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The Development and Design of Ergonomic Fish Smoking Equipments for Smoked Fish Workers in Maluku

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Abstract
Fish is a superior commodity in The Province of Maluku with the potential of fish production is 1,64 million tons per year, although this has not stand by proper processing. Fish are generally processed in traditional way with smoking method and are usually maintained by home industries. This research is aimed to develop and design the equipments for workers base on ergonomic criterias. This effort is purposively to decrease the workers' sighs so the productivity can also be increased. This research has started with problem formulation then data collecting of the workers' sighs,stool and fireplace dimension, and cutting board. From this step then continued with processing of the sighs data, anthropometry data, and percentile adjustment data. The Percentile is 95%. The result of the sighs data processing shows that average number of the workers had suffered by disturbance on skeletal muscle categorized by pain and hardly pain dominantly on bottom 63%, knees 56,7%, left and right thigh 46,7 % and right knee 56,7%. For the result of design has basicly obtained from the worker anthropometry and other ergonomic factors such as work environment and work posture.

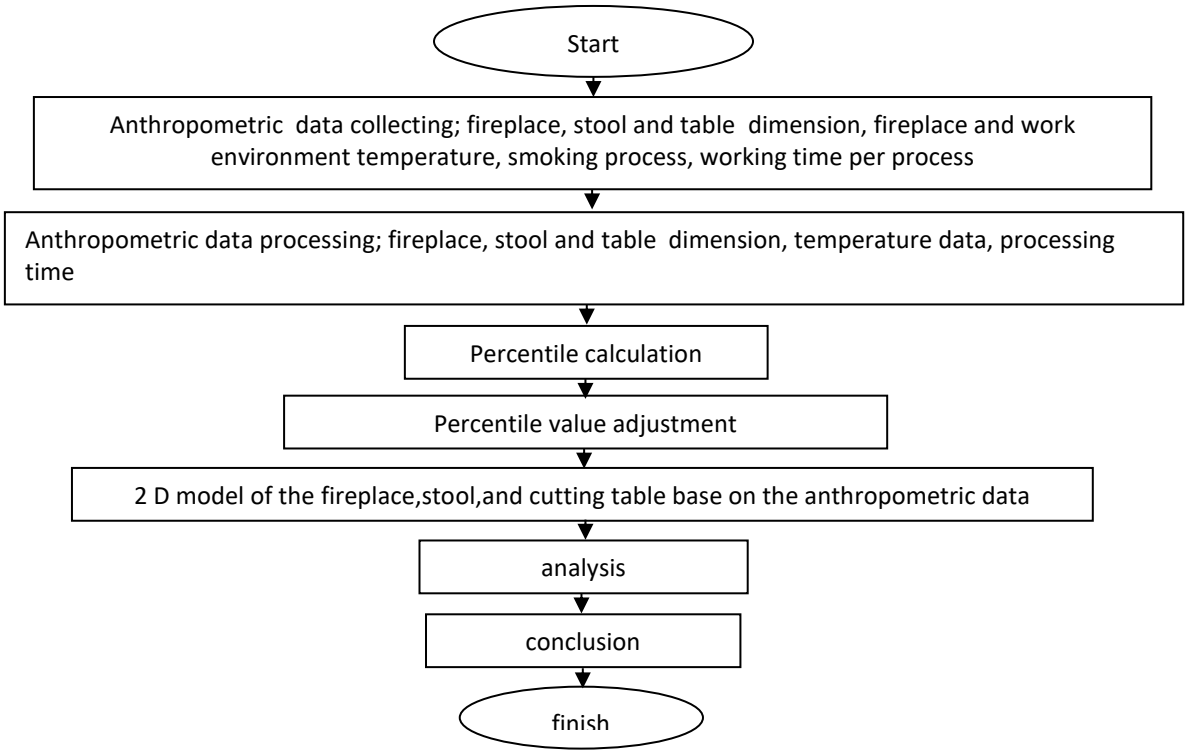
Keywords: *smoked fish, home industry, antropometry, fireplace, stool, cutting board*

