

Design of Grated Coconut Roasting Machine through Ergonomic Approach to Increase Work Productivity

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Keywords: Roasted Grated Coconut, Ergonomic Roast Machine, Work Productivity.

Abstract: In Karangasem Regency, roasted grated coconut is usually used as a way of kit for religious ceremonies. Roasted grated coconut is traditionally made employing a gas range or burning stove with a production capacity of about 1.5 kg of grated coconut. the typical daily production is around 6 kg, therefore the process of roasting grated coconut is repeated. This roasting process is administered for a mean of 90 minutes for one production. During the roasting process, the craftsmen stir the grated coconut continuously, and sometimes because they feel tired, the stirring process gets slower in order that there are parts of the grated coconut that get charred this causes the standard of the roasted grated coconut to be less good. In efforts to beat these problems, a working mechanism is required with the assistance of a roasting machine, in order that it can make it easier for craftsmen within the roasting process, reduce fatigue, reduce workload, and may increase work productivity. For this reason, the planning of the roasting machine was administered through an ergonomic approach in one short case study with a pre- and post-test design group which was administered observationally on the roasting process manually and by employing a roasting machine. Ergonomic Roast Machine specifications are designed with a capacity of 5 Kg as follows: a). The roasting tube may be a chrome steel plate with a thickness of 1.2 mm with a length of 670 mm and a width of 310 mm, b). the facility of the electrical motor is 0.25HP with a rotation of 1400 rpm while the rotation of the drum roast is 50 rpm with a gearbox transmission, c). the size of the machine are 80 cm long, 75 cm wide and 90 cm high. Ergonomic test results show that the utilization of a roasting machine can increase the work productivity of roasted grated coconut craftsmen by 62.07%.

1 INTRODUCTION

The main problem within the roasting process of grated coconut is an unnatural work posture, the work process using hands as a piece tool and an extended working time causing a rise in musculoskeletal complaints, fatigue, and a rise in workload which successively reduces work productivity, and long working time. Adiputra, N. (2000) said that through ergonomic intervention in small-scale industries using ergonomic work equipment will reduce workload and subjective complaints significantly thereby increasing productivity. Pascale C, and Shawna (2020) stated that the discipline of human factors and ergonomics (HFE) can provide approaches and methods to research and overcome these challenges during systematic manners. Ergonomics systems approach to explain some work system barriers and facilitators experienced by

healthcare workers (Carayon P, Hundt AS, Karsh B-T et al, 2006; Carayon P, Wetterneck TB, Rivera-Rodriguez AJ et al, 2014)

Several alternative solutions to the issues above through an ergonomic approach to the stirring process, namely employing a roasting machine model within the roasting process, are expected to scale back workload, musculoskeletal complaints, and fatigue levels also as shorten the working time and increase work productivity. a piece posture that slows down repeatedly for an extended time is non-physiological. Work postures that aren't physiological are often caused by the characteristics of task demands, work tools, work stations, and work.

By designing the assembly process can save the necessity for raw materials and processes, in order that overall costs are often saved within the manufacturing industry (Rusdiyantoro, 2011). Increased pulse at work and complaints after work

cause work productivity to be low (Manuaba, A. 2000). Work posture that's not physiological are often caused by the characteristics of task demands, work tools, work stations, and work Posture that are incompatible with the skills and limitations of workers (Kroemer and Grandjean, 2009; Manuaba, A, 2000) Non-physiological work posture that's administered for years can cause bone deformities in workers (Kroemer and Grandjean,2009).

2 METHODOLOGY

2.1 Research Design

This research is a one-short case study with a pre and post-test design group which was conducted observationally on the working process of grated coconut roasting (Corlett, Nigel, 2005; Nasution, 2012). The chart can be described as follows:

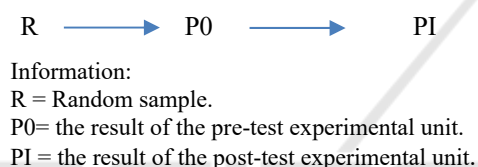


Figure 1: Research Design.

