An Evaluation of Work Posture by REBA: A Case Study in Maintenance Department

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Abstract.

The maintenance and after service company has a duty to maintain and fix broken machines. Eight Workers in maintenance department have to fix 22 broken machines per day on average located on the floor. From the survey of working postures in maintenance department, results showed that workers have to work in a way to bend their back to repair or change some parts of the machine all of their working time. Additionally, workers always pick up the equipment from the toolbox placed on the floor. These working postures can risk health problems of workers such as back muscle injuries. The healthy survey of workers showed that workers have lower back pain problems are 4.30 on average. Furthermore, the result from the Rapid Entire Body Assessment (REBA) showed the average score up to 12.16, which was a high-risk criterion and should be improved immediately. This study aims to improve working posture of workers in maintenance department by using Rapid Entire Body Assessment (REBA) and designing new ergonomic tools. Therefore, this study has designed a toolbox shelf in order to reduce bending postures while working in standing posture and has designed a chair with a tray on which tools can be placed. Workers can fix the machine while sitting. After using the new toolbox shelf and chair, the health survey showed that the lower back pain score reduced to 2.46 on average and the REBA assessment score reduced to 2.83 on averages which is a significant risk reduction

Keywords: Human Factors ·Rapid Entire Body Assessment (REBA) ·Ergonomic Design · Maintenance

1 Introduction

Maintenance is an important task in industries. The typical maintenance works are related to many subcategories including: setting up, preparation, installation, mounting, disassembling, and dismantling repairing, tuning, adjustment and manual cleaning of working areas and machines [1]. Due to many kinds of works, the workers are always exposed to several occupational hazards such as physical risks, and high physical workload. Reference [2] reported that the maintenance workers have an occupational disease rate 10 times higher than for other workers. The accidental statistic from Europe countries showed that around 20% of all accidents in Belgium (in 2013)[3] were related to maintenance operations, as well as around 18-19% in Finland, 14-17% in Spain, and 10-14% in Italy (in 2003-2006) [4]. In Thailand, working posture is a serious problem in many industries. The statistics of work injuries in 2017 [5] are classified by severity and causes of hazard showed that 2,563 workers were exploded to injuries caused by working posture and lifting. These workers lost their working days including 488 workers who stopping working in excess of 3 days, and 2,074 workers stopped working not exceeding 3 days. In addition, many Thai workers experienced musculoskeletal disorders (MSDs). The statistics of work injuries in 2017 classify by severity and disease that caused by work characteristics showed that 1,554 workers developed musculoskeletal disorders. These workers were absent from their work including 248 workers stopping working in excess of 3 days, and 1,306 workers who stopped working not exceeding 3 days.

One of the occupational hazards is an awkward posture, which happens regularly in maintenance activities an example of bending posture. Example in Beverage industries, maintenance workers fixed 22 broken machines per days on average including cooling machines, fountain-making machines and icemaker machines. These machines were placed on the floor due to their heavy weight. Workers have to bend their torso over 60 degrees to fix these machines. In addition, during the fixing time, workers have to bend their torso to pick up or change some tools from their toolbox that placed on the floor. These awkward postures caused health problems such as muscle pain. Reference [6] reported that working with a-60-degree-bending and twisting posture increased significant risk to developed back pain symptoms. In addition, working with the bending that forward above 60 degrees, it increases risk and leads to the development of MSDs rapidly. Reference [6] also reported that working with a bending or twisting posture longer than two hours per day is an important cause of back pain.

Although working posture is one of the main factors determining the musculoskeletal load of the employee. Researchers have paid little attention to maintenance activities [7]. There are few studies on these activities especially in the awkward posture, machinery, and equipment that should be suitable for workers. To decrease the chance of muscle pains, work tasks in the maintenance department should be designed to limit exposure to these risk factors. Engineering control example of redesign tools to enable neutral postures is the needed way. Therefore, this study aims to assess and improve working posture in the maintenance department of Beverage Company by using Entire Body Rapid Assessment (REBA) to evaluate risk from the working pos-

ture and designing new standing tool shelf and chair. Therefore, workers can keep working with their natural posture and limiting awkward posture.

2. Methodology

2.1 Participant

Eight male workers from maintenance department of Beverage Company.

2.2. Working Posture Risk Assessment

There are six processes in maintenance task including 1.check broken machine, 2.unassemble machine, 3.clean some parts, 4.fix broken parts, 5.assemble parts, and 6.test and run machine. Some of these working postures are shown in Fig. 1.

(a) (b) (c) (d)

Fig. 1 shows working posture in maintenance department including (a) checking process, (b) unassembling parts, (c) cleaning parts, and (d) fixing broken parts.

From Fig. 1, Workers always work with bending their torso. The tooling box is placed on the floor. For postural analysis, using REBA, a standard REBA check sheet and its calculation follow the guideline, which the example is shown in Fig. 2 and the scoring is shown in Fig. 3 The more awkward posture taken from the worker, the higher risk score will be obtained. The risk level and action level from REBA score is shown in Table 1.

