# ERGONOMIC INTERVENTION IN ORGANIZATION AND WORK STATION INCREASES STUDENT'S WORK PERFORMANCE AND EFFICIENCY OF ELECTRICAL ENERGY CONSUMPTION

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## Abstract

Woodworking workshop could be hazardous to workers' health, particularly when it is done improperly. Workers could be exposed to the following risks such as overexertion, repetitive motion, noise, dust, and chemicals that may threaten workers' health; decreases work inefficiency and excessive strains due to inappropriate working condition or posture. This study was conducted to examine the effect of ergonomics intervention in the students' work performance and the efficiency of the electrical energy consumption at the woodworking workshop of Bali State Polytechnic.

This is an experimental study with pre and post test control group design. Subjects were divided into 4 groups of students, each consisting of 10 students, all performing the same task with different working condition: (1) the original working condition for control group (CG); (2) a new organization for treatment group 1 (TG1); (3) a new work station for treatment group 2 (TG2); and (4) both new organization and work station for treatment group 3 (TG3). Normally distributed and equal data were analyzed by using the One Way Anova test and followed by the Post Hoc–LSD test, and the remaining data were analyzed by using the Kruskal Wallis test and followed by the Mann-Whitney test at the level of significance $\alpha = 0.05$.

Result showed that students' work performance in TG1 increased in moderately, while those in TG2 and TG3 increased very considerably. Moreover, there was no significant increased of the efficiency of electrical energy consumption in TG1 ($p > 0.05$), but there were significant increased of electrical energy consumption of about 44.74% and 107.89% respectively in TG2 and TG3 ($p < 0.05$). This gain were accompanied by saving cost of the electrical energy consumption of about 38.64% and 58.68% respectively. It also appeared that the increased students' work performance and the efficiency of electrical energy consumption were highest in TG3.

In conclussion, it may be stated that comprehensive ergonomic intervention in both the organization and work station in an effort to apply total ergonomic approach has produced the best effect in terms of increased students' work performance and efficiency of electrical energy consumption at the woodworking workshop Bali State Polytechnic.

*Key words: ergonomics intervention, organization, work station, work performance, electrical energy consumption.*

## INTRODUCTION

Woodworking industry is one of the funding resources of Indonesia. The trend of export value tends to increase yearly and pushed the development of woodworking industries in all over Indonesia, so in Bali Province[1]. To face the market needs, mechanization has been conducted by using high technology woodworking machines, but it lack of qualified human resources and caused inappropriate transfer of technology. Therefore, human resources development is needed and polytechnic education especially Civil Engineering Department is one of the ways out. Recently, there are 21 Polytechnics that run Civil Engineering Department, included Bali State Polytechnic[2]. As a vocational Higher Education, it is more focused on practical skills and all civil engineering departments supported by workshops and laboratories, and woodworking workshop is the most hazardous.

To support the demand of skillful human resources in the woodworking industries, mechanization has been done since 1980s, but unfortunately less considerations of occupational health and safety that caused inefficiency and low productivity. Preliminary study was conducted at the woodworking workshop Bali State Polytechnic and the result showed that the activity needs high muscle force, the work station was not suitable with the students' anthropometry, and there was inharmonic of man-machine interaction that caused awkward posture. Additionally, the work environment was not adequate. Students exposed to the heat stress, noise, vibration and wood dust. Furthermore, the organization was also needs improvement. There were inappropriate work-rest schedule, imbalance work nutrition, poor knowledge about ergonomics, and lack of hazards sign. This improper working condition may threaten the workers' health, decreases the vigilant, increases the occupational accident and finally caused inefficiency and low productivity[3,4]. Based on those data, it means that the woodworking workshop at the Bali State Polytechnic needs the improvement and ergonomics intervention is one of the solutions to provide the appropriate working conditions.

The main objectives of this study were to examine the effect of ergonomics intervention in organization, work station, and the combination of ergonomics intervention inn both organization and work station on the students' work performance and the efficiency of electrical energy consumption at the woodworking workshop of Civil Engineering Department of Bali State Polytechnic.

