Jurnal
Teknologi

Full Paper

ERGONOMIC POSTURE ASSESSMENT OF BUTCHERS: A SMALL ENTERPRISE STUDY IN MALAYSIA FOOD INDUSTRY

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Article history
Received
19 February 2019
Received in revised form
18 July 2019
Accepted
24 July 2019
Published online
24 October 2019

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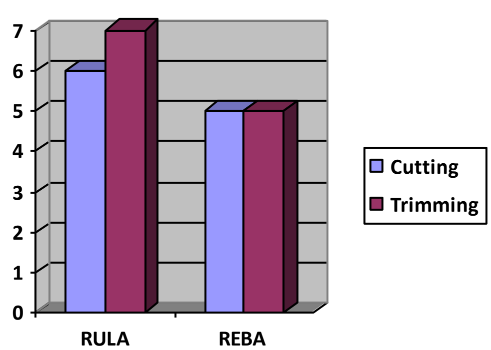
Graphical abstract



Abstract

The development of small and medium-sized enterprises (SMEs) is crucial for improving the economy of a rural area. However, this can cause working posture problems, such as musculoskeletal disorders (MSDs) and cumulative trauma disorders (CTDs). This is especially true for butchers, who work in SMEs that still depend on manual handling processes without standard operating procedures. Posture analysis evaluations using the Rapid Upper Limb Assessment (RULA) and Rapid Entire Body Assessment (REBA) tools have been used to analyse the working postures of butchers working in SMEs. The aim of this study was to identify butchers' risks of working posture problems, and to propose an ergonomic workstation designed to reduce MSDs and CTDs. This study was focused on smoked meat preparation. The butchers there spend 5–8 hours a day cutting and trimming meat. The assessment was conducted using RULA and REBA worksheets. The RULA score for the meat trimming process was 7, with a score of 6 for the meat cutting process. As for REBA, the score was 5 for both the meat trimming and meat cutting processes. Based on these scores, the butchers were at higher risks for MSDs and CTDs. Therefore, a new ergonomic workstation design was proposed based on the principles of motion economy.

Keywords: Ergonomic, musculoskeletal disorders, rapid entire body assessment, rapid upper limb assessment, posture assessment

Abstrak

Pertumbuhan *SME* adalah penting dalam meningkatkan lagi ekonomi di kawasan luar bandar. Namun, ia boleh menyebabkan masalah kesilapan postur dan posisi tubuh semasa bekerja seperti *MSDs* dan *CTDs*. Masalah ini berlaku kepada pemotong daging yang berkerja di SME yang masih melakukan kerja-kerja secara manual tanpa *SOP* yang baik. Analisis postur tubuh telah dinilai dengan menggunakan kaedah *RULA* dan *REBA* dimana posisi tubuh pemotong daging dinilai. Tujuan kajian ini dilakukan adalah untuk mengenal pasti risiko masalah postur tubuh badan pemotong daging dan mencadangkan tempat kerja yang ergonomik bagi mengurangkan risiko *MSDs* dan *CTDs*. Kajian ini focus kepada persiapan penyediaan daging salai. Pemotong daging memperuntukkan masa 5 jam hingga 8 jam sehari untuk proses memotong dan merapikan daging. Penilaian dilakukan menggunakan kaedah skor *RULA* dan *REBA*. Skor *RULA* untuk merapikan daging ialah 7, skor 6 bagi memotong daging. Skor *REBA* menunjukkan skor 5 untuk kedua-dua proses memotong dan merapikan daging. Berdasarkan skor tersebut, pemotong daging berisiko tinggi untuk mengalami gejala *MSDs* dan *CTDs*. Oleh itu, tempat kerja yang ergonomik dicadangkan berdasarkan teori *principle of motion economy.*

Kata kunci: Ergonomik, *musculoskeletal disorders, rapid entire body assessment, rapid upper limb assessment*, analisis postur badan

1.0 INTRODUCTION

In recent years, small and medium-sized enterprises (SMEs) have been developing rapidly, especially in rural areas. However, the increased production processes have exposed workers to working posture problems, such as musculoskeletal disorders (MSDs) and cumulative trauma disorders (CTDs). This is because knowledge and awareness of the importance of ergonomic working postures are still at a minimum in the SME industry [1]. Ergonomics is defined as the interactions between workers and workplace elements, such as machines or workstations [2]. Working posture problems, including MSDs and CTDs, are especially common in developed and developing countries [3]. The potential for working posture problems is mainly due to repetitive work [4], awkward working postures and tough working condition [1]. The production processes of the SME industry still depend on manual handling processes.

MSDs are defined as health problem that affect the ligaments, tendons, bones and muscles due to high intensity work [5]. Workers who are affected by MSDs should seek preliminary treatment, because these can lead to critical health conditions, like movement disabilities and paralysis. MSDs can also affect the company itself due to the increased expenses involved in worker compensation and healthcare for those employees who are affected by MSDs, as well as the costs related to the company's production processes [3]. CTDs are defined as health conditions in which the constant 'wear and tear' of the muscles and/or tendons prevent the injury from healing [6]. CTDs are usually caused by maintaining a static work posture for a long period of time.

MSDs include any injuries to the musculoskeletal system, including the bones, muscles and ligaments, caused by overexposure to the abovementioned risk factors and hazards in the workplace [7, 8, 9]. The results of a study by previous research work shows that MSDs were caused by poor working spaces and manual equipment handling, which force a worker to adapt to poor working condition [8]. According to the Health and Safety Executive of the United Kingdom (Figure 1) during 2016 and 2017, MSDs mainly affected the upper limbs, neck, lower limbs and back.

