APPLICATION OF SYNERGY OF ERGO-MECHANICAL SYSTEM TO IMPROVE FUEL ENERGY EFFICIENCY OF DRYER AND WORKING CAPACITY OF WOMEN EMPLOYEES IN INDUSTRIAL FACILITIES OF BANTEN AT BLAHBATUH GIANYAR BALI

1Adnyana, I.W.B., 2Adiputra, I.N., 2Tirtayasa, Ketut., and 3Wijaya Kusuma, I.G.B

1Ergonomics Department, Post Graduate Program, Udayana University, Bali
2Department of Physiology, Faculty of Medicine, Udayana University, Bali-Indonesia.
3 Faculty of Engineering, Udayana University, Bali-Indonesia.

Abstract

Tumpeng and penek are important facilities on making of banten according to Hinduism in Bali. The use of tumpeng and penek is constantly increases then it needs more effective and efficient in the creation, in order to fulfill the market demand. Tumpeng and penek making process is now done by home industry. Although by home industry, but the production process is still done on the floor with no ergonomic body posture and the drying process is done by a dryer without heat insulation that effects to the woman employees. These conditions affect the working capacity and energy efficiency of the fuel of dryer. Based on the above problems it is necessary to study the synergy of ergonomics and mechanical systems which in this case is expressed as synergy ergo-mechanical systems by ergonomically synergy between the employees and the mechanical system of the dryer in order to increasing labor productivity and efficiency. This is done by redesigning the work system and dryer system that aims to increasing working capacity by reducing workload, decreasing complaints of musculoskeletal, decreasing in fatigue, increasing of comfort, improving energy efficiency of fuel. Research experiments conducted within subject design by involving 15 respondents that randomly selected, all of whom studied in 2 (two) periods, Period I and Period II. Period I is the period prior to the application of synergy ergo-mechanical system, and the second period is the period after the application done of synergy ergo-mechanical system. Each carried in three days period, with washing out of 2 days and 5 days of adaptation. Data were analyzed with descriptive and test for normality using the Shapiro-Wilk. Different test has been done when the data were normally distributed with a t-paired, unless analyzed by the nonparametric Wilcoxon test with the significant-degree of about 5%. The results showed that of about 21.90% reduction occurred in workload, musculoskeletal complaints of about 15.10%, about 22.23% of fatigue, increasing employee comfort of about 59.18%, and fuel efficiency of dryer of about 13.29%. It concluded that synergy of ergo-mechanical system applications improves energy efficiency of dryer fuel and work capacity of industry women employees of banten facility at Blahbatuh Gianyar Bali.

Keywords: Facilities of banten, ergo-mechanical, working capacity, efficiency.

INTRODUCTION

The use of facilities such as tumpeng and penek in the implementation of religious ceremonies in Bali are so important, numerous and also continuous. This is because the way of life of Hindus in Bali has philosophy such as Tri Rnam, Panca Yadnya, Tri Hita Karana and feasts as well as the meaning of tumpeng and penek Hindu philosophy 1. Development of tumpeng and penek production is now doing by home industry that is mostly found in Bali. One tumpeng and penek making process by a home industry is carried out in Banjar Ketandan, Buruan Village, Blahbatuh, Gianyar, Bali which manually done by sitting on the floor with no ergonomic working position and also influenced by convection heat from the dryer to the work environment, that causing discomfort. Un-ergonomic work attitude will affect the working capacity 2. Heat energy convection causes heat transfer to the work environment will affect the efficiency of the tool and also increasing external burden for employees 3.

Preliminary studies carried out with 5 samples and obtained as follows: average workload mean difference of about 28.79 ± 4.23, average musculoskeletal mean difference of about 10.53 ± 1.30, average fatigue mean difference of about 29.87 ± 1.59, average mean subjective thermal comfort of
employees of about 15.60 ± 1.80 and the average energy efficiency of the dryer of about 24.62 ± 0.15. Preliminary studies indicate problems of workload, fatigue and energy efficiency. To solve the above problems, research of ergo-mechanical synergy should be conducted in accordance with redesign of working system such as facilitates the provision of appropriate anthropometric tables and chairs as well as adding insulation and chimney-shaped goose neck pull on the dryer. The results of this study are expected to improve the performance of employees (human) such work capacity through ergonomics disciplines and be able to improve the performance of the appliance energy efficiency of fuel dryer using disciplines of the field of energy conversion.

