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REDESIGN AND IMPROVEMENT OF POTTERY SPINNER TO INCREASE WORKER PRODUCIVITY

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Abstract. *Many small industries produce handicrafts related to art in Bali, one of which is pottery. Pottery is an object made of clay which is formed and then burned to be a unique shape such as: jugs, glassware, cauldron, brazier, piggy bank, and other objects. The process of producing pottery required the complex steps, from preparing clay, printing by turning, drying and burning. The main difficulty of pottery producers is in the process of forming shapes which involved the rotating spinner. Most of small industries still use the manual spin control to rotate clay bucket holder. This research aims to re-design of a rotating spin machine from the existing pottery industries to increase the productivity. The sample was overtaken from 12 craftsmen in Singakerta Village, District of Ubud Gianyar, Bali. Sample P0 was given to craftsmen is still used the old design and P1 was given to sample modified and re-designed the old machine with added automatic control of rotating spinner. Workload is calculated based on the worker's pulse rate which is measured using a pulse meter. Research data were analyzed using descriptive and inferential statistics. T-test method was performed to analyzing the differences range between groups P0 and P1 at significance level of 5%. The results showed a workload was decreased from heavy to moderate by 12.09%. Production rate was increased by 282.1%, and productivity increased by 334.6%*

Keywords: Re-design Pottery Machine, Workload, Work Productivity.

1. INTRODUCTION

Bali area currently stands many small industries that produce crafts related to art, one of which is pottery. Pottery in general is an object made of clay which is formed and then burned and then used as tools to help human activities, such as jugs, pots, pots, jars, bobs, piggy banks, and other objects. However, because Bali is famous for its culture and art, pottery artisans innovate to pour art into pottery.

The process of producing pottery required the complex steps, from preparing clay, printing by turning, drying and burning. The main difficulty of pottery producers is in the process of forming shapes which involved the rotating spinner. Most of small industries still use the manual spin control to rotate clay bucket holder and is still complained because it does not suitable to the needs, limitations, and anthropometry of the user. The production process will take place optimally if the demands of the task, organization and work environment in accordance with the abilities, permissibility and limitations of workers [1]-[3].

A preliminary survey was carried out on pottery craftsmen in Singakerta Village, Ubud District, Gianyar Regency. Most of them was complained about the high cost of spinning machines, ineffective production if using manual method and discomfort in certain body parts after the finished work. In addition, the risk of health problems will increase and eventually the productive age will decrease. Through ergonomic intervention in small-scale industries using ergonomic work equipment is proposed to reduce workload and subjective disorders [4]

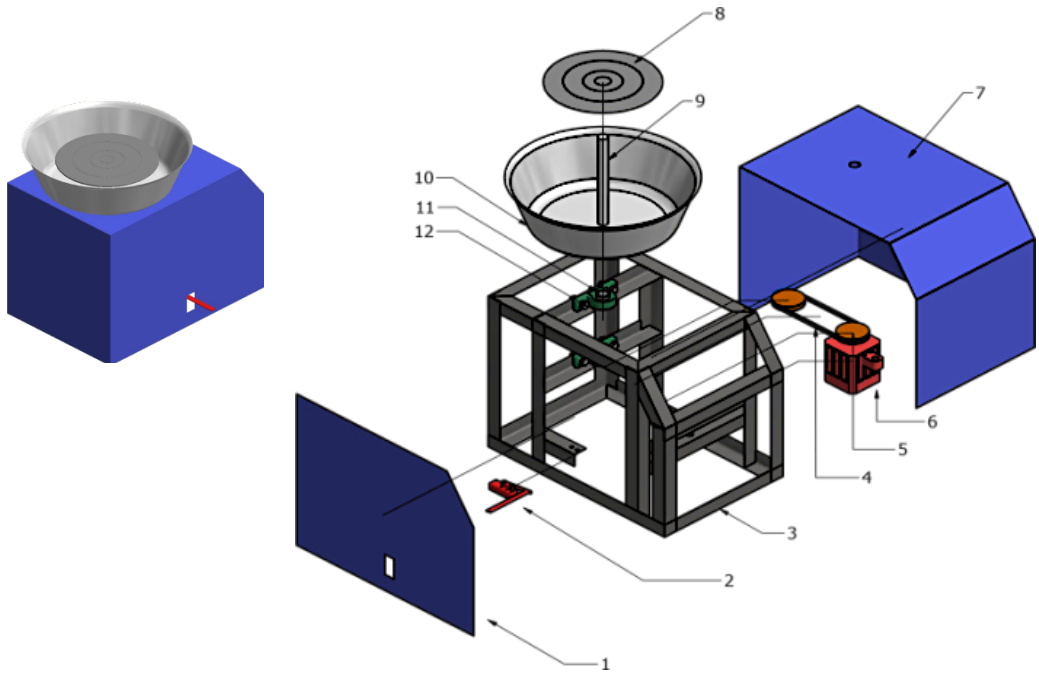
To resolve the problem of this craftsman not only about suitable tools, but needed an ergonomic comprehensive approach. Improvements in working conditions and environments should take into account all aspects of ergonomics, such as the utilization of appropriate technology, the improvement of the whole production

