DESIGN OF WORK FACILITIES FOR SUSTAINABILITY THE PROCESS OF MAKING BAKPAO CAKES

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ABSTRACT
This research is a continuation of research conducted in 2020 related to operator work facilities in the form of Model I chairs in making Bakpao cakes. During work activities, the operator still feels pain in the upper right arm as much as 80% and in the thigh as much as 20%.
The goal of this research is to design and build two new chairs, the Model II chair and the Model III chair so that they can be compared to the Model I chair and operator pain complaints can be reduced with appropriate work facilities.
The research method used is the Nordic Body Map method and experimental the design method conducts a paired sample t-test with SPSS. The results of the study on ten operators by comparing the use of the three chair models and the statistical test t Test obtained the magnitude of the comparative value of complaints about the use of model I chairs with model II chair of -1,510, the model I chair with model III chair of -1,590 while for model II chair with model III chair of 80, while the static test t Test complaints of operators using model II chair with model III chair showed sig values (2 tailed) (0.339 > 0.05), then H0 accepted and H1 rejected. Furthermore, the model II chair was chosen as the operator's work facility for the sustainability of the Bakpao cake-making.

Keywords—*component, formatting, style, styling, insert*

1. INTRODUCTION

The research is a continuation of research in 2020 related to operator work facilities in the form of the model I chair in the process of making Bakpao cakes. In previous research, the design of chair and table of mixer machine operators was carried out based on Anthropometric data by referring to several research results that have been carried out by[8], [13] [10] in his book entitled Industrial Ergonomics. So that the mixing process can run well and the operator will be comfortable when carrying out their work based on the Nordic Body Map method. The results of the design of the work facility can be seen in Fig 1. [6]

Figure 1. Preliminary Design Results Ease of Use

2. FORMULATION OF THE PROBLEM

In work activities, the operator still feels pain in the upper right arm at 80% and pain once as much as 20%. The research location is Sumberan Hamlet RT 01 RW 07 Sumberagung Moyudan Sleman and at the UWM Production Process Laboratory. This study did not calculate the cost factor in designing work facilities, only using the Nordic Body Map method in determining the level of operator comfort, as in Chandra's research (2021) was produced that the average musculoskeletal complaint score after work was 40.67 so it had to be lowered, as well as statistical test t-Test to compare the value of operator complaints.

3. RESEARCH PURPOSES

This study aims to design and create 2 (two) new chairs, namely the model II chair and model III chair, to compare the model I chair so in that operator pain complaints are reduced whit the appropriate work facilities are obtained. This study used the Nordic Body Map method and experimental design and conducted a paired sample t-Test with SPSS.

4. THEORETICAL REVIEW

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Product design and manufacture are a massive part of all existing engineering activities. Design activities begin with obtaining a perception of human needs, followed by the creation of product concepts, then end with the manufacture and distribution of products that can meet human needs. The components that make up the product consist of this component of the product, which appears to be the product packer, and the element of the supporting service. The product's core components are the parts that must be present, it seems, in effect. Meanwhile, the packaging components consist of quality, price and trade name, design, and packaging. The supporting service component consists of delivery, guarantees, spare parts, agencies, and repairs [11].

Design can be interpreted as one of the broad activities of design and technological innovations that are initiated, created, exchanged (through buying and selling transactions), and functional. Good design means having a good quality of function; depending on the goals and philosophy of design in general, plans differ according to their needs and interests, and the result-oriented design efforts are achieved, implemented, and worked on as optimally as possible. Ergonomics is required to perform a qualified, certified, and customer-need design. This science will be a simultaneous linkage and create synergies in the emerging ideas, design processes, and final design.

Before making work facilities for model II chairs and model III chairs, the design and map of the operation process are first made and the materials used are prepared. Making designs, concepts, and final results affects the value and effects of design. Image of the embodiment of an idea from a designer after discussing with the client what he wants to achieve, goals, segments, how to realize the design, etc. Concepts are usually poured into rough drawings (sketches), then presented to the client before being processed to the next stage. The ability to run ideas into concepts is influenced by what a designer sees, hears, and what a designer reads. So the more varied readings will increase the power of a designer.

