ANALYSIS ON THE ANTHROPOMETRIC AND OCCUPATIONAL BIOMECHANICS OF LOCAL GARMENT FACTORY TRIMMERS IN CARMONA, CAVITE: AN INPUT FOR WORKPLACE IMPROVEMENT

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Abstract: In every work environment, it is important to identify risk factors that may contribute to the development of occupational disorders. This study aimed to analyze the work system of a local garment factory's trimming department and to minimize the risk of developing musculoskeletal disorders (MSDs) among workers. The study involved ergonomic assessment wherein the proponents performed job worksite analysis, anthropometric analysis and utilized ergonomic tools such as Body Discomfort Chart (BDC) and Rapid Entire Body Assessment (REBA). This was used to identify the body segments with high degree of perceived discomfort that eventually may lead to work-related disorders. Then, the study developed ergonomic interventions to mitigate the development of MSDs. Lastly, evaluation using postural analysis to simulate the new working posture of the trimmers in improved workplace design was done. The result showed mismatch between workplace design and anthropometric measurements that resulted to strong perceived body discomfort (p = 0.001) predominantly in lower back, shoulder and calf. Assessment indicated medium to high risk exposure to MSDs and implied that change in work system is required immediately (p = 0.000). Ergonomic interventions recommended improvement on workplace design components, which comprised of sitting-standing working position, a chair that every worker would fit in with an adjustable height from 57 - 63 cm (22.44 - 24.80 in) and an adjustable forward-tilting seat up to 15° to address lumbar area problems. The ergonomic solutions involved application of Anthropometry and Occupational Biomechanics guidelines in order to fit the work systems elements to the workers and to maintain the neutral working positions of trimmers.

Keywords: *garment factory, perceived body discomfort, postural analysis, musculoskeletal disorders, ergonomics*

1. INTRODUCTION

Fitting the task requirements and workplace design components to workers characteristics is one of the fundamental requirements in maximizing the well-being of any organizations' human resources. Human Factors and Ergonomics, also known as comfort design, functional design and systems, is the practice of designing products, systems, or processes to take proper account of the interaction between them and the people who use them. The field has seen contributions from numerous disciplines, such as psychology, engineering, biomechanics, industrial design, physiology, and anthropometry. In essence, it is the study of designing equipment, devices and processes that fit the human body and its cognitive abilities.

The current study focused on the ergonomic assessment and analysis of a work system of a local garment factory's trimming section in Carmona, Cavite. The study selected the most labor-intensive process in the garment factory as workers in this section were highly vulnerable to work-related musculoskeletal disorders. The workers in trimming section displayed static sitting postures while working or infrequent sitting mobility. Static sitting postures while working or infrequent sitting mobility may pose risks to workers. As the company meets more production demand, the workers need to extend their working hours from 8-hour to 12-hour shift. A workplace environment not properly designed to support manual activities can result to poor working condition, awkward posture, and strong perceived body discomfort. A study conducted by Caparas *et al*. (2017) showed that awkward sitting posture significantly affect level of perceived body discomfort among jewelry makers (p = 0.006) who exhibit comparable tasks as garment factory workers do. Eventually, this condition may greatly affect the workers and over-all system's performance. The production line monitoring showed that the average output of each worker was decreasing every two hours. Identifying the factors, which influence the level of body discomfort, has impact on productivity improvements. Moreover, workers evaluation revealed problems in consistency on level of difficulty of job orders, extended working hours during high demand, and poor thermal condition and ventilation.

In order to help the company in maximizing workers well-being and performance, the current study aims to investigate ergonomics risk factors present in the work environment of trimming section. The study employed card intended to develop ergonomic interventions considering anthropometry and occupational biomechanics guidelines to fit the work systems components to the workers. Golebowicz *et al*. (2015) attested that anthropometric interventions alleviate muscular discomfort, optimize well-being, and improve the performance of employees. Also, occupational biomechanics is important in investigating risk factors such as working posture, manual handling, and external loading imposed to body structure (Kotadiya *et al*., 2018).

