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THE INFLUENCE OF COMBINING SITTING AND STANDING POSITION IN PLASTIC GLASS PACKAGING

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Abstract

Basically, to stand is more tiring than to sit. Standing position such as in plastic glass packaging is considered to be physically tiring activity because it is monotonous and done repeatedly for 7 hours a day, thus may result in leg muscle strain, pain, fatigue, and health problem. In this study, combining sitting and standing position were conducted to find out operators' fatigue level and packaging speed in plastic glass packaging process. The experiment of combining the sitting and standing position was given to 10 packaging operators who had been working in the industry of plastic glass packaging. They were between 21 – 46 year-old with more than 1 year working experience. The test was done by distributing the questionnaires containing 17 questions known as Instrument of Fatigue Measurement (IFM) to respondents to find out whether they are tired from working and to measure their packaging speed by using stopwatch for each standing position while working. This experiment was divided into Model X and Y. Model X is work position model with achievement of 40 boxes in each variation, while model Y achieved 80 boxes in each variation. From Anova test analysis, the result showed that there was significant influence between variations of Model X towards the operators' fatigue level. Model Y variation also showed significant different influence on the operators. The result of t test analysis on packaging speed showed that there was difference between Model X-3 and X-4 while Model Y-3 and Y-4 to packaging speed of each operator. From the results, it can be concluded that combining sitting and standing position to the operator and determining output amount influence operators' fatigue level and packaging speed. The best result of the 2 position combinations given is the X model, good for time of packaging speed and more stable fatigue rates.

Keywords: Fatigue, standing, sitting, packaging speed, position treatment.

Nomenclatures

X-1	Model of Sitting 40 for 40 boxes
X-2	Model of Standing 40 for 40 boxes
X-3	Model of Sitting 20 to standing 20 for 40 boxes
X-4	Model of Standing 20 to sitting 20 for 40 boxes
Y-1	Model of Sitting 80 for 80 boxes
Y-2	Model of Standing 80 for 80 boxes
Y-3	Model of Sitting 50 to standing 30 for 80 boxes
Y-4	Model of Standing 50 to sitting 30 for 80 boxes

Abbreviations

IFM	Instrument of Fatigue Measurement

1. Introduction

Standing is most convenient position for any task which needs many movements like moving upward, downward, and sideward [1] such as packaging where an operator sits for a long time during working [2, 3].Packaging is considered to be a task which is done repeatedly, monotonously, and in prolonged position physically and mentally [4]. Working in prolonged position may cause illness such as obesity, hypertension, diabetes, cancer, cardiovascular disease, and even death [5-14]. According to Chester [15], standing too long may lead to body discomfort, fatigue, swelling, and back pain, thus position changing should be done to prevent its bad effects while working [16]. Corlett [17] suggests that balancing standing and sitting should be managed at work. Combining those two work postures is hoped to minimize tiredness, fatigue, and boredom during doing repeated tasks. Plastic glass packaging is considered to be monotonous where an operator keeps doing same tasks all the time like removing plastic glasses from conveyor, picking glass one by one, then putting and ordering them inside the provided boxes.

This study offers the method of combining sitting and standing position in plastic glass packaging with some combined models by examining the correlation between combination of position, level of fatigue, and packaging speed.

2. Methods

2.1. Subjects

There were 10 operators who were given different position treatment based on determined experiment model. The operators were 21 to 46 year-old with minimum of 1 year of work experience. Before the treatment, they were assigned to practice working in standing position, which they seldom did, to familiarize them to the position and make them easy to change the position during the treatment.

2.2. Activities

Plastic glass packaging was done in settled standing position. It was done for 7 hours where the glasses were passed on the conveyor, removed, picked by the operators, and later be ordered in boxes. The set of tasks was conducted repeatedly during 7 hours.