## MATERIALS AND METHODS

This current study is an experimental study with pre and post test control group design. Subjects were divided into 4 groups of students, each consisting of 10 students, all performing the same task with different working condition: (1) the original working condition for control group (CG); (2) a new organization for treatment group 1 (TG1); (3) a new work station for treatment group 2 (TG2); and (4) both new organization and work station for treatment group 3 (TG3). The ergonomics intervention in organization has been organized as follows: (1) 5 minutes break and a glass of drinking water (240 cc) at 09.30 am and 01.00 pm; (2) providing the personal protection devices consisting ear plug, masker, and gloves; (3) providing the hand out that emphasizing on the application of ergonomics in the woodworking workshop; and (4) displayed the sign of the occupational safety and health around the working place. In the meantime, the ergonomics intervention in work station has been conducted by redesign the work station on the radial saw and drilling machines and providing the working table for fabrication (Figure 1 to 7). The indicator of the work organization improvement examined through the consistency of the personal protection devices (PPD) usage, while the indicator of the work station improvement examined through the number of students in awkward posture consisting

bending, squatting, and sitting on the floor. Furthermore, the indicator of the work environment measured through the parameter of the humidity (%), wet bulb globe temperature (WBGT) index ($^{o}$C), noise (dB A), and lighting intensity (lux). The indicator of work performance examined through the cumulative value of the decreasing of workload, MSDs, and general fatigue, and the increasing of productivity. Lastly, the indicator of the efficiency of electrical energy consumption measured trough the comparison between the products consisting the miniature of the framework of the roof, the connection of the plank, and the door frame for lockers and the electrical energy consumption in finalizing those products. Normally distributed and equal data were analyzed by using One Way Anova test and continued by the Post Hoc – LSD test, and the remaining data were analyzed by using Kruskal Wallis test and continued by the Mann-Whitney test at the level of significant $\alpha = 0, 05$.