2.2 Research Variable

The variables to be measured during this study include: (1) workload as measured by the heart beat of rice before and after work; (2) complaints of fatigue and skeletal muscles before and after work; (3) work productivity after work by comparing work pulse (beats per minute) with the amount of products produced (kg) during working time (minutes). The measurement of variables number (1) to number (3) is that the information data of the initial condition and therefore the final condition which is then compared to work out the comparison before using the roasting machine and after using the roasting machine.

2.3 Data Analysis

The design data of the roasting a machine are calculated supported the necessity for a load capacity of 5 Kg, then an electrical motor, a shaft and a stirrer tank, and an ergonomic machine holder construction are planned. Test data before using roasting a machine and after using roasting a machine include data on working time/ a length of labour, a workload,

subjective complaints, and work productivity which can then be analyzed descriptively to get conclusions.

3 RESULTS AND OUTCOMES

3.1 Manually Roasted Grated Coconut Process

The process of creating roasted grated coconut on the average takes about 3 hours from preparation to completion. the typical working time of roasted grated coconut craftsmen is around 6-7 hours per day including lunch breaks for every week apart from holidays / other major holidays or if there's no order. They work from 9:00 a.m. to 5:00 p.m. Working environment conditions with hot environmental temperatures because of the influence of warmth radiation from the furnace and solar heat radiation always expose the workers although work is greatly influenced by the working weather during a comfortable working area, so it's not cold and not too hot. Such a cushty temperature is around 24-26 °C for Indonesians (Suma' mur PK, 2013). Thus, it's assumed that the recent ambient temperature will increase the workload of the workers making roasted grated coconut. The working attitude of the roasted grated coconut maker is by bending during a squatting or standing position.



Figure 2: Craftsman Work Posture.

The position is a non-physiological work posture and administered during a relatively long term and plenty of overtime causes striated muscle strain (reaction) and harms health (Manuaba, A, 2000). Non-physiological work postures can be caused by characteristics of task demands, work tools, work stations, and work postures that are not in accordance with the abilities and limitations of workers (Kroemer and Grandjean, 2009), (Manuaba, A, 2000). Non-

physiological work posture carried out for years can cause bone abnormalities for the workers (Kroemer and Grandjean, 2019), and cause subjective disorder of workers (suarbawa, at all, 2018),(Yusuf at all, 2017).

Likewise, the work attitude that accompanies roasted grated coconut makers who are always in an unnatural state will definitely cause disturbances to the striated muscle system. Working continuously for 7-8 hours per day without being amid short breaks will definitely end in the build-up of fatigue which successively increases the workload. It's characterized by a rise within the working pulse and disturbances within the striated muscle system.

In a static working position that needs 50% of the utmost force can't last quite one minute, if the force is employed not up to 20% of the utmost strength then the contraction will continue for a few time. As for the duration of dynamic activity for 4 minutes or less any individual can work with an intensity adequate to aerobic capacity before resting (Kroemer and Grandjean, 2009). Roles, et al. (2009) conducted a study on work models supported ergonomics and located that the work model was ready to reduce fatigue up to 17.71%. Torik, et al. (2009) also stated that the planning of an ergonomic work system can reduce the extent of worker fatigue. The working attitude of craftsmen should be cultivated in physiological positions like when sitting and standing, so as to not cause a forced attitude that exceeds the physiological capabilities of the body (Kroemer and Grandjean, 2009). Which is ergonomically ready to reduce muscles skeletal complaints of workers.

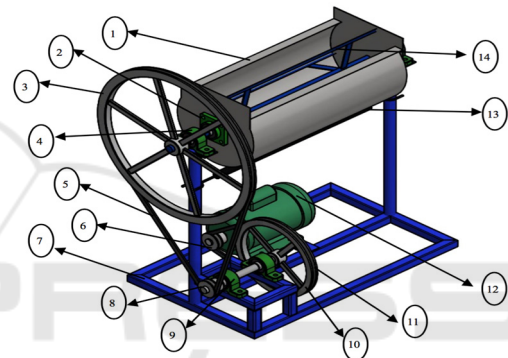
3.2 Roast Machine Design Model

The roasting machine is meant through an ergonomic approach in order that the stress of the task with work capacity should be during a balanced line in order that high work performance is achieved. consistent with Tarwaka (2004), the stress of labour assignments shouldn't be too low and will not be too excessive because both will cause stress.

