DESIGN OF ERGONOMIC TOOL SPECIFICATION TO IMPROVE THE WORK POSTURE OF OPERATOR IN WORKSTATION OF MAINBOARD INSPECTION IN E-KTP READER PRODUCTION PROCESS IN PT ABC BASED ON RAPID UPPER LIMB ASSESMENT METHOD

Nur Intan Dhewanty Mayangari [1], Wiyono Sutari [2], Marina Yustiana Lubis[3]
[1] Program Studi Teknik Industri, Fakultas Rekayasa Industri, Universitas Telkom
Email : [1]intandhewanty@gmail.com [2]wiy2606@gmail.com [3]marina.irawan@gmail.com

Abstract
PT ABC is one of the state-owned companies that produces electronic equipments such as electronic equipment for military, ICT (Information Communication Technology &), electronic equipment for navigation systems, electronic equipment for train, etc. In the production process flow there are 4 (four) inspection processes performed, one of them is mainboard (GPIO & Cubie Board). Based on the observation in the field, the mainboard inspection process is still done manually and the operator works in a standing position with neck bend over to 17.08^0 of extension and the trunk is bending up to 45.18^0 of extension for 7 hours per day. All operators of mainboard inspection experience pain and discomfort in all parts of the body with different percentages. But the parts of the body that have the highest percentage of MSD risks about 10% are neck and legs. In this case the operator feel neck pain and feet pain. Based on Rapid Upper Limb Assesement (RULA) method, the RULA score obtained is 5 which means that the work posture requires analysis and improvement immediately. The RULA score is directly proportional to the risk of MSD, the higher the RULA score the higher also risk of Musculoskeletal Disorders (MSDs) is going. In mainboard inspection, operators only served to evaluate the soldering result by using a tool that is in the form of a magnifier which is equipped with a light that does not fit the operator's need, instead it makes operators doing inspection in such work posture. The initial stage to solve the problem is gathering some data such as anthropometry data and the recommended work method which is doing inspection in sitting position and acommodated by ergonomic tool. Those data are used to design the specification of ergonomic tool. After designing, there will be the dimension specification of the workbench and the chair and also the specification of the magnifier. At last, the output of this research is RULA score of new work posture which is 3.

Keywords : rapid upper limb assesment, specification, work posture, ergonomic tool, musculoskeletal disorders

1. Introduction

PT ABC is one of the state-owned companies that produces electronic equipments such as electronic equipment for military, ICT (Information Communication Technology &), electronic equipment for navigation systems, electronic equipment for train, etc. In the production process flow there are 4 (four) inspection processes performed, one of them is mainboard (GPIO & Cubie Board). Based on the observation in the field, the mainboard inspection process is still done manually and the operator works in a standing position with neck bend over to 17.08^0 and the trunk is bending up to 45.18^0 for 7 hours per day.

Figure 1 The Existing Work Method

Based on initial research result by way of dissemination of the questionnaire to 3 (three) operators of mainboard inspection which aimed to know what part of the body has the risk of MSDs and perceived by the operators due to the existing work posture using Cornell Musculoskeletal Discomfort Questionnaire (CMDQ). All operators of mainboard inspection experience pain and discomfort in all parts of the body with different percentages. But the parts of the body

that have the highest percentage of MSD risks about 10% are neck and legs. In this case the operator feel neck pain and feet pain.

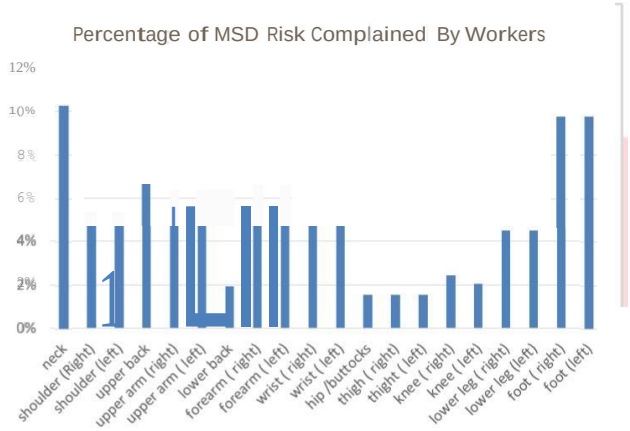

Figure 2 Histogram of MSDs Risk Percentage Complained by Operators

For further evaluation of existing work posture the method which ish used in this research is Rapid Upper Limb Assesement (RULA) method. Based on Rapid Upper Limb Assesement (RULA) method, the RULA score obtained is 5 which means that the work posture requires analysis and improvement immediately. The RULA score is directly proportional to the risk of MSDs, the higher the RULA score the higher also risk of MSDs is going. In RULA method, if the working posture is awkward with the level that requires analysis and or need improvement soon which is level 3 with score 5 – 6 including the neck that forms an angle of more than 20^0, the trunk also bent over 20^0-60^0. Evaluation of working posture of the individual in the awkward posture, muscle strength, and activities that contribute to causing risks of Musculoskeletal Disorders.

