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Analysis of Musculoskeletal Disorder (MSDS) factors in production operator employees using the Quick Exposure Checklist (QEC)

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Abstract

Production department operators perform repetitive work processes continuously, resulting in muscle and joint disorders. The purpose of this research is to identify early and provide preventive strategies for the potential occurrence of diseases due to musculoskeletal disorder complaints. (MSDs). This research is a qualitative study that involves direct observation of the subjects and interviews with sources to collect data using the Quick Exposure Check method. (QEC). The QEC results show that the wave solder workstation has the highest score with a total score of 141 and an exposure score of 80%. The cutting-point workstation has a score of 127 and an exposure score of 72%. The printing workstation has a score of 126 and an exposure score of 78%. The visual inspection workstation has a score of 107 and an exposure score of 61%. Therefore, the priority body parts are back with the highest total score of 30, the arms/shoulders with the highest total score of 36, and the wrists with the highest score of 40.

1. INTRODUCTION

Indonesia is a country with a diverse industrial sector. The emergence of various industries is in line with the improvement of safety and health standards in each industry. According to (Kurnia et al., 2022), occupational safety and health are our efforts to create a healthy and safe work environment, thereby reducing the probability of work accidents and diseases due to negligence that leads to demotivation and deficiencies in work productivity. The company has many departments with their respective functions and tasks, one of which is the production department. The production department is the department responsible for producing products from raw materials into semi-finished goods or finished goods.

PT XX is a Foreign Direct Investment (FDI) company engaged in electronic services, established in Santa Clara, California in 1971. In carrying out their activities, the production department performs repetitive work processes continuously, maintaining a static body posture, which often leads to disturbances in the musculoskeletal system muscles. Based on the survey conducted, employees experience complaints in the muscles, tendons, joints, ligaments, and bones of the operators, ranging from mild to severe complaints.

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Complaints up to damage are usually referred to as musculoskeletal disorder (MSDs) complaints (*Man: An Ergonomic Approach*, 1980).

Based on that background, this research was conducted by early identification and strategizing to prevent the occurrence of diseases or disabilities due to musculoskeletal disorder (MSD) complaints using the Quick Exposure Check (QEC) method as a tool to further analyze musculoskeletal complaints and identify which body parts show the highest values that need immediate attention.

2. METHODS

Musculoskeletal disorder is a discomfort in the musculoskeletal system. These disorders can include injuries to the muscles, nerves, tendons, ligaments, joints, cartilage, or spinal discs caused by work activities (Mindhayani, 2022). The symptoms that generally arise include pain, soreness, discomfort, restlessness, tingling, swelling, cramps, stiffness, numbness, shortness of breath, etc. This disorder can be caused by excessive activity, lifting weights, poor posture, and repetitive stress (Kurnia et al., 2022). This disorder can be caused by three factors: primary, secondary, and a combination of both. Primary factors include awkward posture, repetitive tasks, and excessive muscle contractions. Secondary factors include temperature, vibration, repression, temperature, and excessively cold air humidity (Ananti et al., 2020).

QEC is a method designed to evaluate the work experience of observers, practitioners, and workers (Li & Buckle, 1998). The QEC method has high sensitivity and utility, and its reliability is widely accepted. QEC is a method for assessing work-related risks associated with muscle disorders in the workplace. This method evaluates risk disturbances occurring in the back, spine, shoulders/arms, wrists, and neck. QEC helps prevent the occurrence of WMSDs such as repetitive movements, pressure exertion, incorrect posture, and work duration (Bisbey et al., 2021). The previous research was conducted using the Nordic Body Map method with the same subjects, specifically in the production department. Another study is the research on the working posture conditions of operators that are not yet ergonomic, excessive workload, and minimal use of machines or equipment. This study also uses the Quick Exposure Check (QEC) method to eliminate operator complaints. The analysis was conducted on only 4 points, namely the back, wrist, shoulder/arm, and neck (Hutabarat & Panjaitan, 2020)

Another study is related to the design of work facilities that combine the REBA and QEC methods to address the issue of many workers reporting pain in specific body parts such as the back, neck, arms, legs, and wrists. The result of this research is the creation of an assistive tool in the form of a trolley to facilitate lifting objects, in addition to installing warnings in the production environment to remind workers to always use PPE while working (Sadjar, 2018). From the above research, it can be concluded that the Quick Exposure Check (QEC) method can be used to identify risk factors in the musculoskeletal system and strategies that can be recommended to prevent complaints or work accidents.

