

DESIGN OF JEWEL STONE SHARPENER TO INCREASE JEWEL WORKER WORK PRODUCTIVITY IN BALI

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Abstract

Finishing process of workmanship on jewel stone at small scale industry of jewelry crafting in Subagan village Karangasem was polishing. This process was done manually by working posture were cross-legged sitting on the floor. This awkward working posture (cross-legged sitting) caused increase workload. High work load can decrease production and productivity. To solve these problems, increase productivity and income of craftsmen, the improvement effort should done by design of jewel stone sharpener in order to could be able to use as polishing tools of jewelry and then improve according to ergonomics approach. The research was conducted on 16 jewel craftsmen by "treatment by subject design" and three treatments methods. Work load was measured by using work heart rate which was count using ten pulses methods. Work productivity was assessed by amount of product per pulse rate. The data were analysed by using t pired test at significant level 5%. Results were showed as follows: significant of difference ($p < 0.05$) of work load, subjective disorders, and work productivity between control (T0) and treatments (T1). The average of work load on T0 and T1 were 104.29 ± 4.65 beats/minute and 88.64 ± 2.33 beats/minute or decreased 15.0%. And then the average of work productivity on T0 and T1 were 0.01002 ± 0.00042 and 0.05801 ± 0.00207 or increased 478,9%. Its can be concluded that T1 give larger decreased of work load and give larger increased of productivity compared with T0. That is why, it was recommended the design of jewel stone sharpener should be used by workmanship in polishing the jewel stone and ergonomics work station.

Key Words : Jewel Stone Sharpener Design, Work Load, Subjective disorder, productivity

1. INTRODUCTION

Small scale industry stone crafting which production jewelery such as rings, jewel-necklace , jewelery of kris or spear handle, and etc. Were one alternative to effort to get income since we face crisis monetary nowadays. These effort can be founded at Subagan villige, districts and regency of Karangasem, Bali province. on the figure of small scale industry. The tools they were use such as grind to jewel works . A kinds of stone that were use such as pirus stone, akik stone, kecubung stone mirah stone, and suck akinds. On cutting process the raw material which still stone nugget. as alike stone pirus, akik, kecubung and such alike could be cutting to a little slices using a certain technic and grinds-cutting. In formation process, the litle material were formulated using grind-polish, The figure of jewelery were in accordance with o.'s request of consument order or accordance with the will of craftsmen himself. Finishing process on stone crafting was polishing jewels until smooth and shine, done conventional. When it has finish already then adhere on the top of stick as a handle. The handle long was 10 to 15 cm with diameter 2 to 3 centimeter made of woods.

The stone which was put on handle polish on trace-paper or smooth cloth on the floor. Work attitude was sitting statis on cross-legged sitting on the floor an right hand handle a little wood stick which already adhere jewel that will trace paper, while left hand motionless. Smoothing process usually take time 20 to 30 minutes for one jewel stone.

Polishing jewel conventionally and work posture cross-legged sitting will causes health problem workers. These posture is not natural will causes musculoskeletal disorder [1]. Work posture for long time with work posture non natural bend over causes musculoskeletal disorder system and will be pressure at *discus intervertebralis* so cause *low back pain*, for long time on this work posture will cause bend over [2]; [3].

Polishing manually will need more time which affected to productivities and worker result decreased. To increase worker productivities and decrease workload, subjective complaints were use grinds that used nowadays with modification for finishing process and partisipatif approach.

The modification which done were lossing grind eye and changes with flat-wood as size as eye grind cover with paper trace. Wood using as in change of original eye grind causes of wood surface more smooth compared with original eye grind, decrease fibration and can founded easily.

Because of using remains wood so the cost of modification was cheap and fixing process as same as original eye grinds fixing. Using grinds modification need work table and chair for sitting down. The table and chair should be according to anthropometrics size of the body worker. The resolution were find two alternative such as using grind sharpening modification for smoothing jewelery stone on cross leg sitdown on the floor (without table work) and sit on the chair(using table work as stand for grind). Those alternative will be test, which of them could more decreased workload and complain subjective and increase height work productivity table

Base on above analysis, so the problems which can be exposed in this research were as follows

1. Is with usage of design of jewel stone sharpener can increase work productivity jewel worker in Subagan village, Karangasem?
2. How many improvement of work productivity jewel worker effect of usage design of jewel stone sharpener at jewel worker in Subagan village, Karangasem?

