Redesign of the Traditional Handloom for Sarong Female-Weavers Based on Anthropometric Data

by Iwan Muhamad Ramdan

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Abstract

Introduction: Poor working posture due to non-ergonomic handloom design might be a cause of musculoskeletal disorders (MSDs) in Samarinda Sarong weavers.

Objectives: This study describes the inconsistency of the present handloom used with weaver anthropometry data and presents a new design of handloom based on anthropometric dimensions.

Method: An anthropometric survey was carried out to determine the anthropometric dimensions of 50 female weavers. The existing handloom dimensions were also measured. The data were analysed using descriptive statistics (min., max., mean, median, mode, standard deviation and 5th, 50th and 95th percentiles), as well as distribution and uniformity. The Indonesian Standard for Workstation Design (ISWD) was used to redesign the chair and table of the traditional handloom.

Results: The traditional handloom dimensions were found to be incompatible with the body dimensions of the female weavers. This suggests that the weavers MSD sexhibited could be due to this incompatibility. Based on the anthropometric data collected, we have redesigned the traditional handloom.

Conclusions: The anthropometric data of the Samarinda Sarong female-weavers revealed body dimensions ill-suited to current traditional handloom dimensions. We have redesigned the traditional handloom based on these findings.

Keywards: *Anthropometric dimension, musculoskeletal disorders, ergonomic, working posture, redesign handloom.*

Introduction

In several countries, the rising of musculoskeletal disorders (MSDs) prevalence resulted considerable costs for both healt hand the weaving industry.(1),(2) Recently, we reported that 85% of Sarong Samarinda weavers in Indonesia experienced MSDs prevalence, with incidence of low, moderate, and high ratings at 15.0%, 7.5% and 77.5%, respectively.(3)Skeletal muscle pain was primarily detected in the lower neck, shoulders, upper hands, bottom, waist, thighs, calves and ankles. MSDs were found to be associated with the education level, work experience, prolonged sitting time, work posture and body anthropometry. Work posture was the dominant variable responsible for MSD prevalence. Poor work posture may be caused by the ill-suited fit of the handlooms' design to the anthropometry dimensions of the weavers.(3)

The risk factors of MSDs for the weavers are include awkward and static work postures, twisting and lifting motions, pushing and pulling motions, and repetitive work.(2),(3),(4)Awkward and static posture problems are generally caused by non-ergonomic work equipment and workstation design,(5) which greatly affectedon performance and work productivity.(6)This research describes the redesign of traditional handlooms, which is used by Samarinda Sarong weavers based on their anthropometricdata.

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Material and Method

An anthropometric survey was carried out to determine the anthropometric dimensions of 50 female weavers of Samarinda Sarongat East Kalimantan, Indonesia, from March to August in 2018.

Anthropometric dimensionsof the weavers, i.e. sitting height, sitting eye height, sitting shoulder height, sitting elbow height, sitting mid-shoulder height, waist height, popliteal height, buttock-popliteal length, shoulder breadth, hip breadth, waist breadth, elbow-to-elbow width, forearm-hand length and upper limb length (maximum extended arm) were determined. While the handloom chair dimensions measured were height,depth,width,backrest tilt angle,upper backrest, lower backrest, armrest height and armrest length; the handloom table dimensions included surface height, surface width, surface depth, foot rest/step-on height, swing arm handleand the surface angle.

Data were analysed using descriptive statistics (minimum, maximum, mean, median, mode, standard deviation and 5th, 50th and 95th percentiles), in addition to distribution and uniformity.[7]

Results and Discussion

Demographic, anthropometric and current handloom dimension data: Demographic and anthropometric data of the weavers in this study are shown in Table 1 and Table 2, while dimension data of the current handloom[3] is shown in Table 3.

Table 1. Personal Characteristics of Samarinda Sarong Female Weavers (census, n=50)

Characteristics	Mean	SD	Range	Min	Max
Age (years)	45.60	11.55	45.00	28.00	73.00
Weight (kg)	55.88	9.40	39.00	35.00	74.00
Height (cm)	151.12	6.30	25.00	140.00	165.00
Working period (years)	20.38	13.43	57.00	1.00	58.00
Working time per day (hours)	6.12	1.25	7.00	3.00	10.00

Table 2. Anthropometric dimension of Samarinda Sarong weavers (census, n=50)