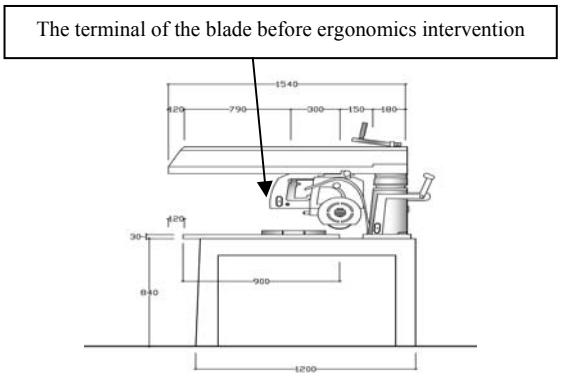


Figure 1 The Radial Saw Machine Before Redesign of Work Station

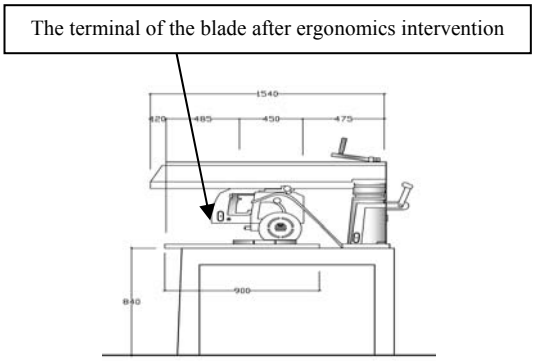


Figure 2 The Radial Saw Machine After Redesign of Work Station

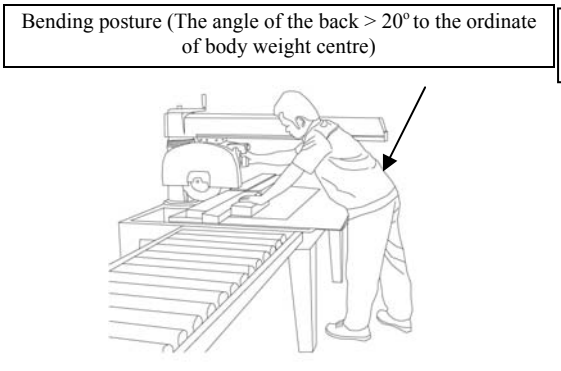


Figure 3
The Work Posture at the Radial Saw Machine before Redesign Work Station

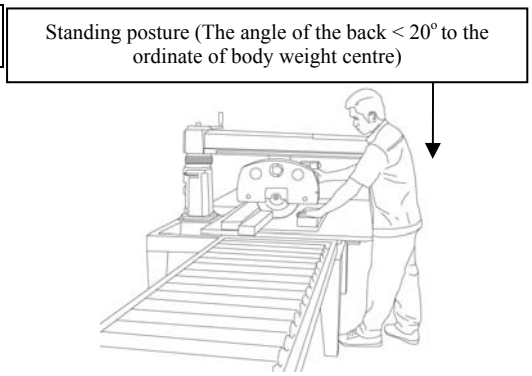


Figure 4
The Work Posture at the Radial Saw Machine after Redesign Work Station

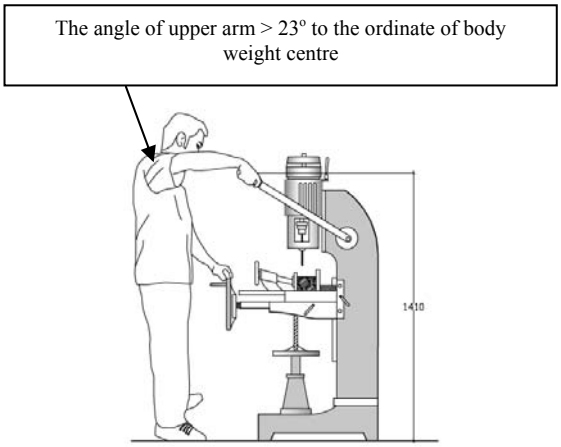


Figure 3.5
The Angel of the Handle of Drilling Bit and the Work Posture Before Redesign Work Station

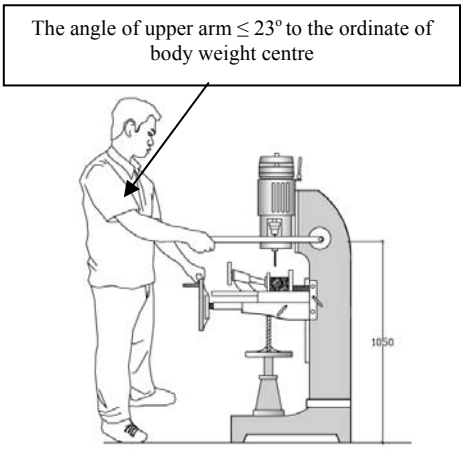


Figure 3.6
The Angel of the Handle of Drilling Bit and the Work Posture After Redesign Work Station

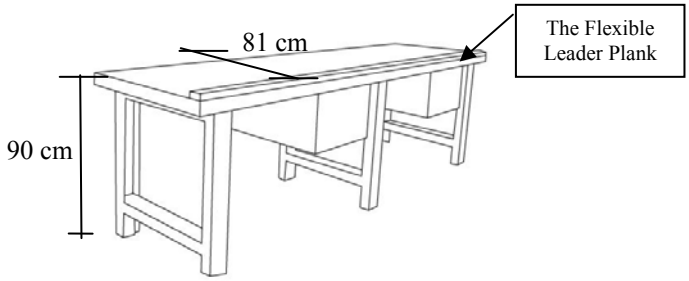


Figure 5
Redesain the Working Table for Fabrication

Figure 6
The Work Posture in Fabrication Process Before Redesign of Work Station

Figure 7
The Work Posture in Fabrication Process After Redesign of Work Station

**RESULT**

The result of mean different test described in the Table 4.1. It showed that there were no significant differences of the subjects' characters and so the physical work environment ($p > 0.05$). Furthermore, it also described that all groups were in equal condition before start working. There were no significant differences of resting hearth rate (RHR), MSDs, and general fatigue before start working ($p > 0.05$). On the other hand, there were

significant differences of working hearth rate (WHR), MSDs, general fatigue, productivity, work performance, and the efficiency of electrical energy consumption within groups ($p < 0.05$). Moreover, the cumulative value of workload, MSDs, general fatigue, and productivity increased the work performance moderately in TG1, while in TG2 and TG3 increased very considerably. The mean different tests followed by the multiple comparisons test and the result described in Table 4.2.

