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Reducing musculoskeletal complaints and fatigue through participatory ergonomics on the table and chair design of participants of Halal Assurance System (HAS) training in LPPOM MUI of Banten, Indonesia

Wahyu Susihono Rodani Rodani I Putu Gede Adiatmika

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Acute toxicity profile and Sun Protection Factor (SPF) nanoemulgel combination of C-phenylcalix[4]resorcinaryl octacinnamate, C-methylcalix[4]resorcinaryl octabenzoate, and quercetin in vitro and in vivo



Reducing musculoskeletal complaints and fatigue through participatory ergonomics on the table and chair design of participants of Halal Assurance System (HAS) training in LPPOM MUI of Banten, Indonesia



Wahyu Susihono,^{1*} Rodani,² I Putu Gede Adiatmika³

ABSTRACT

Background: Halal Assurance System (HAS) training is mandatory for industries that will apply for halal certification at LPPOM MUI of Banten Province. In some trainings, the participants felt uncomfortable which can be seen from the level of fatigue and complaints caused by an uncomfortable sitting position due to poor design of tables and chairs. This condition is very detrimental to participants.

Methods: This treatment by subject design study did from April to November 2019. The participants were who attended the HAS Training-23000 that fulfilled the inclusion and exclusion criteria. Samples then grouped into three group with different condition in each. We took indoor environment data and each sample about sample characteristics and business characteristics. Muscle complaints took by subjective questionnaires before and after training. The data analyzed by SPSS and $p < 0.05$ was significant.

Results: Total 120 participants were included consisting of 40 participants in each condition. The indoor environment conditions in the three conditions are the same ($p > 0.05$). There were significant reduce of score of musculoskeletal complaints and fatigue before and after trainings in each condition ($p < 0.0001$). Seats with multilevel arrangement (condition III) have the lowest value of musculoskeletal complaints and fatigue.

Conclusions: The smooth communication among participants influences the speed in implementing participatory ergonomics. The use of tables and chairs with a seating capacity of 6 people/table is the most effective when compared to others. The application of participatory ergonomics can reduce musculoskeletal complaints and fatigue of participants of the Halal Assurance System.

Keyword: participatory ergonomics, fatigue, musculoskeletal complaints, Halal Assurance System

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INTRODUCTION

Halal is one way of ensuring products free from contaminants that are not permitted by Islamic Sharia. Some researches relating to the consumption of halal food have been carried out in several countries.^{1,2,34} In Indonesia, according to the issuance of Law No. 33 of 2014 makes processed food and beverage products in Indonesia must be halal certified. The halal certification domain is at *Majelis Ulama Indonesia* (MUI). Before registering their products for halal certification, companies need to prepare and build their own system first. The initial step is that they must understand the halal certification requirements and attend Halal Assurance System (HAS) training. Then, they apply HAS, prepare halal certification documents, and then register for halal certification. There must be the halal logo on the packaging of halal-certified products. There must be particular characteristics of the halal-certified material in the form of product name, code or others.

Halal Assurance System (HAS) 23000 Training is mandatory for industries to apply for halal certification at LPPOM MUI of Banten Province. It aims to create the same understanding of the implementation of existing systems in the company. Thus, this training is an initial series of companies to implement the halal system in the industry. The ultimate goal of this training is to create a HAS document, so there is technical guidance material for making a HAS manual. Halal Management System is an information relating to the standards applied in the company.⁷ One of the steps that must be maintained is raw material. The critical point of raw materials must be monitored.^{8,9}

Some trainings did not consider the participants convenience. Most trainings only consider the ultimate goal of knowledge transfer. This condition was felt to be less effective and uncomfortable by the participants, resulting in suboptimal understanding of the material. The LPPOM MUI of Banten

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Province has been conducting Halal Assurance System (HAS) training in a variety of places, moving from several buildings. This condition greatly influences the attitude and service of each participant. In addition to the changing in buildings, the seating layout also changes, starting from folding chairs, chairs with tables, and multilevel seating layout. This condition affects the comfort of participants viewed from the level of body musculoskeletal fatigue and complaints. Several papers follow the assumption that there is a relationship between discomfort and musculoskeletal complaints; these complaints affect the perceived comfort.¹⁰ Several previous researches relating to comfort in the workplace have been carried out,^{10,11} including several ergonomic issues, especially in work organizations.