Table 1. Data subjects characteristic on worker Jewel

No	Variabel	Means	SD	Range	95% Confidence Interval for Mean	
					lower	upper
1	Age (yr)	26,38	5,898	20 – 39	23,23	29,52
2	Body weight (kg)	59,77	3,168	55,5 – 65	162,46	165,66
3	Body weight (cm)	164,06	2,999	159 – 168	58,08	61,46
4	Work experiences (yr)	7,75	5,053	3 – 17	5,06	10,44
5	Body Mass Indeks	22,19	0,69	21,15 – 23,25	21,82	22,56

Note: SD : Standard Deviation

The means of age subjects on this research is 26,38 ± 5,89 year with ranges 20 – 39 year and total subjects 16 person. Base on statistic analysis can be seen on Table 5.1, subject ages 95% be on interval 23,23 to 29,52 year. So can be said that ranges subject age still on optimal to work because of productive age. Irawan & Suparmoko reported that productive age around 15 – 64 year [4]. Beside of that Grandjean reported that age condition affected to physical work ability or the strength of muscle in self [3]. The maximal fisic ability can be acheave on age

2. MATERIAL AND METHODE

Using design of jewel stone sharpener, as material research can increased work productivity the jewel worker, Smoothing processing part at Subagan village, Karangsem regency. Time of research from April to July 2006 with the experimental research design, by using treatment by subject design which were developed in two treatments such as T0 (polishing jewel stone manually with work posture cross leg sitting on floor), T1 (polishing jewel stone usage design of jewel stone sharpener with work posture sitting on the chair). Work load was predicted from heart rate that was counted by 10 rates method on arteriae radialis by digital stop watch trademark Alba. Environ temperture was measured by sling Psychometer trademark Casella. Noise was measured with sound level meter, trademark Gossen. Work load was predicted from heart rates that was counted with 10 pulses method. While the work productivity was assessed from wide of land that can be tillaged for one hour. Statistical analysis to know the significant different from data which were collected before and after work, were analyzed with t-paired test at a degree of significance 5%.

3. RESULT AND DISCUSSION

3.1 Subject Charecteristic

The total descriptive analysis to data subject charascteristic include age, body height, body weight, and work experiences. was presented on Table 1.

range 25 –35 years and decrease continously paralel ages increase.

3.2 Enviromnetal Work Condition

Environmental work condition can indicated from wet temperature, dry temperature, relative humadity, ITWB (Indeks Temperature Wet Ball), noising and light intensities. Environmental condition data which were attained in this research its normality were tested with Kolmogorov – Smirnov.

(K-S) The result showed that the data work environmental on three treatment distributed normal ($P > 0.05$), To know each treatment showed

homogenous data, there were t-paired test. The analysis result work environmental on the research showed on table 2 as follows:

Table 2 Analysis result work environmental measuring on the research

No	Variable	Treatment 0		Treatment 1		t	p
		average	SD	average	SD		
1	Wet temperature (°c)	28,69	1,07	29,12	1,25	-1,433	0,195
2	Dry temperature (°c)	24,75	0,71	24,75	0,71	-0,798	0,451
3	Relative humidity (%)	71,50	3,66	71,25	3,73	0,509	0,626
4	ITWB (°C)	26,24	0,63	26,31	0,66	-1,949	0,092
5	Wind velocity	1,26	0,43	1,30	0,46	-2,049	0,080
6	Voice intensity (dBA)	68,50	2,78	68,31	2,53	1,158	0,285

Note SD = Standar Deviasion

Analysis result showed on table 2, clarified that wet and dry temperature variable were under borderline value Humindities average each treatment between 70 – 80 %. And voice intensity (noising) also under borderline voices highest (85 dBA). Those showed that work environmental were on save and comfortable for each treatment so it can't cause physiologies effect that can disturb work. Those result concord with research which were performed by Sutjana located at Subak Yeh Ghe Kediri District Tabanan Regency where its dry temperature around between 28-29° C [5]. While the research that was performed by Kerana at al [6], revealed that the means of dry temperature were 29.94° C, while Manuaba and Vanwongerghem [7] stated, that the temperature at dry monsoon increased until 31-32° C at the shade place and attained 36° C under the direct sun rays.

The result t paired test to environmental as showed on table 2 stated that the variable wet, dry temperature relative humidity, and lighting intensity (at T0 and T1) founded $p > 0,05$. This case stated that each group not different significantly so it can the same effect each group treatment.

3.3 Workload

3.3.1 Normalities test workload data

Workload treat base on heart pulse jewel worker during a rest (rest heart pulse) Base on heart pulse can be counted %CVL (*Cardio Vasculer Load*). Before analysis treatment effect was done, it need to normalities test to heart pulse. Normalities test done using *Kolmogorov-Smirnov (K-S) test*. Test result *Kolmogorov-Smirnov (K-S)* founded that rest heart pulse and work heart pulse the third treatment normal distributed ($P > 0,05$).

3.3.2 Compatibilities rest heart pulse

Compatible rest heart pulse done to know first condition the works, are there significant differentiated or not. It need to known what the changed workload is original caused by treatment effect or outside factors that follows give changed that workload. Compatibilities rest heart pulse of jewel workers done using t paired test. . Analysis result can be seen at Table 3.

Table 3. Compatibilities Heart Pulse Jewel Worker between Treatment

Variable	Treatment 0		Treatment 1		t	p
	Average	SD	Average	SD		
Rest Heart Pulse (Pulse/minutes)	67,35	4,293	67,01	4,061	0,030	0,971
Work Heart Pulse (Pulse/minutes)	104,29	4,649	88,64	2,333	105,039	0,000

Note : SD : Standard Deviation

On Table 3, can be found that rest heart pulse each group treatment not significantly different ($p > 0,05$). That means first condition rest heart pulse

workers for each group treatment can be consider the same. Can we see that the average decrease among

treatment 0 (control), treatment 1. Among group T0 with T1 were significance differences ($P < 0,05$).