Firstly, Table 4.2 showed that ergonomics intervention decreased the workload and increased the productivity significantly in all groups ($p < 0.05$). The workload in TG1, TG2, and TG3 decreased of about 12.53%, 16.71%, and 17.93%, while the productivity increased of about 87.50%, 118.75%, and 221.875% respectively. It also improved the workload category from heavy workload in CG (between 110-130 pulse/minute) into moderate workload in TG1, TG2, and TG3 (between 90-110 pulse/minute). Secondly, there were no significantly different of MSDs and general fatigue after working in TG1 ($p > 0.05$), but there were respectively different in TG2 and TG3 ($p < 0.05$). Furthermore, there were also no significantly different of the efficiency and the expenses of electrical energy consumption in TG1 ($p > 0.05$), while those in TG2 and TG3 were significantly different ($p < 0.05$). The MSDs in TG2 and TG3 decreased of about 21.52% and 22.45%; the general fatigue decreased of about 21.52% and 22.45%; and the efficiency of electrical energy consumption increased of about 44.74% and 107.89% that followed by the decreasing of the expenses of electrical energy consumption of about 38.64% and 58.68%.

Based on those data, it showed that ergonomic intervention in organization only decreased the work load, increased the productivity and work performance. Meanwhile, the ergonomic intervention in work station and the combination of ergonomic intervention in both organization and work station decreased the workload, MSDs, and general fatigue, and also increased the productivity, work performance and the efficiency of electrical energy consumption that followed by the decreasing of the expenses of the electrical energy consumption.

Table 4.1
Mean Difference

| Variable | n | Average | | | | p |
|---|---|---|---|---|---|---|
| | | CG | TG1 | TG2 | TG3 | |
| **Subjects' Characters** | | | | | | |
| Age (year) | 10 | 18.60± 0.52 | 18.30±0.48 | 18.20±0.42 | 18.50±0.71 | 0.317 |
| Body Mass Index | 10 | 20.26±2.63 | 20.89±2.52 | 21.54±1.98 | 21.43± 3.08 | 0.380 |
| **Physical Work Environment** | | | | | | |
| Noise (dB A) | 6 | 78.99± 3.74 | 81.30±2.54 | 81.38±3.30 | 80.40±3.49 | 0.587 |
| Humidity (%) | 6 | 75.33± 16.59 | 78.00±9.70 | 82.40±4.34 | 86.80±3.90 | 0.218 |
| WBGT ($^{o}$C) | 6 | 27.39± 1.04 | 27.81±0.72 | 27.50±0.58 | 26.95±0.30 | 0.228 |
| Lighting (Lux) | 6 | 886+ 204.79 | 684+ 146.24 | 855+ 58.7 | 916+ 326.71 | 0.197 |
| **Workload** | | | | | | |
| RHR (pulse/minute) | 10 | 81.20± 5.00 | 83.66±3.53 | 83.16±3.03 | 82.63±3.63 | 0.473 |
| WHR (pulse/minute) | 10 | 113.21±3.04 | 99.03±6.62 | 94.29±2.56 | 92.91±2.93 | 0.000* |
| **Musculoskeletal Disorders (MSDs)** | | | | | | |
| MSDs score –before working | 10 | 33,05±3,16 | 32,93±5,70 | 30,26±3,10 | 31,82±4,20 | 0,127 |
| MSDS score –after working | 10 | 53,15±8,45 | 53,53±8,01 | 43,95±4,31 | 34,98±2,77 | 0,000* |
| **General Fatigue (GF)** | | | | | | |
| GF before working | 10 | 32.87±0.54 | 32.90±0.47 | 32.74±0.67 | 32.78±0.63 | 0.825 |
| GF after working | 10 | 47.48±3.53 | 45.23±1.90 | 37.26±1.30 | 36.82±0.69 | 0.000* |
| **Productivity** | | | | | | |
| Productivity | 10 | 0,32 ± 0,06 | 0,60 ± 0,11 | 0,70 ± 0,06 | 1,03 ± 0,09 | 0,000* |
| **Work Performance** | | | | | | |
| Work performance's Score | 10 | 1 ± 0 (standard) | 2,88 ± 0,56 (moderate category) | 4,48 ± 0,73 (very high category) | 4,88 ± 0,24 (very high category) | 0,000* |
| **Efficiency of Electrical Energy consumption (E)** | | | | | | |
| E (KWH/student) | 10 | 0,38±0,14 | 0,50±0,13 | 0,55±0,13 | 0,79±0,13 | 0,000* |
| **Cost of electrical energy consumption** | | | | | | |
| Cost of electrical energy consumption | 10 | 9.450,95 ± 4911,41 | 6.348,68 ± 1512,77 | 5799,00 ± 2088,23 | 3905,43 ± 716,67 | 0,000* |