Excessive fatigue will result in suboptimal understanding of the material. Excessive fatigue affects the concentration and absorption of the matter that continuously decrease. This condition is very detrimental to participants, coupled with the presence of musculoskeletal complaints caused by an uncomfortable sitting position, minimal flexibility of body movements, and seating layout that is not well designed. Thus, a holistic evaluation is needed to get the most comfortable condition seen from the reduction in fatigue and musculoskeletal complaints of participants.

Some improvements have been made by the training organizers, including lighting, temperature, and sound control system in the room. However, the improvement also needs to consider what the participants want. To obtain proposals of what the participants want, an evaluation of the participatory ergonomic approach needs to be done. Several previous researches have linked participatory ergonomics with musculoskeletal complaints.¹³ Musculoskeletal complaints are a serious problem. If the complaints are left alone, it can cause disability.^{14,15,16}

Participatory ergonomics is a method for exploring various ideas, thoughts and inputs that can be used to develop and perfect the Halal Assurance System (HAS) training. Participatory ergonomics is an approach centered on the employee involvement.¹⁷

Because ideas and thoughts come from the participants, the application of such ideas becomes satisfaction for the participants. Ideas are accepted and run by the training manager. Participants' ideas and inputs form the basis for improving the seating layout, so the musculoskeletal complaints and fatigue of the participant can decrease. There are theories that connect comfort with product and product design characteristics.^{18,19,20} The improvement product is in the form of participatory

ergonomic intervention. The use of participatory ergonomic method is expected to increase comfort in Halal Assurance System (HAS) training activities at LPPOM MUI Banten Province.

METHOD

The design of this research was treatment by subject design from April until November 2019. The research subjects were participants who attended the Halal Assurance System (HAS) Training-23000 organized by LPPOM MUI of Banten Province by total sampling. They have fulfilled the inclusion and exclusion criteria from the research. The inclusion criteria in this research are (a) the participants register for the Halal Assurance System (HAS) training organized by LPPOM MUI of Banten Province, (b) they already have a business registered at an official government institution, and (c) they are willing to be involved to fill out the questionnaire in accordance with the actual conditions during the Halal Assurance System (HAS) training activities. The exclusion criteria are (a) the participants ask permission at the end of the training and (b) are not willing to fill out the questionnaire due to certain reasons. Samples grouped in three different condition. Condition I used chairs equipped with tables. Condition II used chairs and tables with the layout of the front and back chairs of the same height. Condition III used chairs and tables with the multilevel seating layout, the back-row chairs higher than the front-row. We collected data about room environment include lighting (Lux), noise (dbA), temperature (°C), humidity (%), and wind speed (m/s) in each condition. Each sample was given a questionnaire that collect data about sample characteristics and their business characteristics. We also gave subjective questionnaires to collect muscle complaints data which gave before and after training. The data then analyzed by SPSS ver. 23 and describe by table for descriptive data and by cross tabulation for analytic data. $p < 0.05$ showed significant. This study has approved by Dr. Moewardi General Hospital Ethic Commission with number 165/II/HREC/2015.

RESULTS

Subject Characteristics

The characteristics of the subjects in this research varied among the 3 locations, but all of them were included in the research's inclusion and exclusion criteria. Table 1 reports that the average age of the oldest respondents is in condition I, which is 34.45 ± 7.93 , but there is no too large difference in the three conditions. The participants with the highest

Table 1 Research Subject Characteristics

Criteria	Condition I	Condition II	Condition III
Average age of respondent	34.45±7.93	33.23±7.42	31.025±8.17
Gender	M 18 / W 22	M 11 / W 29	M 7 / W 33
Business Scale (Industry)			
Micro Company	6	18	11
Small Company	20	15	23
Intermediate Company	3	22	6
Big Company	11	5	0
Experience in running a business			
0.0 - 2.0 years	12	7	27
2.1 - 4.0 years	8	2	9
4.1 - 6.0 years	9	5	3
above 6.1 years	11	6	1
Industrial Production Conditions			
Production per day (%)	67.5	77.5	62.5
Production per week (%)	17.5	15	15
Production per month (%)	15	7.5	22.5
Sales system			
Traditional only (%)	7.5	15	12.5
Just online (%)	15	40	17.5
Semi Online (%)	47.5	35	42.5
Full Online (%)	30	10	27.5
Division of training hours (%)			
Core material	40	50	30
Simulation	30	30	40
Independent task	30	20	30

