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Total Ergonomic Approach Minimize Work Accidents at Workshop Company

Abstract

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Research on total ergonomics to minimized numbers of work accidents at PB workshop company has been done, based on some approach such as: eight ergonomic aspects approach, appropriate technology application and SHIP approach. The aim of this study was to find out potential solutions to minimized work accidents. Data obtained through questionnaire, face to face asking and answering the questionnaire between researcher and employees, as well as fill in the questionnaire by the employees. Result shows that eight ergonomic aspects approach, application of appropriate technology and SHIP approach in minimized work accidents were good and very good. Total ergonomics approach model reveal a linear reduction in work accidents. It was suggested, to improve theory and practical skill of the workers by training about total ergonomics approach and provide safety equipments to worker who work at dangerous area

Keywords: Ergonomics, workplace accidents, workshop

1. Introduction

Workshop is a place (a building or room) for the manufacture, care/maintenance, repair, modification, and other assembly tools and machines. The workshop's function in broadest sense is to develop human creativeness such as to create machines that is perfect for comprehensive human life. Each activity in the workshop has different characteristic as well as work accidents risk, that threaten the worker's safety. The main causes of occupational accidents include some factors i.e (a) human factor or known as unsafe acts (unsafe actions) which is a harmful action of the workers who may be motivated by various reasons, foreexample: lack of knowledge and skills, inability to work normally (inadequate capability), lack of body function due to defects that are not visible (body defect), fatigue and weariness (fatigue and boredom), attitudes and behavior that are not safe (unsafe attitude and habits), confusion and stress of new work who could not understand the work procedure, not yet mastered / not yet skilled the equipment or the new machines (lack of skill), lack of concentration (difficulty in concentrating) on labor when performing work, indifference (ignorance) of manpower, lack of motivation to work (improper motivation) of manpower, lack of job satisfaction the attitude or the tendency of hurting his self or others. Human factors as the cause of the accident is often referred to as human error and is often misunderstood because it is always blamed as the cause of the accident. Though, oftenly accidents occur because of a machinery design errors or work equipment that does not fit; (b) Environmental factors or known as the unsafe condition of: machinery, equipment, aircraft, materials, environmental and workplace, work processes, nature of work and the work system. Environment in broad sense can be defined not only the physical environment, but also factors relating to the provision of facilities, human experience past and just before serving, setting the organization of work, relationship among workers, economic and political conditions that could interfere with concentration; (c) The interaction of human and labor support means is the cause of the accident. If the interaction between the two do not match then it will cause an error that leads to accidents. (d) Work equipment component. The whole work equipment must be designed, maintained and used properly. Control potential hazards can be influenced by the form of equipment, size, severity of equipment, operator comfort, and strength necessary to use or operate equipment and machinery. These variables affect the interaction between workers and work equipment used. Variables other equipment that is important in the recognition of potential hazards including potential operating speed and mechanical hazards; (e) Work environment component. Particular consideration should be given to the work environment factors (such as the layout or the layout of the room, cleanliness, light intensity, temperature, humidity, noise, vibration, ventilation and other). Which may affect the comfort, health and safety of workers; (f) Work organization. Behavioral safety management in the future is a very important variable in the development

of safety programs in workplace. Structure of work organization that promotes cooperation between employees for recognition and control potential hazards will affect the behavior of workers positively, Sucipta (2016), Brake and Bates (2011), Christopherson (2005), Greef and Van den Broek (2004).

To reduce the number of accidents at the company's workshop in this research, a total ergonomic approach such as reactive approach, a systemic, holistic, interdisciplinary and participation (SHIP) 'built-in' in every intervention based on the concept of appropriate technology, (Manuaba (2001). Selection of appropriate technology which encouraged any improvement should be reviewed in six criterias: technical, economical, ergonomic, social, cultural, energy saving and environmentally friendly, Shahnava (2000), Hyperphysics (2005), Monteiro and Alucci (2005), Moran and Epstein (2006). Application of total ergonomic approach allows in bargaining the process to obtain an optimal working conditions. Therefore it needs participation of all parties in the production process to determine the priority of improvement that can provide optimal results and can ultimately minimize accidents. After that problems to minimize workplace accidents in the company workshop can be formulated. Also, how to analyze the works and identify potential solutions addresses to workplace accidents in the company workshop could be done.

