

**REDESIGN OF WORK PLACE AND SYSTEM WITH
ERGONOMIC INTERVENTION IMPROVES THE PERFORMANCE OF
THE SKT (HAND ROLLED CIGARETTE) ROLLERS
AT CIGARETTE INDUSTRY “X” IN KEDIRI EAST JAVA**

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ABSTRACT

In this research ergonomic intervention of the 4 main factors influencing performance was conducted. The four main factors are : (a) intervention of human covering the change in position of the SKT rollers from the position of facing one another into that of facing the same direction, from the hunchbacked sitting position into the upright one; (b) intervention of work equipment covering the changes in form, dimension, table and chair size, and layouts of space and work facilities ; (c) intervention of work system covering the changes in work process arrangement, right and left hand movement, time allocated for active break and in the removal of tobacco which used to be done by the knockers but now is done by the rollers; (d) intervention of work environment, that is, exhaust installation to regulate the circulation and wind humidity in the SKT rollers' room. Redesign of place and work system with ergonomic intervention contribute to : (a) the decrease in work load from medium category into light category; (b) the decrease in work tiredness from being very tired category into being not tired; (c) the decrease in musculoskeletal complaint from high category (being disturbed) into light category (being undisturbed); (d) the decrease in medical treatment cost by 56,97%; (e) the increase in work productivity by 41,47%; (f) the increase in the SKT rollers' salaries by 15,10%; and (g) the increase in the company's profit by 12,76%. Generally, redesign of place and work system can increase the performance of the SKT rollers at cigarette industry “X” at Kediri, East Java. Therefore, it has been suggested that the company continue to redesign the place and work system with ergonomic intervention in the other units.

Keywords: ergonomic, intervention, performance, work load, tiredness, musculoskeletal, productivity, income and profit.

INTRODUCTION

The cigarette industry “X” in Kediri, East Java has become the revenue source for 41.019 employees and the tax paid to the government has amounted to not less

than US\$ 3,3 billion / year (Anonim, 2004). The industry can be developed by increasing the human resource performance. According to Wibowo (2007) performance is a process of how to keep work going in order to achieve the target. Pulat (1992) and Grandjean (2000) state that performance will be better if employees can utilize their energy effectively, arrange their work movement and apply the work method ergonomically. Bridger (1995) and Sajiyo (2006) state that performance will be better if employees have the knowledge and skills needed by their work fields, especially the knowledge and skills related to work physiology, procedure and work system.

The identification of problems in this study was based on 8 ergonomic aspects; they are: nutrient status (nutrition); utilization of muscle energy; body posture; environmental condition; time condition; social and cultural condition; information condition; and interaction between human and machine (Manuaba, 2003a). In ergonomic intervention, systematic, holistic, interdisciplinary and participatory approach is employed (Manuaba, 2005a). In addition, the technology used in the ergonomic intervention is the one which has local wisdom and is comprehensively studied so that it is technically economical, ergonomic, socio cultural, and environmental friendly reasonable (Manuaba, 2006a).

The problems in this study are formulated as follows : (a) is there any decrease in the SKT rollers' work load after application of the re-designed place and work system with ergonomic intervention ?; (2) is there any decrease in the SKT rollers' work tiredness after application of the re-designed place and work system with ergonomic intervention?; (3) is there any decrease in the SKT rollers' musculoskeletal complaint after application of the re-designed place and work system with ergonomic intervention ?; (4) is there any increase in the SKT rollers' productivity after application of the re-designed place and work system with ergonomic intervention ?; (5) is there any decrease in the SKT rollers' medical treatment cost after application of the re-designed place and work system with ergonomic intervention?; (6) is there any increase in the SKT rollers' salaries after application of the re-designed place and work system with ergonomic intervention?; and (7) is there any increase in the company's profit after application of the re-designed place and work system with ergonomic intervention?

Generally, this study aims at finding out whether the SKT rollers' performance would improve after application of the re-designed place and work system with ergonomic intervention. Specifically, this study aims at finding out : (1) the decrease in SKT rollers' work load after application of the re-designed place and work system with ergonomic intervention; (2) the decrease in the SKT rollers' work tiredness after application of the re-designed place and work system with ergonomic intervention; (3) the decrease in the SKT rollers' musculoskeletal complaint after application of the re-designed place and work system with ergonomic intervention; (4) the increase in the SKT rollers' productivity after application of the re-designed place and work system with ergonomic intervention; (5) the decrease in the SKT rollers' medical treatment cost after application of the re-designed place and work system with ergonomic intervention; (6) the increase in

the SKT rollers' salaries after application of the re-designed place and work system with ergonomic intervention; and (7) the increase in the company's profit after application of the re-designed place and work system with ergonomic intervention.