process with a systematic, comprehensive approach, involving various discipline and active participation both physically and psychologically in all components involved in the production process. The application of the concept of appropriate technology and the overall improvement of the production process of the SHIP (Systemic Holistic Interdisciplinary Participatory) approach should be done in a consistent and sustainable manner [2]. And the various factors that need to be considered in relation to the production process such as work tools and work stations include the size, dimension, way of work, work attitude to match the abilities, permissibility and limitations of workers [2],[3].

Based on the above description it is deemed necessary to research the improvement of working conditions by redesign and modification of the existing rotating spinner machine on the appropriateness of the function, the anthropometric dimensions of workers and easy user maintenance by an ergonomic approach.

2. METHODS

The experimental method was conducted by redesign of the existing rotating spinner machine. The sample was overtaken from 12 craftsmen in Singakerta Village, District of Ubud Gianyar, Bali. Sample P0 was given to craftsmen is still used the old design and P1 was given to sample modified and re-designed the old machine with added automatic control of rotating spinner. Workload is calculated based on the worker's pulse rate which is measured using a pulse meter. Fatigue was predicted from 30 items of general fatigue questionnaire. Skeletal muscle complaints were predicted from the Nordic Body Map questionnaire. The work productivity of the subjects is recorded based on the ratio of amount of production (output) to the workload (input) at a certain time unit. Research data were analyzed using descriptive and inferential statistics. T-test method was performed to analyzing the differences range between groups P0 and P1 at significance level of 5%. The rotating spinner with semi-automatic control driven by electrical motor was designed as the Figure 1 below



1. External cover
2. Variable speed control
3. Metal frame
4. V-belt
5. Driven pulley
6. Electrical motor
7. Upper safety cover
8. Rotating plate
9. Main shaft
10. Bucket clay
11. Bearing
12. Bolt

Figure1. The schematic design of rotating spinner using semi-automatic control

The working principle of this machine is the rotation of the motor electricity as the primary power source is forwarded to the pulley, v-belt, and finally the main shaft which is connected directly to the rotating plate. The speed of motor was controlled by stepping on a pedal connected to variable speed control. The dimension of each component was designed to the size of the worker anthropometry. The height of the tool is adjusted to the height of the sitting elbow of the worker. The length or width of the tool is adjusted to the length of the worker's hand. The position of the driving pedal is adjusted to the position of the worker's feet.

3. RESULTS AND DISCUSSION

3.1 Subject Characteristic

The number of subject samples in this study was taken from 12 craftsmen. Subject characteristics include age, height, weight, and work experience. The mean characteristics of the subjects are presented in Table 1.

Table1. Research Subjects Characteristic Summary

Variable	Mean	SD	Range
Age (year)	32.25	1.50	26-47
Body Weight (kg)	62.85	3.58	57-74
Body Height (cm)	167.48	4.37	159.5-175.5
Working Experience (year)	6.15	1.25	4-10

Mean age of subject is 32.25 ± 1.50 year and age range still included the working age group at 26 - 47 years old. The age range still includes a productive workforce with the age limit of the labor force applicable in Indonesia that is aged 15 to 64 years. The optimum muscle strength for recommended work is between 20 to 30 years [5] and the mean age of this study subjects has decreased since the optimum muscle strength. Age conditions affect the ability of physical work or muscle strength of a person. Maximum physical ability of a person is achieved at the age between 25 - 35 years and will continue to decline with age [3]. Organ systems such as the cardiovascular, respiratory, and muscular systems may decrease by 2% per year after the age of 30 years [6]. Based on the characteristics of the research subjects, the work experiences of the craftsmen that is normally considered to be experienced with an average working in their field of 6.15 years. This work experience supports the expertise of a worker in the production process. Work experience is one of the factors that influence the level of skills of workers, complaints that occur in the musculoskeletal system, as well as on productivity [3].