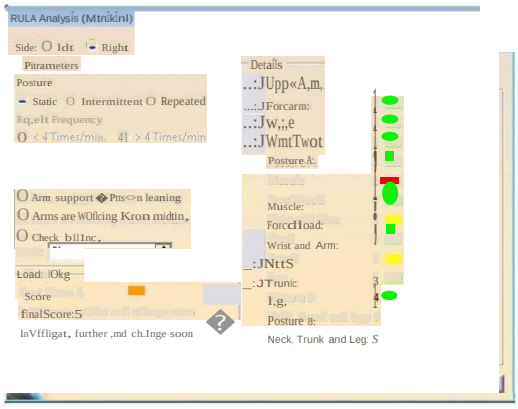

Figure 3 RULA Score for Standing Position (right side)

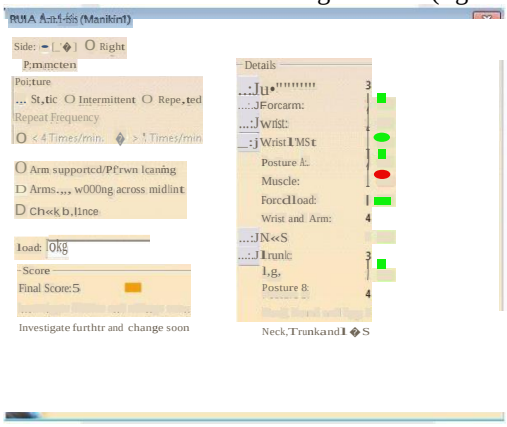

Figure 4 RULA Score for Standing Position (left side)

In mainboard inspection, operators only served to evaluate the slodering result by using a tool that is in the form of a magnifier which is equipped with a light that is shown in the following.

Figure 5 The Workbench of Mainboard Inspection

Figure 6 Upper Display of The Existing Inspection Tool (Magnifier)

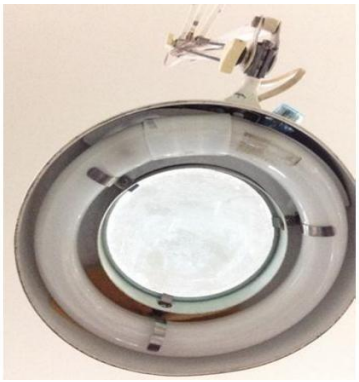

Figure 7 Lower Display of The Existing Inspection Tool (Light)

In such condition and tools lead operator must inspect the mainboard in the standing position and looked down for 7 hours of work per day. It certainly will also lead to fatigue occurs quicker on the operators. Some of ways that can be done to reduce fatigue due to standing position such as altering the standing position to a sitting position. The weakness of the work with the sitting position for a long period of time causing problems in some parts of the body, especially to the spine and the bottom posterior of hip bone [1]. It is necessary to has tools that are able to accommodate a sitting position with ergonomic aspects into consideration

2. Literature Review and Research Methodology

2.1 Literature Review

2.1.1. Ergonomics

Ergonomics is a science that examines the various characteristics and aspects of human-like capabilities, limitations and others that fit the context of the work, and make use of information obtained in an attempt to design the products, machines, tools, environments and better work system [2]

2.1.2. Work Posture

Work posture is the deciding point in analyzing the effectiveness of a job. If the posture of the work done by the operator is already good and ergonomic then the results obtained can be ensured by the operator will be good. But if the work posture of operator does not ergonomic then the operator will be easily exhausted. When the operator easily exhausted then the results of work done, these operators will also decline and not as expected (Susihono,2012).

2.1.3. Rapid Upper Limb Assesment

Rapid Upper Limb Assessment (RULA) is a method that developed in the field of ergonomics that investigate and assess posture the work done by the upper body. Work posture assessment method does not require special tools in conducting measurements of neck posture, back, and upper body (McAtamney, 1993).

2.1.4. Work-Related Musculoskeletal Disorder

According to the National Institute of Occupational Safety and Health (NIOSH) and the WHO Musculoskeletal Disorders (MSDs) is the nuisance caused when someone does work activities and conditions of the work thus affecting significantly the presence of normal functioning of silky tissue on the musculoskeletal system that covers nerves, tendons, muscles.