The stages in designing a design can be described into six processes, namely: 1) Concept, 2) Media, 3) Ideas/ideas, 4) Data preparation, 5) Visualization 6) Production. In the end, the design stage process is not always standard like this; it can be adjusted to the budget, time, and desired results of a design. Some may be just three stages or four stages. It all depends on the designer and the client, of course. [5]. In making the chair, the researcher asked a carpenter to obtain results that matched the desired quality. The process of making the chair work facility is carried out by purchasing the materials in question, explaining the sizes as drawn, and explaining the sequence of work based on the operation process map, the process of making the chair work facility is carried out.

Experimental Design, The basic principles of experiment design are; repetition, randomization, and local control. However, previously known, the terms Treatment, experimental units, object populations, experiment patterns, and experimental errors [9].

5. RESEARCH METHODS

The tools and materials used in this study are digital cameras, chair design data, met lines, wooden boards, saws, nails and glue, sandpaper and putty, NBM questionnaires, and stationery.

The stages of research that will be carried out in the study consist of six steps, namely:

a. Phase I. Evaluation of current work facilities (Model I Chairs), using the Nordic Body Map questionnaire as the basis for determining the facility design.
b. Phase II. Making 2 (two) facility designs, namely making a design of 2 new chair models (Model II chair and Model III Chair). The word design of the model II chair is still partly the same as the design of the Model I chair (current seats) by adding seat height and legroom. Meanwhile, the word design of the Model III Chair is the same as the design of the Model I chair, and a sponge is added to the seat base.
c. Phase III Data retrieval. What is done in this case is to make a comparison of the usage of the three chair models by distributing the Nordic Body Map questionnaire to operators when using work facilities to obtain appropriate work facilities.
d. Phase IV Data processing. First, an evaluation of the use of existing facilities (Model I Chair) is carried out. Then made two designs, namely the Model II Chair and the Model III Chair, as a work facility. The results of the tabulation of Nordic Body Map questionnaire data (physical complaint questionnaire) both before and after 2 (two) work facility designs, namely model II and Model III chairs, to obtain an appropriate design method.
e. Phase V Analysis and discussion. Inter-performance of the results from data processing was further tested for design. The feasibility to determine the difference (Gab) of operator complaints and statistical test t-Test of the use of the three chair designs, namely the Model I Chair (current chair), the Model II Chair, and the designed Model III Chair.
f. Phase VI Conclusions and Suggestions. At this stage is to answer from the purpose of conducting research

6. RESULTS AND DISCUSSION

The results of the evaluation of current work facilities and use of work facilities, namely the current operator's seat, according to Figure 1. Dissemination of the questionnaire to 10 people in the group as respondents. The results of complaints felt by ten respondents using Model I Chairs were that the respondents' body parts as a whole felt painless as much as 33.6% and somewhat painful 34.3%. As many as 25.4% felt pain, and 6.8% felt pain once. The amount of complaints is a bit sick, sick, and sick once >50%, so the results of the evaluation of the Model I Chair need to be redesigned so that appropriate work facilities are obtained in the process of making Bakpao cakes.

The following shows the sizes used by each seat model according to Table I.

TABEL I. SEAT MODEL SIZE

Num	Type	Part	Size (cm)
1	Model I Chair	Width of Seating Mats	32
		Length of Seating Mats	35
		Chair Height	56
2	Model II Chair	Width of Seating Mats	32
		Length of Seating Mats	35
		Chair Height	60
3	Model III Chair	Width of Seating Mats	32
		Length of Seating Mats	35
		Chair Height	56
		Foam Height	4

The discussion includes three steps, namely: 1) Designing the operator's work facilities, namely making a chair model design according to Figure 3 and Figure 4, making a map of the chair-making operation process, and holding materials. 2) Making two chair models with the help of a carpenter. 3) Comparing what the operator feels when using the three chair models to find out whether or not there are differences in operator complaints based on the Nordic Body Map questionnaire distributed to respondents, with provisions on use:

1. Model I Chairs are built with Model II Chairs,
2. Model I Chair compared to Model III Chair,
3. Model II Seats compared to Model III Chairs.