Table 4.2
Multiple Comparisons

| Variables | Pair groups | Differences (%) | p |
|---|---|---|---|
| **Workload** | | | |
| **WHR (pulse/minute)** | **CG – TG1** | **12.53** | **0.000*** |
| | **CG – TG2** | **16.71** | **0.000*** |
| | **CG – TG3** | **17.93** | **0.000*** |
| **Musculoskeletal Disorders (MSDs)** | | | |
| **MSDs – score after working** | **CG – TG1** | **(0.71)** | **0.796** |
| | **CG – TG2** | **17.31** | **0.023*** |
| | **CG – TG3** | **24.78** | **0.000*** |
| **General Fatigue** | | | |
| **General Fatigue after working** | **CG – TG1** | **4.74** | **0.165** |
| | **CG – TG2** | **21.52** | **0.000*** |
| | **CG – TG3** | **22.45** | **0.000*** |
| **Productivity** | | | |
| **Productivity** | **CG – TG1** | **87.50** | **0.000*** |
| | **CG – TG2** | **118.75** | **0.000*** |
| | **CG – TG3** | **221.875** | **0.000*** |
| **Efficiency of Electrical Energy consumption** | | | |
| **E (KWH/student)** | **CG – TG1** | **31.58** | **0.057** |
| | **CG – TG2** | **44.74** | **0.007*** |
| | **CG – TG3** | **107.89** | **0.000*** |
| **Cost of Electrical Energy consumption** | | | |
| **Cost of electrical energy consumption** | **CG – TG1** | **32.82** | **0.247** |
| | **CG – TG2** | **38.64** | **0.005*** |
| | **CG – TG3** | **58.68** | **0.000*** |

## DISCUSSION

### Students' Characters

Result showed that the average age of the subjects was between 18.20-18.60 years old and the BMI were 20.26-21.54. In this stage of age, the relative capability and productivity level increase gradually and reached the maximum value between the early 20s and the end of 30s[5,6]. Besides, people with BMI > 25 have higher risk of hypertension, and people with BMI > 29 (Obesity) have 2.5 higher risk of musculoskeletal disorders (MSDs) compare with whom with BMI < 20[7]. Furthermore, the result of the analyses showed that there was not a significant difference of BMI within groups (p > 0, 05). It means that the character of subjects in all groups is comparable and will not influence the result of the study since the entire subjects in the same level of relative capability, productivity and health.

### Physical Work Environment

Firstly, the average of humidity was between 75.33-86.80%. Those data were mach with the data that published by Balai Besar Meteorologi dan Geofisika Wilayah III Denpasar. It reported that during the period of June 2008, the humidity was about 62-92%[8]. Secondly, the average of WBGT index in CG, TG1, TG2 and TG3 were 26.95-27.81 $^{o}$C. Based on the Indonesian National Standard, the recommended of WBGT index for 8 hours continuous work is 26.7 $^{o}$C for moderate workload category and 25 $^{o}$C for

heavy workload category[9]. It means that the WBGT index for all groups were not adiquate. Thirdly, the average level of noise in CG, TG1, TG2 and TG3 were between 78.99-81.38 dB A. This data showed that the level of noise in all groups were nearly in the upper limit (85 dB A). The level of noise more than 85 dB A will increase the blood tension and hearth rate, caused the hearing lost, early fatigue, and finally decreased the productivity. Meanwhile, the level of noise more than 80 dB A is not suitable for conversation[10]. Lastly, the average of the lighting intensity in CG, TG1, TG2, and TG3 were between 684-916 lux. It is recommended about 500-600 lux for high rate accurateness of jobs[5,11]. It means that the lighting intensity in all groups were adequate. However, statistic analyses showed that there were not significantly differences of humidity, ISBB, noise and lighting intensity within groups ($p > 0.05$). It means that the physical work environment in all groups were comparable and will not influenced in the result of the study, since each group got the same effect of physical work environment.

**Workload**

The workload was examined through the number of the resting hearth rate (DNI) and working hearth rate (WHR). The averages of DNI were 81.20-83.66 pulse/minute and there were not significant differences within groups ($p > 0.5$). In addition, the resting hearth rate in all groups were in the light category of workload (< 90 pulse/minute)[12]. Thus, the resting hearth rate in all groups was comparable and will not influence in the result of the study. Furthermore, the average of WHR in CG was in the heavy workload category (between 110-130 pulse/minute), but in TG1, TG2, and TG3 were in the moderate workload category (between 90-110 pulse/minute)[11]. Meanwhile, Table 4.2 showed that there were significant different of WHR between CG and all TG1, TG2, and TG3. The decreasing of WHR in TG1, TG2, and TG3 were about 12.53%, 16.71%, and 17.93% from CG.