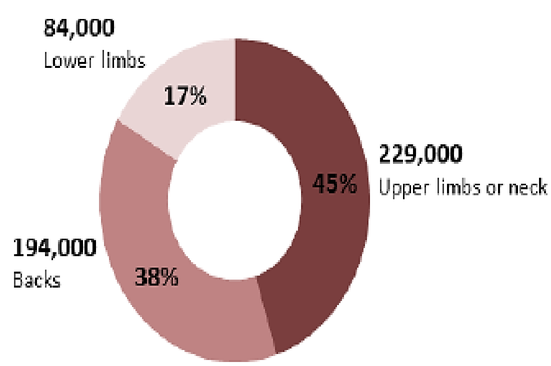


Figure 1 The affected area of MSDs [10]

CTDs are health conditions describing 'wear and tear' on the muscles, tendons and nerves that exceed the ability of the tissues to heal themselves. Moreover, CTDs are categorized by discomfort, disability and pain in the muscle, tendons and tissues that is caused by repetitive work, excessive vibration, a constraining work posture and forceful movement [11]. CTDs commonly affect the upper part of the body, such as the wrists. Silverstein *et al*. (1986) suggested that CTDs of the hands and wrists are usually caused by repetitive and forceful work. The results of the study by Mahoney (1995) showed that a CTD can be categorized as a chronic injury caused by a heavy load or force that gradually develops over time.

According to the Department of Occupational Safety and Health Malaysia statistics, an increasing number of MSD cases has been reported, from 10 cases in 2005 to 675 cases in 2014 [2]. Problems related to MSDs of poultry meat industry are severe in developing countries because of poor working condition and lack of effective preventive programs contributing in high rates of musculoskeletal symptoms [12]. This shows that awareness regarding the importance of ergonomic working postures is still lacking in poultry meat industries.

The aim of this study was to identify and analyse the working posture problems of the butchers by using Rapid Upper Limb Assessment (RULA) and Rapid Entire Body Assessment (REBA) analyses. The RULA and REBA are observationally based techniques used to quantitatively measure human postures, and to evaluate any discomfort and postural strain due to poor body positioning. Additionally, a more ergonomic workstation design for the butchers has been proposed in order to reduce the MSD and CTD risks and overcome the working posture problems.

2.0 LITERATURE REVIEW

Ergonomics is defined as the study of the relationship between workers and their working environment [1, 4]. More specifically, ergonomics consists of designing a working environment that is more compatible with the workers, rather than forcing the workers to physically adapt to the working environment [13]. An ergonomic working posture is important, because it can reduce the risk of injuries caused by poor working conditions. According to Occupational Health and Safety Council of Ontario (2007), poor working postures are usually associated with repetitive work, stress, strain, constant force and excessive vibration [14].

The RULA is an ergonomic observation method that is used to evaluate the risk of working posture problems, specifically MSDs. The RULA was originally intended as an objective measurement of the MSD risk during inactive work periods [15, 16, 17]. It is based on an evaluation of work posture problems, such as static movement, repetitive work, external forces and the work duration, related to the arms, trunk, neck, legs and wrists [17]. Four action levels must be observed in order to obtain the score in a RULA analysis.

The REBA shares the same work posture analysis principle as the RULA with regard to the evaluation of body parts and work posture problems [18]. In a REBA analysis, the body parts are divided into sections, and the score is calculated based on the movement planes and muscle activity [3]. Five levels of action are used to determine the score, including articular angle measurements, force or load observations, movement repetitiveness and the postural change frequency.

The major difference between the RULA and the REBA is the analysis of the profession or job scope. The results of this study showed that the REBA is a more efficient evaluation for the service sector. The REBA is also focused on an analysis of the entire body when compared to the RULA, which is only focused on an analysis of the upper body. Therefore, the RULA more suitable for analysing sedentary and seated work, while the REBA is better for analysing both static and dynamic work.

The principles of motion economy include the characteristics of easy movement, which refers to minimizing the number of movements while performing work, with an objective of improving a worker's productivity [19]. The basic principles are to eliminate unnecessary motion, reduce the cycle time and reduce the MSD and CTD risks. There are three principles of work design involved in motion economy: the use of the human body, the arrangement of the workplace and the design of the tools and equipment.

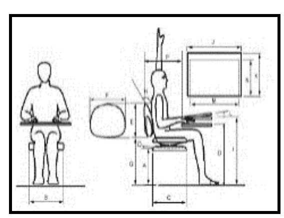
The principle of motion economy is an ergonomic guideline which is invented by Frank B. Gillbreth and improvised by R. M. Barnes to facilitate the work performance of a worker who is performing repetitive and mechanical works with definite steps [20]. It gives better movement of an operator while performing any tasks, minimizing workers fatigue and eliminate unwanted workers movement while doing their tasks. Work and workplace arrangement should well design to ensure jobs can be done in the most productive manner [21].

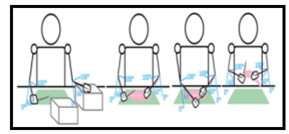
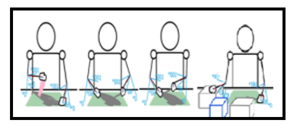
2.1 Previous RULA and REBA Studies

Previously, no research had been done in RULA and REBA specifically for butcher at Malaysia food industries. However, an evaluation of ergonomics risk factors had been done among meat cutter in India [8]. This study aims to investigate the nature and magnitude of WMSDs among manual meat cutters. This study used direct observation, questionnaires, interview and photography or measure the ergonomic risk factors. The finding of this study shows that posture analysis indicated high risk especially for mincing task, which is need further investigation for reducing the risks factors.

Table 1 shows the previous work posture research including RULA and REBA analyses in different industries.