Table 2 Indoor Environmental Conditions of the Building

Criteria	Condition I	Condition II	Condition III
Lighting (Lux)	315	232	223
Noise (dbA)	50.4	43.6	47.6
Temperature (°C)	26.5	28.6	28.1
Humidity (%)	62.2	68.7	65.4
Wind Speed (m/s)	0.2	0.1	0.2

number of men are in condition I (18 people), while the highest number of women exists in condition III (33 people). The largest number of businesses included in the micro and medium enterprise scale is in condition II, while the small industry scale is in condition II.

Based on Table 1, it can be reported that the conditions of production in the industry run daily are highest at condition II (77.5%), weekly in condition I (17.5%), and monthly in condition III (22.5%). The general sales system in conditions I and III is run semi-online and in condition II is online only.

Indoor Environmental Conditions of the Building

The indoor environment is crucial in meeting the comfort of trainees. The environments of the 3 locations have different values, but they are still in the permitted threshold conditions. The company's indoor environment is taken by measuring each of the criteria.

Table and Chair Design of Training

Halal Assurance System (HAS) training activities conducted by LPPOM MUI of Banten Province in this research were carried out in three different buildings with different time periods. However, some conditions are standardized, so they share something in common, namely the facilities provided to participants, the training curriculum, the duration of material delivery. The condition of seated can be seen in Figure 1 – 3.

Participatory Ergonomics for Evaluating the Design of Tables and Chairs

The steps of Participatory Ergonomics begin with identifying and analyzing problems, developing, and ending with implementing an effective solution.²¹ The steps in implementing participatory ergonomics in this research are (a) the participants are given direction related to the training mechanism to follow, (b) the participants are given the opportunity to assess the condition of the surrounding environment including the seating layout, (c) the participants get Halal Assurance System training for 4 hours; then, they are given a piece of paper to give their inputs, ideas and thoughts in arranging the layout of their respective seats, (d) they are given time to implement their inputs, ideas and ideas in arranging the seating layout of the training and the arrangement of the items to be placed on the table, (e) they are given further material in the form of technical guidance for making HAS for 4 hours, (f) they are asked to compare comfort in the form of musculoskeletal complaints and fatigue before and after the intervention for improvement, and (g) the participants are asked to conclude the layout improvement based on their respective feelings. Participatory Ergonomics is a method for actively involving workers in developing and implementing improvised changes to improve performance and reduce risks.²²

Musculoskeletal Complaints and Fatigue in Training

The data on musculoskeletal complaints were obtained by distributing subjective questionnaires to each participant. The distribution of musculoskeletal complaints and fatigue questionnaires was

Table 3 Changes in Musculoskeletal Complaints and Fatigue

Conditions of Participants				
Variable	Before	After	Changes (%)	p
Condition I				
Musculoskeletal Complaints	67.41±0.46	39.07±1.25	42.04	0.0001
Fatigue	61.84±1.44	45.40±0.56	26.58	0.0001
Condition II				
Musculoskeletal Complaints	51.19±1.55	41.29±1.66	19.34	0.0001
Fatigue	80.64±0.57	65.69±2.90	18,54	0.0001
Condition III				
Musculoskeletal Complaints	47.01±3.91	34.85±1.87	25.87	0.0001
Fatigue	55.63±0.70	35.96±2.07	35.36	0.0001

**Figure 1** Condition I (Participants of the Halal Assurance System (HAS) training use chairs and tables (capacity of 1 person)**Figure 2** Condition II (participants of the Halal Assurance System (HAS) training use chairs and tables (capacity of 2 people), with the parallel seating layout in the front to the back rows or of the same height

carried out before and after the implementation of the participatory ergonomics. The participants were given an explanation before filling out the questionnaire independently. The data obtained were analyzed using statistics. There were not normally distributed data, so the discrimination test used was a non-parametric test.