2.1.5. Anthropometry Concept

Anthropometry is a science that studies of human body dimension and its characteristic that relevant in making design (Purnomo,2012).

2.2 Conceptual Model

The specification design of ergonomic tools are identified based on anthropometry data and the recommended work method. The recommended work method previously obtained by performing an analysis of the existing work method. The recommended work method is a combination between a work posture with the use of the ergonomic tools. Then, ergonomic tool specification design will generate new work posture that would later be processed into variable of score RULA from new work posture.

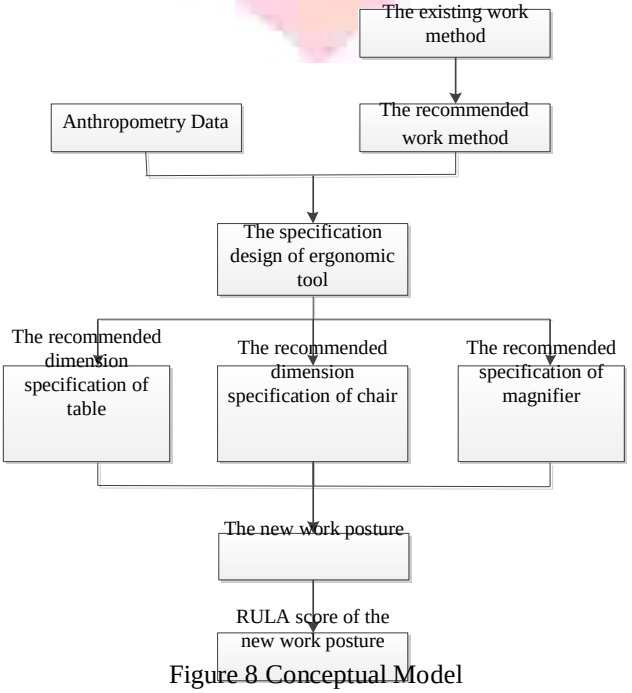

Figure 8 Conceptual Model

3. Analysis

3.1 Specification Design of Ergonomic Tools

Table 1 The Size Dimension Based on The Percentile and The Tolerance

Number	Dimension	Function	Percentile	Reason of the percentile	Size (cm)	Tolerance	Reason of tolerance	Final Size (cm)
1	hip breadth	seat width	50-th	it is not too narrow for user with wider hip and vice versa	33,7	1,3		35
2	buttock-popliteal length	seat length	50-th	if it uses 95-th percentil it does exceed the buttock popliteal length of the short user and vice	43,3	0,7		44
3	popliteal height	seat height	50-th	if it uses 5-th percentil it will be too short and vice versa	47,0	0		47
4	sitting shoulder height	the backrest height	95-th	user with higher shoulder can lean on comfortably	63,8	0,2		64
5	shoulder width	the backrest width	95-th	user with wider shoulder can lean on comfortably	48,4	0,6	easier design	49
6	sitting eye height	workbench surface height above the floor	50-th	so that user do not need to bent	77,3	0,7		78
7	knee height & thigh depth	workbench base height above the floor	50-th	it is not too narrow for user with heigher knee and vice versa	71,0	0		71
8	sideway reach of hand	workbench length	5-th	it can be reached by user with shorter arm	169,5	0,5		170
9	forward reach of hand	workbench width	5-th	it can be reached by user with shorter arm	71,7	0,3		72

Table 2 The Recommended Size Dimension of The Workbench

function	size (cm)
workbench surface depth	7
workbench length	170
workbench width	72
workbench height above the floor	71
workbench surface height above floor	78

Table 3 The Recommended Size Dimension of The Chair

function	size (cm)
seat width	35
seat length	44
seat height	47
backrest height	64
backrest width	49

While the specification for the recommended magnifier are 10x magnification, equipped with light, and portable because after trial and error activity, that magnification has been quite clear to observe very small soldering results performed by operators. The recommended magnifier should has the same features with the existing magnifier but still its specifications should fit to the needs of the operator.