Table 1 Previous research on RULA and REBA

Author/s	Method/s	Sector	Research	Result and Recommendation
[8]	REBA	Food Industry	Study are focused on meat cutter in India for repetitive task specifically in mincing process.	The result show that the meat cutter is in high risk since the works is repetitive for long hour a day. Results suggest that ergonomic interventions that address retooling and workstation and process redesign would be useful in reducing the number of injuries.
[13]	RULA and REBA	Clothing Industry	Study are focused on 60 males tailor that work on job task of stitching, ironing, and cutting.	The result for RULA shows that 40% of tailors are in risk of MSDs in cutting, 55% for stitching, and 65% for ironing. For REBA, the cutting activities show that 5% are at risk of MSDs, 35% for stitching, and 30% for ironing. The ergonomic workstation is suggested to reduce the risk of MSDs.
[22]	REBA	Engine Oil Company	Study on 40 jobs scopes with 123 different tasks. For each jobs scope, only one task is selected to be analyzed by REBA.	The result found that the risk work posture problem is in low and moderate level. As a recommendation, further investigation is needed to be done on selected workstations.
[23]	RULA and REBA	Manufacturing Industry	The study conducted on 15 workers that engage with different job task.	From the analysis, RULA determined that 40% of workers are on higher risk and REBA analysis recorded 53% of workers are at higher risk of MSDs. The recommendation that proposed is the immediate implementation of ergonomic knowledge among workers and implement the law on SMEs industry.
[24]	RULA	Manufacturing Industry	This study has performed an evaluation of workstation for workers.	The score for RULA evaluation is 5. It shows that further investigation is required with immediately changes. The recommendation is to design an ergonomic chair as shown in Figure 2.  **Figure 2** Ergonomic chair
[25]	RULA	Seafood Processing	The study is focused on the processing	The RULA score for both processes is 5. 5. The workers are in medium

Author/s	Method/s	Sector	Research	Result and Recommendation
		Industry	of raw fish including the trimming and filleting process.	risk of MSDs due to the repetition work. The suggested improvement is to change the way of holding a knife and change the position of items in the working tables as shown in Figure 3 (a) for filleting and Figure 3 (b) for trimming.  **Figure 3 (a)** Filleting process improvement  **Figure 3 (b)** Trimming process improvement
[26]	RULA and REBA	University Personnel/Office Workers	The study is conducted over 72 workers to analyze the work posture and their workstation to provide the information for the future design of ergonomic computer workstation.	The result shows that analysis of RULA is on average score 5 and for REBA are on average score 4. The solution is by designing new computer workstation with several important consideration factors such as monitor position, seat adjustability, and keyboard or mouse design.
[27]	REBA	Mining Industry	The study is conducted on 18 workers that carried out wet screening job.	The result from REBA analysis is a score of 8.24. The score shows the workers are on the higher risk of MSDs. The recommended solution is to improve the work process, design workstation, and improving work posture of workers.
[28]	RULA and REBA	Forging Industry	The study is conducted on 130 workers engaged with the various job scope in the small forging industry.	The result from REBA shows that 10.65% of workers are at the higher risk of MSDs and required immediate changes. The result from RULA shows that 30% of workers are at the higher risk of MSDs. The solution that proposed is the implementation of ergonomic intervention with the proper awareness among workers.

Author/s	Method/s	Sector	Research	Result and Recommendation
[29]	RULA	Batik Stamp Industry	For this study, 4 workers are selected on RULA analysis to obtain the result for muscle or bone disorder.	The RULA score is 6 which shows that workers are on medium and higher risk of MSDs. The solution is by design the workbench that suitable on the job scope as shown in Figure 4.  **Figure 4** Standing workbench
[30]	REBA	Agri-Machinery Industry	The study is conducted on 10 workers of an assembly unit.	The study showed that 60% of workers have a very high risk of MSDs, 30% of the high risk, and 30% of the medium risk. The study recommends the proper awareness of ergonomic training to the workers and changes of the working environment.
[31]	RULA and REBA	School Workshop	The study is done at the secondary school with student ages from 13 to 15 years old. There are 93 work postures being analysed.	The result for RULA score shows an average of 4.87 and for REBA score is 5.87. This shows that the risk of work posture problem is medium and need further action. The recommendation is by intervention student about ergonomic working posture, work performance, and level comfort.
[32]	RULA	Plastic Injection Industry	This study focused on the job scope of shoe sole trimming process.	The score for RULA is 5 which means it is in medium condition and further investigation is needed. The solution is by designing the new production line and reduce the working hour to 4 in this workstation.

3.0 METHODOLOGY

An observational method is often used to analyse the ergonomics of the working posture in the workplace in order to determine the MSD and CTD risk factors. For this study, the RULA and REBA were chosen to analyse the working postures of butchers. The RULA and REBA analyses were conducted using worksheets. In this study, number of sample taken is one. Direct observational method is selected for obtaining best posture shoot of butcher.

3.1 Rapid Upper Limb Assessment

McAtamney and Corlett introduced the RULA method in 1993. The RULA is a postural assessment method used to analyse the working posture risk to the upper limbs. It is acknowledged that the RULA worksheet is focused on analysing the body posture, work repetitiveness and force applied while working [17]. The assessment is divided into two sections: section A focuses on analysing the arms and wrists, while section B focuses on the neck, trunk and legs. Based on these analyses, a RULA score is obtained to determine the work posture risks.

The RULA worksheet is used to analyse the working posture risk factors, such as movement, exertion force, repetitive work and work posture, which may affect the body, including the upper arms, lower arms, wrists, neck, trunk and legs. The steps involved in analysing the working posture using the RULA worksheet are shown in Table 2.