The working rule of this coconut roasting machine is that when the electrical motor is on, the pulley which is one shaft with the electrical motor will rotate. The rotation of the pulley will cause the rotation of the pulley within the speed reducer because it's connected by a v-belt. within the speed reducer, the rotational speed coming from the electrical motor are going to be reduced (reduced) because the speed reducer contains a pair of gears.

Furthermore, the rotation are going to be transmitted to the cylindrical axis of the roaster by a pair of gears and chains. The horizontal cylinder (roast holder) crammed with grated coconut rotates at low speed and is heated by a heat source from LPG gas which is channeled through holes within the heating pipe located at rock bottom of the cylinder.

The results of the planning specifications for a 5 kg roasting machine are as follows: a). The roasting tube may be a chrome steel plate with a thickness of 1.2 mm with a length of 670 mm and a width of 310 mm, b). the facility of the electrical motor is 0.25HP with a rotation of 1400 rpm while the rotation of the drum roast is 50 rpm with a gearbox transmission, c). the size of the machine are 80 cm long, 75 cm wide and 90 cm high.



Caption
 1. Roaster tube
 2. Bearing
 3. Pulley 1
 4. Pillowblock
 5. V-belt 1
 6. Pulley 2
 7. Body
 8. Pulley 3
 9. Pillowblock
 10. Pulley 4
 11. V-belt 2
 12. Electric motor
 13. Gas stove
 14. Grated coconut player

Figure 3: Design of Coconut Roasting Machine.



Figure 4: The Result Coconut Roasting Machine.

3.3 The Result of Ergonomics Test using Roasted Machine

3.3.1 Subjective Complaint

The working posture of the craftsman by sitting hunched over causes a rise in musculoskeletal complaints and complaints of fatigue because of the bent attitude of the craftsmen amid exposure to environmental heat because of radiation from the stove/stove. A working posture that bends over and over for an extended time may be a work posture that's not physiological. Muscle complaints occur because the muscles receive pressure because of continuous workloads without relaxation (Bridge, 2005).

The results of measurements with a Nordic body map questionnaire for 10 craftsmen who were measured before and after work obtained the typical difference between musculoskeletal disorders before work and after work before treatment was 28.90 and after treatment was 16.70. The decrease within the mean difference between musculoskeletal disorders before treatment and after treatment was significant ($p < 0.05$) or 42.21%. This is in accordance with the results of Habib's and Hojeij (2019) research on 504 bakery workers in Lebanon who were taken randomly, showing that 23% of the workers at the bakery reported experiencing upper extremity complaints.

Table 1: Measurement Results of Musculoskeletal Disorder.

Descriptions	Everage difference musculoskeletal disorder		t	p
	Mean	Standard Deviation		
Manual roasting process	28,90	3,31	6,578	0,00
Machine roasting process	16,70	4,30		

3.3.2 Work Load

The average resting pulse of craftsmen within the manual work process (before using the roasting machine) is 69.84 (± 2.31) bpm and therefore the average working pulse is 105.96 (± 1.46) bpm and therefore the increase in work pulse is 37.53 (± 2.98) bpm or 54.48%. the typical resting pulse of craftsmen after employing a roasting machine is 68.43 (± 1.71) bpm and therefore the average working pulse is 97.08 (± 2.00) bpm and a rise in work pulse is 27.24 (± 1.64) bpm or 39.00 %.

The average working pulse of the serundeng maker before treatment was 105.96 (± 1.46) beats/minute including the category of medium workload (Kimberly, 2011). This workload is caused by workers working continuously without rest amid a hot work environment because of heat radiation from the furnace and solar heat radiation also as heat radiation through the kitchen wall causing the workload to extend.