MATERIAL AND METHOD

This research involved 36 samples of the SKT rollers; all of them were female and were randomly chosen and were 17 - 39 years old, and had work experience ≥ 1 year; they were physically and psychologically healthy, and stayed in Kediri, East Java. This study is a true experimental research classified as Treatment by Subject Design which was designed for the same subjects (Bakta, 1997 & 2000, Pocock, 1986, and Zainuddin, 1999).

The ergonomic intervention in the re-designed work place covers: (a) re-design of tables; the tables which used to be very low, that is, 222,5 cm long, 105 cm wide and 62 cm high were changed into those which are 120 cm long, 70,59 cm wide and 73,05 cm high; (b) redesign of chairs; the chairs which used too high, that is, 200 cm long, 48 cm high with 23.5 cm deep seating pads were changed into those which are 42,86 cm wide with 47.46 cm deep seating pads. The front parts of the chairs are made 38, 57 cm high, the lower back parts are made 37, 07 cm high, the upper back parts are made 93, 69 cm high and the declivity of the seating pads are made 5°; (c) redesign of SKT rollers' room layout; it used to be made of 2 zones with 60 cm wide aisles and is changed into one which is made of 3 zones with 75 cm wide aisles in accordance with the number of supervisors. Furthermore, the rooms for the administrators, Supervisors and Ocher are made to be close to the SKT rollers division heads and the exits so that control and coordination can be easily done; (d) the positions of the SKT rollers which used to face one another with relatively close distance resulting in concentration disturbed by the smell of mouth are changed into those where they sit facing the same direction; (e) the SKT rollers' work posture which used to be hunchbacked is changed into that in which they sit upright; and (f) the exhaust at the SKT rollers' room which used to be only in the form of ventilation is now changed into one which is in the form of ventilation and exhaust.

The ergonomic intervention in redesigning the work system covers : (a) the work process sequence in which the rolling used to be dominantly done by SKT rollers using right hand movement is changed into that in which the rolling is equally and symmetrically done using movement of both right and left hands making the work activity more effective and efficient; and (b) time allocated for active break; SKT rollers used to work monotonously for a period of 4.5 hours without break but now they work dynamically for a short period of one office hour with an active maximum 6 minute break; (c) the work division in which the knockers were

supposed to remove tobacco is changed into that in which the SKT rollers are supposed to do that which functions as the active break.

RESULT AND DISCUSSION

In the old work place condition, the mean of the work pulse beat was $122, 94 \pm 4, 45$ pulse/minute, whereas in the new work place condition it was $97, 36 \pm 2, 96$ pulse/minute. The result of Paired-Sample Test showed that the Sig. (2 tailed) value was equal to $0,000 < 0,025$. This means that the work pulse beat at the new work place condition was lower than that at the old one. The mean of increase work pulse beat at the old work place condition was $51, 12 \pm 6, 43\%$, while at the new work place condition it was $24, 17 \pm 4, 20\%$ times/day. The result of Paired-Sample Test showed that the Sig. (2 tailed) value was equal to $0,000 < 0,025$. This means that the increase in work pulse beat at the new work place condition was lower than that at the old one.

The mean of the total score of the answer to the questionnaire concerning tiredness after finishing work at the old work place condition was $71,46 \pm 12,51$. The mean of $2,86 \pm 0,63$ for the score of the answer means in the being tired category. On the other hand, the mean of the total score of the answer to the questionnaire concerning tiredness after finishing work at the new place condition was $44, 86 \pm 12, 80$. The mean of $1, 69 \pm 0, 47$ for the score of the answer refers to the being not tired category. The result of Wilcoxon Signed Ranks Test showed that the Sig. (2 tailed) value was equal to $0,000 < 0,025$. This means that tiredness after finishing work at the new work place condition was lower than that at the old work place condition.

The mean of the head movement deviation at the old work place condition was $4,66 \pm 1,77$ time/day and the mean of the head movement deviation at the new work place condition was $1,54 \pm 0,97$ time/day. The result of the Paired-Sample Test showed the Sig. (2 tailed) value was equal to $0,000 < 0,025$. This means that the head movement deviation at the new work place condition was lower than that at the old work place condition. The mean of the shoulder movement deviation at the old work place condition was $6, 14 \pm 1, 76$ time/day and the mean of the shoulder movement deviation at the new work place condition was $2, 36 \pm 0, 59$ time/day. The result of the Paired-Sample Test showed the Sig. (2 tailed) value was equal to $0,000 < 0,025$. This means that the shoulder movement deviation at the new work place condition was lower than that at the old work place condition.

The mean of the movement deviation of the top moving parts of the body at the old work place condition was $2,96 \pm 1,14$ time/day, whereas that of the movement deviation of the top moving parts of the body at the new work place was $0,54 \pm 0,13$ time/day. The result of the Paired-Sample Test showed that the Sig. (2 tailed) value was equal to $0,000 < 0,025$. This means that the movement deviation of the top moving parts of the body was lower than that at the old work place condition.