2.3. Experiment

For the experiment, a room was provided with two big tables inside the room. The tables were used to place the drinking glasses. The first table was equipped by chairs while the second was not to facilitate the position change during the treatment. The tables' height was not more than operators' elbow height when they were sitting. The chairs height enabled the operators to sit with his/her knees bent properly and their feet flat on the floor.

Table height is ± 70 cm high, 40 cm width, and 1 m length. The chair is ± 45 cm high, 30 cm both length and width. In one session, there were 2 kinds of task to be accomplished: packaging 40 boxes and 80 boxes. The amount of 40 and 80 boxes was determined because usually the operators got bored after packaging 80 boxes and would ask to move to the back line. At the back line, the packaging would be slower because the operators who were in front line packaged more boxes and it made those who were in the back line package less with low speed. 40 boxes amount was determined to find out whether similar boredom appeared when the operators packaged 80 boxes. While packaging, the operators used the sitting and standing combination alternately.

After packaging 40 boxes in sitting position, the operators would shift to the other table to do the packaging in standing position as for those who packaged 80 boxes in sitting position would shift to the other table and changed their position to standing. Previously, the operators were given ±5minutes break after finishing 1 process of work position, and then continued to other work position process. There were 8 conditions of experiment which were used. Design experiment of model combination of treatment is shown in Fig. 1 and Table 1.

In Fig 1 and Table 1, 8 models of experiment which were applied by each operator are displayed. The models are divided into two packaging targets which are 40 boxes packaging output and 80 boxes packaging output. There were 4 experiment models applied for each output.

Table 1.The model of combination.

Output 40 boxes (X)	Model X-1 Sitting 40	Model X-2 Standing 40
	Model X-3 Sitting 20 → Standing 20	Model X-4 Standing 20 → Sitting 20
Output 80 boxes (Y)	Model Y-1 Sitting 80	Model Y-2 Standing 80
	Model Y-3 Sitting 50 → Standing 30	Model Y-4 Standing 50 → Sitting 30