2. METHODOLOGY

The methodological framework used to achieve the objectives of this study, as outlined in Figure 1, consists of three phases, namely, (1) ergonomic assessment and analysis; (2) ergonomic intervention; and (3) ergonomic improvement evaluation.

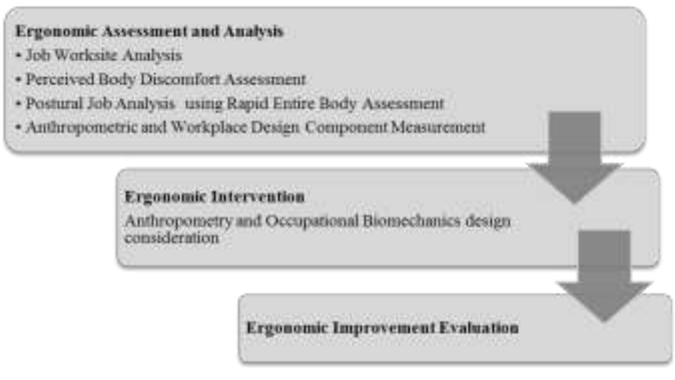

Figure 1. Methodological framework of the study.

2.1 Ergonomic assessment and analysis

This phase focused on evaluation of present system that involved job worksite analysis of the current working environment of trimming section. In this phase, the researchers conducted preliminary survey, observation and assessment of the task requirements, workplace design components, environmental factors and the workers characteristics. Preliminary survey consisted of collecting data to clearly understand the current condition of trimming section's work system. The level of perceived body discomfort presently experienced by the workers was evaluated using Body Discomfort Chart (Corlett & Bishop, 1976). This ergonomic tool helped to investigate the severity, frequency and duration of body discomfort of the workers and to determine the body segments, which highly experienced body discomfort. This initial assessment tool aided the researchers to further analyze the identified problem areas. After conducting a preliminary survey and determining the existing problem areas, the next step was postural job analysis among workers. The study used Rapid Entire Body Assessment (REBA) by (McAtamney & Corlett (1993). Using REBA worksheet, the evaluators assigned posture deviation scores for each of the following body regions: wrists, forearms, elbows, shoulder, neck, trunk, back, legs and knees. This analysis is comprised of complete postural analysis, evaluation of forces exerted by the worker, number of task repetitions and the condition of coupling used by the workers. Lastly, the researchers performed anthropometric measurements to the workers of trimming department using flexible measuring tapes. Different body segments were correctly measured while the respondent was in neutral standing and sitting position. Specifications of the current workplace design components were also collected and compared with the anthropometric measurements of the workers.

The study used descriptive statistics to interpret the data gathered from the ergonomic assessment and describe the distribution of the collected data from the workers. Furthermore, a test of hypothesis was performed to statistically verify whether there is a relationship between a body segment significantly experiencing high body discomfort and high postural deviation from neutral working posture. For the Body Discomfort Chart (How often the body discomfort is experienced by the workers), null hypothesis ($H_0 = 3$) states that the occurrence of body discomfort to specified body part is occasionally to almost never and for the alternative hypothesis ($H_0 > 3$) states that the occurrence of body discomfort to specified body part is frequently to constantly. For the intensity of the body discomfort the workers experienced, the researchers set the null hypothesis as $H_0 = 3$, which states that the level of discomfort to specified body part is weak to moderate. And the alternative hypothesis, ($H_0 > 3$) states that the level of discomfort to specified body part is strong. The null hypothesis is rejected if the p-value is less than $\alpha = 0.05$. The result of the analysis would be the basis for redesigning and improvement of current work system design of trimming department.

2.2 Ergonomic intervention

After analyzing the data gathered, the researchers proceeded to redesigning and improvement of current work system design of trimming section. This stage involved the use of anthropometric measurements to fit work system design to workers. The researchers decided to consider 90th and 10th percentile of the anthropometric measurements of the workers so that a greater portion of the users would be accommodated in the design. Also, occupational biomechanics considerations were included in the design to utilize the mechanical advantage of the workers while performing their tasks, minimize the internal load exerted and the risk of developing work-related musculoskeletal disorders.

