prospect of further study. The cross-sectional inquiry is one of the limitation for it only pinpoint outcomes to certain circumstances. Hence, further longitudinal research is needed to build strong support in this study. Secondly, the focus of the study was on the employee of the public sectors in the northern region of Malaysia. Probably, there could be different of perception in different industries in Malaysia. Besides, studies made in different location is needed in making comparisons. Thirdly, further replicate research should be conducted examining into the structural equation

modeling. Finally, it required future study refining this instrument making use of confirmatory factor analysis to produce with a "good fit model" for examining the relationship between these factors and body discomfort.

4.6 Conclusion

The goal of this study was to develop ergonomic measurement scale to measure employees' perception on ergonomic problem at the workplace. The data was analyzed using construct validity and internal consistency for its reliability. This study has verified the constructs demonstrated an adequate internal consistency. Also, the instrument verified a rational validity in evaluating the measurement.

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