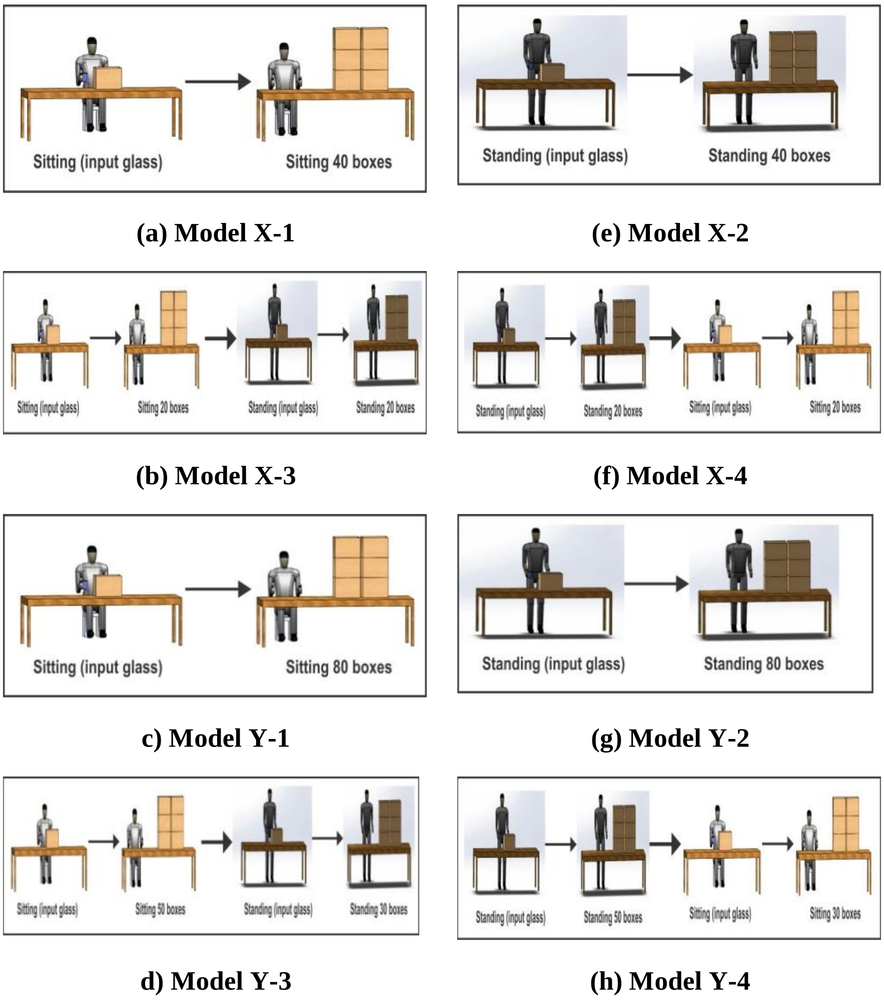

Fig. 1. Work position in experiment model

2.4. Procedure

The measurement was conducted to know the effect of sitting and standing position while packaging. It was done by measuring each operator’s fatigue level by using questionnaire of Instrument of Fatigue Measurement (IFM) consisting of 17 subjective questions. The questionnaire was used because there was no direct way to measure the fatigue source and no absolute way to measure fatigue. To evaluate packaging result, stopwatch was used to note the time needed by each operator to package with determined output amount.

The questionnaire was given to the operators before they worked and after they finished packaging both in sitting and standing position with determined output amount. Each of 10 operators was treated 8 experiments as shown in Table 1, the model of combination.

The measurement by using the stopwatch was run when the operator started packaging and it was stopped if they had reached the determined target. The most optimum amount of time spent by the operators from each position experiment was obtained. The goal was to find out if the position changing would effect on their work speed.

3. Result and Discussion

3.1. Time of accomplishment

The data of packaging speed of each operator during they were given position change treatment is displayed in Table 2.

Table 2. Packaging speed based on treatment model.

Operator	The Speed of packing (Minute)							
	X - 1	X - 2	X - 3	X - 4	Y - 1	Y - 2	Y – 3	Y - 4
1	14,85	13,98	14,95	13,3	27,9	26,65	28,3	26,28
2	16,75	15,65	17,5	14,5	30,28	27,57	31,75	28,18
3	15,02	14,17	15,77	13,68	29,33	27,5	31,82	28,43
4	13,57	13,1	14,02	12,92	27,2	25,35	29,05	27,5
5	15,73	14,2	15,9	13,8	30,6	28,57	32,12	28,38
6	13,93	13,2	13,95	12,77	31,63	28,7	33,03	30,5
7	15,45	14,72	15,2	12,95	30,95	28,55	32,33	29
8	14,48	14,77	15,25	12,58	31,8	28,57	34,25	29,28
9	12,6	11,83	12,38	10,38	24,25	23,27	24,82	22,88
10	14,13	13,57	14,05	11,22	26,4	25,05	27,93	25,27
Total	**146,5**	**139,2**	**148,9**	**128,1**	**290,3**	**269,8**	**305,4**	**272,7**

The low and high of each operator's to finish packaging during some models of position change be seen in Table 2. Each of data in Table 2 was analyzed by using t test on 2 independent samples by using software SPSS 22. t test of 2 samples was used to find out time difference of packaging speed from each treatment model given. Data in Table 3 are the result on t test of 2 independent samples of packaging speed.

Table 3. Results on (t test on 2 samples) Experiment on 2 independent samples in terms of packaging speed.