The decreasing of workload in TG1, TG2, and TG3 from CG was caused by the improving of organization and work station. The understanding about role of ergonomics that supported by the occupational Safety and Health (OSH) sign increased the awareness of students to concern the standard operating procedure properly, included in using personnel protection devices (PPD). The result of the analyses showed that the consistency of students in using PPD in TG1 and TG3 increased significantly from CG ($p < 0, 05$). On the other hand, two glasses of drinking water (240 cc each) improved the work nutrition that shown by the decreasing of the weight lost soon after stop working. The weight lost in CG was 1.72% and it was more than recommended limit (< 1, 5%). In the contrary, the body weight of students soon after stop working in TG1 was 0.25% over than before start working. It means that two glasses of drinking water kept the body liquid in balance and avoid the body weigh lost. More than 1.5% body weight lost will caused dehydration, give additional workload and caused the early fatigue and it is very dangerous for students' health[13,14]. Meanwhile, redesigned of work station based on students' anthropometry was lead the students to work in natural posture. Statistic analyses showed that the number of students in awkward postured in TG2 and TG3 significantly decreased from CG and TG1 ($p < 0, 05$). Working in natural posture avoids the over exertion, maintain the blood flow and the supply of oxygen to the body muscle, avoid muscle fatigue and the additional workload[4].

Additionally, statistic analyses of the workload in each 30 minutes showed that the maximum workload in all groups achieved at 11.00 am (before long break at 11.00-12.00 am), while the analyses of daily workload showed that the maximum workload achieved on the second day (Figure 8 and 9).

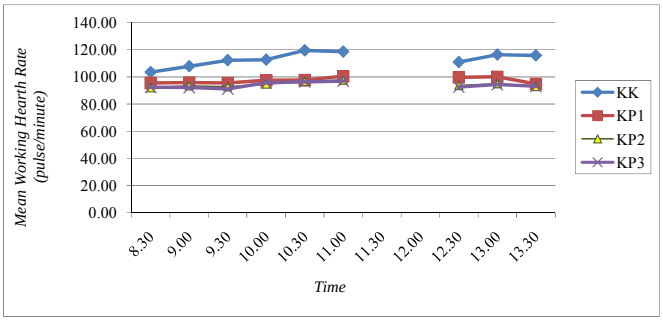


Figure 8 Mean Workload in Each 30 Minutes

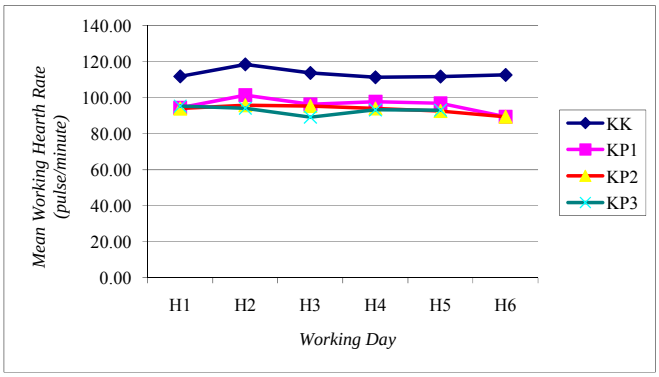


Figure 9 Mean Daily Workload

**Musculoskeletal Disorders (MSDs)**

The major hazards in woodworking activities were the lifting load and awkward posture caused by the facilities and working tools that not suitable with students' anthropometry. Result showed that there were significant differences of the MSDs score after working within groups ($p < 0.5$). In addition, the daily analyses showed that MSDs score inclined gradually during manual working process, and then declined when it used woodworking machines. Furthermore, it was back to incline during fabrication and finishing process in CG and TG1, but constant in TG2, and TG3 (Figure 4.3). It proved that the work station that suitable with students' anthropometry in TG2 and TG3 decreased the MSDs effectively.

In the mean time, the MSDs score in TG3 was the lowest. Ergonomic intervention in organization was indebt the understanding of students about how to behave appropriately, while the anthropometric work station was minimized the awkward posture. In addition, the comprehensive ergonomic intervention shortened the working period from six days into five days. Students could perform their task in more convenient and healthy working condition that decreased the MSDs, increased the vigilant, quicken the working process and avoid the early fatigue[4]. The daily MSDs score described in Figure 10.