Figure 9 The Recommended Magnifier

Figure 10 The New Work Posture

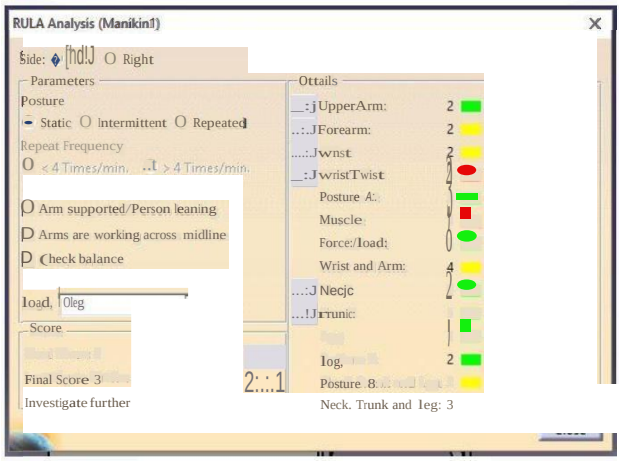

Figure 11 RULA Score for Sitting Position (left side)

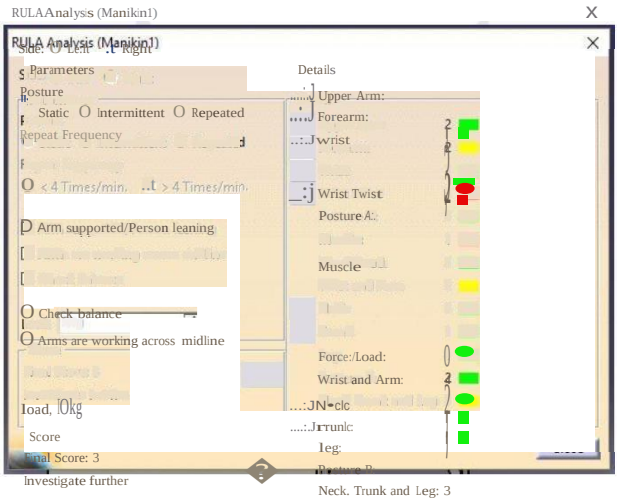

Figure 12 RULA Score for Sitting Position (right side)

3.2 The RULA Score Between Standing Position and Sitting Position

It had obtained that the RULA score of the recommended work posture is 3 with action level 2. The score is smaller than the RULA score for the existing work posture which is 6 with the action level 3. RULA score that are 3-4 means small risk against the potential risk of MSDs and needed some time in the future to improve. RULA score that are 5-6 has MSDs risk that bigger and necessary improvement action immediately. In the final, the RULA score of the new work posture is smaller than the existing, it means that the MSDs risk of the new work posture is reduce. sitting posture has a number of advantages over the standing posture. Sitting posture is better because some of the support that can be used such as floor, seat, backrest, armrest, and the surface of a desk. Therefore the relative body positions when operators are sitting may reduce fatigue rather than standing posture [3].

4. Conclusion

The RULA score of sitting position is 3 which means analysis and improvement may be required. However, at least that score is smaller than the existing RULA score (standing position) which is 6. Smaller the RULA score also smaller the MSDs risk. In additional, the dimension specification design obtained from this research are workbench surface depth 7 cm, workbench length 170 cm , workbench width 72 cm, seat width 35 cm, seat height 47 cm, seat length 44 cm, backrest height 64 cm, backrest and width 49 cm. While the specification for the recommended magnifier are 10x magnification, equipped with light (LED), and portable.

References

[1] Susihono, Wahyu. (2012) Perbaikan Postur Kerja Untuk Mengurangi Keluhan Musculoskeletal Dengan Pendekatan Metode OWAS (Studi Kasus Di UD. Rizki Ragil Jaya - Kota Cilegon). Spektrum Industri Fakultas Teknik Universitas Sultan Ageng Tirtayasa, Serang

[2] Jansen, Kristjan (2012) Musculoskeletal Discomfort In Production Assembly Workers.

[3] Dina Meliana Pangaribuan .(2009). Analisa Postur Kerja Dengan Metode Rula Pada Bagian Pelayanan Perpustakaan USU Medan

[4] Mutiara sari, Yuvie (2015) Analysis of Working Posture on Musculoskeletal Disorders of Operator in stamp scraping in 'Batik Cap' Industry

[5] Abdol Rahman, Mohd (2006) Musculoskeletal Discomfort Among Workers In Mould Making Manufacturing Industry.

[6] Muharram Taofik, Iqbal (2015) Evaluasi Ergonomi Menggunakan Metode RULA(Rapid Upper Limb Assessment) Untuk Mengidentifikasi Alat Bantu Pada Mesin Roasting Kopi.

[7] Mulayaningsih, Wiwit (2015) Designing Ergonomic Tools On Book Packaging at PT Karya Kita Using Framework DMechanical design

[8] Fachin Greca, Moema (2015) Work Ergonomic Analysis at The Quality Material Inspection Station In a Graphic Industry.

[9] Mufidah, Ilma (2015) The Design of Batik Stamp Tool Scraping Working Table Using Ergonomics Principles.

[10] Kaya, Ozlem (2015) Design of Work Place and Ergonomics in Garment Enterprises.