Based on Table 3, there is the biggest change in the application of participatory ergonomic seating layout in Condition I (42.04%). In condition I, the participants used chairs equipped with tables directly, so it is very easy to arrange the suggested layout, but the musculoskeletal complaints before the intervention had the highest value among the other conditions (67.41±0.46). There is the biggest change in fatigue after the intervention in condition III (35.36%). In condition III, the participants participated in the HAS training using chairs and tables, with the multilevel seating layout. This condition provides comfort when sitting. There is a change in the distance arrangement between the chairs and adjustment in the participant's traffic. This arrangement also has an impact on fatigue reduction. The most dominant change in fatigue reduction is in Condition III due to the improvements based on participants' desires. The participants choose a seat based on their desires, not based on the desires of the training manager. Seats with multilevel arrangement (condition III) have the lowest value of musculoskeletal complaints and fatigue. Participants feel more comfortable compared to using other seat facilities.

Musculoskeletal complaints and work fatigue occur in the three conditions. The implementation of participatory ergonomics has an impact on increasing the comfort of the trainees indicated by the value of $p < 0.05$. Because all conditions have an impact, it is necessary to compare the acquired value of musculoskeletal complaints and fatigue from each condition to find out the highest change value.

DISCUSSION

Research Subject Characteristics

The characteristics of the research subjects will affect findings. The characteristics of the respondents of the three conditions are not significantly different ($P > 0.05$). In condition I, the respondents are averagely older compared to other conditions and dominated by women. This has an impact on the discussion when revealing ideas and thoughts and also choosing ergonomic interventions to be applied. Meanwhile, in the third condition, there are more men than women, which will make a difference to revealing the problem in the discussion.



Figure 3 Condition III (participants of the Halal Assurance System (HAS) training using chairs and tables (capacity of 6 people), with the multilevel seating layout, with the chairs in the back row higher than in the front

In general, there will be more considerations and requires longer decision in the discussion with women dominantly members. The average age of the participants belongs to mature category. Age affects decision in intervention conditions greatly, so a participatory ergonomic approach is needed. Participatory ergonomic creates improved activities that adjusted on human desires to reduce musculoskeletal complaints.²³ Age variation provides more comprehensive and holistic inputs.

However, in the third condition, small industry business was more dominant compared to condition I and II; this effects on the exchange of information and ideas in the opinion expressing process. Industrial scale equality influences the participatory ergonomic process. Participatory ergonomics will produce optimal output if done by members with the same interests, equal knowledge and equal education.

In general, the trainees of these three conditions have more than one-year experience of running a business, meaning that they have a lot of experience in product marketing and scheduling mechanism of product manufacturing. Auditors of LPPOM MUI Banten Province look at the consistency of raw materials used in conducting product audits. The inconsistency of the use of raw materials will have an impact on aborting the certificates. Companies must be consistent with the matrix of materials that has been registered and common understanding to make the products. Business experience is one of the considerations in running a business. Companies that have been running a business for more than five years have more consistent opportunities in maintaining their products or have submitted at least two-time halal certification to LPPOM MUI. The experience of applying for halal certification is the initial capital to illustrate the extension of the next halal certification.

Condition II had highest production per day compared to other conditions. This high percentage provides information that the participants have a very high desire to pass the training because it has an impact on the legality of the business being run. The highest production per month was in the condition III. This condition will affect the desires of participants in seriously conducting the training. Variations in business experience have an impact on the results of the implementation of participatory ergonomics. However, the variation of experience in running a business and in production conditions did not affect the results of inputs, ideas and thoughts on improving musculoskeletal and fatigue when using chairs and tables during training.

The sales system can be used as a basis to see the level of company adoption of technological advances. Sales with an online model are dominant among all trainees. This condition illustrates that the participants of the Halal Assurance System (HAS) training have used digital technology well. However, there were little percentage in the three conditions which still used traditional methods in sales and had not yet adopted technology. This condition does not have an impact when carrying out a participatory ergonomic process, such as expressing ideas, thoughts and alternative implementations of solutions to work attitude towards the use of chairs and tables. Participatory ergonomics is an approach centered on the employee involvement. More improvements were made to meet what the users want. Participatory ergonomics can be done in groups and in a relatively long time. Some participatory ergonomic researches are used to observe the quality of work life.²⁴