Based on data from Table 1. can be obtained design from the seat model shown in Fig 2 and Fig 3.

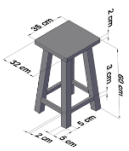

Fig 2. Model II Chair Design

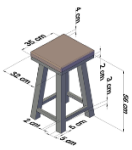

Fig 3. Model III Chair Design

The questionnaires were distributed to respondents two (2) times, namely when using model II chairs and model III chairs, to 10 respondents by work standards.

The questionnaire distribution results using the Model II Chair with working conditions, such as Fig 4. Of the 10 (ten) respondents, 58.9% did not feel pain, 33.2% felt a bit painful, 5.4% felt pain, and 2.5% felt pain once. There were complaints of pain in the upper right arm body of as many as 1 person, the waist of as many as 2 people, and the bottom of as many as 4 people. This shows that there has been an increase in painlessness in body parts by 25.3% of the use of model I chair.

When using a model III chair with working conditions such as Fig 5. obtained the results of complaints felt by 10 respondents as many as 61.7% did not feel pain, felt somewhat pain 29.5%, 7.4% felt pain and 1.4% felt pain once. The complaints of pain are found in four (4) parts of the respondent's body, namely the left calf and right calf 1 person each, and in the ping a section as many as 2 people. This shows that there has been an increase in painlessness in body parts by 2.8% of the use of model I chair.

Fig 4. Use of Model II Chair Fig 5. Use of Model III Chair

The data on the comparison of the use of Model I Chair with Model II Chair, the comparison of the use of Model I Chair with Model III Chair, and the comparison of the use of Model III Chair with Model II Chair. Used to determine the value of complaints based on the types of respondents' complaints (Nordic Body Map questionnaire) can be obtained the total number of complaints when using each seat model and its weight value as in Table II, Table III, and Table IV.

TABLE II. RECAPITULATION OF TOTAL COMPLAINTS OF MODEL I AND MODEL II CHAIR USAGE RESPONDENTS.

Num	Taste Complaints	Total Number		Weight
		Model I Chair	Model II Chair	
1	It doesn't hurt	940	1,650	1
2	A bit sick	960	930	2
3	Sick	710	150	3
4	It hurts so much	190	70	4

TABLE III. RECAPITULATION OF TOTAL COMPLAINTS OF MODEL I AND MODEL III CHAIR USAGE RESPONDENTS

Num	Taste Complaints	Total Number		Weight
		Model I Chair	Model III Chair	
1	It doesn't hurt	940	1,730	1
2	A bit sick	960	820	2
3	Sick	710	210	3
4	It hurts so much	190	40	4

TABLE IV. RECAPITULATION OF TOTAL COMPLAINTS OF MODEL III AND MODEL II CHAIR USAGE RESPONDENTS

Num	Taste Complaints	Total Number		Weight
		Model III Chair	Model II Chair	
1	It doesn't hurt	1,730	1,650	1
2	A bit sick	820	930	2
3	Sick	210	150	3
4	It hurts so much	40	70	4

Based on the data in Table II, Table III, and Table IV, the magnitude of the comparison between the complaints of using the chair model was obtained. The weight value does not hurt complaints weighting of 1, complaints a bit sick weight 2, complaints of the sick weight of 3, and complaints of pain it hurts so much 4. Based on the total percentage value of each pain complaint and the weight value of the use of the chair model that has been compared, the most suitable chair model will be obtained based on the results of the comparison value.