The research method used is qualitative research by conducting direct observation of the object to be studied and direct interviews with informants to collect the necessary data. Data collection was conducted through interviews and the completion of questionnaires filled out by 10 representative operators from 4 workstations in the production department, namely wave solder, cutting point, visual inspection, and printing. The observer questionnaire focuses on the body posture formed by the operator when performing their work. Meanwhile, the operator questionnaire focuses more on the complaints when performing their work. The questionnaire results are then processed to calculate the exposure score for the observed body parts. Quick Exposure Check method is used to determine whether a type of job has a risk of musculoskeletal system injuries by examining the overall risk factors. The exposure level to determine the risk of injury to each body part can be seen in Table 1.

Table 1. *Exposure Level* QEC

Score	Low	Moderate	High	Very High
Back (static)	8-15	16-22	23-29	29-40
Back (moving)	10-20	21-30	31-40	41-56
Shoulder/arm	10-20	21-30	31-40	41-56
Wrist	10-20	21-30	31-40	41-56
Neck	4-6	8-10	12-14	16-18

3. RESULT AND DISCUSSION

In this study, the operators of the production department at each workstation were analyzed. The number of operators at the wave soldering station is 10 operators, the cutting point is 10 operators, printing station is 10 operators. In this case, the result of the QEC was used as primary data. This questionnaire sheet contains 2 sets of questions that must be filled in, namely the operator questionnaire and the observer questionnaire or those conducting the research. The operator questionnaire is filled in directly by each operator, while the observer questionnaire is filled in by observers who make direct observations based on the images taken.

Calculating the number of exposure scores assessment

Following completion, the questionnaire is processed and the exposure checklist table is used to determine the score. The exposure score is then determined using the processed questionnaire data.

Table 2. Wave Solder Exposure Score

Body Area	Wave Solder Work station									
	OP 1	OP 2	OP 3	OP 4	OP 5	OP 6	OP 7	OP 8	OP 9	OP 10
Back	22	22	30	22	26	30	28	30	32	30
Shoulder/arm	30	30	30	30	30	34	36	30	36	32
Wrist	36	22	36	28	22	32	28	22	28	40
Neck	16	16	16	16	18	18	16	14	16	18

Based on the exposure score of each operator at the wave solder workstation for the back with a value of 22-32. Shoulders/arms with a value of 30-36. Wrists with a value of 22-36. Neck with a value of 14-18.

Table 3. Cutting point Exposure Score

Body Area	Cutting Point Work station									
	OP 1	OP 2	OP 3	OP 4	OP 5	OP 6	OP 7	OP 8	OP 9	OP 10
Back	30	26	22	26	26	26	22	26	30	30
Shoulder/arm	26	30	26	22	22	22	26	26	34	26
Wrist	18	22	22	28	32	28	22	28	32	28
Neck	14	16	14	16	14	16	14	14	16	16

Based on the exposure score of each operator at the cutting point workstation for the back with a value of 22-30, shoulders/arms with a value of 22-34, wrists with a value of 18-32, and neck with a value of 14-18.

Table 4. Visual Inspection Exposure Score

Body Area	Cutting Point Work station									
	OP 1	OP 2	OP 3	OP 4	OP 5	OP 6	OP 7	OP 8	OP 9	OP 10
Back	22	22	8	14	8	14	18	14	14	18
Shoulder/arm	22	26	18	22	18	18	14	14	18	14
Wrist	22	28	20	10	14	18	10	14	10	18
Neck	16	16	6	8	8	8	10	8	8	8

Based on the exposure score of each operator at the visual inspection workstation for the back with a score of 8-22, shoulders/arms with a score of 14-26, wrists with a score of 10-28, and neck with a score of 6-16.