The purpose of this study is to minimize workplace accidents in the company workshop, analyze the works and identify potential solutions addresses to workplace accidents in the company workshop with total ergonomic approach.

2. Materials And Methods

Population. The population in this study was all workers at the company's workshop PB. (a). Samples size. Sample size was determined purposively in accordance with the purpose of research. In this study, the sample compose of workers who meet the criteria of the sample. (b). Gender male (c). Age 20-50 years (d). Height 155-180 cm (e). Healthy physically (f) Willing to be a subject of study to completion; (g). Experienced as a worker at least 1 year.

The research location is PB Company Workshop, 95 Trenggana Road, Penatih village, East Denpasar District, is a company workshop that produced machines for agricultural postharvest, agricultural processing, slicing machine, mixing machine, wood lathe, machine for manufacturing organic fertilizers and various kinds of sharp appliance based iron/steel, both for domestic use, other daily life as well as for collection or art-cultural activities.

Stages of total ergonomic approach is : (1). Ergonomics extension service in the workplace by showing problems directly, and give examples for improvements theoretically and practically in the workplace; (2) doing simple focus group discussions (FGD), by sitting in a circle in the workplace; (3) measure worker's anthropometric using percentiles, through the highest and lowest workers in the workplace. They are invited to try out the size that may still be acceptable to all workers; (4) setting of work attitude, by making changes to work stations, work environment, placement of equipment in stages so that workers feel comfortable. Changes in attitude, done gradually to obtain the optimal changes, that can be accepted by any worker. This needs to be done for every worker, since the size, attitude and character of each worker was different; (5) menu settings, with flavors that can be accepted, sufficient portion received by workers, using domestic household measurement such as a plate, a spoon, a large glass, and others; (6) information board displays, using simple materials and the letter size was big enough to read clearly by worker who sitting farthest from the information board; (7) arrangements in break and working time, placement of working equipment, take adequate enough tools and material, so workers automatically stand up, changed position and walks to take tool, so there is a chance for relaxation

Focus group discussion were held every week for three months every Monday, do interviews to each worker to obtain information for research purposes through question and answer face to face. The questionnaire contains a set of questions posed on workers as respondents to fill in and answered. Tools such questionnaire to be filled are closed. Filling out this questionnaire conducted to obtain feedback related to the total ergonomics-related research, and employee work accidents. Before it is used to analyze the effects of ergonomic approach for this study, the validity, reliability of the data were tested. Processing and analysis of data done on the computer with SPSS 22 version.

3. Results And Discussion

3.1 Characteristics of Research Subjects

Characteristics of the study subjects such shown in Table 1.

Tabel 1. Subject Characteristics of the Study

Variable	Minimum	Maximum	Average	SD
Age (years)	18.00	40.00	26.50	7.74
Weigh (kgs)	58.00	72.00	64.90	3.30
Height (cms)	160.00	175.00	166.75	3.72
Work experience (years)	1.00	18.00	6.40	6.07

Table 1. shows the characteristics of the data was normally distributed. Number of subjects / study sample was 20 with age ranged between 18 to 40 years. The range was categories as productive age in which the capacity of muscle strength and physic was optimum for activity in accordance with the demands of work required. This statement is strengthened by Grandjean (1988), Hudock (2005), Wargocki, Wyon and Fanfeer (2004), that peak muscle strength for both men and women reached between ages 25 to 35 years.

Weight of the subjects ranged between 58 to 72 kg, and height were in the range of 160 to 175 cm. Aryatmo (1981) states that difference between height and weight can be used to calculate the ideal weight, through reducing the height by $100 \pm 10\%$ (reduction yield). The result of the calculation formula shows that body weight of the subjects in this study approached the ideal weight, Robert, Waller and Caine (2007).