Based on the size of the respondents' complaints, the use of the chair model compared to small means that there is a decrease in pain complaints, according to the equation:

Complaint Value = ∑(Total presentation value* weight) comparison chair model complaint – ∑(Total presentation value * weight) compared chair model complaints. (1)

Based on the data of Table II and equation 1, the magnitude of the comparative value of complaints is obtained:

The value of the complaint = The value of the model II complaint - The value of model I complaints

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std Deviation	Std Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pair 1 Chair I Chair III	6.3000	2.16282	0.68394	4.75281	7.84719	9.211	9	0.000

= ((1,650*1) + (930*2) + (150 *3) + (70*4)) – ((940*1) + (960*2) + (710*3) + (190*4)
= -1,510

Because the comparative value of the use of the Model I Chair and Model II Chair is negative, the chosen one is Model II Chair.

Based on the data of Table III and equation 1, the magnitude of the comparative value of complaints:

The value of the complaint = The value of model III complaint - The value of a model I complaints

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= ((1,730*1) + (820*2) + (210 *3) + (40*4)) – ((940*1) + (960*2) + (710*3) + (190*4)
= - 1,590

Because the comparative value of the use of the Model I Chair and Model III Chair resulted in negativity, the chosen one was the Model III Chair.

Based on the data of Table IV and equation 1, the magnitude of the complaint comparison value is obtained:

The value of the complaint = The value of the model II complaint - The value of model III complaints

= ((1,650*1) + (930*2) + (150*3) + (70*4) – ((1,730*1) + (820*2) + (210*3) + (40*4))
= 80

The complaint value of comparison of the model I chair with the model II chair and model I chair with the model III chair results were negative. So there was a decrease in the value of pain complaints from using the model II and model III chairs. While the pain complaint value of using the Model III Chair and the Model II Chair resulted in a positive result so that there was no decrease in the value of the complaint, the model II chair was chosen.

Based on the statistical test t-Test using SPSS 22 software with a 95% probability rate and 5% accuracy rate, then three comparisons of chair model usage such Table V, Table VI, and Table VII

TABLE V. DATA PROCESSING OUTPUT OF RESPONDENTS' COMPLAINTS USING MODEL I CHAIRS WITH MODEL II.

TABLE VI. DATA PROCESSING OUTPUT OF RESPONDENTS' COMPLAINTS USING MODEL I CHAIRS WITH MODEL III

TABLE VII. DATA PROCESSING OUTPUT OF RESPONDENTS' COMPLAINTS USING MODEL II CHAIRS WITH MODEL III

Based on the results of the SPSS 22 data processing output, the hypothesis tested is the difference in the average complaints of respondents using the chair model compared to the comparison chair model; the following are the results of the output analysis for the statistical test t-Test:
The Hypothesis of using the compared chair model and the comparison chair model.

H_0: there was no significant difference between pain complaints using the comparison chair model and pain complaints after using the comparison chair model.
H_1: there is a significant difference between pain complaints using the comparison chair model and pain complaints after using the comparison chair model.

Decision criteria
Sig. (2-tailed) < 0.05, then H0 is rejected, and H1 is accepted Sig. (2-tailed) > 0.05, then H0 is accepted and H1 is rejected (if the calculation results compare the probability value (Sig.)
Or
t count > t table, then H0 is rejected and H1 is accepted
t count < t table, then H0 is accepted and H1 is rejected
(if the calculation results compare the calculated t values) obtain the results as per Table VIII.

TABLE VIII. RESULTS OF RECAPITULATION OF STATISTICAL TEST CALCULATIONS T-TESTS

No	Model Chair	t count	t table (α=0,05)	Sig. Value	Description
1	The Model I chair with Model II chair	10.673	2.14	0.000	H_0 is rejected and H_1 accepted
2	The Model I chair with Model III chair	9.211	2.14	0.000	H_0 is rejected and H_1 accepted
3	Model II chair with Model III chair	0.885	2.14	0.399	H_0 is accepted and H_1 rejected

Based on Table VIII, there are differences in pain complaints between respondents when using the model I chair with the model II chair and the model I chair with the model III chair. However, there was no difference in pain complaints between respondents using model II chairs and model III chairs. Respondents felt more pain complaints when the model III chair. So it can be said that respondents chose to use the model II chair because they experienced fewer complaints than when using the model III chair. In accordance with Table 7, it is seen that the results of paired statistics of negative mean values mean that there is an increase in complaints from the use of the III chair model, then the model II chair is chosen.

