Decreasing Musculoskeletal Complaints by Developing Product Design based on Ergonomics Participatory

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Abstract- The farming tools are vary, but nevertheless there are still some design of farming and building tools only consider the function but do not consider the wants and needs of users. Farmer are given product that are ready to use produced by large industry while construction workers only hammering the nail using ready to use hammer every day. Some tools only consider the function and have not adjusted to anthropometry of hands so that there are potential of force postures in operating, handle is not comfortable, early Complaints frequently happen when operating tools which is signed by spontan rest. Using of tools which does not consider the wants of users will effect to increase of postural stress of workers. Therefore design that considering the wants and needs of users by using participatory ergonomic approach is needed. This research is an experimental research using the post test only control group design because population of farmer considered homogen. Subjects totaled 46 are chosen randomly. Musculoskeletal complaints are measured by questionnaire Nordic Body Map (NBM). Result of questionnaire are compared and analyzed. Result shows that there is meaningful decrease between average score of musculoskeletal complaints when using conventional sickle with new design of sickle, but in use of hammer, there is no meaningful decrease because the change is only 3.681%. Redesign of tools based on user need could decrease musculoskeletal complaint as 15.517%

Index Terms— Musculoskeletal, Product Design, Ergonomics Participatory

1 INTRODUCTION

Ergonomic participatory is an activity involving some parties to be interacted. Interaction involves all parties starting from product user, interdicipliner and product developer. Product outstanded to the market, especially tools to support farming activities tend to ready to use tools which are produced massively by big industry. Farmers are required and forced to use ready to use tools such are sicle and hammer. Function of sickle is to help farmer in uprooting grass, cutting branch of rice etc. Operation of this tool generally using human muscle especially hand muscle. Besides hand muscle, movement cuase contraction of other body part. Unnatural working posture giving more addional workload than main workload. Beside of working posture, workload also given by work organization to complete the job. Product designs have not considered ergonomic participatory concept, while this concept is already used and developed in some research [4],[7],[10],[11],[17],[18],[21],[22],24]. Application of ergonomic participatory giving impact to lasting of use of tools in longterm, because the need and interest of user is considered in designing product.

An not good work organization will impact to inefficient and uneffective work. Since working posture is still unnatural, worker will get tired soonly. Similarly to construction workers in operating hammer as auxiliary tool to pull the nails. This hammering activities are done repeteadly and statically. Movement generally using one hand, generally right hand. The working organization are the left hand handling nail while the right hand hammering. The loading between right and left hand is not same. Working load increased by activities in hot environment or directly exposed by sunlight. Farmer work in field or farm while construction worker hammering in long frequency on rooftop.

Design of tools which is not considering need of user will impact to activity and not maximal productivity. Tools are designed to help and abridging user to complete the job. In designing tools, the designer should be adjust to human activities not the reverse. Thus natural body movement could be realized. Hammaer and sickle always handled by one hand. Anthropometry of fingers become important to pairement and development of newe design of hammer and sickle. The size of hand anthropometry is used as reference to redesigning handle. Size of product more fit to size of user hand, then the product developed are more comfort and save to be used.

The anthropometry of hands for each people is different then one product to other should be adjust to the nation or residents from different country. Anthropometry is used as the reference [1], [13] in designing product besides inputs or participatory of user. Product should be designed adjusted to size of body part of user. Untill now, industry make product in same size and sold to large area even between contries, while user of product from different contries have different anthropometry of finger size [26], [3]. This condition will impact to unoptimal use of product, unconfortable and potention of injury to some body part. Use of antropometry data to design farming tools have beed developed rapidly [5], [14] but designing tools by

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considering willingness and need of user is still minim.

Musculoskeletal complaints is condition where worker feeling hurt on some body part when completing the job. Eralier muscle suffering complaints, it could be conclude that worker is not comfort. When musscoluskeletal complaints always suffered by workers and it being let for long time, there will be comulative disolders, result of work not maximal, and not maximal productivity. Another impact is workers suffer for complaints on certain muscles after activity of works.