Weight of the subjects ranged between 58 to 72 kg, and height were in the range of 160 to 175 cm. Aryatmo (1981) states that difference between height and weight can be used to calculate the ideal weight, through reducing the height by $100 \pm 10\%$ (reduction yield). The result of the calculation formula shows that body weight of the subjects in this study approached the ideal weight.

3.2 Total ergonomic approach to minimize workplace accidents

To minimize worker's work accidents at the company workshop PB, total ergonomics approach has been taken through focus group discussion (FGD) activities, every Monday for 3 months (August, September and October 2016). At the end of the FGD activities, workers / samples were given questionnaires to be answered. Results shown through interpretation of the eight ergonomic aspects questions were as follows:

1. Body Size, height and weight: The larger the size of a person's body
2. The greater the caloric needs despite the age, gender and activity which has the same
3. Age: The youth age, relatively requires more calories and nutrient substances than adult or old age
4. Gender: Male generally needs more calories than women
5. Activity / activities: Hard work requires more calories and protein than medium and light work
6. Condition certain body: Workers who are recovering from illness need more calories and nutrients than before the illness
7. Environmental conditions: In the rainy season requires more calories than in summer
8. Hard work: cutting plate / steel, weld, assemble requiring muscle exertion.
9. Muscle contraction will accelerate fatigue and skeletal muscle disturbance which cause muscle pain
10. Working attitude should be pursued in a natural position, so that isn't caused a forced work attitude that exceeded the ability of the body's physiologic
11. The forced work attitude occurred, while handling, transporting, lifting, sitting or standing for long time
12. Unnatural work attitude will cause musculoskeletal disorders, premature fatigue, decrease in activity and motivation
13. Interaction between workers with working tools should be considered.
14. Microclimates: the microclimates at the workshop was affected by temperature and humidity; suboptimal microclimate will cause sweating and accelerate fatigue
15. Lack of air movement due to bad ventilation system gives a bad taste in caused uncomfortable body condition
16. Noise in the workplace / workshop can reduce comfort, tension in the workplace will accelerate fatigue and can reduce labor productivity.
17. Good lighting allows workers to be able to see objects clearly, quickly without unnecessary effort, on the other side unfavorable lighting resulting in mental fatigue, eyestrain thus decreasing the efficiency of work
18. Work time arrangement is closely related to work capability, task demands and the work environment. Lower task demands compared to the worker's capability will yield boring, but high task demand beyond the capability of the worker can lead to premature fatigue and ultimately degrade the quality of work
19. Two-ways communication involving any part which is related to every stage of the process through thoughts, ideas, messages and views contribution will make them all have responsibility for the results to be achieved.

20. Workers will feel secure when their family condition, family relationships, among workers and between supervisors and employee occurred harmoniously

Tabel 2. Interpretation of Worker/Samples to Any of the 21 Ergonomical Aspect Questions

Question	Minimum	Maximum	Average	SD	Intpretation
1	4.00	5.00	4.50	0.51	Very Good
2	4.00	5.00	4.25	0.44	Very Good
3	3.00	5.00	3.95	0.68	Good
4	4.00	5.00	4.70	0.47	Very Good
5	4.00	5.00	4.10	0.30	Good
6	4.00	5.00	4.68	0.47	Very Good
7	4.00	5.00	4.20	0.41	Good
8	4.00	5.00	4.25	0.44	Very Good
9	4.00	5.00	4.45	0.51	Very Good
10	4.00	5.00	4.10	0.30	Good
11	4.00	5.00	4.10	0.30	Good
12	3.00	5.00	3.94	0.70	Good
13	4.00	5.00	4.55	0.51	Very Good
14	4.00	5.00	4.40	0.50	Very Good
15	4.00	5.00	4.75	0.44	Very Good
16	4.00	5.00	4.30	0.47	Very Good
17	4.00	5.00	4.85	0.36	Very Good
18	3.00	5.00	3.95	0.68	Good
19	4.00	5.00	4.70	0.47	Very Good
20	4.00	5.00	4.40	0.50	Very Good
21	4.00	5.00	4.40	0.50	Very Good

21. The interaction of workers with machinery and work equipment were in accordance with body anthropometry or the size of each part of the worker's body, which will create harmony between the machine and the workers.