For the data analysis, the RULA worksheet consists of the scoring decisions used to determine the work posture risks. Table 3 shows the RULA scoring decisions. A score of 1 to 2 is considered to be an acceptable work posture. Scores from 3 to 4 and 5 to 6 show low and medium risks of work posture problems, respectively, and further investigation is required to determine the actual work posture problems. Finally, a score of 7 or more indicates a higher risk of work posture problems.

Table 2 Parameters display by OSD

Steps	Descriptions	Analysis
1	Locate Upper Arm Position	Arm and Wrist Analysis
2	Locate Lower Arm Position	
3	Locate Wrist Position	
4	Locate Wrist Twist Position	
5	Determine Posture Score A	
6	Add Muscle Use Score	
7	Add Force/Load Score	
8	Find Row in Posture Score C	
9	Locate Neck Position	Neck, Trunk and Leg Analysis
10	Locate Trunk Position	
11	Determine Legs Condition	
12	Determine Posture Score B	
13	Add Muscle Use Score	
14	Add Force/Load Score	
15	Find Column in Posture Score C	
16	Determine Final Score	

Table 3 RULA score decision

Score	Risk of Work Posture Problem
1 - 2	Acceptable posture
3 - 4	Need further investigation and changes may be needed
5 - 6	Need further investigation and changes soon
7+	Investigate and implement changes

3.2 Rapid Entire Body Assessment

Hignett and McAtamney introduced the REBA analysis method in 2000. The REBA is an ergonomic body posture assessment method that evaluates the whole body to determine any risk factors with regard to the work posture. The REBA analysis worksheet used to evaluate the work posture, especially the body posture, movement, force exerted and work repetition. The assessment worksheet is divided into two sections: section A includes the neck, trunk and legs and section B includes the arms and wrists.

The REBA worksheet was used to analyse the working posture problem risk factors with regard to the movement, exertion force, repetitive work and work posture. The steps used to analyse the working posture using the REBA worksheet are shown in Table 4.

Table 4 Steps of REBA assessment method

Steps	Descriptions	Analysis
1	Locate Neck Position	Neck, Trunk and Legs Analysis
2	Locate Trunk Position	
3	Locate Legs Position	
4	Determine Posture Score A	
5	Add Force/Load Score	
6	Find Row in Posture Score C	
7	Locate Upper Arm Position	Arm and Wrist Analysis
8	Locate Lower Arm Position	
9	Locate Wrist Position	
10	Determine Posture Score B	
11	Add Coupling Score	
12	Find Column in Posture Score C	
13	Add Activity Score	
14	Determine Final Score	

The REBA data analysis consists of making decisions while determining the work posture problem risks. Table 5 shows the REBA scoring decisions. A score of 1 represents a negligible risk. Scores of 2 to 3 and 4 to 7 show low and medium risks, respectively, which require further investigation and possible changes. A score of 8 to 10 represents a higher risk, with an investigation and the implementation of a solution required. Finally, a score of 11 or more indicates a very high risk, with the implementation of a solution or recommendation being compulsory.

Table 5 REBA score decision

Score	Risk of Work Posture Problem
1	Negligible risk
2 - 3	Low risk, changes may be needed
4 - 7	Medium risk, need further investigation and changes soon
8 - 10	High risk, need further investigation and implementation soon
11+	Very high risk, implementation soon

4.0 RESULTS AND ANALYSIS

4.1 Meat Cutting RULA Analysis

Section A consists of the analysis of the upper arm, lower arm and wrist positions. Figure 5 shows the RULA analysis based on the angles obtained from the body posture for the upper arm (a), lower arm (b) and wrist (c). Table 6 shows the analysis score based on the data provided in Figure 5.

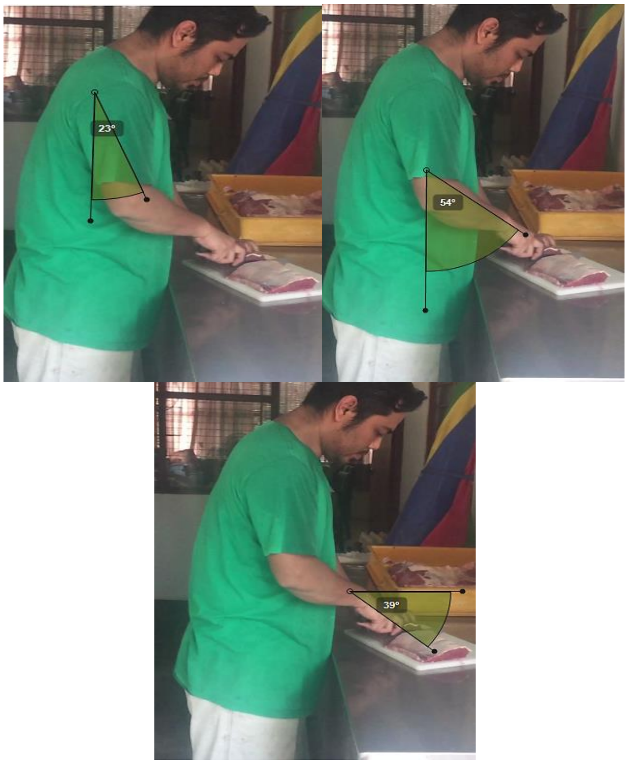


Figure 5 Upper arm, lower arm, and wrist analysis for RULA

Table 6 RULA analysis assessment score for the upper arm, lower arm, and wrist analysis

Score	Analysis	Descriptions
+2	Upper Arm Position	Upper arm position is flexion for 23°.
+1	Lower Arm Position	Lower position is flexion for 54°.
+3	Wrist Position	Wrist position is flexion for 39°.
+1	Wrist Twist Position	Wrist is twisted in the mid-range position.
+1	Muscle Use Score	Repeated movement.