Providing of appropriate work facility such as anthropometric tables and chairs will be able to make changes in body posture asymmetrical or twisted, sitting with legs crossed and resting on the squat and leg strength became physiological body posture or natural. One of the seven forced posture that should be avoid as the body posture such as asymmetrical or twisted, in order to be able working ergonomically 4. Ergonomic body posture will affect a person's work capacity.

The addition of insulation and chimney-shaped goose neck pull on the dryer will be able to make changes the energy and mass transfer phenomena inside the dryer and reduce the effects of heat into the work environment or where it will affect the workload and energy efficiency of fuel dryer.

Application of synergy ergo-mechanical systems such as redesign to working station such as appropriate anthropometric tables and chairs as well as adding insulation and chimney-shaped goose neck pull on the dryer has been categorized into second period (P II), but the period before the application of synergy ergo-mechanical systems the so called period I (P I). Conditions of period I and II can be shown in the following figure below:

Figure 1.a
Stirring Process (PI)

Figure 1.b
Stirring Process (PII)

Figure 2.a
Formation Process (PI)

Figure 2.b.
Formation Process (PII)

Figure 3.a
Drying Process Position Open (PI)

Figure 3.b
Drying Process Position Closed (PII)
RESEARCH METHODS

The study was conducted on an experimental basis with the treatment by subject design. Samples were counted as many as 15 people and at random selection. Data taken for period of I has been made on 3 days, whereas after 2 days washing carried out and 5 days of adaptation data collection period II. Data were analyzed descriptively and with the Shapiro-Wilk normality. Another different test has been done when the data were normally distributed with a t-paired, unless analyzed by the nonparametric Wilcoxon test with the significant degree at both 5%.

RESULTS AND DISCUSSION

Characteristics of Research Subjects

The mean age of subjects in the study was 46.73 ± 7.89 years, mean weight 52.93 ± 7.19 kg, mean height 164.53 ± 9.61 cm. Body weight and height can be used to determine body mass index (BMI) in kg/m² which is a ratio of weight in kilograms by height units in meters squared, where the results of calculations obtained mean BMI of about 19.49 ± 1.26 kg/m².

Judging from the range of workers including BMI in the normal range is between 18.5 -25 kg/m² with good nutritional status. Limitation of IMT is a requirement in this study. Value ratio of weight to height in the normal range can be found at the study on student of AKPER PPNI Denpasar, with the average height and weight in the control group of about 49.17 ± 4.67 kg and of about 156.08 ± 3.61 cm, whereas the treatment group and 50.50 ± 5.43 158.16 ± 4.68 kg. Research on the students in the Department of Biology IKIP Singaraja with mean BMI of about 19.79 ± 1.99 kg/m² in the control group and of about 20.39 ± 2.51 kg/m² in the experimental group. Research on painting metal craft artisans in Kediri Tabanan indicated mean BMI of about 20.20 ± 2.90 kg/m² in the period I and II.

Judging from the worker’s age range between 40-60 years with a mean of about 46.73 ± 7.89 years, including the less productive, and this is because the employees in the home industry facility of tumpeng and penek in Banjar Ketandan, Blahbatuh Gianyar employs mothers households around the local Banjar who do not have main jobs which most of the principal’s age has been in over 40 years, where the ability of muscle strength has begun to decline. A person's physical capacity is directly proportional to a certain extent with age, and reaches its peak at the age of 25 years. The influence and the ability of the muscles are in the range of 20-30 years. Physical strength decreases from the age of 39 years and also the decrease of muscle strength into 75-85% at age 50-60 years compared with age 25-35 years. This work is not a job that idolized by young people who still have a productive life span, but the work is well-liked by women who are married and understand the rituals of life, so the work is fun and were able to add family’s income so it becomes quite productive in old age.
Work load

Major changes in workload (BK) on the activities of domestic industry (home industry) on making offerings facility in the form of *tumpeng* and *penek* in this study was measured in periods I and II. The workload is determined by the difference or differences from the resting pulse rate (DNI) with a working pulse (DNK). Changing in workload of this activity is determined by the activity of the production process. Resting pulse rate in period I was taken at 09.00 am while working pulse rate taken at 12.00 pm; 3.00 pm and 5.00 pm. In the second period the resting pulse rate taken at 08.00 am while working pulse rate taken at 10.00 am; 12.00 pm, and 4:00 pm. To assess the changes in workload is doing after work done different test workload. The results of the different test measurements and are shown in Table 1