Workers/samples interpretation to the 21 questions of ergonomical aspect were shown in Table 2 above

Worker / samples answers to the question about the application of appropriate technology were as follows:

1. It can be done using owned technology
2. Easy to work with, to be repaired and to maintain
3. Safe. and strong
4. The quality of the result is good
5. Efficient in material need
6. Cost efficiency
7. Effective used of materials
8. Material used easy to be acquired
9. Using a versatile construction system
10. More profitable
11. Natural air movement and lighting which distributed evenly, optimized by making good ventilation.
12. Minimizing workplace accidents due to temperature and noise
13. Skills workers about occupational health and safety improved
14. All activities in the shop ergonomic principles can be justified
15. The use of energy (primary) cultivated in relatively low numbers

16. Things to consider in designing energy-efficient workplace, among others: pasilitas workplace, proper lighting arrangement.

17. Setting the layout, functions and rules of tradition optimally follow the values, religious customs, beliefs and needs of users

18. The activities and the effect of the use of materials in order to pay attention to the environment or environmentally friendly.

Workers/samples interpretation to the 18 questions were shown in Table 3

Worker/samples answers which express through interpretation to SHIP approach questions were as follows:

1. The approach will be used in these activities are in accordance with government policy
2. The approach used in this activity, make workers more understand about workplace accidents and its consequent.
3. The approach used in this activity increases worker motivation in a career in the field of workshop
4. The approach used in this activity makes intense communication among the workers
5. The approach used in this activity pay attention to factors faced by workers
6. The approach used in these activities pay attention to other factors
7. The approach used in this activity involves many disciplines
8. All workers are involved in planning, implementing and evaluating activities at the company workshop

Workers/samples answer express through interpretation to the 8 SHIP approach questions were shown in Table 4

Tabel 3. Interpretation of Workers/Samples to Any Question Concerning Appropriate Technology Application

Question	Minimum	Maximum	Average	SD	Intrepretation
1	4.00	5.00	4.30	0.47	Very Good
2	4.00	5.00	4.25	0.44	Very Good
3	4.00	5.00	4.75	0.44	Very Good
4	4.00	5.00	4.40	0.50	Very Good
5	4.00	5.00	4.10	0.30	Good
6	4.00	5.00	4.75	0.44	Very Good
7	4.00	5.00	4.40	0.50	Very Good
8	3.00	5.00	4.05	0.60	Good
9	4.00	5.00	4.15	0.36	Good
10	4.00	5.00	4.30	0.47	Very Good
11	4.00	5.00	4.45	0.51	Very Good
12	4.00	5.00	4.85	0.36	Very Good
13	4.00	5.00	4.40	0.50	Very Good
14	4.00	5.00	4.85	0.36	Very Good
15	4.00	5.00	4.30	0.47	Very Good
16	4.00	5.00	4.10	0.30	Good
17	4.00	5.00	4.80	0.41	Very Good
18	4.00	5.00	4.15	0.36	Good

Table 4. Interpretation of workers/samples to each SHIP approach questions

Question	Minimum	Maximum	Average	SD	Intrepretation
1	4.00	5.00	4.25	0.44	Very Good
2	4.00	5.00	4.55	0.51	Very Good
3	4.00	5.00	4.25	0.44	Very Good
4	4.00	5.00	4.15	0.36	Good
5	4.00	5.00	4.55	0.51	Very Good
6	4.00	5.00	4.45	0.51	Very Good
7	4.00	5.00	4.15	0.36	Good
8	4.00	5.00	4.25	0.44	Very Good

3.3 Total Ergonomic Approach Model, Minimize Work Accidents in Workshop Company

SPSS version 22 software was used for total ergonomic approach model in this study, through the following stages: distribute questionnaires to workers/samples, and collect the worker/samples answers which express in the interpretation to questions on work accident which consists of government policy, conditions of employment, working conditions and working facilities.