For section B, the RULA worksheet focuses on the body posture of the neck, trunk and legs. Figure 6 shows the analysis of a butcher's body posture, which includes determining the angles of the body posture for the neck (a) and trunk (b). Table 7 shows the RULA worksheet analysis based figures captured.

Figure 6 Neck and trunk analysis for RULA

Table 7 RULA analysis assessment score for neck and trunk analysis

Score	Analysis	Descriptions
+3	Neck Position	Neck position is flexion for 49°.
+3	Trunk Position	Trunk position is flexion for 25°.
+2	Legs Position	Legs position is assumed to unsupported due to the legs position cannot be seen in the video.
+1	Muscle Use Score	Repeated movement.
+0	Force/Load Score	Load is lower than 2 kg.

4.2 Meat Trimming Process RULA Analysis

Section A consists of an analysis of the positions of the upper arms, lower arms and wrists. Figure 7 shows the RULA analysis based on the angles obtained from the body posture for the upper (a), lower arm (b) and wrist (c). Table 8 shows the RULA worksheet analysis based on the data provided.

Table 8 RULA analysis assessment score for neck and trunk analysis

Score	Analysis	Descriptions
+2	Upper Arm Position	Upper arm position is flexion for 31°.
+1	Lower Arm Position	Lower position is flexion for 75°.
+4	Wrist Position	Wrist position is flexion for 31°.
+1	Wrist Twist Position	Wrist is twisted in the mid-range position.
+1	Muscle Use Score	Repeated movement.
+0	Force/Load Score	Load is lower than 2 kg.

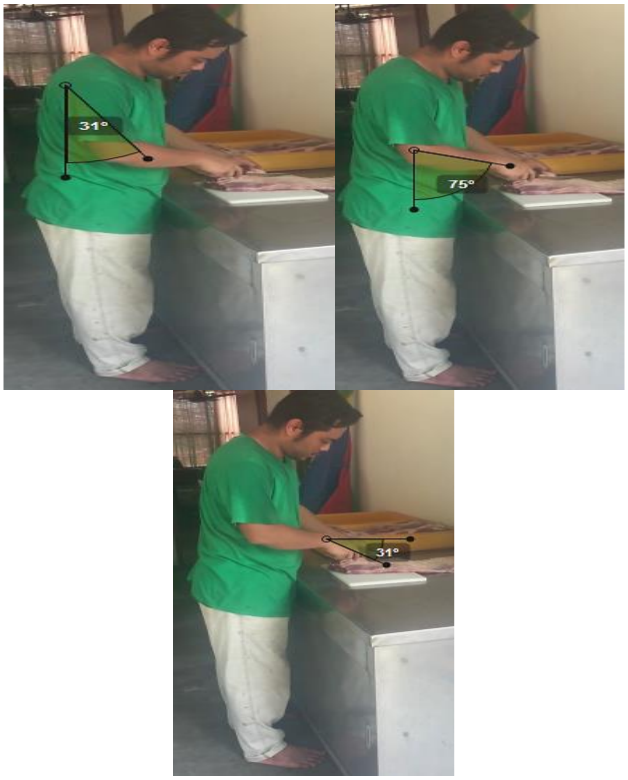


Figure 7 Upper arm, lower arm, and wrist analysis for RULA

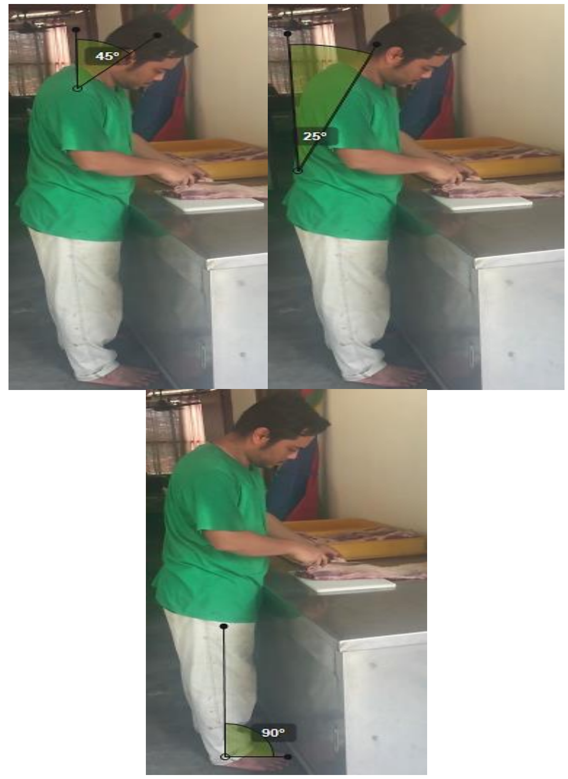


Figure 8 Neck, trunk, and leg analysis for RULA

For section B, the RULA worksheet analysis focuses on the body posture for the neck, trunk and legs. Figure 8 shows the analysis of a butcher's body posture with regard to the neck (a), trunk (b) and leg (c) by determining the angle of each body posture. Table 9 shows the RULA worksheet analysis based on the data obtained from figures captured.

Table 9 RULA assessment score for the neck and trunk analysis

Score	Analysis	Descriptions
+3	Neck Position	Neck position is flexion for 45°.
+3	Trunk Position	Trunk position is flexion for 25°.
+2	Legs Position	Legs position is not supported by another element.
+1	Muscle Use Score	Repeated movement.
+0	Force/Load Score	Load is lower than 2 kg.