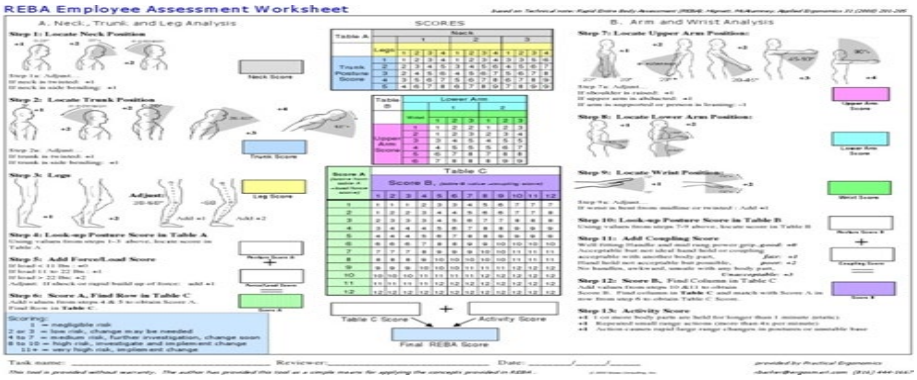


Table 1 shows the guidelines of essential activities to be taken after the REBA scoring has been accomplished. The REBA score indicates the risk level of the measured tasks. If the risk score is very high, this task is needed to improve immediately in order to reduce the risk.

Table 1. REBA Action Level

Action Level	REBA score	Risk Level	Action (including further assessment)
0	1	Negligible	None necessary
1	2-3	Low	May be necessary
2	4-7	Medium	Necessary
3	8-10	High	Necessary soon
4	11-15	Very High	Necessary now

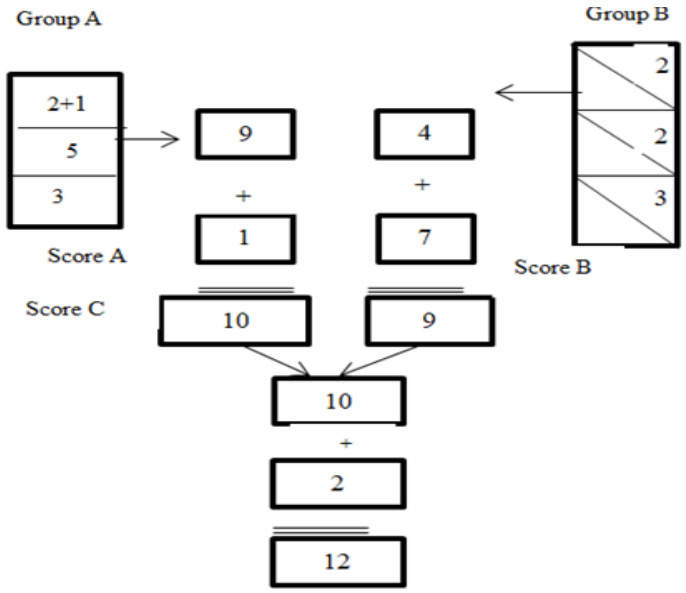


Fig. 3 shows REBA Score

2.3 Tooling shelf and chair design

Reference [9] suggests the safety model for maintenance. There are five basic guidelines to follow to safety maintenance. Use of appropriate equipment is one of them. Appropriate tools and equipment should be provided and used to eliminate or limit the risks. There are two causes that relate to awkward posture including the position of the machine on the floor and the toolbox also place on the floor. Due to the heavy weight of machines approximately 43 kilograms on average , workers cannot lift and place it at a the suitable height. The alternative way is to design the tool shelf to place the toolbox. This way can limit the bending torso while workers are fixing the machine. In addition, the designed chair with tray at the right side is a desirable way to fix machine while sitting. The 13 body dimensions of workers such as height, arm reach etc. were measured to calculate the dimension of the shelf and chair by using this equation

$$X_p = X + z*s \quad (1)$$

Where
X_p = percentile at p value,
X = mean,
Z = standard value from normal table
S= standard deviation

The results from these calculations were used to design and build the tooling shelf and chair. After a 1-month trial, REBA assessment and body part discomfort were used to analyze the working posture again

2.4. Data Analysis

Paired-T test analysis is used to compare the result between before and after working posture improvement by using the new tooling shelf and chair such as body part discomfort.

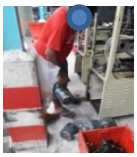
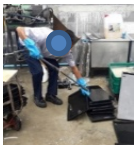
3. Results

3.1. Working posture assessment

The postural analysis using REBA was used to measure the risk score at the maintenance department. Eight workers worked on six step maintenance tasks. Both a right and left hand side in sagittal plan of each worker was measured and averaged the risk score. The result is shown in Table 2.