Table 5. Recapitulation of Exposure Score Printing

Body Area	Cutting Point Work station									
	OP 1	OP 2	OP 3	OP 4	OP 5	OP 6	OP 7	OP 8	OP 9	OP 10
Back	14	14	32	28	30	12	12	12	22	34
Shoulder/arm	14	14	22	22	26	16	10	10	10	34
Wrist	16	14	28	26	26	16	10	10	10	32

Body Area	Cutting Point Work station									
	OP 1	OP 2	OP 3	OP 4	OP 5	OP 6	OP 7	OP 8	OP 9	OP 10
Neck	6	8	16	14	14	6	6	8	8	16

Based on the exposure score of each operator at the printing workstation for the back with a score of 12-34, shoulders/arms with a score of 10-34, wrists with a score of 10-32, neck with a score of 6-16.

Determining Exposure Level

After obtaining the recap of the exposure scores, we can then calculate the exposure level value.

Table 5. Summary of final score addition and Wave solder actions

Work station		Number of scores	Exposure score (%)	Action Level	Action
Wave Solder	OP1	111	63%	Action level 3	Investigate further and change the work situation as soon as possible (1-6 months)
	OP2	94	53%	Action level 3	Investigate further and change the work situation as soon as possible (1-6 months)
	OP3	116	65%	Action level 3	Investigate further and change the work situation as soon as possible (1-6 months)
	OP4	100	56%	Action level 3	Investigate further and change the work situation as soon as possible (1-6 months)
	OP5	128	73%	Action level 4	Investigate and change the work situation immediately (max. 1 month)
	OP6	129	73%	Action level 4	Investigate and change the work situation immediately (max. 1 month)
	OP7	134	76%	Action level 4	Investigate and change the work situation immediately (max. 1 month)
	OP8	100	56%	Action level 3	Investigate further and change the work situation as soon as possible (1-6 months)
	OP9	138	78%	Action level 4	Investigate and change the work situation immediately (max. 1 month)
	OP10	141	80%	Action level 4	Investigate and change the work situation immediately (max. 1 month)

5 operators have an exposure level value greater than 70%, according to the chart pertaining to the QEC action level standards in the wave solder department. This indicates that urgent research and adjustments must be conducted immediately. 5 other operators have exposure level values greater than 50%, indicating the need for more investigation and the imminence of changes.

Table 6. Summary of final score addition and cutting point actions

Work station		Number of scores	Exposure score (%)	Action Level	Actions
Cutting Point	OP1	95	54%	Action level 3	Investigate further and change the work situation as soon as possible (1-6 months)
	OP2	101	*57%*	Action level 3	Investigate further and change the work situation as soon as possible (1-6 months)
	OP3	91	*51%*	Action level 3	Investigate further and change the work situation as soon as possible (1-6 months)
	OP4	107	*61%*	Action level 3	Investigate further and change the work situation as soon as possible (1-6 months)
	OP5	109	*62%*	Action level 4	Investigate and change the work situation immediately (max. 1 month)
	OP6	107	*61%*	Action level 3	Investigate further and change the work situation as soon as possible (1-6 months)
	OP7	88	*5%*	Action level 1	Accepted

	OP8	109	*62%*	Action level 3	Investigate further and change the work situation as soon as possible (1-6 months)
	OP9	127	*72%*	Action level 4	Investigate and change the work situation immediately (max. 1 month)

According to the cutting point department's QEC action level standards table, 1 operator has an exposure level value greater than 70%, indicating the necessity for investigation and quick adjustments as soon as feasible. 1 operator has an exposure level of 5% or accepted level, while the other 7 operators have an exposure level >50%, meaning that more thorough research and changes must be conducted over a longer period of time.