2.3 Ergonomic improvement evaluation

This phase involved the discussion of the proposed system. A comparative analysis of the present and proposed changes in the work system determined what would be the effect to workers as well as to the over-all performance of the production. The evaluation of the recommendation used REBA on the simulated working posture of the workers in the redesigned work system and compared the result to the present REBA score to theoretically measure the improvement.

3. RESULTS AND DISCUSSION

Data were presented using graphs to directly illustrate the distribution of the response to ergonomic tools. The result of workers perceived body discomfort assessment revealed prevalence of high level of body discomfort among workers in trimming department. Figures 2 and 3 show the severity and frequency of occurrence of localized body discomfort.

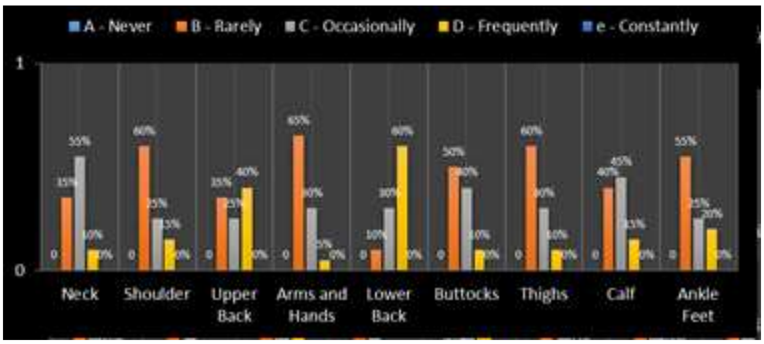

Figure 2. Graphical representation of how often the workers experience discomforts.

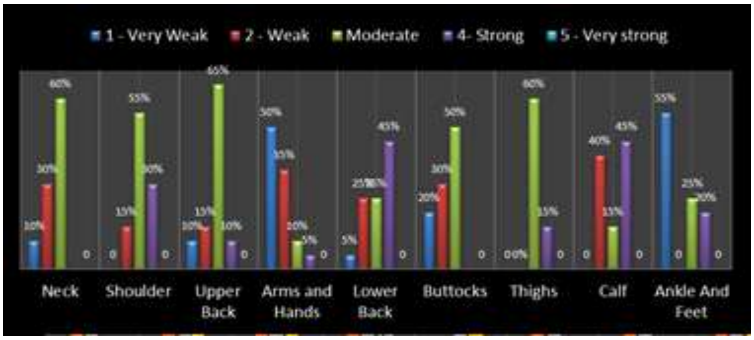

Figure 3. Graphical representation of how much body discomfort the workers experienced.

The illustrations show that the body discomfort frequently occurred in lower back (60%) while discomfort in other body regions arise from rare to occasional. In addition, 45% of the respondents indicated that lower back has strong level of perceived body discomfort.

Figure 4 shows the result of workers subjective evaluation regarding the causes of decrease in their productivity. The outcome indicated that 30% of the workers attributed the decline in performance to inconsistency of tasks for difficulty levels, extended working hours with less rest period and due to poor workplace design that often resulted to sustained awkward working posture. Also, 25% of the workers responded that exposure to high room temperature in the working area had an effect of decreasing their productivity.

Designing a work system for workers requires the consideration of the target users' characteristics. Among 30 female workers in the trimming department, 20 workers were selected. The average age of workers selected for anthropometric measurement ranges from 25 to 30 years old.