The division of training hours affects the level of understanding of the participants. Longer interaction between the instructor and the participants will make the delivery of new information to the material clearer. However, the time of giving the material is not directly proportional to the level of understanding of the material by the participant. The duration of material delivery does not guarantee absorption rate of the material. Easy to understand communication, the method of delivering the material, examples of problems that are easy to understand, responsive language style and teaching techniques are indicators of the participants' understanding. The three conditions did not have significant duration difference in this research. Simulation time is the time required by the participants to be active in working independently accompanied by the instructor, while the independent task is the time required by the participants to complete the task without any assistance from the instructor. Simulation time and task completion

time in the three conditions in this research are not significantly different.

Indoor Environmental Conditions of the Building

The indoor environmental condition of the building will affect the comfort when the participants attend the training. Workplace conditions affect the level of musculoskeletal complaints.^{25,26} Comfortable environmental conditions have an impact on optimizing material understanding. The measurement of environmental conditions in this research is on the lighting, noise, temperature, humidity and wind speed. There was no difference of indoor environmental in that three conditions. The Minister of Manpower and Transmigration Regulation No. 13 of 2011 has established threshold values for physical and chemical factors that become a reference in maintaining work comfort. Also, in Minister of Health Regulation No. 70 of 2016 regulates the standards and requirements of the industry work environment.

The working environment climate threshold value is determined by considering the allocation of work and rest time in one work cycle (8 hours per day) as well as the average metabolic rate of workers and the correction value of work clothes. Because in general, the industry in Indonesia operates for 8 hours, the Threshold Value (TV) of the work environment climate is the limit of climate exposure to work environment or heat stress which must not be exceeded for 8 hours per day.

The lighting in this research in all three conditions has been above 200 lux; this shows that the lighting in the training area is quite good. The lighting level has an impact on concentration. Lighting less than 200 lux will have an impact on the participants easily getting sleepy.

The noise level is below 85 dBA, meaning that the noise in the room is caused by the sound of the instructor delivering the material and the trainees. The intensity of noise is still within the allowed threshold. The Threshold Value (TV) is an effective dose of noise exposure in dBA units received by the ear (hearing organ) within a certain period of time that should not be passed by workers who do not use ear protection. The Minister of Health Regulation No. 70 of 2016 states that if a worker is exposed to noise at work without using ear protection for 8 hours of work per day, then the noise exposure NAB that may be accepted by the worker is 85 dBA.

Humidity, in general, affects the level of evaporation of sweat in the participant's body, while the wind speed affects the comfort level in breathing air in the room. Faster air circulation has an impact on

the pressure on the body, but if there is no wind, the air circulation in the room will not be maximal. The wind in this room comes from the air conditioner. Humidity and wind speed of the three conditions in this research are not significantly different. Most of the previous researches on the relationship between environmental factors such as temperature, humidity, strength and the level of comfort or discomfort felt by workers have been discussed.¹⁰

Design of Chair and Table

An independent sitting position, without any disturbance from the activities of the participants who sit next to, provides flexibility in body movement. The individual sitting position does not influence the next chair. Sitting comfort is influenced by the seating design. The seating design in [Figure 1](#) is for individual sitting. The position of the bag is under the chair, so the distance between the seats needs to be considered in order to function normally. The movement of taking and storing bags under a chair requires bending. Bending movements of more than 90 degrees are not allowed. The ultimate design of the table and its facilities have been carried out in several previous researches. In general, the table redesign aims to provide comfort in activities.^{27,28}

Based on [Figure 1](#), it can be explained that each participant can adjust the position of the chair. The seat arrangement is not good at the beginning. The light weight of the chair makes it easy for participants to change the sitting position and has higher flexibility to move. Seats will be disorganized, and the participants' comfort will decrease. Chairs and tables are one of the products whose design needs to combine with anthropometric data. Several previous researches have linked comfort with product design.