I. INTRODUCTION

Maluku is a province in Indonesia with a huge potential of catching fishery. As the National Fish Barn, fishery potential in The Province of Maluku can reach out of 1,64 million tons per year (Yudha Putra,2014). From the whole catching fishery potential, the production level in 2010 was 359.590,6 tonsor 27,65% of the eternal potential, and in 2011 was 528.337,4 tonsor approximately 33%. One cause of this 33% utilization of the fish potential is the less availability of fish production facilities. (Bertindak Untuk Rakyat, 2012). According to Herawati (2002), most of fish processing in Indonesia can be classified into traditional fish production and scale of home industry. In Maluku, fish production operates on the basic if smoking system or called *Ikan Asar*But the system has still very simple and poorly inadequate attention to product hygiene or the environment surround the smoking area. The existing smoking system consists of some integrated components are: 1) Input component (raw fish), 2) Process component consists of processing and smoking. In processing, firstly the fish has cleaned from its gills and scales, half cutted, submerged in water without any mixture during 40 – 60 minutes and drained. It causes the taste and color of the fish change and increase water content in the fish. This will effect to the fish quality such as the dissolved fish meat or change of the taste become itch and undelicious. In smoking process, fish has smoked in a fireplace which has a burning room, smoking shells, and drying shells. Height of the fireplace approximately 2,1 m and weight of approximately 2–3 m. The shells are very low with insufficient dimension with the workers' anthropometry. Its average capacity is 10 to 20 fish. The number of fish production per day is 100 to 300 fish so the time needed for fish smoking is 6 to 7 hours/100 fish. With these fireplace and shell sizes, the workers are frequently pushing hard efforts such as squat and stand to sit repeatedly, for drying process. According to Tarwaka, et.al (2004) innatural work position like squat during a long time will cause fatique and disturbance to the back muscle. Poor air circulation in the fireplace with uncovered burning room cause the high concentration of thick smoke that will effect to the health of smoking workers. According to Kaswandani, (2013), if a worker shackles in smoke during a short time, can cause to allergy to respiration system and caugh, while for a long time will cause to heavier disturbance such as TBC . Thick smoke also can cause eye to become poignant. Uncovered burning room also can conduct to inefficient smoke utilization because smoke spread everywhere and increase the environment temperature. A condition where air temperature is very hot and high moist, will effect to heat decreasing from the body at the same time, because of the evaporation system and other impacts will cause faster heart throb because the more active of blood distribution to fulfil the need of oxygen (Sutalaksana,2006). Beside the high temperature can effect the raise of body temperature, fatique, and unconscious (Suma'mur, 2009). To increase the product quality and fish smoking worker productivity, then it need to redesign equipments that sufficient to theirn anthropometryand take into consideration the other ergonomic aspects like work posture and work environment.

II. RESEARCH METHOD

This research is a quantitative research with the object is fish smoking workers in Maluku. The stage of research as Figure 1.



Data collecting uses questionnaires of *Nordic Body Map*and the measurement of equipment dimension and workers' anthropometry. Data processing are the data processing to sighs and anthropometric data of the workers.

III. RESULTS

A. Percentage of Workers' Sighs Base on Nordic Body Map

The results for the percentage of workers' sighs taken from *Nordic Body Map*is as shown in Table 1

Table 1. Percentage of Workers' Sighs

		PERSENtTAGE			
NO	QUESTION	A	B	C	D
1	Pain in upper neck	36,7	46,7	3,3	13,3
2	Pain lower neck	30,0	43,3	16,7	10,0
3	Pain in left shoulder	30,0	36,7	13,3	20,0
4	Pain in right shoulder	33,3	23,3	26,7	16,7
5	Pain in left upper arm	23,3	10,0	50,0	16,7
6	Pain in back	23,3	33,3	10,0	33,3
7	Pain in right upper arm	30,0	30,0	36,7	3,3
8	Pain in loins	16,7	13,3	30,0	40,0
9	Pain in buttocks	13,3	10,0	63,3	13,3
10	Pain in bottom	20,0	16,7	36,7	26,7
11	Pain in left elbow	26,7	23,3	36,7	13,3
12	Pain in right elbow	26,7	40,0	20,0	13,3
13	Pain on lower left arm	30,0	20,0	46,7	3,3