No	Model	Sig. Value (2-tailed)	Note
1	Model X-1 and X-2	0.163>0.05	No time difference in packaging speed between Model X-1 and X-2
2	Model X-3 and X-4	0.002< 0.05	There is time difference in packaging speed between Model X-3 and X-4
3	Model Y-1 and Y-2	0.052> 0.05	No time difference in packaging speed between Model Y-1 and Y-2
4	Model Y-3 and Y-4	0.003< 0.05	There is time difference in packaging speed between Model Y-3 and Y-4

T test result on 2 samples is displayed in Table 3. The result shows that there is no time difference of packaging speed between Model X-1 and X-2 after treatment; there is time difference in packaging speed between Model X-3 and X-4 after treatment; there is no time difference of packaging speed between Model Y-1 and Y-2 after treatment; and there is time difference of packaging speed between Model Y-3 and Y-4 after treatment.

3.2. Instrument of fatigue measurement (IFM)

IFM is a questionnaire consisting 17 questions on fatigue felt by somebody after working which functions to measure fatigue. In Table 4, fatigue level felt by each operator after the treatment is displayed. The result is in percentage which is an accumulation of answers to 17 questions given to the operators.

Table 4. The difference on level of fatigue.

Model	Level of Fatigue (%)									
	A	B	C	D	E	F	G	H	I	J
X – 1	29,41	41,18	29,41	29,41	35,29	41,18	23,53	35,29	23,53	35,29
X – 2	35,29	47,06	35,29	35,41	41,18	47,06	29,41	41,18	35,29	41,18
X – 3	41,18	52,94	41,18	41,18	47,06	52,94	35,29	47,06	41,18	47,06
X – 4	47,06	58,82	47,06	47,06	52,94	58,82	41,18	52,94	47,06	52,94
Y – 1	41,18	35,29	64,71	41,18	41,18	52,94	35,29	47,06	35,29	52,94
Y – 2	47,06	41,18	52,94	47,06	58,82	70,59	41,18	52,94	41,18	76,47
Y – 3	52,94	47,06	58,82	52,94	52,94	64,71	47,06	58,82	47,06	64,71
Y – 4	58,82	52,94	47,06	58,82	47,06	58,82	52,94	64,71	52,94	58,82

The fatigue level variation felt by each operator during some models of work position treatment with different output is shown in Table 4. The data in Table 4 was analyzed by using Analysis of Variation (*Analisis Varians (ANOVA*)) to find out an average difference on each model by comparing its variants. *ANOVA* analysis used software SPSS 22. Result of *ANOVA* test on fatigue level from Table 4 is displayed in Table 5.

Table 5. Fatigue level difference between model variations applied to the operators.

No	Packaging Output	Model	Sig. Value (Two Ways Anova)	Note
1	40 dos	X-1 → sitting 40 boxes X-2 → standing 40 boxes X-3 → sitting 20 boxes continued to standing 20 boxes X-4 → standing 20 boxes continued to sitting 20 boxes	0,000 < 0,05	There is significant value between variations of Model X towards the operator's level of fatigue
2	80 dos	Y-1 → Sitting 80 boxes Y-2 → standing 80 boxes Y-3 → Sitting 50 boxes continued to standing 30 boxes Y-4 → standing 50 boxes continued to sitting 30 boxes	0,004 < 0,05	There is significant influence between variations of Model Y towards the operator's level of fatigue

Tukey HSD test result on all applied Model X experiments shows that the sig. value is< 0.05. It can be concluded that there is different significant influence between variations of Model X which had been applied on experiment standard of 95% and it indicated different fatigue level on each operator.

Tukey HSD result states that sig. value for applied Model Y is < 0.05. It indicates that there is different significant effect between variations of Model Y and it gives different result towards the fatigue level felt by each operator.

4. Conclusion

Experiment on both Model X with 40 boxes packaging output and Model Y with 80 boxes packaging output shows that position change treatment given to the operators gives effect towards each operator's packaging speed and fatigue level. The information is hoped to be useful and can be sustainably applied, thus it can minimize fatigue in doing repeated and monotonous work and also may improve operators' performance to increase packaging output in order to achieve company target. In this packing process the X model has a better impact than the Y model. Good for time of packaging speed and more stable fatigue rates.

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