Table 2: Resting Pulse, Pulse Working and Work Pulse.

Descriptions	Manual roasting process		Machine roasting process		t	p
	Mean	SD	Mean	SD		
Resting Pulse	69.84	2.31	68.43	11.71	-1,53	0,16
Pulse Working	105.96	1.46	97.08	2.00	10.51	0.00
Work Pulse	37.53	2.80	27.24	1.64	15.55	0.00

SD: Standard Deviation

3.3.3 Work Productivity

The work productivity of craftsmen within the roasted grated coconut process is recorded supported the ratio of output to input at a specific unit of time. The output produced is that the amount of roasted grated coconut (kilograms) produced by the crafted during working hours, while the input is that the working pulse of the crafted. The results of the calculation of productivity after using the roasting machine is 152.69 ± 3.37 while before using the roasting machine it's 94.21 ± 3.09 or a rise of 62.07%. This increase in productivity is because of a decrease in workload and an ergonomic work attitude in order that fatigue and musculoskeletal complaints are reduced and production is increased. to extend productivity, consistent with Kimberly (2011), it's necessary to vary the work system to scale back the extent of worker fatigue, in order that working time is shorter and production can increase. Torik, et al. (2009) also stated that the planning of an ergonomic work system can reduce the extent of worker fatigue.

Table 3: Work Productivity of Craftsmen in The Roasted Grated Coconut Process.

Descriptions	n	Mini-mum	Maxi-mum	Mean	Standard Deviation
Manual roasting process	10	149	151	152.69	3.370
Machine roasting process	10	91	102	94.21	3.091

Ergonomics intervention recommendations to extend work productivity also are widely stated by ergonomics researchers, like in Priambadi's research

(2012) through improving working conditions for a smelting gamelan craftsmen can increase work productivity by 26.67% and Bawa Susana's research (2014) with ergonomics interventions can increase work productivity 54.88%. Setiawan's research (2016) through the work a station design can increase work productivity by 20.29%

4 CONCLUSIONS

Based on the discussion that has been administered, the subsequent conclusions can be:

1. The working posture of roasted grated coconut craftsmen by sitting hunched over causes a rise in musculoskeletal complaints and fatigue complaints because of the craftsman's bending work posture amid exposure to environmental heat because of radiation from the stove/stove. The working posture that bends over and over for an extended time may be a work posture that's not physiological.
2. The results of the planning of the roasted grated coconut machine with a capacity specification of 5 Kg are as follows: a). The roasting tube may be a chrome steel plate with a thickness of 1.2 mm with a length of 670 mm and a width of 310 mm, b). the facility of the electrical motor is 0.25HP with a rotation of 1400 rpm while the rotation of the drum roast is 50 rpm with a gearbox transmission, c). the size of the machine are 80 cm long, 75 cm wide and 90 cm high.
3. The results of testing the work productivity of craftsmen through an ergonomic approach are obtained that: a). the typical resting pulse of roasted grated coconut craftsmen before using the roasting machine was 69.84 (± 2.31) bpm and therefore the average working pulse was 105.96 (± 1.46) bpm and therefore the increase in working pulse was 37.53 (± 2.98) bpm or 54.48%. the typical resting pulse of roasted grated coconut craftsmen after employing a roasting machine is 68.43 (± 1.71) bpm and therefore the average working pulse is 97.08 (± 2.00) bpm and a rise in work pulse is 27.24 (± 1.64) bpm or 39.00 %; b). the typical difference between musculoskeletal disorders before work and after work before employing a roasting machine is 28.90 (± 3.31) and therefore the average difference between striated muscle disorders before work and after work after employing a roasting machine is 16.70 (± 4.30). The decrease within the mean of striated muscle disorders before using the roasting machine and after using the roasting machine was

significant ($p < 0.05$) or 42.21%; and c). The results of calculating the work productivity of craftsmen before using the roasting machine is 94.21 \pm 3.09 and a rise after using the roasting machine is 152.69 \pm 3.37 or a rise of 62.07%.

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