From Table 2, the REBA score indicated that all working steps have very high-risk score at 12.16 on average that located in action level 4. It means these maintenance tasks needed to improve immediately.

Table 2. The REBA Score

Working step	Photograph	REBA score	Analysis and action needed
1. Checking		13	Very high risk and needed to improve immediately
2.disassembling parts		13	Very high risk and needed to improve immediately
3.Cleaning parts		12	Very high risk and needed to improve immediately
4.Fixing broken parts		11	Very high risk and needed to improve immediately
5.Assembling parts		13	Very high risk and needed to improve immediately
6.Test run/ QC		11	Very high risk and needed to improve immediately

3.2. The shelf and chair design

To reduce awkward posture in the maintenance department, the two level shelf and chair were designed based on the workers' body dimensions. The shelf and chair are designed based on 5 and 95 percentile of workers' body dimensions. Example of the shelf height is 97 centimeter and 47 centimeter width. The height is calculated from hip height level at 91.82 centimeter on average, 3.57 centimeter on standardization and 1.64 of 95 percentile. The top level of the shelf is declined at 15 degree to facili-

tate picking up the tools without bending of the wrist. Workers can pick up or change the tools without bending their torso or wrist. The designed chair is 43 centimeter height and 36 centimeter width. The chair has four wheels so it easy to move around the machine while fixing. It also has tray attached at the right side on which workers can place tools. It is easy to pick up the tools without bending their torso. In addition, the bottom side of the designed chair is divided into three slots for placing tools. It allows workers continuous work without stopping and walking to find and change tools. The picture of shelf and chair are shown in Fig. 4 and Fig. 5, respectively.

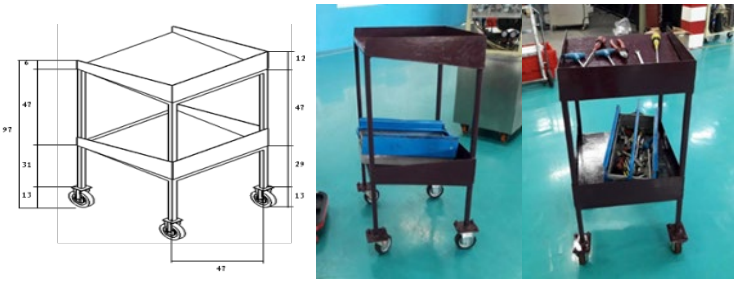


Fig. 4 shows the stand shelf tool (diameter in centimeter) including (a) sketch view, (b) side view, (c) front view

Fig. 5 shows the designed chair (diameter in centimeter) including (a) sketch view, (b) front view, (c) front view with shelf

After a-1-month trials using the shelf and chair in the maintenance department, the results showed that this equipment can help to reduce body pain of workers and the risk score from REBA decreased. The new working posture while using the shelf and chair is shown in Fig 6.

Fig. 6 shows the working posture using designed shelf and chair

The statistical analysis by Pair-T- test from body parts discomfort table showed that the body part discomfort of employees compared between before and after using the shelf and chair are significantly different (P-value < 0). After working posture improvement affects the average score is reduced by injury, torso pain score decreased from 4.07 to 2.53, hand and wrist pain score decreased from 4.38 to 2.07 and lower back pain score decreased from 4.30 to 2.46. The body part discomfort scores are shown in Table 3.

Table 3. Body Part Discomfort Score

Body part	Discomfort score (before working posture improvement)	Discomfort score (after working posture improvement)
1.Neck	2.76	2.07
2. Torso	4.07	2.53
3. Lower back	4.30	2.46
4.Upper arm	3.69	2.30
5.Lower arm	3.84	2.30
6.Hand/wrist	4.38	2.07
7.Foot	2.92	2.23
Average	3.70	2.28

REBA assessment showed that the risk score of all working steps are decreased example of at the checking step the risk scores decreased from 13 to four, the disassembling parts risk scores decreased from 13 to 3 and the fixing broken parts risk scores decreased from 11 to 2 etc. The average risk score decreased from 12.16 to 2.83

4. Discussion

From the results obtained, the average risk score after using the designed shelf and chair is 2.83 on average, which are under action level 1. This average value still indicates that it may be necessary to be reduced further in the future. In addition, the average score of body part discomfort decreased from 3.70 to 2.28. This average value shows that workers felt less body part discomfort while using the designed shelf and chair.

5. Conclusion

The REBA risk score shows a critical postural issue. The suitable equipment should be used to reduce awkward postures. The results can be used as a guideline to the risk related with postural or work related musculoskeletal injuries. The applications of REBA will give a priority order for maintenance- working- tasks, which should be investigated. The Score of the individual posture indicates very high and need immediately to improve. The designed shelf and chair can help to improve working postures. As a result, it helps workers feel less pain in their body parts especially in torso and lower back.

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