Table 1. Outcomes and Workload Differences Test Period I and II.

| Subject Group | n | Means | SB | Difference | Value | Value S-W | p |
|---------------|---|-------|----|------------|-------|-----------|---|
| Period I      | 15 | 28,80 | 3,28 | 6,29       | 0,345 | 0,000     |   |
| Period II     | 15 | 22,51 | 2,77 | 0,364      |       |           |   |

Note: $S-W= Shapiro-Wilk$

Test results for normality (Shapiro-Wilk) workloads in the period I and II were normally distributed ($p>0.05$) and a different test (t-paired) where $p<0.05$ was stated that there were significant differences between workload period I to II or a decline in workload significantly by 21.90% from period I to II.

Decrease workload means work becomes lighter. The decreasing of workload would theoretically improve worker's performance while this is one of the characteristics of increasing quality of work so that the employees can be more health and has a better life. According to Hettinger that workload changes from category to category of being lightweight. The decrease is due to the workload application synergy ergo-mechanical system that are problem solving simultaneous based of study of ergonomics and mechanical engineering. In ergonomics include changes in body posture and positions that are part of the task, changes to meal breaks and work hours that are part of the organization, and changes in the work environment micro-climate result of changes in the application of science dryer system heat and mass transfer, thermodynamics, fuel and process fuel combustion engineering is a discipline so as to provide thermal comfort for workers.

Decreasing workload can be found on the research redesign of workplaces and working system with ergonomic intervention on miller hand-rolled kretek cigarette industry "X" in Kediri, East Java, where workload changes based on changes of mean pulse length work on the working conditions $122.94 \pm 4.747$ in the category a workload is becoming $97.36 \pm 2.959$ beats / min in the category of very light load. The workload changes weight category (34-42) beats / minute on concrete without the use of tools of ergonomics interventions into the category of medium (26-32) beats per minute on ergonomics intervention.

Musculoskeletal Complaints

Musculoskeletal complaints are common complaints in the system of muscle skeletal or muscles attached to the bones that comprise the muscle fiber cross-motion properties which can be set (volunteer). Complaints are indicated by pain in parts of the body organs. Data measurement of musculoskeletal complaints (KM) obtained using a questionnaire by Nordic Body Map using scores based on Likert scale. Fetching data before work (SBK) was conducted at 09.00 am in the period of I, and at 08.00 am in period of II. Data retrieval after work (SSK) was conducted at 5.00 pm in the period I and at 4.00 pm in the second period. The results of measurements of different musculoskeletal complaints and different test are shown in Table 2.

Table 2. Test Results and Musculoskeletal Complaints Difference in Period I and II.

| Subject Group | n | Means | SB | Difference | Value | Value S-W | p |
|---------------|---|-------|----|------------|-------|-----------|---|
| Period I      | 15 | 10,13 | 1,08 | 1,53       | 0,065 | 0,000     |   |
| Period II     | 15 | 8,86  | 0,93 |           | 0,263 |           |   |

Note: $S-W= Shapiro-Wilk$

Test results for normality (Shapiro-Wilk) different musculoskeletal complaints in the period I and II were normally distributed ($p>0.05$) and different test different musculoskeletal complaint (t-paired) where $p<0.05$ was stated that there were significant differences between different musculoskeletal complaint ts of period I to II or the decline in musculoskeletal significant complaints of 15.10%.
Decreasing in complaints of musculoskeletal is an indication that a skeletal muscle has functioned better then it decreases pain in the body organs of workers. This decreasing caused that the workers to become healthier so that the production process can be maintained and even improved.

Decreasing in complaints of musculoskeletal caused by synergy ergo-mechanical systems applications such as changes in body posture production process from a seated position on the floor that is not ergonomically to be seated in a chair that becomes ergonomic working posture in which the particular organs no longer experience under 90° flexion or suppression mainly in the legs. This will cause the blood circulation becomes normal with enough oxygen to the tissues so that the formation of carbon dioxide and lactic acid can be avoid because organs can work physiology. Similarly, seating position in line with the raw material will process the establishing position of the body state on asymmetrical or twisted is no longer. These changes led to ergonomic working posture.

Decreasing musculoskeletal complaints can also be encountered in the study in treatment modification overthrow of coffee or a working tool after modification decreased 37.5% with the difference in value before and after the complaint musculoskeletal work mean 8.8 ± 2.4 treatment I to 5.5 ± 1.9 treatment I and II. The study of ergonomics intervention process with fishing trawlers Amurang ring in South Minahasa district of North Sulawesi province shows that the mean scores complaint musculoskeletal of about 88.75 ± 7.89 in the condition without intervention and of about 76.53 ± 9.32 in the intervention condition or a decline of 13.77%.