On group control (T0) moderate workload, because working jewel polishing use hand need a little struct to polish continuously so it can increase heart pulse. This work needs more energy as physiologically the energy come from metabolism process of the body. This metabolism needs O_2 as burning material that was taken through breathing so it need more and more energy until more quicker breathing frequency and heart pulse.

Where as group T1, work heart pulse significant decrease ($p < 0,05$) to P0 as 15,0%, because on T2 jewelley polishing use design of jewel stone sharpener and body posture sitting on the chair. Wehe as group T1 were using design of jewel stone sharpener, so it need a litle energy compared with group T0, but difference work posture also affected needs of energy. Work posture group T0 is cross-legged sitting on the floor staisly, made blood

circulation under body part not run well. Where as work posture group T1 sitting naturally on the chair. So blood circulation will run well compared with group P1.

Same as Gilad and Rempel [8] stated that work polishing jewel manually need heigher energy and work heart quite heavy compared with using grind. Polishing jewel using grind has work posture more stable and work heart more light .compared with manually. While Kadefors [9] stated that work posture problem and work manual can be cover by given a set of apparatus work.

3.4 Work Produktivity

To known treatment effect was done difference significant. Average among each group treatment (Control groups or T0, treatment 1 or T1). Statistics test that used is t paired test. Result analysis shown on table 4 as follows:

Table 4. Result product and Work Produktivity Jewel Worker

Variable	Treatment 0		Treatment 2		t	p
	Average	SD	Average	SD		
Product (one/day time)	3,13	0,095	15,41	0,224	19009,648	0,000
Produkti-vity	0,01002	0,00042	0,05801	0,00207	3839,179	0,000

On Table 4 above can shown that product and work productivity jewel worker has difference significant among both treatment ($p < 0,05$). Shown that product or productivity on Treatment 1 (T1) more height than Control (T0). Average result producs jewel stone at group control is $3,13 \pm 0,09$, on treatment 1, Average result product were $15,41 \pm 0,22$ or increased as much 392,3% to T0. Average work productivity jewel worker on group T0 is $0,01002 \pm 0,00042$. Average productivity treatment 1 is $0,05801 \pm 0,00207$ or significant increase ($p < 0,05$) as much 478,9% to T0.

This condition shown that T1 (working use design of jewel stone sharpener with work posture sitting on the cahir) give effect increase work productivity better than T0 (working manually with hand and work posture sitting cross legs on th floor) It haven cause of jewel polishing using modification so polishing continuously with hand changes with adhere jewel at eye girnd. Beside of that work posture cross-legged sitting on the floor is not work posture not naturally. improve to sitting on the chair naturally. So production result will increase and work heart pulse will decrease.

Ergonomics intervention to improvement work posture or work station its needed especially at small scale industry [10]. Because of ergonomics intervention at home isdustry , intervetion use work chair appropriate with anthropometry and etc. will

can decrease workload or subjective complain also increase work productivity [11]; [12].

3.6 Break even point and benefit cost ratio

Break even point happened if expense of intervention have been fulfilled by make-up of earnings. Expense of intervention at treatment 1 (T1) = expense of T1 - expense of T0 = 264.544 - 246.504 = Rp 18.040. Make-Up of earnings of P2 to P0 is Rp 3.911.560. Break even point at this P2 also happened in one day just job bigly the following ratio cost benefit

$$\frac{\text{Benefit}}{\text{cost}} = \frac{3.911.560}{13.084} = 298,9 > 1$$

From breakdown of above indicating that intervention by ergonomi give advantage/benefit of economic facet after going through one day good job at treatment 1 (T1) assign value larger ones ratio cost benefit compared to T0.

4. CONSLUSION AND SUGGESTION

4.1 Conslussion

Some conclusion can be take like as follows.

- a. Usage of design of jewel stone sharpener can increase work productivity jewel worker in Subagan village, Karangasem.
- b. Improvement of work productivity jewel worker effect of usage design of jewel stone sharpener at jewel worker in Subagan village, Karangasem, it's about to 478,8%
- c. Usage of this design of jewel stone sharpener not only useful from good economics, but from good health of work also useful.

4.2 Suggestion

There are some suggestion can be present on this research such as follows:

- a. From the research which has done evidence using design of jewel stone sharpener can increase result production and work productivity jewel worker so its suggestion design of jewel stone sharpener used on smoothing jewel stone
- b. Work polishing jewel with work posture cross-legged sitting on the floor increase many subjective complain and increase work load, while work polishing with ergonomics work station (using table and work chair) evidence can decrease subjective complain and decrease work load polishing jewel worker. Because of that its suggestion to jewel worker whose still work posture not ergonomic(cross-legged sitting on the floor) to improvement work posture by using ergonomics work station (chair and work table).

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