Further analyses showed that ergonomics intervention in work station was minimized the bending, squatting, and sitting posture, even eliminate the sitting posture in TG2 and TG3. This data is in accordance with the study in some small industries in Philippine during 1994-1996 and the result showed that the improving of work station minimized the tension on the body muscles and decreased the MSDs[15].

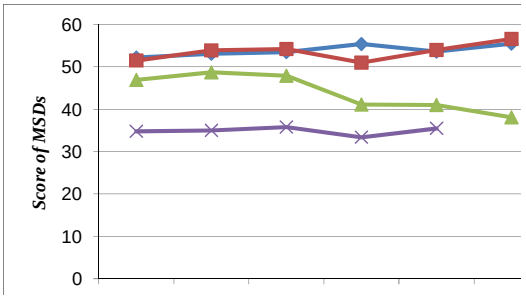


Figure 10 Daily MSDs Score within Groups

**General Fatigue**

The multiple comparisons test showed that there was no significantly different of the general fatigue after working between CG and TG1 ($p > 0.05$), but it was significantly difference in TG2 and TG3 ($p < 0.05$). The previous study reported that there were a very strong correlation between general fatigue and the increasing of hearth rate that indicate the workload category[16]. In line with the MSDs, the general fatigue score inclined gradually during manual working process, and then declined when it used woodworking machines. Furthermore, it was back to incline during fabrication and finishing process in CG and TG1, but constant in TG2, and TG3. It proved that the work station that suitable with students' anthropometry in TG2 and TG3 decreased the general fatigue effectively. Besides, the decreasing of the general fatigue score on the fourth day caused by two days holydays during the week end (Saturday and Sunday), and then the students continued finishing the task for the first three days on the next week. These data showed that the long break during week end definitely recovered the students even eliminated the fatigue during the last three days. Moreover, the analyses showed that the daily general fatigue score after working in TG2 and TG3 keep constant from the first to the six$^{th}$ day as described in Figure 11.

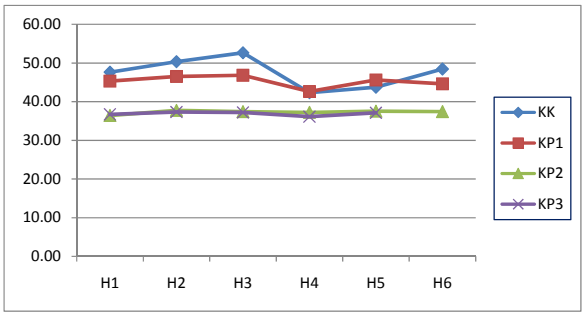


Figure 11 Daily General Fatigue Score

**Students' Productivity**

The productivity in TG1, TG2, and TG3 significantly increased of about 87.5%, 118.75%, and 221.875%. The increasing of productivity was caused by the improving of students' health status that indicated by the decreasing of workload, MSDs, and general fatigue. It is in line with the report that ergonomic intervention in work station increased the productivity at the electronic industries between 20-25%[17].

In this current study, ergonomic intervention in organization and work station decreased the workload, MSDs, and general fatigue, increased the activation and motivation, minimized the inappropriate break time and work duration that finally increased the productivity comprehensively.

**Students' Work Performance**

Table 4.1 described that there was a significant difference of the average score of the work performance within groups ($p < 0.05$). The work performance in TG1 was increased mederately (5% < (P-) or (P+) > 10%), while both in TG2 and TG3 were increased in the very high category ((P-) or (P+) > 15%) as shown in Figure 12. The increasing of the work performance was due to the improving of the health status that indicated through the decreasing of workload, MSDs, general fatigue, and increased the productivity that finally increased the work performance. This data is in line with the previous study. It reported that the ergonomic model of field activity increased the students' work performance significantly about 78.704-80.025% ($p < 0.05$)[18]. Other references also stated that the working condition and behavior affects the work performance[4,19].