The questions of the government policy were as follows:

1. Act of workforce jobs, especially regarding to health and safety at work, not yet available
2. The regulations on the implementation of occupational safety and health, not yet available
3. Control and legal actions for companies that ignore the laws and regulations applicable for occupational safety and health have not been there even if already exists but is not applied strictly.

All the 3 questions were answered and express through workers/samples interpretation as shown in Table 5
Tabel 5. Interpretation of Workers/Samples to Any question About Government Policy

Question	Minimum	Maximum	Average	SD	Intrepretation
1	4.00	5.00	4.45	0.51	Very Good
2	2.00	4.00	3.40	0.68	Uncertain
3	4.00	5.00	4.45	0.51	Very Good

The questions concerning to the work conditions were as follows:

1. Standard of working less precise and the implementation was also not appropriate
2. The type of physical work is very dangerous, but lack of safety facilities
3. Little working convenience due to lack of available elements supporting work safety and comfort
4. Non-availability of work manual instructions procedures
5. Lack of control, evaluation and maintenance of working tools on a regular basis

Workers/ samples interpretation to the 5 questions of work condition were answered, and shown in Table 6

Tabel 6. Interpretasi pekerja/sampel dari masing-masing pertanyaan kondisi pekerjaan

Question	Minimum	Maximum	Average	SD	Intrepretation
1	4.00	5.00	4.45	0.51	Very Good
2	2.00	4.00	3.40	0.68	Uncertain
3	2.00	3.00	2.60	0.50	Not Good
4	3.00	4.00	3.70	0.47	Good
5	3.00	5.00	3.95	0.51	Good

Questions concerning to labor conditions were as follows:

1. Worker's skills about occupational, health and safety was low
2. Worker's physical health conditions were not prima
3. Mental health conditions such as low motivation to health and safety at work and the high degree of

depression

4. Addiction to smoking, and alcohol

Worker/samples interpretation to the 4 questions were answered, as shown in Table 7.

Tabel 7. Interpretation of Worker/Samples to Any Work Condition Question

Question	Minimum	Maximum	Average	SD	Intrepretation
1	2.00	3.00	2.30	0.47	Not Good
2	2.00	3.00	2.25	0.44	Not Good
3	2.00	4.00	3.40	0.68	Uncertaint
4	3.00	4.00	3.70	0.47	Good

Questions concerning working facilities were as follows:

1. Availability of facilities that are sufficient (quantity and quality)
 2. Conditions of work are less comfortable
 3. Unavailability of accident insurance facility
 4. Non-availability of health facilities and clinics companies
 5. Lack of training and dissemination on the importance of safety among workers
- Worker / samples interpretation to the 5 questions were answered, as shown in Table 8.

Tabel 8. Interpretation of Worker/Sample to Any Work Facility Question

Question	Minimum	Maximum	Average	SD	Intrepretation
1	4.00	5.00	4.45	0.51	Very Good
2	2.00	4.00	3.40	0.68	Uncertaint
3	4.00	5.00	4.20	0.41	Good
4	2.00	3.00	2.30	0.47	Not Good
5	2.00	3.00	2.60	0.50	Not Good

Based on Table 6, 7 and 8, good and very good interpretation of worker / samples to total ergonomic approach in this study could minimize workplace accidents to workers at the PB workshop company. It is in accordance with Sucipta (2004), Artayasa (2007), Purnomo (2007), Adiatmika (2007), Sajiyo (2008) and Rolles (2008), in Sutapa (2016). Application of total ergonomic approach has been implemented in some workplaces and industries, as well as research conducted by

Total Ergonomics Approach Model minimized work accidents at workshops company as shown in the following figure