4.3 Meat Cutting Process REBA Analysis

Section A consists of an analysis of the positions of the neck and trunk. Figure 9 shows the REBA analysis based on the angles obtained from the body postures of the neck (a) and trunk (b). Table 10 shows the REBA worksheet analysis based on the data provided in Figure 9.

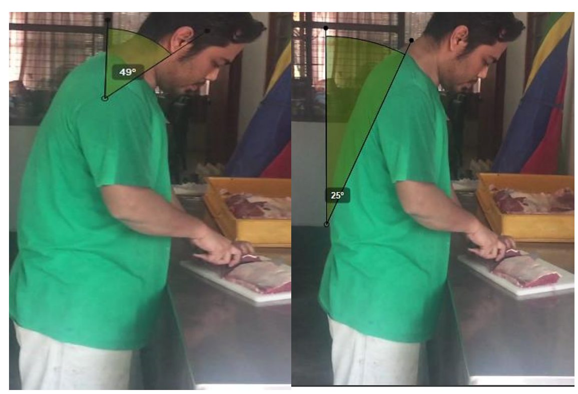


Figure 9 Neck and trunk analysis for REBA

Table 10 REBA assessment score for the neck and trunk analysis

Score	Analysis	Descriptions
+2	Neck Position	Neck position is flexion for 49°.
+3	Trunk Position	Trunk position is flexion for 25°.
+1	Leg Position	Legs position is assumed bending for 90° due to the leg position cannot be seen in the video.
+0	Force/Load Score	Load is lower than 2 kg.

For section B, the REBA worksheet analysis focuses on the body postures of the upper arms, lower arms and wrists. Figure 10 shows the analysis method with regard to the butcher's body posture including the upper arm (a) and lower arm (b) by determining the angle of each body posture. Table 11 shows the RULA worksheet analysis based on the data obtained in Figure 10.

Figure 10 Upper arm and lower arm analysis for REBA

Table 11 REBA assessment score for the upper arm, lower arm, and wrist position analysis

Score	Analysis	Descriptions
+2	Upper Arm Position	Upper arm is flexion for 23°.
+1	Lower Arm Position	Lower arm is flexion for 54°.
+2	Wrist Position	Wrist is flexion for 39°.
+0	Coupling Score	Well-fitting handle and mid-range power grip.
+1	Activity Score	Repeated small range actions (more than 4 times per minute).

4.4 Meat Trimming Process REBA Analysis

Section A consists of an analysis of the positions of the neck, trunk and legs. Figure 11 shows the REBA analysis based on the body posture angles obtained for the neck (a), trunk (b) and leg (c). Table 12 shows the REBA worksheet analysis based on the data provided in Figure 11.

Table 12 REBA assessment score for the neck and trunk position analysis

Score	Analysis	Descriptions
2	Neck Position	Neck position is flexion for 45°.
3	Trunk Position	Trunk position is flexion for 25°.
1	Leg Position	Legs position is straight for 90°.
0	Force/Load Score	Load is lower than 2 kg.

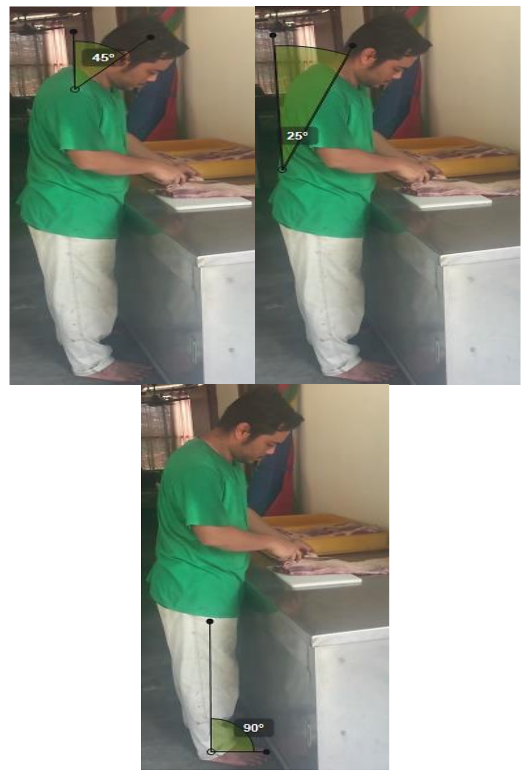


Figure 11 Neck and trunk analysis for REBA

For section B, the REBA worksheet analysis focuses on the body postures of the upper arms, lower arms and wrists. Figure 12 shows the REBA analysis method for a butcher's body posture, including the upper arm (a), lower arm (b) and wrist (c), by determining the angle for each body posture. Table 13 shows the REBA worksheet analysis based on the data obtained in Figure 12.

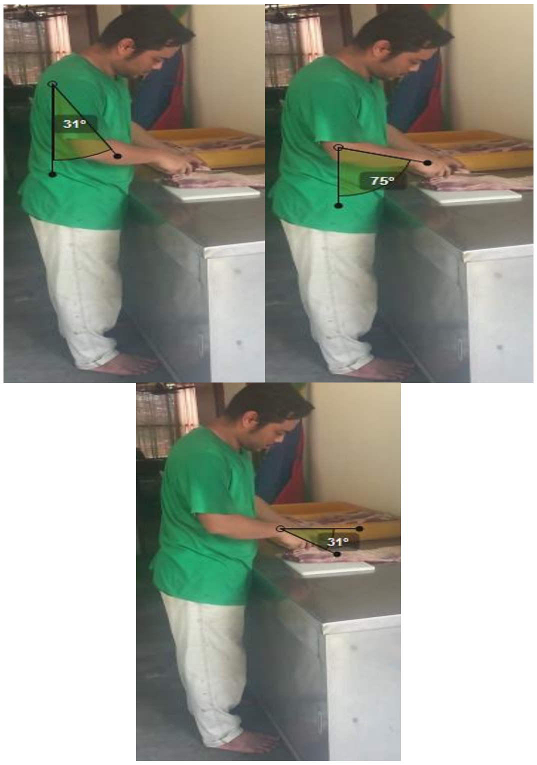


Figure 12 Upper arm, lower arm, and trunk analysis for REBA

Table 13 REBA assessment score for the upper arm, lower arm, and wrist position analysis