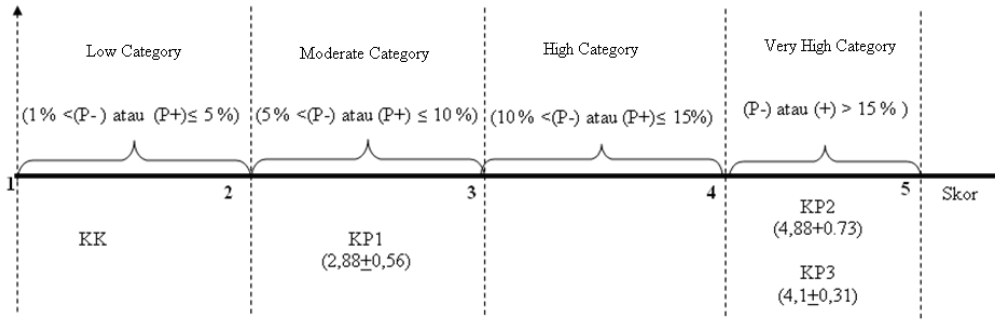


Figure 12
Model of the Work Performance Category

**Efficiency of Electrical Energy consumption**

Table 4.1 showed that a significant difference of the eficiency of electrical energy consumption were found out within groups ($p < 0.05$). Moreover, Table 4.2 showed that the eficiency of electrical energy consumption in TG1 was not significantly different ($p > 0.05$), while in TG2 and TG3 were significantly different compare with CG ($p < 0.05$). The eficiency of electrical energy consumption in TG2 and TG3 increased about 44.74% and 107.89% from CG. Refers to these data means that ergonomics intervention in work station gave the beter effect of the increasing of electrical energy consumption. The improving of work station in TG2 reduced the duration of woodworking process that followed by the decreasing of electrical energy consumption and finally increased the eficiency of electrical energy consumption. Furthermore, the increasing of the efficiency of electrical energy consumption in TG3 caused by the ergonomic intervention in both organization and work station. The improving of organization indebt the understanding of students about the working procedure. On the other hand, the improving of work station reduced the duration of woodworking process and the electrical energy consumption, and lastly, the comprehensive ergonomic intervention in both organization and work station in TG3 gave the highest increased of the eficiensy of electrical energy consumption confidently. The analyses showed that the increasing of the eficiency of electrical energy consumption in TG3 was 43.64% higher than TG2 and statistically significant ($p < 0.05$). in accordance with the previous study, it reported that the improving of kitchen facilities at the canteens, cafes, restaurants, and hotels in England that influenced ergonomics consideration increased the eficiency of electrical energy consumption for at least 25%[20].

In line with the increasing of the eficiency of electrical energy consumption, it was followed by the decreasing of the expences of electrical energy consumption. The expenses of electrical energy consumption in TG2 and TG3 significantly decreased of about 38.64% and 58.68%. These data were in accordance with the previous report that ergonomic

intervention in the circuit breaker saved the direct operational expenses about 66.69%[21]. In this recent study, the decreasing of the expenses of electrical energy consumption was calculated for the personal task only (excluded training process, group task, and other activities).

Bali State Polytechnic as a vocational higher education supports by the curriculum that more focuses on the practical skills. Therefore, about 60% of the curriculum was focuses on the practical activities in the workshops or laboratories. Based on the result of this study, the proportion of the practical activities, and the number of students (about 1,500 students/semester), it definitely can be estimate how much is the saving cost for electrical energy consumption yearly as one of the direct advantage for Bali State Polytechnic.

## NOVELTY

This study found out that comprehensive ergonomic intervention in both organization and work station in an effort to apply total ergonomic approach has produced the best effect in terms of increased students' work performance and efficiency of electrical energy consumption at the woodworking workshop Bali State Polytechnic compare with the ergonomic intervention in organization or work station that conducted partially.

## CONCLUSSION

It may be stated that ergonomic intervention in organization decreased the workload and increased the productivity and the work performance, while those ergonomics intervention in work station and the combination of ergonomic intervention in both organization and work station decreased the workload, MSDs, general fatigue and increased the productivity, work performance, and the efficiency of electrical energy consumption respectively that accompanied by saving cost of the electrical energy consumption.

## SUGGESTION

Based on the result of this study, it is suggested that the basic knowledge of ergonomics should be influenced in the job sheet as the reference for the lecturers, technicians, and students that involve in the woodworking workshop activities at the Civil Engineering Department Bali State Polytechnic. Additionally, the basic principal of ergonomic intervention in organization and work station is available for all workshops and laboratories at the Bali State Polytechnic with some adjustment.

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