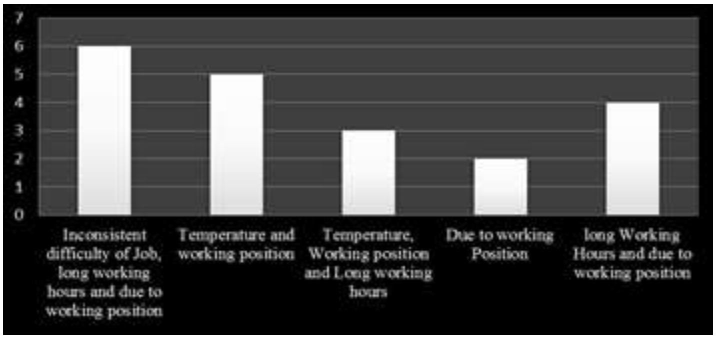

Figure 4. Graphical representation of factors that affect the efficiency of workers.

Anthropometric measurements of selected body segments served as basis for redesigning the workstation. Mismatches in anthropometric dimensions have been claimed to be one of the main causes of work-related fatigue and occupational illness (Chan & Jiao, 1996). Table 1 below shows the summary of selected anthropometric measurements of trimmers for standing. Body segments that are measured and analyzed were the following: stature, eye height, shoulder height, hip height, fingertip height, elbow span and their span with the mean measurement of 152.6 cm. 141.6 cm, 125.8 cm, 85.3 cm, 59.3 cm, 81.7 cm and 152 cm respectively. In addition, 10th percentile and 90th percentile were computed.

Table 1. Summary of selected anthropometric measurement for standing.

Body Segment	Sex	Standard Deviation	Dimension (cm)		
			10th Percentile	50th Percentile	90th Percentile
Stature	Female	5.9	145.04	152.6	160.11
Eye Height	Female	5.4	134.66	141.6	148.52
Shoulder Height	Female	4.7	119.82	125.8	131.79
Hip Height	Female	3.6	80.77	85.3	89.92
Fingertip Height	Female	3.0	55.34	59.2	63.14
Elbow Span	Female	10.3	68.49	81.7	94.93
Span	Female	6.3	143.98	152	160.02

Table 2 shows the summary of selected length anthropometric measurements, including the shoulder-elbow length with a 10th percentile dimension of 28.12 cm, 90th percentile of 35.01 cm and the median value of 31.6 cm. And the elbow-fingertip length with 36.36 cm at 10th percentile, 39.9 cm median value and 43.5 cm at 90th percentile.

Table 2. Summary of selected length anthropometric measurement.

Body Segment	Sex	Standard Deviation	Dimension (cm)		
			10th Percentile	50th Percentile	90th Percentile
Shoulder-Elbow Length	Female	2.7	28.12	31.6	35.01
Elbow-Fingertip Length	Female	2.8	36.36	39.9	43.50

Table 3 shows the summary of selected anthropometric measurements for sitting. Body segments included here are the sitting height, sitting shoulder height, sitting elbow height and the knee height with the median value of 82.7 cm, 59.96 cm, 26.6 cm, and 45.1 cm, respectively.

The researchers selected body segments to measure and analyze according to the subject workers tasks. Anthropometric measurements were limited to body segments essential to the design requirements. The study did not include measurement of body segments, which were not important in redesigning of the work station. For instance, circumference anthropometric measurement, which includes the head, shoulder, biceps, lower arm, buttocks, upper and lower leg, chest, waist and hips were not included.

The researchers based the table height on the workers 90th percentile of hip height, foot rest on the 90th percentile of popliteal height, chair height on the table height less the sitting elbow height.

3.1 Analysis for the rapid entire body assessment results

Along with anthropometric measurements is the Rapid Entire Body Assessment (REBA), which is a postural targeting method for estimating the risks of work-related entire body disorders. This measure gives a quick and systematic assessment of the complete body postural risks to workers.

Table 3. Summary of selected anthropometric measurement for sitting.

Body Segment	Sex	Standard Deviation	Dimension (cm)		
			10th Percentile	50th Percentile	90th Percentile
Sitting Height	Female	3.4	78.31	82.7	87.04
Sitting Shoulder Height	Female	2.6	53.60	59.96	60.31
Sitting Elbow Height	Female	2.6	23.33	26.6	29.93
Knee Height	Female	2.7	41.58	45.1	48.58

Tables 4 – 7 show the tally of REBA scores. The data in each region is collected and scored. Tables on the form are then used to compile the risk factor variables, generating a single score that represents the level of MSD risk.