Table 7. Summary of final score addition and visual inspections actions

Work station		Number of scores	Exposure score (%)	Action Level	Actions
Visual Inspection	OP1	77	44%	Action level 2	Investigate further
	OP2	107	61%	Action level 3	Investigate further and change the work situation as soon as possible (1-6 months)
	OP3	59	34%	Action level 1	Accepted
	OP4	61	35%	Action level 1	Accepted
	OP5	55	31%	Action level 1	Accepted
	OP6	65	37%	Action level 1	Accepted
	OP7	59	34%	Action level 1	Accepted
	OP8	57	32%	Action level 1	Accepted
	OP9	57	32%	Action level 1	Accepted
	OP10	115	65%	Action level 3	Investigate further and change the work situation as soon as possible (1-6 months)

2 operators have an exposure level value >50%, which indicates that changes and additional investigation are needed soon, 1 operator has an exposure level of 44%, which indicates that additional investigation is required and 7 other operators have an exposure level <40% or are at a safe level, according to the table pertaining to the QEC action level standards for the visual inspection department.

Table 8. Summary of final score addition and printing actions

Work station		Number of scores	Exposure score (%)	Action Level	Actions
Printing	OP1	54	48%	Action level 2	Investigate further
	OP2	54	*33%*	Action level 1	Accepted
	OP3	102	*63%*	Action level 3	Investigate further and change the work situation as soon as possible (1-6 months)
	OP4	94	*58%*	Action level 3	Investigate further and change the work situation as soon as possible (1-6 months)
	OP5	106	*60%*	Action level 3	Investigate further and change the work situation as soon as possible (1-6 months)
	OP6	57	*35%*	Action level 1	Accepted

Work station	Number of scores	Exposure score (%)	Action Level	Actions
OP7	42	*30%*	Action level 1	Accepted
OP8	52	*32%*	Action level 1	Accepted
OP9	62	*38%*	Action level 1	Accepted
OP10	126	*78%*	Action level 4	Investigate and change the work situation immediately (max. 1 month)

1 operator is known to have an exposure level greater than 70%, according to the table pertaining to the QEC action level guidelines for the visual inspection department. This indicates that additional research and adjustments must be undertaken soon. 3 operators whose exposure level is greater than 50% also need to be looked at further and corrected right away. 1 operator with an exposure level of 48% needs further investigation, and 5 other operators have an exposure level <40%, which is considered safe and accepted.

4. CONCLUSION

Based on the analysis and discussion above, it can be concluded that the work posture in the wave solder and cutting point workstation, which have a risk of musculoskeletal injuries, is evident from the high exposure score values in the back, shoulder/arm, wrist, and neck areas, and immediate follow-up actions are necessary.

In the wave solder workstation, 3 operators' backs are at a moderate level and 7 operators' backs are at a high level. In the shoulder/arm area, 5 operators are at a moderate level and 5 operators are at a high level. In the wrist area, 6 operators are at a moderate level and 4 operators are at a high level. In the neck area, 9 operators are at a very high level, and 1 operator is at a high level. The QEC results show that the wave solder workstation has the highest score with a total score of 141 and an exposure score of 80%.

In the cutting point workstation, there are 2 operators' backs at a moderate level and 8 operators' backs at a high level. In the shoulder/arm area, 9 operators are at a moderate level and 1 operator is at a high level. In the wrist area, 1 operator is at a low level, 8 operators are at a moderate level, and 1 operator is at a high level. In the neck area, 5 operators are at a very high level, and 5 operators are at a high level. The cutting-point workstation has a score of 127 and an exposure score of 72%. The printing workstation has a score of 126 and an exposure score of 78%. The visual inspection workstation has a score of 107 and an exposure score of 61%.

Based on the exposure level values, immediate follow-up actions are needed for the wave solder and cutting point departments. For the wave solder department, 50% are at level 4, and 50% are at level 3, which means immediate action is required. In the cutting point department, 10% are at level 4, and 80% are at level 3, so these two departments also need immediate follow-up. The proposed recommendations include: incorporating foam padding as a base for tables to facilitate wave soldering of components, providing arm or wrist supports for operators working at cutting points, enhancing the design of keyboard footrests with a rotating axis, and supplying hand pads for operators involved in visual inspection and printing tasks. These measures aim to improve ergonomics and reduce physical strain during work activities. Furthermore, the institution must prioritize and evaluate the work conditions and activities of its employees to promote overall workplace well-being.

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