Score	Analysis	Descriptions
+2	Upper Arm Position	Upper arm is flexion for 31°.
+1	Lower Arm Position	Lower arm is flexion for 75°.
+3	Wrist Position	Wrist is flexion for 31° and twisted from the midline.
+0	Coupling Score	Well-fitting handle and mid-range power grip.
+1	Activity Score	Repeated small range actions (more than 4 times per minute).

4.5 Analysis Result

Table 14 shows the RULA analysis for both meat preparation processes: cutting and trimming the meat. In the RULA analysis, the work posture was divided into two different sections: section A for the arm and wrist analysis and section B for the neck, trunk and leg analysis. Based on the analysis, the final RULA score for the meat cutting working posture was 6, and the score for meat trimming was 7. Both of the processes fell into the high risk category for work posture problems, such as MSDs and CTDs.

Table 14 RULA assessment analysis

RULA Analysis	Scoring	
	Cutting meat	Trimming meat
A. Arm and wrist analysis		
Locate upper arm position	2	2
Locate lower arm position	1	1
Locate wrist position	3	4
Wrist twist	1	1
Posture score A	3	4
Muscle use score	1	1
Force/Load score	0	0
Wrist and arm score	*4*	*5*
B. Neck, trunk, and leg analysis		
Locate neck position	3	3
Locate trunk position	3	3
Legs	2	2
Posture score B	5	5
Muscle use score	1	1
Force/Load score	0	0
Neck, trunk, leg score	6	6
Final Score	**6**	**7**

The bar graph shown in Figure 13 indicates the RULA analysis scores for the meat cutting and trimming process for each part of the analysis. The scores for the upper arms, wrist twisting, neck, trunk, legs, muscle use and force/load were the same for both processes. However, there were differences between the scores for the lower arm and wrist positions. The score for the meat trimming process was slightly higher when compared to the meat cutting process. The graph shows that the meat trimming process is associated with a higher risk of work posture problems when compared to the meat cutting process.

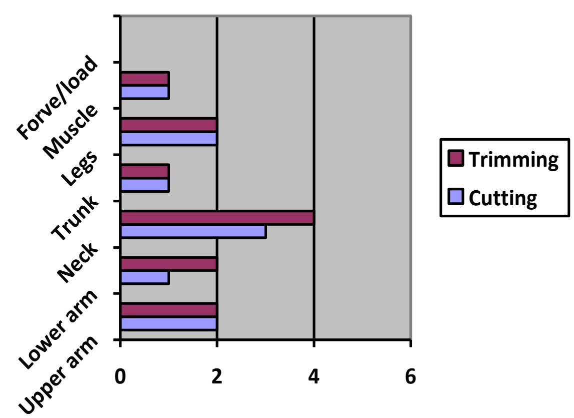


Figure 13 Analysis of the RULA score

Table 15 REBA assessment analysis

REBA Analysis	Scoring Cutting meat	 Trimming meat
A. Neck, trunk and leg analysis		
Locate neck position	2	2
Locate trunk position	3	3
Legs	1	1
Posture score A	4	4
Force/Load score	0	0
Score A	4	4
B. Arm and wrist analysis		
Locate upper arm position	2	2
Locate lower arm position	1	1
Locate wrist position	2	3
Posture score B	2	3
Coupling score	0	0
Score B	2	3
Table C score	4	4
Activity score	1	1
Final Score	**5**	**5**

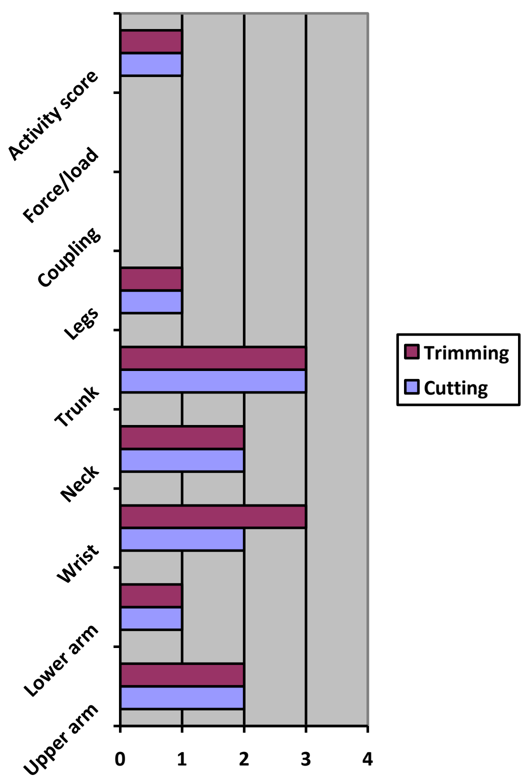


Figure 14 Analysis of the REBA score

The graph in Figure 14 shows the score analysis for each part of the REBA assessment worksheet. The upper arm, lower arm, neck, trunk, leg, force/load and activity scores were the same for both the meat cutting and trimming processes. However, the differences between the scores of the two processes were in terms of the wrist position. The wrist position score for the trimming process was slightly higher than that for the cutting process. Therefore, one can conclude that the meat trimming process affects the wrist position more than the meat cutting process.