Table 4 shows the tally for Score A. These steps include analysis of neck position, trunk position, legs position as well as the posture score and the force/load score. As seen in the table, 13 out of 20 workers have the score of 2 in neck position, which indicates that while they are working, they bend their head greater than 20°. For the trunk position, 13 out of 20 workers have the score of 2, which indicates that they either bend their trunk in extension or in flexion from 0° to 20°. And for the leg position, 15 out of 20 workers have the score of 2, which indicates that their legs are not in straight position; one of the knees is in flexion but not greater than 30°. And for the force/load score, all of them got the score of 1 since all of them carry a load that does not exceed 10 kg but greater than 5 kg.

Table 5 shows the tally of Score B. These steps include upper arm position, lower arm position, wrist position as well as the posture and coupling score. As seen in the table, all workers in the upper arm position analysis have the score of 2, which means that all of the workers' shoulders are in flexion between 20°-45°. For the lower arm position, 15 workers have the score of 1, which indicates that most of the workers' elbow positions are between 80° to 100°. For the wrist position, all of the workers have the score of 1 since all of them move their wrist 15° either flexion or extension.

Table 4. Rapid entire body assessment (REBA): neck, trunk and leg analysis.

	1	2	3	4	5	Average
Neck position	7	13				1.65
Trunk position	7	13				1.65
Legs	5	15				1.75
Posture score A		4	8	8		3.2
Force/load score	20					1
Score A			**4**	**8**	**8**	**4.2**

Table 5. Rapid entire body assessment (REBA): arm and wrist analysis.

	1	2	3	4	5	Average
Upper arm position		20				2
Lower arm position	15	5				1.25
Wrist position	20					1
Posture score B	8	12				1.6
Coupling score		20				2
Score B			**8**	**12**	**0**	**3.6**

Table 6. Rapid entire body assessment (REBA): combination of scores from A and B.

Score	3	4	5	Average
Score A	4	8	8	4.2
Score B	8	12	0	3.6
Score C	**9**	**5**	**6**	**3.85**

Table 7. Rapid entire body assessment (REBA): final score.

Final Score	3	4	5	6	7	8	9	10	11	Average
Score C	9	5	6							3.85
Activity Score	20									3
Final REBA Score				**9**	**5**	**6**				**6.85**

Table 6 shows tally for the combination of scores in Tables 4 and 5. The combined score will be used to determine the score in Table 6 while Table 7 shows the tally of final REBA score. This table clearly shows that all of the workers have the activity score of 3 since one or more of their body parts are held for longer than 1 minute, repeated small range actions and unstable posture are present. Nine out of 20 workers have the final REBA score of 6 and five of them have the final score of 7. This indicates that medium risk is present and changes need to be implemented soon while the remaining six workers have the final score of 8, which means that there is a high risk. Immediate investigation to present system is needed then implement change.

3.2 Analysis for the body discomfort assessment results

The last to be considered is the analysis of body discomfort chart result. Body Discomfort Chart determines whether occupational bodily discomfort exists, how serious the discomfort and what location of the body the discomfort occurs. This assessment provides awareness to the workers to all risks factors, symptoms and the impact of body discomfort.

Table 8 shows the tally of the result of the body discomfort chart. This table shows how often the discomfort occurs to the workers. Discomfort does not only occur on only one part of the body, so each worker has their answers on how often they feel discomfort on some designated body parts. For the neck region, 55% of the workers feel discomfort occasionally. For the shoulder and thigh, 60% of them rarely feel discomfort. For the arms and hands, only 5% of the workers frequently experience discomfort to these parts of the body. For the lower back or in the lumbar area, 60% of the workers suffer frequently discomfort or pain in this part. For the buttocks, half of the workers rarely feel discomfort to this part while for the ankle and feet, 55% of the workers suffer discomfort to these parts rarely, and for the calf, 5% difference between rarely and occasionally.