3.2 Anthropometry of Craftsmen

The suitability between the work station and the workers will affect to the ergonomic work attitude of the craftsmen. Unnatural work attitude occurs if the work equipment is not in suitable with the anthropometry of the worker's body. This will increase the physical workload of workers. Anthropometry is a one method to fitting of body dimensions and other physical characteristics of the body that are used to design a product or device [3]. Anthropometry model used in this study considered of dimensions and design of the machine to working attitude of the craftsmen. The height of the rotating spinner machine adjusted to the height of the crafter's elbow in a sitting position. The rotate plate which is above of the instrument should be within the reach of the hand of the craftsman. The length and width of the machine also need to be adjusted when forming the shape in order to ideal position with the body of the craftsman. The position of the variable speeds control pedal is adjusted to the position of the worker's feet when sitting.

Anthropometric data in design model considerations is best presented in the percentiles form [3]. Therefore, the calculation of the size and dimensions of the machine is used 5% percentile that occurs workers can use the rotating spinner machine more comfortably.

3.3 Workloads

Pulse frequency was used an objective measure, quantitative and accurate assessment of workload [7]. The work pulse frequency of working hours can be used as a basis for evaluating of physical workload. The pulse at rest is called the resting pulse and the pulse at work is called the working pulse. The results of workload measurements from pottery craftsmen are shown in Table 2 below:

Table2. Workloads Results Analysis of Pottery Craftsmen

Variable	P1		P2		t	p
	Mean	SD	Mean	SD		
Resting pulse (beat/minute)	72.12	2.31	71.76	2.19	1.328	0.419
Working pulse (beat/minute)	125.27	4.26	110.12	3.37	3.721	0.000

From the results of the t-test on the resting pulse showed p value > 0.05, indicates the initial conditions of the craftsmen pulse are in the same condition or not significantly different. While on the pulse of work (workload) tested proved there was significant difference between P1 and P2 ($p < 0.05$). The average working pulse value deceased from 125.27 beats per minute (P1) to 110.12 beats per second (P2). The classification of workloads in P1 is included in the category of “heavy” workload due to the range 125-150 / min while in P2 includes “medium” work load that is in the range of 100 - 125 beats per minute [3]. The results of the comparison between

P1 and P2 showed the workload decreased from heavy to moderate with a value decreasing at 12.09%.

The decreased of workload due to used rotating spinner machine in the manufacturing process can reduced the physical work. The results of this study are show good agreement with other studies which indicates the ergonomic interventions can reduce the workload of workers [8].

3.4 Work Productivity

The work productivity of the subjects was calculated based on the ratio of output to the input at a certain time unit. Output generated by the amount of produced the pottery shape during the working hour (average 7 hours per day), while the input is the craftsmen workload (work pulse).

Table3. Work Productivity Results Analysis of Pottery Craftsmen

Variable	P1		P2		t	p
	Mean	SD	Mean	SD		
Work Productivity	0.362	0.013	1.571	0.017	1.216	0.000

The result of the analysis showed that there was a significant difference ($p > 0.005$) between P1 and P2 indicated work productivity was increased from 0.362 (P1) to 1.571 (P2) or an increase of 334.6%. Increased work productivity can be done by improving machine tools and work systems based on ergonomic principles [9,10,11]. The principles of ergonomic also increase the influence of the work more effective and efficient [12].

4. CONCLUSION

Based on the results of the discussion above, the conclusions can be conveyed as follows: a) redesigned and improved the rotating spinner machine based on an ergonomic approach reduces the workload of pottery craftsmen by 12.09%. The rotating spinner machine design increases the work productivity of pottery craftsmen by 334.6%.

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