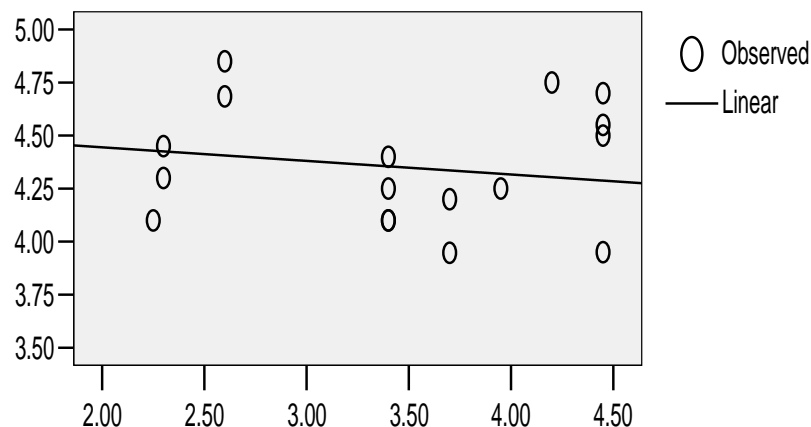


Figure 1. Eight Ergonomical Aspects Model

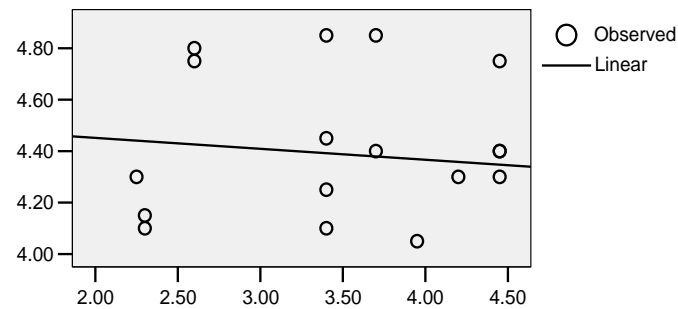


Figure 2. Appropriate Technology Application Model

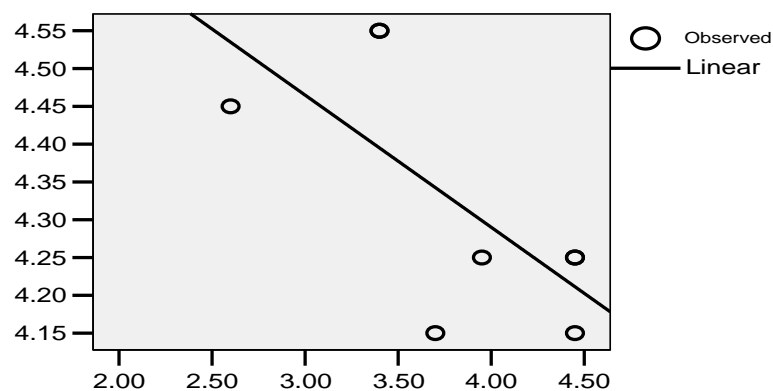


Figure 3. SHIP Approach Model

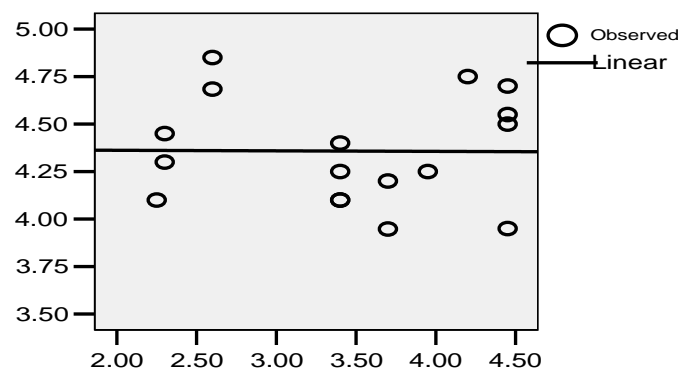


Figure 4. Total Ergonomics Approach Model

5. Conclusions And Recommendations

Conclusion

From the results and discussion can be concluded that workplace accidents minimization in the workshop company were as follows:

1. That eight ergonomic aspects approach, application of appropriate technology and SHIP approach in minimized work accidents were good and very good.
2. Total ergonomics approach model reveal a linear reduction in work accidents.

Recommendations

To improve theory and practical skill of the workers by training about total ergonomics approach and provide

safety equipments to worker who work at dangerous area

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