Musculoskeletal complaints and fatigue are caused by the length of time sitting in a chair, so the design of the chair in [Figure 1](#) is not allowed for more than 4 hours of static sitting. It requires a combination of movements such as standing or moving the body within a certain period. Static conditions affect the high musculoskeletal complaints, especially in the neck (because there is no neck rest), the popliteal part of the foot (because there is no footrest), and the shoulder (due to a static position), and eye fatigue (due to the position of the layers and the static sitting position). The use of chairs equipped with tables ([Figure 1](#)) has provided comfort in the sitting position of participants, but the duration of the use of chairs needs to be re-evaluated. The weight of the chair is not assessed because under conditions II and III, the table is designed to be permanent that cannot be

moved. In another research, table weight becomes a variable of improvement. However, it was reported that the tightness of the chair affected the lift power of participants, but the height of the table did not affect.²⁹

The implementation of participatory ergonomics can give change and have an impact ($p < 0.05$). This change is caused by the placement of various personal belongings which are adjusted according to the participants' desire. The desires of most participants do not follow the function of the chair, namely the placement of bags of 76% mostly next to the chair (the function of this chair is at the bottom of the chair) and the placement of the consumption of 43% under the chair (the actual function is for bags). The design condition that needs to be considered is that there is no pencil, ballpoint or other stationery holder, so everything is put in the bag. For the chair and table design developer (condition I), it is necessary to add a footrest, a stationery holder, and snack holder to meet the user's need.

The sitting position in Figure 2 is different from that in Figure 1. It is explained that the sitting position in Figure 2 was with a table and a separate chair, so the chair can be adjusted to the user's comfort. The table provides for 2 people/table. This condition is certainly a consideration when the trainees are not from one company. There are some people who are not willing to be in one table when they don't know each other. The training organizer needs to arrange the seating position among participants, so they do not choose one participant from the others. The comparison of comfort is seen from musculoskeletal complaints. In the second condition, it provides a more intimate atmosphere. The participants are required to get to know one another, at least of one table. The participatory ergonomics in the second condition is easier to implement because the participants already know each other. When compared with the first condition, the second condition has faster duration of time in sharing new ideas and thoughts.

The design of chairs and tables influences the application of total ergonomics. Mental burden becomes lighter when compared to the chairs in condition I. However, the weakness in the design of tables and chairs in the second condition is the flow of transportation of participants. If the participant in the middle want to going out, then it is necessary to move the chair next to the other participant. This needs to be considered by the training manager to arrange that the distance between the tables by at least twice the size of the anthropometric width of the human body. Thus, when the participants move to the other places, they do not disturb other participants. Another disadvantage is there is no footrest, so the dominant musculoskeletal complaints are

felt at the bottom such as the foot, popliteal, waist, and hip. The selection of chair design needs to be considered because sitting for 8 hours of training requires modification by stretching the muscles every 2 hours of sitting activity. The layout in the placement of the distance between the tables needs to be arranged for its looseness, so participants have relatively loose space adjusted to the comfort of gestures.

When viewed in the third condition, the seat layout was made like a ladder. This condition provides fairness to the receipt of information from the speaker. All eyes can see fairly ahead without anyone getting in the way. The table design in the third condition is different from the others (Condition I and Condition II). The table is made elongated which can accommodate six people, three times of the length of the table from the second condition. Because of the close interaction between participants of at least 6 people at one table, the communication climate is faster and the interaction between participants is easier. They can exchange information easily to each other. The weakness of the third condition is that the table design is quite long compared to the conditions I and II, so the use of the area is often ineffective. Placement of belongings between participants often uses inappropriate areas. Placement of books and food uses other participant areas. This will disadvantage other participants. There is a high potential of exchanged belongings.

The implementation of participatory ergonomics in this third condition is the fastest than the other conditions (Conditions I and II). The table design with a capacity of 6 people has an impact on the speed of communication. Participants can interact with at least 6 people at each table. A slightly circular table design makes it easy for each participant to face to face. Armrests provide additional comfort in the move. The foam in the chair and the backrest add a duration of sitting more than 4 hours of training. The selection of chair and table design in condition III gives fairness to each participant because the participants at the back have the same opportunity to be able to see forward without any obstacles from the other participants.