### Subjective Fatigue

Fatigue of workers is an accumulation of an acceptable body load due to work activities performed too long to produce a production. Fatigue is actually an indicator of a reduction in work capacity in the form of fatigue activity, motivation and physical activity can influence the success of a production process or an indication of a turning point maximum ability and skill of the worker or someone as a gesture or a natural sign to immediately break. In this study to determine the worker fatigue measured objectively by the measurement workload while fatigue opinion (KS) were measured using 30 items questionnaire fatigue and value based on the Likert scoring.

Fetching data before work (SBK) was conducted at 09.00 am in the period I and at 08.00 am in the second period. Data retrieval after work (SSK) was conducted at 5.00 pm in the period I and at 4.00 pm in the second period. The results of different measurements and subjective fatigue different test different subjective complaints are shown in Table 3.

| Subject Group | N | Means | SB | Difference | Value S-W | Value p  |
|---------------|---|-------|----|------------|-----------|---------|
| Period I      | 15| 29.29 | 1.36| 6.51       | 0.669     | 0.893   |
| Period II     | 15| 22.78 | 1.05| 1.05       | 0.893     | 0.000   |

Note: S-W= Shapiro-Wilk

Test results for normality (Shapiro-Wilk) fatigue has different opinion on the period I and II were normally distributed (p> 0.05) and different test different opinion fatigue (t-paired) where p <0.05 was stated that there were significant differences between different subjective fatigue period I to II or a decline in a significant reduction in fatigue opinion of 22.23%.

Reduction in fatigue showed improved quality of work so the ability effectiveness workers become better, more worker morale, job lighter (decreased workload) or the ability to produce can be improved so that increasing workers' incomes and livelihoods achieved.

The decreasing was caused by fatigue synergy ergo-mechanical systems applications that work as well as the change of body posture and micro-climate environment. This change will affect the production so that workers be working with an ergonomic working conditions and more comfortable. Decrease fatigue can also be found in the research approach to ergonomic transport workers lift at Badung traditional market with values in general fatigue after working on the pre-treatment amounting of about 77.44 ± 3.93 and after treatment amounted to 50.36 ± 2.21 with a mean difference of 27.08 or decreasing fatigue after working with quality improvement. Decrease fatigue score in the research repair drier seaweed in the village of Nusa Penida Ped before repair and after repair drier seaweed of about 20.10 ± 1.63 and 9.87 ± 1.36 or a decrease of 50.85%.

### Subjective Thermal Comfort

Subjective thermal comfort is a comfort that is felt directly by workers due to thermal effects caused dryer. In this study, measurements the subjective thermal comfort conducted by giving questionnaires.
9 items. Data retrieval is done by providing a questionnaire after work during the period I and II. The results of the different test measurements and subjective thermal comfort shown in Table 4

Table 4. Test Results and Subjective Thermal Comfort Different of Period I and II.

| Subject Group | N  | Means | SB  | Difference | Value S-W | Value p |
|---------------|----|-------|-----|------------|-----------|---------|
| Period I      | 15 | 15,58 | 1,43| 9,22       | 0.107     | 0.000   |
| Period II     | 15 | 24,80 | 1,85| 0.689      |           |         |

Note: S-W = Shapiro-Wilk

Test results for normality (Shapiro-Wilk) mean subjective thermal comfort in the period I and II were normally distributed (p > 0.05) and a different test (t-paired) where p < 0.05 was stated that there were significant differences between the mean subjective thermal comfort period I to II or an increase in a meaningful sense of comfort at 59.18%.

Increased sense of comfort means better conditions micro-climate. This increase was caused by the synergy of ergo-mechanical application to the improvement of the dryer with the addition of insulation and traction redesign natural funnel shaped goose neck. The addition of the small isolator has been converted from energy into the work environment of micro-climate working environment such as dry air temperature, wet air temperature and relative humidity for the better. This will create a sense of comfort to move so as to produce as much as possible.