This muscoluskeletal complaint could be fixed by some alternatives, one is by developing product or dedesigning ergonomic work tools, considering anthropometry of human hands or fingers along woth needs and willingness of user. Thererefore product function is not become the main consideration, but human is.

2 METHODS

2.1 Subject

Subject of research are chosen randomly, thise are 46 workers which have been chosen randomly, male, have been a farmer for 5 years for sickle and have been a construction worker for 2 years, age between 20 to 40 years old, IMT in normal category.

2.2 Procedure Research

This research is in category real experimental using the post test only control group design since population sample of farmer and construction worker considered homogen. Subject are explained about puspose nad objective of research continued by filling of informed consent. Postural stress complaints measured by questionere of Nordic Body Map (NBM), then the data is compared and analyzed.

2.3 Procedure of the analysis

Statistical analysis using software SPSS Version 17. Average result of musculoskeletal complaint before and after using redesigned tools by t test mean which have been performed normality test using uji shapiro wilk with meaning degree α=0.05, while test of treatment effect using uji t-paired when data is normal (p>0.05), and data transformation wahen data is ubnormal. When data is still ubnormal, it will be test by non parametrik Wilcoxon matched pairs. Data collection performed in 3 times repetition and Washing Out Period (WOP) is 1 day, adaptation of new tools is one day.

2.4 Hyposttesis in this research

Ho : $\mu 0=\mu 1$ Average musculoskeletal complaints when using conventional tools is same with musculoskeletal complaints when using redesigned tools

Ha : $\mu 0 > \mu 1$ Average musculoskeletal complaints when using conventional tools is greater than musculoskeletal complaints when using redesigned tools

3 RESULT AND DISCUSSION

Skeletal muscle complaints of workers as known as musculoskeletal complaints of subject measured by Nordic Body Map (NBM) questionere before and after working activities. Questionere have been validity tested with result shows that every question is valid (r count > r table) whereas table r on α = 5% is 0.458 or significance <0,05 while reliability questionere is in Cronbach's Alpha over 0.6. Detailed shown in table 1. So that queastionere is valid anda reliable. Output of validity and reliability test is Nordic Body Map.

Respondent of this research is 46 males of farmer and constructuion worker. Quaestionere is chosen randomly. Subject is asked to use conventional and redesigned tool. After finishing his job, subject is given questionere of Nordic Body Map (NBM) to be filled according to complaints that being suffered when using the tools. Result of questionere then being processed and analyzed.

TABEL 1.
RESULT OF NORMALITY TEST OF PRODUCT (KOLMOGOROV-SMIRNOV)

Variable	n	Value	SB	z	p
Conventional Sickle	46	89.804	5.569	0.094	0.200
Redesigned Sickle	46	75.870	9.985	0.238	0.000
Conventional Hammer	46	89.174	6.775	0.099	0.200
Redesigned Hammaer	46	85.891	7.388	0.142	0.021

TABEL 2.
MUSKOLUSKELETAL DIFFERENCE USING NON-PARAMETRIC TEST, WILCOXON SIGN RANKS TEST

Product	Value	SB	z	p
Conventional Sickle	89.804	5.569	-5.200	0.000
Redesigned Sickle	75.870	9.985		
Conventional Hammer	89.174	6.775	-1.531	0.126
Redesigned Hammaer	85.891	7.388		

Analysis of treatment effect based on table 2, show that average score of musculoskeletal complaint using conventional sickle and redesigned sickle is 89.804 ± 5.469 and 75.870 ± 9.985. Meaning analysis by nonparametrik uji Wilcoxon sign ranks test shows that z = -5.200 and p = 0.000, means that musculoskeletal complaint score in both perioed is have different meaning (p<0.05), condition of using conventional arit is menalingly different with using dedesigned sickle. While analysis of treatment effect test shows that average muskoluskeletal complaint skore using conventional and redesigned sickle is 89.174 ± 6.775 and

85.891 ± 6.775. Meaningful analysis by nonparametrik non-parametric Wilcoxon sign ranks test shows that score of z = -1.531 and p = 0.126 then Ho accepted, means that average score of muskoluskeletal complaint in both period is not meaningly different ($p<0.05$), condition using conventional hammer is not menangly diffenerent with condition of using redesigned hammer. Percentage of change because of modification of handle in sickle as can be seen in table 5.