	Paired Differences					t	df	Sig. (2-talled)
	Mean	Std Deviation	Std Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pair 1 Chair II Chair III	-4.000	1.42984	0.4516	-1.42285	0.62285	0.885	9	0.399

CONCLUSIONS AND RECOMMENDATIONS

The comparative value of the model I chair with model II chair is -1,510, the model I chair with model III chair is -1,590, while for model II chair with model III chair is 80.
The results of the statistical test t-Test of operator complaints using model I chair and model II chair showed sig values (2-tailed) (0 > 0.05) H0 were rejected, and H1 was accepted. For the model I chair and model III chair show sig values (2-tailed) (0 > 0.05), H0 is rejected, and H1 is accepted. The operator used the model II chair, and the model III chair showed a sig value (2-tailed) (0.339 > 0.05), H0 was accepted, and H1 was rejected. The model II chair was chosen as a working facility for the sustainability of the Bakpao cake-making process.

REFERENCES

[1] Dewi, C. K. 2021. Identifikasi Beban Kerja Dan Keluhan Muskuloskeletal Pakerja Untuk Memperbaiki Respon Fisiologis Pada Aktivitas Memilin Serat Agel Di IKM Kulon Progo. Jurnal REVAKASI, Vol. 9, No. 2, 31-36.

[2] Frans, B., dkk. 2017. Perancangan Fasilitas Kerja Yang Ergonomi Dengan Menggunakan Metode Rasional Di Dusun serdang Bedagai Provinsi Sumatra Utara. Journal of Industrial and Manufacture Engineering. Vol 1, 1-13

[3] Hunusalela, Z.F, dkk. 2022. Analisis Posturkerja Operator Dengan Metode RULA dan REBA Di Juragan Konveksi Jakarta. Jurnal IKRAITH-TEKNOLOGI Vol 6. No1, 1-6.

[4] Kaebernick, H., L. E. Farmer, dan s. Mozart. 1997. Concurrent Product and Process Design, Sydney: UNSW.

[5] http://akh3ru.blogspot.com/2015/12/tahapan-dalam-desain.html 06 februari 2022

[6] Lestariningsih, S. 2022. Rancangan Fasilitas Kerja Berdasarkan Data Antropometri Pada Proses Pembuatan Kue Bakpao Kelompok Sumberan Mentas Unggul. Jurnal Aplikasi Ilmu Teknik Industri. Volume 3.No. 1, 1-10.

[7] Nurmianto, E. 1996. Ergonomi, Konsep Dasar dan Aplikasinya, Edisi pertama, Guna Widya, Jakarta.

[8] Sokhibi, A. 2017. Perancangan Kursi Ergonomis Untuk Memperbaiki Posisi Kerja Pada Proses Packing Jenang Kudus. Jurnal Rekayasa Sistem Industri. Vol 3. No 1, 61-72.

[9] Suwanda, 2015, Desain Eksperimen untuk Penelitian Ilmiah, Penerbit Alfabeta, Bandung.

[10] Tarwaka, dkk.2010. Ergonomi Industri, Dasar-dasar Pengetahuan Ergonomi Dan Aplikasi DI Tempat Kerja Ed1, Cet.1. Surakarta: Harapan Press

[11] Widodo.I.J, 2004. Perencanaan dan Pengembangan Produk, UII Press. Jogjakarta.

[12] Wignjosoebroto, S. 2008. Ergonomi Studi Gerak dan Waktu, Surabaya, PT. Guna Widya.

[13] Zulfahmi, A., dkk. (2020). Rancang Bangun Alat Adon Bambu Pecel Menggunakan Metode Nordic Bady Map (NBM) Dengan Pendekatan Antropometri. Jurnal TIN Universitas Tanjungpura. Vol 4. No. 2, 30-35