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Design of Ergonomic Work Facilities to Reduce Skuble Muscle Disorders with Quick Exposure Check (QEC) Method in CV. XYZ

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ABSTRACT

Work facilities can affect an operator. Unsafe and comfortable work facilities can reduce operator performance and pose a risk of work accidents. CV. XYZ is a business entity engaged in contracting and advertising services. Every day, operators work with non-ideal body positions (bent, sit down) which affects their performance in fulfilling work and causes disturbances in the skeletal muscles of work-related musculoskeletal disorders (WMSDs). It is necessary to review the work facilities for operators. This study aims to design an ergonomic work facility to reduce skeletal muscle disorders at certain work stations based on an evaluation using the Quick Exposure Check (QEC) method. The results showed that the highest average exposure level value was found in the workstation on the raised letter work, which was 71.60%, so it was necessary to make changes to the workstation. The proposal given is in the form of a chair and table design for operators using anthropometric data. The new design is expected to reduce the risk of injury to the operator's work, especially injuries to the skeletal muscles, and improve the performance of the workers themselves.

Keywords: Ergonomics, posture load measurement, quick exposure check

Introduction

One of the factors that can affect the performance of a worker is the work facility factor. The existence of work facilities aims to make it easier for someone to do their work. Abidah et al. (2018) stated that work facilities will affect a person's quality of life. So that apart from making work easier, work facilities also aim to improve a person's quality of life. This is because work facilities such as chairs or tables need to be designed according to workers to make work easier and reduce the incidence of health complaints.

CV. XYZ is engaged in contractor services and advertising. Operators at each workstation work in non-ideal working positions such as bending over or having to sit down. It needs to be reviewed. Based on these problems, the researcher proposes to design work facilities such as ergonomic desks and chairs using a work risk assessment related to muscle disorders (Quick Exposure Check).

Literature Review

Ergonomics

The term ergonomics, which comes from the Greek ergon and nomos, means the consideration of law into the work (Satish et al., 2020; Gangopadhyay et al., 2020; Srinivasan et al., 2020). Ergonomics is a strategy to make work easier for workers. According to Shoubi et al.,

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(2013) ergonomic strategies can relieve workers from pain and others related to their work which can lead to quality improvement and job development.

Workstation design

Workstation design is a concept to support efficiency and safety in the use of product design. Both in modifying or redesigning existing work stations, new work stations. Designers are often constrained by both financial and technological factors (Colim et al., 2020; Kovács et al., 2017)

Workload

The workload is a stimulus received by the body when carrying out activities or work, whether light or heavy. According to Manuaba (2008) in general, the relationship between workload and work capacity is influenced by various very complex factors, both external factors (tasks, organization, and work environment) and internal factors (factors originating from within the body itself as a result of reactions to workloads). external).

Anthropometry

The term anthropometry comes from the word "Anthropos" (man) which means human and "Metron" (measure) which means size (Milania & Prabaswari, 2021). Every product design, both simple products and very complex products, must be guided by the anthropometry of the user.

Methodology

Variable Identification

The independent variables contained in this study were worker anthropometry data which included hip-width in a sitting position which was used to determine the width of the worker's chair, a knee-fold height which was used to determine the seat height when the worker sat, arms reach to the side which was used to determine the length of the table, a forward hand reaches used to determine the width of the table, elbow height used to determine the length of the chair from the floor of the worker. The dependent variable in this study is designing ergonomic work facilities to reduce skeletal muscle complaints by using the QEC method on the CV. XYZ.

Respondent

The population in this study includes 7 work stations (cutting stations, welding stations, drilling stations, paint stations, embossing stations, sticker stations, and finishing stations) and consists of 14 people covering all work stations at CV. XYZ.

Standard Nordic Questionnaire (SNQ) & Quick Exposure Check (QEC)

According to Gómez-Rodríguez et al. (2020), the measurement of skeletal muscle physical stress is quite difficult because it involves subjective factors such as performance, motivation, expectations, and fatigue tolerance, one of which is through the Standard Nordic Questionnaire (SNQ). Quick Exposure Check (QEC) is a tool for assessing work-related musculoskeletal disorders (WMSDs).