Decrease of musculoskeletal complaint in activities of using sickle is influenced by product design that consider anthropometry of user and data directly collected from farmer, as stated in another research that determination of handgloves dimention that recommend measurement of hand should be directly done so that design of product fit to actual anthropometry [12], or other research report state that body dimention of swedes male and female is different in 4 years so measurement of the latest antrhropometry is needed as base of product design and new workplace so product will not give bad impact to healthy of workers [9].

While musculoskeletal complaint in activity of using hammer did not give significant impact of decrease on skeletal muscle, this condition is influenced by acrtivities and loading of static muscle. Workers doing activities of hammering using static muscle repeteadly, so that complaints suffered in activities of using conventional product and redesigned product is same. Nevertheless peak of complaints is sickness in long period when worker doing activities in unnatural posture, for example workers who always standing, doing monoton activities, or the job that need muscle work in heavy category so improvement applying ergonomic concept to reduce complaints of body posture and biomecjanic load earlier [2], [6].

TABEL 3.
PERCENTAGE OF CHANGES CAUSE BY MODIFICATION OF HANDLE ON SICKLE AND HAMMER

Product	Value	SB	Percentage Change
Conventional Sickle	89.804	5.569	15.517
Redesigned Sickle	75.870	9.985	
Conventional Hammer	89.174	6.775	3.681
Redesigned Hammaer	85.891	7.388	

Untill now, research related to effort to decrease musculoskeletal complaint have been performed numerously [19], [25] because giving various impact to productivity of work, comfort of work, satisfaction of work, and boredom of work. Table 3 shows that percentage of change caused by modification of product handle shows that changes between conventional sickle and redesigned sickle is 15.517% that stated in statistical test as meaningly different. This changes impact to more comfort and saver use of sickle by user, so that complaint of skeletal muscle or musculoskeletal could decrease significantly.

While changes in use of conventional hammer and redesigned hammer is 3.681%, this canges did not cause improvement on skeletal muscle, because statistical tesy shows that changes is relatively small, so it did not give impact to muskuloskeletal complaint. This condition is caused of use of hammer is more static while research subject that using sickle is dynamic. Another cause is when using sickle, beside of hand muscle, other body part movement is adding workload in completing the job. Muskoluskeletal complaints before activities will add musculoskeletal complaint degree in activities of finishing main work. This Muskuloskeletal complaints could be cover by repairement of worktools, work system and break setting [15], [23].

Operation of hammer, muscle mostly contract on hand, arm and right shoulder, so that should be base on ability, capacity, and limitation of human [8, [16]. Muskuloskeletal complaint on physic activities exceed ability limit and work on (multifunctional jobs) will create healthy problemsuch as uncomfort feeling or in other words physical activities is the main cause of muskoluskeletal complaints [20]. Farming and building activities generally done in an extreme hot environment, so adjustment of worktime and break time is needed.

4. CONCLUSION

Conclusion obtained from this research is sickle product give significant impact to muscoluskeletal complaint as of 15.517%, while hammer product is not gve significant impact to muscoluskeletal complaint. Use of redesigned sickle impact to change of work posture and movement of finger, while in use of hammer, there is no different movement of hand or still using right hand muscle to complete the job. Pressure give by right hand when operating hammer is still the same. Advance research is needed to design more ergonomic hammer to minimize forced movement that cause exceed of workload.

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