Dimension (cm)	Mean	SD	Percentile			p*
			5th	50th	95th	
Sitting height	81.50	3.63	74.00	82.00	87.45	
Sitting eye height	69.44	3.79	62.55	70.00	75.45	
Sitting shoulder height	52.90	2.92	47.00	53.00	58.00	0.909
Sitting elbow height	32.92	4.14	24.10	33.50	37.45	1.18
Sitting mid shoulder height	38.44	4.45	30.00	39.00	44.00	
Waist height	23.88	2.56	20.00	24.00	28.00	
Popliteal height	45.88	4.95	35.55	46.00	54.90	0.492
Buttock-popliteal length	53.32	3.49	47.00	53.50	60.45	0.928
Shoulder breadth	21.36	4.10	17.00	20.00	30.90	
Hip breadth	34.34	4.52	27.00	34.50	42.45	0.662
Waist breadth	29.16	3.90	24.10	28.00	36.90	
Elbow to elbow	35.14	4.10	29.55	35.00	42.00	
Forearm-hand length	33.72	2.09	30.00	34.00	37.00	
Upper limb length/arm reach forward	69.20	3.44	63.55	70.00	73.00	1.158

Note: * Normality distribution and uniformity data test (Kolmogorov–Smirnov at α 0.05)

Table 3. Dimension difference of current and redesigned traditional handloom

Part	Current	Redesigned
Chair		
Height (cm)	56.00	55.35
Depth (cm)	27.00	47.00
Width (cm)	40.00	48.65
Backrest tilt angle	-	120°
Upper backrest (cm)	-	47.00
Lower backrest (cm)	-	24.10
Armrest height (cm)	-	37.45
Armrest length (cm)	-	37.00
Table		
Surface height (cm)	79.00	88.44
Surface width (cm)	92.00	92.00
Surface depth (cm)	150.00	150.00
Foot rest/Step on height (cm)	17.00	17.00
Swing arm handle (cm)	33-37	33-37
Angle to horizontal (°)	0° (flat)	0° (flat)

The proposed dimension of redesign handloom: Based on the MSDs prevalence from the previous study,[3] we consider the dimension of the current traditional handloom design. Seven dimensions for the chair design (seat height, seat width, seat depth, seat angle/backrest tilt angle, seat backrest height (upper), seat backrest height (lower) and armrest height and length) and six dimensions for the table design (table surface height, table surface width, table surface depth, foot rest/step-on, swing arm handle depth and table angle).

From in depth interviews with the female weavers, we found that only the table surface height dimension was detected as uncomfortable. We changed the table surface dimension and the rest of the handloom table dimensions remained the same as the original dimensions (Table 3). The proposed dimension of redesign handloom is shown in Figure 1.

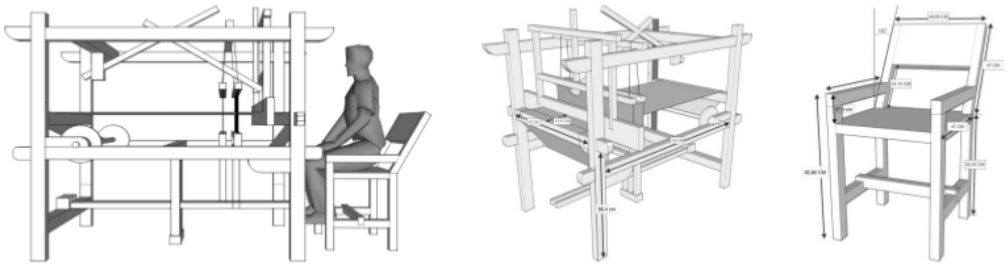

Figure 1. Construction of redesigned traditional handloom for Sarong Samarinda woman weavers.

Seat height: The seat height is set to the non-adjustable height of 55.35 cm. It was designed using the 95th percentile of the popliteal height, as suggested by the ISWD,[8] combined with the requirements of addinga shoe-heel allowance of 0.45 cm.[9],[10] The 95th percentile of the popliteal height of the weavers is 54.90 cm, while the handloom 'step-on' component is 0.45 cm because the weavers work without shoes.

Seat depth: The seat depth is set to 47 cm, as suggested by Molenbroek et al.[11], Thariq et al.,[12] and Woo et al.,[13] to adhere to the 5th percentile of the buttock-popliteal length and therequirement that the seat depth should not exceed the buttock-popliteal length of the shortest user.

Seat width: The seat width of handloom chair is designed to be 42.45 cm with an allowance of 15% (6.3 cm), which translates to a seat width of 48.65 cm. The chair width constitutes the horizontal distance from the outer left side of the sitting surface of the seat to the outer right side.[9] The seat width was designed using the 95th percentile of hip breadth.[15,18,17]

Seat angle: The seat angle, orbackrest tilt angle,is set to 120°, as this will reducethe occurrence of disc pressure as recommended from previous studies.[13–15]

Upper backrest height: The upper backrest height(the vertical distance from the top side of the seat surface to the highest point of the backrest) is set to 47 cm, based on the recommendations to use the 5th percentile of sitting shoulder height.[18,14,19]The upper backrest heightis the key ergonomic element in thechair's design,withitsform and degrees importantinfluences in improving sitting posture and maintaining a normal spine.[10]