The next table, which is Table 9, also shows body discomfort survey result, but the difference to the previous table is that, this table is the tally of result on how often they feel discomfort on each body segment. For the lumbar area, 55% of the workers suffer from strong discomfort. Forty-five percent of the workers feel strong discomfort to their calf. For the neck and thigh part, 60% of them feel moderate pain in these areas. For the shoulder part, 55% of the workers also feel moderate discomfort and for the buttocks part, 50% of them are in moderate discomfort. Sixty-five percent of the workers suffer moderate pain to their upper back. For the arms and hands, and ankle and feet, most of the workers suffer from weak discomfort, which is according to them is somehow tolerable.

The Minitab result for the body discomfort tally for how often clearly stated that the Lower back P-value = 0.002 and the General Body discomfort P-value = 0.001 are significantly greater than 3 since their P-value is less than α = 0.05, which means that the pain occurs frequently and constantly.

Table 8. Body discomfort tally: how often.

Body Segment	Never	Rarely	Occasionally	Frequently	Constantly
Neck	0%	35%	55%	10%	0%
Shoulder	0%	60%	25%	15%	0%
Upper Back	0%	35%	25%	40%	0%
Arms and Hands	0%	65%	30%	5%	0%
Lower Back	0%	10%	30%	60%	0%
Buttocks	0%	50%	40%	10%	0%
Thighs	0%	60%	30%	10%	0%
Calf	0%	40%	45%	15%	0%
Ankle Feet	0%	55%	25%	20%	0%

Table 9. Body discomfort tally: how much.

Body Segment	Very Weak	Weak	Moderate	Strong	Very strong
Neck	10%	30%	60%	0%	0%
Shoulder	0%	15%	55%	30%	0%
Upper Back	10%	15%	65%	10%	0%
Arms and Hands	50%	35%	10%	5%	0%
Lower Back	0%	20%	25%	55%	0%
Buttocks	20%	30%	50%	0%	0%
Thighs	0%	25%	60%	15%	0%
Calf	0%	40%	15%	45%	0%
Ankle and Feet	55%	0%	25%	20%	0%

Table 10. Summary of statistical analysis for rapid entire body assessment final score.

	Hypothesis	P-value	Interpretation
Final Score	$H_0 = 6$: the final REBA Score is equal to 6. $H_1 > 6$: the final REBA Score is greater than 6	0.000	REBA score is significantly higher than 6, which indicate medium to high risk and change is required soon.

3.3 Minitab results

The Minitab result of the final REBA score clearly stated that it is significantly greater than 6 (see Table 10). The null hypothesis states that the result of final REBA score should be at most equal to 6 but then, the P-value = 0.0000 is less than α = .05, therefore, the null hypothesis will be rejected, this means that the trimmers' task has a high risk of developing some posture-related ailment. The Minitab result for the body discomfort tally for how much clearly stated that the lower back P-value = 0.035 is significantly greater than 3 since their P-value is less than α = 0.05, which means that the pain occurs with an intensity of strong to very strong.

After analyzing the data that have been gathered, recognizing the most affected body part in order to rectify those problems will be the next step. Using the anthropometric measurements that have been discussed and presented by Tables 1 to 3, the researchers arrived to the following dimensions and design of workplace components. From 244 cm length of the table, the researcher extended the length of it to 285 cm so the table is occupied by three workers (Figure 5). The height of the table will be based on the elbow height of the workers' which is equal to 90 cm. The width of the table is 78 cm, which enables the workers to reach for the edge of the table when transferring trimmed goods to the pallet in front of the table. After the workers trim the garment product, they just push it forward to reach the pallet. Moreover, untrimmed garments are placed in the pallet on the side of the workers with the dimension of 50cm in length x 30cm in width and 55 cm in height.

The material that will be used for the table is wood with aluminum to each edge. The pallet is made out of wood since pallet made up of plastic was more expensive that improvised pallet.