Figure 15 shows the comparison between the RULA and REBA scores for the meat cutting and trimming processes. For the meat cutting process, the RULA score was higher than the REBA score. For the meat trimming process, the RULA and REBA scores were the same. Based on the results of the analysis, one can conclude that a butcher's working posture affects the upper part of the body more than the lower part of the body.

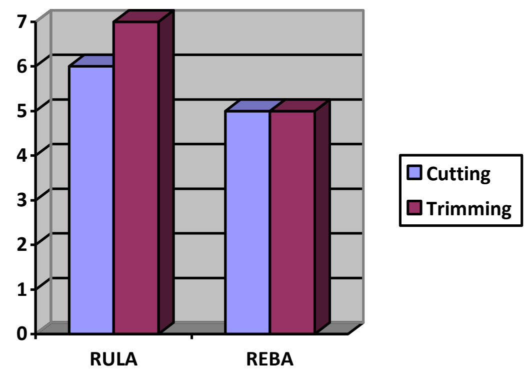


Figure 15 Comparison between a score of RULA and REBA for cutting and trimming process

4.5 Proposed Design of an Ergonomic Workstation for a Butcher

Based on the score of RULA and REBA for cutting and trimming process, an ergonomic workstation is needed for a butcher. Figure 16 shows the meat preparation process ergonomic workstation design, in which an ergonomic workstation for a butcher, with the proper working posture, has been proposed. The table height should be between 650 mm and 950 mm from the ground as shown in Figure 17; however, the table height is designed to be adjusted based on the butcher's preference. The table is designed with a footrest to support the legs while standing, and anti-fatigue mats to reduce fatigue when standing for a long duration of time. The workstation has been designed based on the principles of motion economy.

Based on these principles, minimized movement is recommended to increase productivity. The workstation is designed to utilize both hands while performing a task, with one hand holding the knife while the other hand is placing the meat on the chopping block. In addition, the principles of motion economy were also applied to the arrangement and design of the tools and equipment, such as the knife. The tools are placed in a location that can be accessed easily by the butcher while maintaining a good working posture. Supported from previous research study, it is suggested that ergonomic interventions that address retooling and workstation and process redesign would be useful in reducing the number of injuries [8].

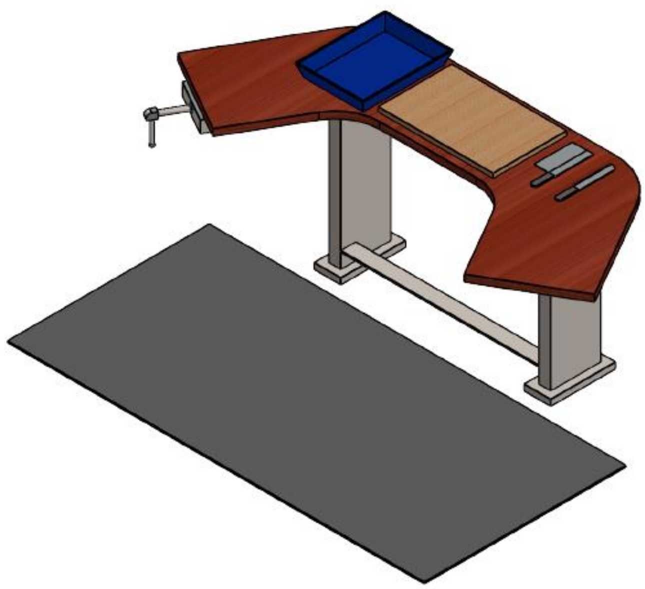


Figure 16 The design of ergonomic workstation for the butcher

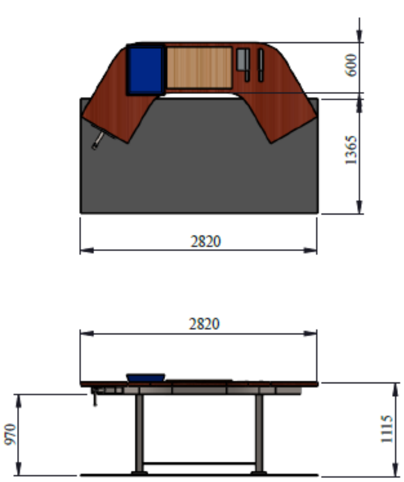


Figure 17 The proposed ergonomic workstation with dimension

4.0 CONCLUSION

In this study, the main meat preparation processes of the butcher; cutting and trimming the meat at the SME poultry workstation has been analyzed. During these processes, the work posture of the butcher was examined by using RULA and REBA methods analysis.

Based on the results of the RULA and REBA analyses, a butcher is exposed to a higher risk of working posture problems, such as MSDs and CTDs. Based on RULA analysis, the cutting process score 6 while trimming score 7. It indicate that the cutting process in consider in medium risk of working posture problem which this activity need further investigation and changes may made soon to make butcher more comfortable while doing the activity. However, trimming process score 7 that highlight that investigation is needed and implement changes is a must. However, the REBA score was 5 for both the meat cutting and meat trimming processes. It consider as a medium risk where further investigation are needed and changes may made soon.

As recommendation, an ergonomic workstation for a butcher has been proposed in order to reduce the risk of work posture problems. The designed workstation is complete with footrest and anti-fatigue mat to reduce fatigue while performing job and all equipment are arranged accordingly with minimum movement and no awkward position by the butcher.

Acknowledgement

The authors are thankful for the Research University Grant they received, which is a Tier 1 Scheme (Grant No. H250), and the Universiti Tun Hussein Onn Malaysia (UTHM) for the research funding. The authors are grateful to the Faculty of Engineering Technology at the UTHM and Erul Food Industries Sdn Bhd for their research support and opportunities.

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