Result and Discussion

SNQ & QEC Questionnaire

The following is an example of the results of the SNQ and QEC questionnaires for all operators, which can be seen in the table.

Table 1. Sample answers to snq questionnaire respondents

Standard Nordic Questionaire
Operator Name: Pairien Age: 45 Tahun Work station: *Cutting*
How to fill out the questionnaire: check (√) how do you feel when you work Value of weight in each category: - Painless: 0 - Rather pain: 1 - Pain: 2 - Very ill: 3 The categories of pain felt at work are as follows: - Painless: The operator's body part does not feel pain at all because the muscle contractions that occur run normally, usually this happens if the body part is not directly in contact with the workpiece. - Rather pain: The operator's body part begins to feel sore, but the pain that arises does not make the operator tired or tired. - Pain: The operator's body part feels quite severe pain and this situation makes the operator get bored and tired quickly. - Very ill: The operator's body part feels excruciating pain accompanied by tension (extreme muscle contractions) that makes the operator feel quite saturated and tired.

Table 2. Sample answers to qec questionnaire respondents

Kuisioner *Quick Exposure Check* (QEC) / BACK
Observer: Eko Wahyudi Worker: Pairien Work station: *cutting* Research Date: April, 29th 2017
A. When working back position? (Choose the worst situation) A1. Almost neutral A2. Slightly twisting or bending B. A3. Too twisting or bending 1. For lifting, pushing, or pulling and carrying jobs (such as carrying weights). How often do you move your back? B3. Less (about 3 times per minute or less)? B4. Average (about 8 times per minute)? B5. Often (about 12 times per minute or more)?

Exposure score & exposure level

Exposure score is calculated for each body part such as the back, shoulders/upper arms. Wrist and neck by considering ±5 combinations/interactions, namely posture with force/load, movement, duration with force, posture with duration, and movement with duration. The

following is a recapitulation of the exposure score calculation results for all operators at all work stations, which can be seen in Table 1 and 2.

Table 3. Recapitulation of exposure score results all workstation

Work Station	Operator	Operator Name	Exposure Score Value on Observed Body Members					Total Exposure Level
			Back (static)	Back (move)	Shoulder	Wrist	Neck	
Cutting	1	Pairin	-	32	20	26	10	88
	2	Jasmuni	-	28	20	26	10	84
Welding	1	Supardi	26	-	30	26	12	94
	2	Firmansya	26	-	26	26	14	92
Drilling	1	Fasikin	-	34	26	30	10	100
	2	Suhadi	-	34	26	30	12	102
Painting	1	Ismail	-	30	38	26	14	108
	2	Abdul	-	30	34	26	14	104
Embossed Letters	1	Antok	30	-	34	34	18	116
	2	Huda	30	-	34	34	18	116
Sticker	1	Dirgantara	-	20	20	16	12	68
	2	Solikin	-	20	20	20	12	72
Finishing	1	Budi	16	-	28	24	10	78
	2	Mustaqin	18	-	28	24	10	80

After obtaining the exposure score of each member of the body that has been studied for each operator at the work station, the next step is to calculate the exposure level. Here's the formula for calculating the exposure level.

$$E(\%) = \frac{X}{X_{max}} x\ 100\% \qquad (1)$$

The following is a recapitulation of the exposure level calculation results for all operators at work stations, which can be seen in the table.

Table 4. Recapitulation of exposure level calculation results

Work Station	Operator	Operator Name	Exposure Level	Average Exposure Level	Action
Cutting (g)	1	Pairin	50,00%	48,86%	Need more research
	2	Jasmuni	47,72%		
Welding (s)	1	Supardi	58,02%	57,40%	Further research is needed and changes are made
	2	Firmansyah	56,79%		
Drilling (g)	1	Fasikin	56,81%	57,38%	Further research is needed and changes are made
	2	Suhadi	57,95%		
Painting (g)	1	Ismail	61,36%	60,22%	Further research is needed and changes are made
	2	Abdul	59,09%		

To be continued

Em-bossed Letters (s)	1	Antok	71,60%	71,60%	Conduct research and changes as soon as possible
	2	Huda	71,60%		
Sticker (g)	1	Dirgantara	38,63%	39,77%	Safe
	2	Solikin	40,90%		
Finishing (s)	1	Budi	48,14%	48,76%	Need more research
	2	Mustaqin	49,38 %		

Data uniformity test

The data uniformity test was conducted to determine whether the body dimension data taken were uniform or within the upper control limit and lower control limit. If in a measurement there are one or more non-uniform data types, the data will be immediately rejected. In this study, the researcher used a 95% confidence level and 5% accuracy level, so, k = 2. The results of the data uniformity test on all body dimensions can be seen in table 5.