Fuel Energy Efficiency Tool maker

Energy efficiency in the current era is a must considering the rising fuel prices and the depletion of world energy backup source. Energy efficiency fuel dryer is actually one of the performances of the dryer that used in industrial facilities offerings. The amount of fuel energy efficiency is determined by the ratio of the dryer energy required theoretically evaporate water vapor to fuel energy used in actual expressed in (%) in period I and II. The measurements were made by determining the amount of water vapor that can be evaporated and the amount of fuel required so that energy requirements can be determined. The amount of water vapor and the amount of fuel is determined from the difference in mass before and after drying whereas dried mass of fuel is determined from the difference in mass before it is used to heat after heat. Measurements were performed with 18 observations (n) or the drying process. The results of energy efficiency measures and fuel drier different test durations are shown in Table 5.

Table 5. Different Test Results and Fuel Efficiency Energy Equipment Dryer Period I and II

| Subject Group | N  | Means | SB  | Difference | Value S-W | Value p |
|---------------|----|-------|-----|------------|-----------|---------|
| Period I      | 18 | 23,27 | 0,98| 0,000      | 0,000     | 0,000   |
| Period II     | 18 | 36,56 | 1,46| 0,893      |           |         |

Test results for normality (Shapiro-Wilk) average energy efficiency of fuel drier period I and II are not normally distributed (p < 0.05) and a different test (Wilcoxon) where p < 0.05 was stated that there were significant differences between the mean energy efficiency fuel drier periods I and II or increased energy efficiency of fuel drier significant at 13.29%.

Improved energy efficiency of fuel drier meant that occur increase the performance of the dryer to evaporate the water vapor in the production of wet from period I to II so that the energy consumption is reduced fuel consumption or decrease fuel energy.

Improved energy efficiency of fuel caused by the application of a hair ergo-mechanical synergy with the consummation of the hair through the addition of insulation materials (insulation), merging units and natural funnel-shaped pull goose neck. The addition of insulation and merging unit can reduce the loss of thermal energy generated by fuel combustion process to the work environment. The use of natural chimney-shaped pull goose neck would make a more complete combustion process because the air is used for combustion processes in the work environment has a relative humidity better (smaller) in the second period so that the energy that vaporizes fuel not used the water vapor content in the air environment. Water vapor is the result of mass transfer from vehicle offerings into the gases of combustion in the chimney to pull over immediately separated from air and water vapor system is already saturated separated by a swan neck shaped curve so that the process becomes faster drying, use fuel more bit and the quality of the products produced better views of the water content.

Conclusions and Suggestions

Conclusions

Based on the research that has been done, statistical analysis, and discussion of it can be summed up as
follows:
1. Applications of synergy ergo-mechanical system can reduce the workload of women employees in industries facilities of banten at Blahbatuh Gianyar Bali of 21.90%
2. Applications of synergy ergo-mechanical system can reduce the complaints musculoskeletal of women employees in industries making offerings facilities industry at Blahbatuh Gianyar Bali of 15.10%
3. Application synergy ergo-mechanical system can reduce fatigue opinion of women employees in industries facilities of banten at Blahbatuh Gianyar Bali of 22.23%
4. Applications of synergy ergo-mechanical system can increase thermal comfort of women employees in industries facilities of banten at Blahbatuh Gianyar Bali of 59.18%
5. Applications of ergo-mechanical synergy can increase energy efficiency of fuel in industries facilities of banten at Blahbatuh Gianyar Bali of 13.29%

Suggestion
Based on the conclusion, it can be delivered that the following suggestions: Synergy of ergo-mechanical can be used as a reference in solving the production process so as to provide protection to workers (human) and suffer from performance improvements and cost savings in energy costs of production especially considering the limited energy resources in order to achieve healthy working conditions, safe, convenient, effective and efficient with the expectation that labor productivity in order to achieve the highest.