NO	QUESTION	PERSENtTAGE			
		A	B	C	D
14	Pain on lower right arm	30,0	23,3	43,3	3,3
15	Pain on left handcircle	26,7	33,3	40,0	0,0
16	Pain on right handcircle	30,0	16,7	33,3	20,0
17	Pain on left hand	26,7	56,7	13,3	3,3
18	Pain on right hand	26,7	30,0	13,3	30,0
19	Pain on left thigh	40,0	10,0	46,7	3,3
20	Pain on right thigh	33,3	13,3	46,7	6,7
21	Pain on left knee	26,7	20,0	33,3	20,0
22	Pain on right knee	16,7	13,3	56,7	13,3
23	Pain on left calf	30,0	13,3	30,0	26,7
24	Pain on right calf	26,7	13,3	43,3	16,7
25	Pain on left ankle	33,3	10,0	33,3	23,3
26	Pain on right ankle	36,7	13,3	30,0	20,0
27	Pain in left foot	26,7	20,0	33,3	20,0
28	Pain in right foot	26,7	26,7	26,7	20,0

Note: A=Not pain B= rather pain C= pain D = Hardly Pain

Base on the data i Table 1, we csan see that body parts of the workers that had suffered with rather pain to hardly pain are in the area of hands, legs, calf and loins. These can be the impacts of the workers work in innatural body position such as sit and humped during a long time repeatedly.

B. Results of Anthropometric Data

Percentile calculation for 5% and 95% as shown in Table 2, although the value in designing process if percentile of 95%

Table 2. The Results of Percentile Calculation

Variable	Percentile	
	5%	95%
Tdt	71,1	84,8
Tdn	71,1	84,45
Tbd	46,65	60,35
Tmd	59,1	71
Tsd	17,55	40,5
Tsp	29	60,9
Tp	16,55	25
Tpd	40	60
TbPh	25	39,45
Tpop	33	45,45
Ppop	41,1	52
PL	50	61,9
LB	36,1	47,9
LSD	25,55	42,25
Lgul	29,2	45,05
Lping	25	41,35
SS	33,95	55

	Percentile	
Variable	5%	95%
TBT	84,95	163,35
TMb	132,55	153,9
Tbb	117,1	135,8
Tsb	91,1	104
TPb	84	103,9
TLb	37,85	52,8
PLb	37,1	46,45
Plshoulder	55	77
RT	141.95	191.00

C. Results of Percentile Adjustments

After the percentile value has obtained, then also some adjustments as seen in table 3

Table 3 Percentile Adjustments

NO	Part of Body	95%	Size	Dimention	Design
1	RT	191	225	P	Fireplace
	Plshoulder	77	100	L	
	TBT + PlShoulder	268	300	T	
	Tsb	104	104		
2	Lbgul	45	46	P	Stool
	Ppop	52	26	L	
	Tpop	45,45	25	T	
3	Plshoulder	77	80	P	Cutting table
	Tpop	45,45	15	T	
	Lshoulder	77	77	L	

Base on the data in Table 3, we can obtain anthropometric adjustments for each model. for long size fireplace, the length had adjusted with the length of hand distance (RT) added with 34 cm because considering weight of the brick. For Uthe weight and height, each will be adjusted with the length of upper arm to the lower (Plshoulder) and the stand body height (TBT). For the stool length has adjusted with the weight of thigh (Lbgul), the stool weight has adjusted with popliteal height (Ppop) divided with two. The stool height has adjusted with the height of popliteal divided with twoa. For cutting table, the length has adjusted with Plshoulder or the length of reach, the height of cutting table has determined by the height of popliteal (Tpop) divided with two but some centimeters lower than the stool size. For the weight of cutting table has based on the weight of shoulder (Lshoulder).

D. The Design base on Anthropometric Data

After some percentile adjustments, we construct a new design for fireplace, stool, and cutting table.

A.Fireplace

B.Stool

C.Cutting table

IV. CONCLUSION DAN SUGGESTION

A. Conclusion

1. The dominant pain sigh are at the bottom 63%, knee 56,7%, left and right thighs 46,7 % and right knee 56,7%
2. The new design of the fireplace is based on the consideration of the workers' anthropometry with revises to some components such as material, dimension, and function of the fireplace, to decrease sighs and more ergonomic work environment.

B. Suggestion

Beside anthropometry in designing process there is also needed to consider more detailed ergonomic factors such as work time, work posture, and work environment

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