Table 5. Anthropometric data uniformity test results

Dimension	σ	$\bar{X}$	Upper Control Limit	Lower Control Limit	
Hip Width	2,44	41	46,04	36,24	Uniform data
Knee Fold Height	1,17	45	47,78	43,07	Uniform data
Hand reach sideways	4,27	122	130,55	113,44	Uniform data
Hand Reach Forward	2,21	51	55,57	46,71	Uniform data
Sitting Elbow Height	3,46	76	82,49	68,64	Uniform data

New work facility design recommendations

Percentile calculation is used as a recommendation to make work facilities according to anthropometric measurements. The following are the dimensions of the proposed work facilities according to the calculations that have been made.

Table 6. Data dimensions of the proposed working facility at the embing letters station

Dimension	(cm)
Suggested seat width	45
Chair height from the proposed floor	45
Suggestion table length	115
Suggestion table width	47
Suggested table height	76

Body dimension data are taken from CV. XYZ corresponds to the number of operators at the embossed letter station, namely 2 people plus 12 all the operators who work. The following is an image of the result of the proposed work facility design, which can be seen in figure 1.

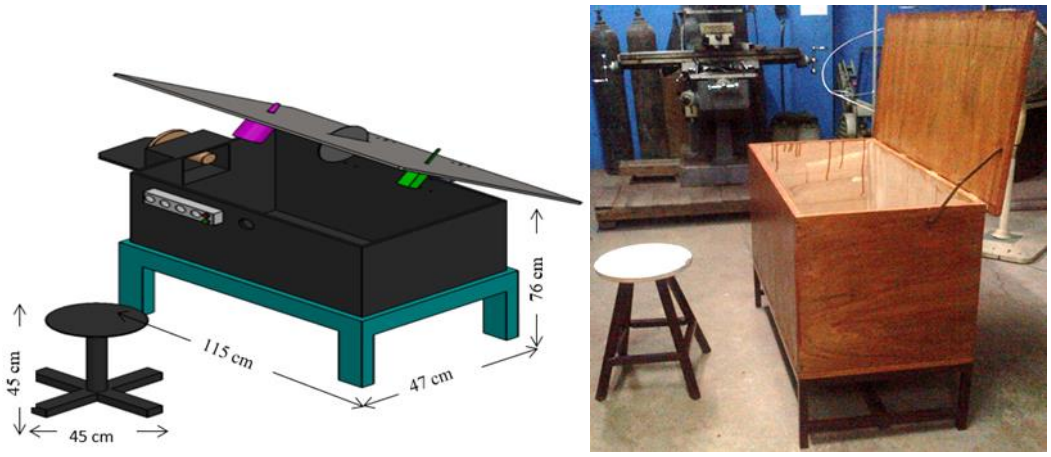

Figure 1. Suggested Products

Proposed product trial

From the results of the questionnaire on the proposed chair and table product, according to the physical criteria, the answers are very dissatisfied with 0 answers, dissatisfied with 0 answers, 22 answers sufficient, 20 answers satisfied and very satisfied 28 answers. Meanwhile, according to the application, the criteria for the answer are very dissatisfied as many as 0 answers, dissatisfied as many as 0 answers, sufficient as 7 answers, satisfied as many as 22 answers, and very satisfied with 27 answers

Conclusions

Calculation of Quick Exposure Check (QEC) for raised letter stations has an exposure level value of 71.60%, after being given a new work facility design proposal it decreased by 30.13% which means it is at a safe level. Based on the comparison of the results of the questionnaire respondents, the proposed table and chair design have the most satisfied and very satisfied criteria according to the physical and its application. So, it can be concluded that the proposed chairs and tables have entered the ergonomic product requirements.

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