REFERENCES
1. Wijayananda, MJ.2003. Tetandingan lan Sorohan Banten. Surabaya: Paramita
2. Manuaba, A. 2006. Total Approach Is A Must For Small And Medium Enterprises To Attain Sustainable Working Conditions And Environment, With Special Reference To Bali Indonesia. Industrial Health. January 2006;44 (1):22-26, Nasional Center for Biotechnology Information (NCBI). US National Library Of Medicine And National Institute For Health. [cited 2007 April 21]. AvailableFrom: URL: http://141.99.140.157.d/aws/index.gov
3. Adiputra, N. 1998. Metodologi Ergonomi. Program Studi Ergonomi-Fisiologi Kerja, Program Pascasarjana Universitas Udayana.
4. Pheasant, S. 1991. Ergonomics, Work and Health. London: Macmillan Academic Professional Ltd.
5. Colton, T. 1985. Statistik Kedokteran (Terjemahan Oleh Rosel Sanusi). Yogyakarta: Gajah Mada University Press.
6. Heryudarini, H., Widodo, Y., Mulyati, S. 2005. Penggunaan Berbagai Cut Off Indeks Massa Tubuh sebagai Indikator Obesitas terkait Penyakit Degeneratif di Indonesia. Pusat Penelitian dan Pengembangan Gizi dan Makanan. Badan Penelitian dan Pengembangan Kesehatan. Departemen Kesehatan.
7. Tirtayasa, K.2003. Pelatihan Olah Raga KS selama 12 Minggu, Dua Kali Perminggu, Dua Jam Sekali Latihan Meningkatkan Kekuatan Otot Tangan Mahasiswa Akademi Perawat PPNI Denpasar, Udayana Medical Journal, ISSN 02216-4701 Vol: 34 No. 119. Hal. 42-45.
8. Sutajaya, IM. 2006. Pembelajaran Melalui Pendekatan Sistemik, Holistik, Interdisipliner dan Partisipator (SHIP) Mengurangi Kelelahan, Keluhan Musculoskeletal Dan Kebersihan Serta Meningkatkan Luanan Proses Belajar Mahasiswa Biologi IKIP Singaraja. (Desertasi). Denpasar : Program Pascasarjana Universitas Udayana.
9. Adiatmika, IP.G. 2007. Perbaikan Kondisi Kerja Dengan Pendekatan Ergonomi Total Menurunkan Kelelahan Musculoskeletal Dan Kelelahan Serta Meningkatkan Produktivitas Dan Pengasistan Perajin Pengecata Logam di Kediri Tabanan. (Desertasi). Denpasar : Program Pascasarjana Universitas Udayana.
10. Manuaba, A. 1990. Beban Tugas Untuk Prajurit Dikaftikan Dengan Norma Ergonomi Di Indonesia. Seminar Ergonomi di Lingkungan ABRI, Jakarta 20 Pebruari.
11. Nala, I G.N. 1991. Penerapan Teknologi Tepat Guna Di Pedesaan. Denpasar: Pusat Pengabdian Pada Masyarakat Universitas Udayana Denpasar – Bali.
12. Grandjean, E., Kromer, 2000. Fitting The Task To The Human, A Textbook Of Occupational Ergonomics 5th ed. London: Taylor & Francis Inc.
13. Sajiwo, H. 2008. Redisain Tempat Dan Sistem Kerja Dengan Intervensi Ergonomi Meningkatkan Kinerja Tukang Giling Sigaret Kretek Tangan Pada Industri Rokok “X” di Kediri Jawa Timur. (Desertasi). Denpasar : Program Pascasarjana Universitas Udayana.
14. Sudiajeng, L & Wulanyani. 2010. Maintaining the worker’s health condition by sheltering the work area increased productivity in conventional mixing mortar for building materials (Makalah). Denpasar. Civil Engineering Department – Bali State Polytechnic, Denpasar.

15. Adnyana, I W.B. 2001. Perbaikan Pegangan Dan Penambahan Bantalan Pada Poros Pengguling Kopi Dapat Menurunkan Keluhan Subjektif Sistem Muskuloskeletal Pekerja Penggiling Kopi Tradisional. Prosiding Seminar Nasional XII Ikatan Ahli Ilmu Faal Indonesia. Malang, 27 – 28 Oktober.

16. Josephus, J. 2011. Intervensi Ergonomi Pada Proses Penangkapan Ikan Dengan Pukat Cincin Meningkatkan Kinerja Dan Kesejahteraan Nelayan Di Amurang Kabupaten Minahasa Selatan Propinsi Sulawesi Utara. (Ringkasan Desertasi). Denpasar : Program Pascasarjana Universitas Udayana.

17. Hutagalung, R. 2009. Perbaikan Kualitas Kerja Dengan Menerapkan Pendekatan Ergonomi Meningkatkan Kinerja Buruh Angkut Tradisional Di Pasar Badung Denpasar. (Ringkasan Desertasi). Denpasar : Program Pascasarjana Universitas Udayana.

18. Surata, W. 2011. Redesain Alat Pengering Dan Sistem Kerja Meningkatkan Kinerja Petani Dan Mutu Rumput Laut Di Desa Ped Nusa Penida. (Ringkasan Desertasi). Denpasar : Program Pascasarjana Universitas Udayana.