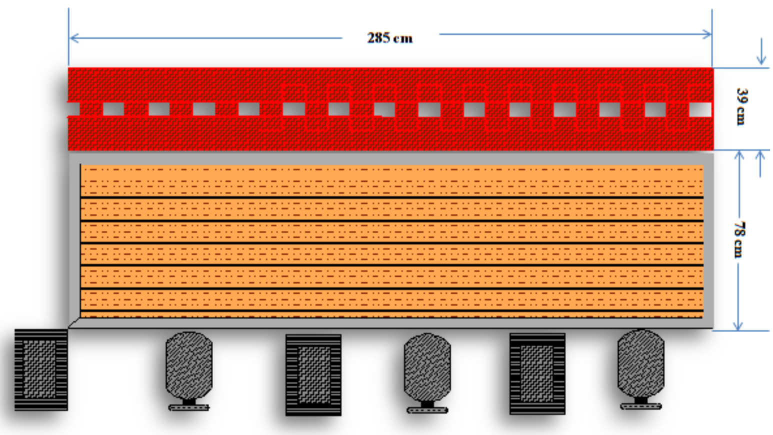

Figure 5. Top view of the proposed working component.

In order to solve the problem concerning the lumbar area, the researchers designed a new chair that will fit for every worker (Figure 6). The new chair height is adjustable to 63 cm from 57 cm. The design is based on a version of the Nottingham Chair, called the checkmate made by the Osmond Group. The chair has an adjustable forward-titling seat up to 15°. Instead of providing a chair with lumbar support, a chair with forward-titling seat is much better since efficiency may be affected. The forward tilt of the chair will create a great distance between the torso and thigh. This can help reduce the pressure in the lumbar area that will help in reducing the pelvic rotation to prevent the flattening of the lordotic curve. An 18 cm footrest from the ground which is based on the chair's height less the workers' popliteal height is also provided to lessen the additional stress on the knees.

Figure 6. Side view of proposed chair.

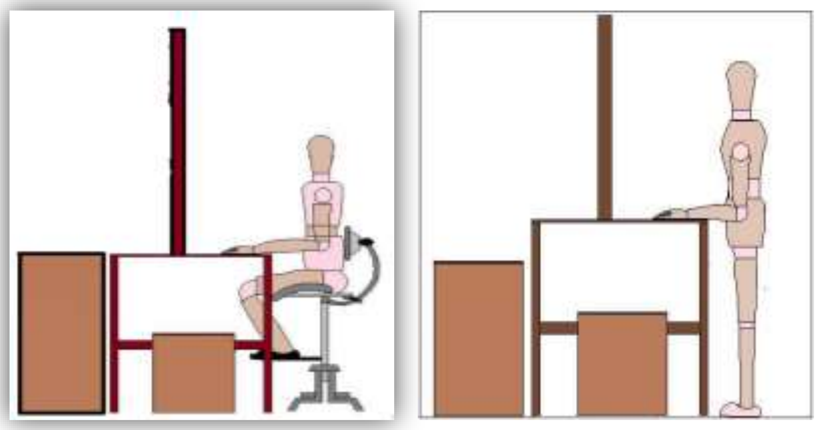

Figure 7. Visualization of working position with the proposed workplace components, both standing and seated.

In addition, the researchers suggested having an alternative sitting-standing working posture given that standing for long period of time may result to less mobility and high perceived discomfort to workers (Figure 7). When a person is in neutral standing posture, the lumbar portion of the spine curves naturally inward while it flattens and pressure increases on the disks in vertebral column when a person sits down. Table 11 below shows the schedule set by the researchers.

Table 11. Alternate sitting-standing working schedule for the workers.