Musculoskeletal Complaints and Fatigue

In general, musculoskeletal complaints are still a global problem. Global prevalence reaches 30%.³⁰ Musculoskeletal complaints continue to increase over time.³¹ Musculoskeletal complaints in this research differ significantly from the three conditions. Musculoskeletal complaints (before intervention) in condition I was the highest than the other conditions. Condition II (after intervention) was the highest than the other conditions, but all

conditions experience a decrease in musculoskeletal complaints after the participatory ergonomic intervention. The highest decrease in musculoskeletal complaints was in condition I. The trainees used independent chairs and tables. This makes sense because of the ease in changing the layout, the chair can be shifted and moved as the users want, including the angle of direction between the chairs that can be adjusted. The higher intervention opportunities given to users (training participants) influence the comfort of the use of chairs and tables (tools). The level of change after the participatory ergonomic implementation in condition I was the highest compared to changes in other conditions. The participants will feel the level of musculoskeletal complaints greater with minimal ergonomic knowledge conditions.³²

The lowest musculoskeletal complaints are experienced by the participants of condition III. In condition III, the participants sit with a capacity of 6 people. Effective interactions have an impact on the speed of ergonomic participatory implementation. The design of chairs and tables influences the speed of application of participatory ergonomics, resulting in a decrease in musculoskeletal complaints. Good social relations affect the decrease in musculoskeletal complaints.³³ Some musculoskeletal complaints, reported from previous researches, are reduced with ergonomic training. Ergonomic training reduces pain in skeletal muscle.³⁴ Therefore, the body's cardiovascular condition can function normally. Each joint has its own role and function, according to the anatomical conditions of the body.^{35,36}

Changes of fatigue in condition III (35.36%) are highest of the other conditions due to working together. Sitting together can increase the perceived feeling of fatigue. Adoption of ideas and thoughts from each participant impacts on the comfort during the implementation of the intervention. The fatigue felt is less. The dynamic and harmonious climate of each participant has an impact on decreasing feelings of fatigue.

Work fatigue is a feeling of tiredness experienced by everyone, in other words, a decrease in alertness. Fatigue is a signal of the body or a protective mechanism so that the body is protected from further damage. Thus, recovery takes the form of rest releasing fatigue. The feeling of fatigue that is felt by each individual varies according to the condition of the body's stamina, but fatigue certainly leads to loss of work efficiency, decrease work capacity, and endurance. Efforts are needed to reduce fatigue in work activities.

Fatigue can be muscle fatigue, a tremor in the muscles or a feeling of pain in the muscles, while

general fatigue is characterized by a reduced willingness to work which is a psychological or prerequisite. In training activities, fatigue is generally caused by monotonous activity, intensity and duration of training. Many previous researches have revealed the effects of fatigue that are accompanied by their treatment.^{37,38,39} In general, countermeasures are carried out with ergonomic interventions.

Fatigue in Condition II is at its highest before intervention and after intervention. This is reasonable because there are limitations in body movements for each participant. The participants find it difficult to leave the room. Other participants will be disturbed by the movement of sliding a chair near other participants. Other participants will also be distracted by the participants in front of them because the eyes are blocked. The placement and distance of chairs and tables need improvement. The arrangement of the seating layout also needs improvement. As an alternative solution, improvements can be made in the form of elevating the display on the front, so each participant can see clearly the writing in front. The participants' fatigue is caused by not being ergonomically seated. Participatory ergonomics can reduce fatigue because the sitting position is adjusted to the user's comfort. Other researches also have provided recommendations related to the effects of fatigue and the preventions.^{40,41}

CONCLUSIONS AND RECCOMENDATIONS

The table design greatly influences the duration of the speed of participatory ergonomic application. The smooth communication among participants influences improvisation and time to come up with ideas and thoughts for improvement. Tables and chairs with a seating capacity of 6 people/table are most effective than those with a seating capacity of 2 people/table and 1 person.

The selection of the table and chair design with a seating capacity of 6 people/table, plus a multilevel design, is better than the use of other types of tables and chairs.

It is recommended that all tables and chairs for training (classical) be designed with a minimum seating capacity of 6 people/table and between there be no obstacle between participants in receiving materials. Well-prepared schedules and materials need to be supported with comfortable table and chair facilities, so the understanding of the participants can be maximized. Further researches also need to be linked to the results of training achievements in class to find out the direct impact of improving training achievement. It is also necessary to evaluate the percentage of participants who pass the training.

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CONFLICT OF INTEREST

The authors declare no conflict of interest regarding the publication of this article.

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