Lower and upper backrest heights: The lower and upper backrest heights of the handloom chair seatare set to 24.10 cm and 47 cm, respectively, based on the 5th percentile of sitting elbow height and the 5th percentile of sitting shoulder height measurements.[18,21]

Armrest height and length: The armrest height and length are set to 37.45 cm and 37.00 cm, respectively. Appropriate height adjustments and sufficient armrest padding can reduce pressure on the undersides of the forearms and elbows.Unfortunately, some national standards provide missing or ambiguous information on the requirements for armrest design.[13]Thesearmrest height and length dimensions are based on the use of the 95th percentile of the sitting elbow height and the 95th percentile of forearm-hand length.[8]

Table surface height: The table surface heightfor the redesign is set to 88.4 cm, usingthe 50th percentile of the sitting elbow height (vertical distance of the seat to the bottom of the elbow) plus the 95th percentile of the popliteal. The formula recommended by the ISWD[8]is more suitable for the female weavers of the Samarinda Sarong than the formula proposed by Ismaila et al.[10]

Table underneath the knees height: The height of the table underneath the knees (i.e. the distance between the bottom of the table and the knees of the user) is set to 25.50 cm based on considerations to use the 95th percentile popliteal height, which is 54.90 cm, added to the thickness of the handloom table (8.00 cm). This distance allows weavers space to perform "step-on" activities and to cross their legs.[19,22]

Table surface: The ISWD[8]recommends using the 95th percentile of forward arm reach, which was 73.00 cm in this study. Other standards suggest minimum work desk areasof 150 cm (Australia), 90 cm (Canada) and 70 cm (United States).[13]However, the traditional handloom table surface width featured in this study is 92 cm, and the majority of weavers interviewed said they could operate comfortably within this space. Therefore, the width was not modified from this in the redesigned handloom.

Table surface depth: The table surface depthupholds the original dimensions of the traditional handloom (150 cm) because the weavers cited feeling comfortable with the original table surface depth dimensions in usingthe tool to roll the thread and stretch it into the swing arm handle. It is different with recommends the use of the 50th percentile of the forearm-hand length to determine table surface depth[16] or other recommended standards of the table surface depth minimums of 90 cm (Australia and Canada) or 50 cm (United States).[13]

Swing arm handle depth: The swing arm handle depth also maintains the same dimensions as the traditional handloom at 33-37 cm. The swing arm handle is used to compress the woven thread and is operated by pushing and pulling the handle. The weavers reported being comfortable with the current swing arm distance,and it fitstheir anthropometric dimensions; therefore,it did not need to be modified.

Table angle: The horizontal table angleis set to remain flat at 0°. Chaffin[18] suggests that the slope of the table surface has a positive impact on the neck, back and shoulders, but that it must be adjusted according to its function. For reading and writing activities, users being able to adjust table tilt settings can reduce spinal flexion, which in turn reduces the risk of fatigue.[21,25] However, the slope of the handloom table should be set to 0°to keep all components and materials sitting on the surface of the weaving table from falling off. Changing this angle will cause the table to slope, which can cause the components and material son top to shift, disrupting the weaving activities.

The limitation of the redesign traditional handloom: The redesign of the traditional handloom is expectedto reduce the prevalence of MSDs in the

Samarinda Sarong weavers studied,similar to the results of the study by Purnomo et al.[20]on redesigning school furniture. Choobineh et al.[21]also showed that upholding appropriate workstation dimensions for carpet hand-weaving improved the weavers' work posture and reduced incidence of MSDs. Currently, no data exists on the impact of redesigning traditional handlooms based on the work posture and MSD prevalence of the weavers. However, we are now preparing a follow-up study to test the handloom chair and table we developed in this study to determine how it affects weavers' posture, comfort and MSD occurrences. The limitation of this study is that our handloom redesign is only applicable to users in the south eastern region of Asian because the anthropometry dimensions gathered exclusively reflect the Samarinda Sarong weavers of this region. However, the newly redesigned handloom may be usable for weaving workstations beyond traditional weaving products.

Conclusion

The traditional handloom currently used by female weavers making Samarinda Sarongs is not compatible with the anthropometric dimensions of these female Indonesian weavers. In this study, we redesigned the traditional handloom based on the anthropometry data collected from the woman weavers to fit the handloom dimensions to their body characteristics. The redesigned handloom is significantly different from the current traditional handloom in several ways. Moving forward, the new design needs to be assessed to determine if it will improve posture and comfort and reduce MSD occurrences in the weavers.

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Ethical Clearence: This study was reviewed and approved by the Ethical Commission of Health and Medical Research of Mulawarman University (Indonesia) Faculty of Medicine, with the reference number of 33/KEPK-FK/IV/2018.

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Conflict of Interest: Nil

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