Time	Working position
6:00 am – 8:00 am	Standing
8:00 am – 9:30 am	Sitting
9:30 am – 11:30 pm	Sitting (Use the forward-tilt of the chair)
10:30 am – 12:00 pm	Standing
12:00 pm – 1:00 pm	Noon Break
1:00 pm – 2:30 pm	Sitting
2:30 pm – 4:30 pm	Standing
4:30 pm – 7:00 pm	Sitting (Use the forward-tilt of the chair)

3.4 Evaluation for proposed working station

The REBA is then applied to the posture representation above to evaluate the proposed work station against the present condition. Given that the final score is 3, which implies that risk is low compared to the average final REBA score of present system, which is 6.85, it indicates high risk to the worker and changes must be implemented soon. In the theoretical REBA, the neck position scores 1 since the neck of the workers doesn't need to flex greater than 20°. For the trunk position, the observer gives the score of 2 since there is still a tendency that the workers flex their trunk but this will not exceed 20°. For the legs, the observer gives the score of 1 since they will stand straight and afterwards, they can sit if they feel tired of standing. The final score for Table 12A is 2, since the force or external loading score is 0.

Table 12B has the final score of 1 since the scores in upper arm wrist and lower arm position are all equal to 1. The coupling score is 1, therefore the Score B is equal to 2. From the previous REBA score of 8, after the workplace has been improved, the score became 3. From high risk work station, the possibility of developing body discomfort or the chance of acquiring various work-related disorders becomes low.

Table 12. Comparison of REBA scores of present and proposed working component.

	Present	Proposed
A. Neck, Trunk and Leg Analysis		
Neck	2	1
Trunk	2	2
Legs	2	1
Posture Score	4	2
Force/Load Score	1	0
Score A	5	2
B. Arm and Wrist Analysis		
Upper Arm	2	1
Lower Arm	1	1
Wrist	1	1
Posture Score	1	1
Coupling score	3	1
Score B	4	2
Score C	5	2
Activity Score	3	1
FINAL REBA SCORE	**8**	**3**

4. CONCLUSIONS

In order to decrease the risk of having body discomfort of the trimmers, it is important to identify the major contributor of those discomforts with the use of observation, right analysis and assessments. Ergonomic tools such as REBA and body discomfort assessment were used in this study and the researchers were able to measure the extent of deviation from neutral working posture and recommended ergonomic interventions for trimmers. In order to lessen the stress in the lumbar area and to maintain the natural lordosis-kyposis structure of the spinal column of the workers, the researchers recommended a chair with forward-tilting seat up to 15° instead of providing a chair with lumbar support. Forward-tilting chair would help maintain a large distance between the torso and the thighs of the user to reduce the pressure in the lumbar area. Also, the researchers suggested having an alternate sitting-standing working position.

To ensure that the working components are suitable to every worker, the researchers design the working components based on the anthropometric measurement of the workers. The forward-titling chair is adjustable from 57 cm to 63 cm, which was based on the 10^{th} and 90^{th} percentile of the workers' popliteal height. The table height was based on the workers' 90^{th} percentile of elbow height.

In general, the study focused on assessing the working posture and perceived level of body discomfort among trimmers exposed in current workplace design. Nevertheless, the researchers recommended including in the future study the analysis of work performance and productivity of trimmers and its influence to the level of body discomfort and risk of developing musculoskeletal disorders.

5. RECOMMENDATIONS

The most affected body region is the lower back or the lumbar area. The next affected body part is the calf because they need to maintain standing posture for long periods of time. For ergonomic interventions, the researchers intend to redesign their working station components wherein the dimension will be based on the worker's anthropometric measurements.

The researcher will propose a chair that was based on the Nottingham chair that has an adjustable height with an adjustable forward-tilt seat up to 15°. This chair will help create a great distance between the user's torso and thigh. Large distance between torso and thigh will help reduce the pelvic rotation to prevent the flattening of the lordotic curve. The chair is also armed with a footrest to lessen the additional stress on the knee while using the forward-tilt feature of the chair.

The researchers will also suggest having an alternative sitting-standing working posture given that pressure increases on the disks in vertebral column when a person sits down while when a person is in neutral standing posture, the lumbar portion of the spine curves naturally inward. But standing for too long or long period of time may result to less mobility and high perceived discomfort to workers.

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