The mean of the score of the answers to NBM after finishing work was $2, 83 \pm 0, 60$. This means that high complaint category (disturbed) was referred to, whereas

the mean of 1, 14 ± 0, 18 referred to light complain category (not disturbed). The result of the Wilcoxon Signed Ranks Test showed that the Sig. (2 tailed) value equaled 0,000 < 0,025. This means that musculoskeletal complaint at the new work place condition was smaller than that at the old work place condition.

The cost spent on medicine went down by 78,16% (from the mean of Rp. 1.526,08/ head/day at the old work place condition to that of Rp. 333,33/head/day , t at the new place condition . The cost spent on the alternative treatment fell by 37,75% (from the mean of Rp. 1.383,33/head /day at the old work place condition to that of Rp. 861,08/head /day at the new work place condition). The cost spent on *jamu* (tonic made of medicinal herbs) decreased by 56% (from the mean of Rp.777,75/head /day at the old work place condition to that of Rp. 350,00/head/day at the new work place condition).

The mean of the amount of good products rose by 12, 51% (from the mean of 2.980,84 sticks/day at the old work place condition to that of 3.353,89 sticks/day at the new work place condition). The mean of the amount of bad products dipped by 15,94% (from the mean of 45,29 sticks/day at the old work place condition to 38,07 sticks/day at the new work place condition). The mean of the amount of products rose by 12,55% (from the mean of 3.025,75 sticks/day at the old work place condition to 3.405,93 sticks/day at the new work place condition). The work productivity of the SKT rollers increased by 41, 47% (from 5, 86% at the old work place condition to 8, 29% at the new work place).

The SKT rollers' salaries went up by 15,10% (from the mean of Rp. 29.806,39/day at the old work place condition to Rp. 34.308,9/day at the new work place condition). The company's profit increased by 12, 76% (from the mean of Rp. 179.029.250,40/day at the old work place condition to Rp. 201.868.260,00/day at the new work place condition). The total cost for redesigning work place and system with ergonomic intervention was Rp. 834.600.000. The return of investment period with 10%/month depreciation cost, 0.75%/month inflation rate, (based on the assumption of the mean of inflation in 2008), and 1%/month bank interest rate (based on the assumption of the highest bank interest rate in 2008) was 44,07/day.

CONCLUSION AND SUGGESTION

The result of the redesigned work place and system with ergonomic intervention at cigarette industry X in Kediri East Java can be concluded as follows : (1) the work load could be reduced, that is, from the medium category to the light one, as shown by the decrease in work pulse beat, that is, from the mean of 122.94 pulse/minute to 97,36 pulse/minute; (2) the work tiredness could be objectively reduced, that is, from the being tired category to the being not tired one, as shown by the rise in the work pulse beat, that is, from the mean of 51,13% to that of 24,52%; and the work tiredness could be subjectively reduced from the being very tired category to being not tired one as shown by the answers to the tiredness questionnaire, that is, from the mean of 3,05 to 1,99; (3) the musculoskeletal complaint could be objectively reduced as shown by the 66,94% decrease in head

movement deviation, the 61,52% shoulder movement and the 81,75% movement of the top moving parts of the body ; and musculoskeletal complaint could be subjectively reduced, that is, from the high category (disturbed) to the low one (undisturbed), as shown by the decrease in the mean score of the answers to NBM questionnaire, that is, from 2,70 to 1,99; (4) the cost spent on medical treatment during 12 days (when the research was conducted) could be reduced by 78,16%, as shown by the decrease in the money spent on medicine and on traditional herbs which was 54,99%; (5) the work productivity could be increased, that is, from 5,86% to 8,29%; the bad products could be decreased, that is, from 1,50% to 1,12% (close to the company's target, that is, maximum 1%). The rise in productivity resulted from the 12,67% decrease in input and the 11,16% increase in output; (6) the 12,67% increase in the SKT rollers' wages (from the mean of Rp. 29.810,-/day to Rp. 34.310,-/day) was achieved; and (7) the increase in the company's profit which was achieved covered : (a) the rise in the company's profit which totaled 12,77%; and (b) the fairly high inventory circulation as shown by the return of investment (RoI) of what is redesigned which was only equal to 44,07 days of the capital invested amounting to Rp. 834.600.000,00. After the company's RoI is achieved the company will get profit totaling Rp. 520.708.929,23/month.

Based on the conclusions stated above, it is suggested that : (1) Re-design of work place and system with ergonomic intervention should be referred to when redesigning or designing work place and system because it has been proved to increase the company's performance and profit; (2) Further researches which are not covered in this study need to be conducted such as to what extent ergonomic intervention influences psychological tiredness, dust, pulsation, smell, employees' health and the society around the factory; (3) Multivariate researches also need to be conducted in order to be able to measure the partial effects of the intervention because this study only measured the cumulative effects.

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**REDESAIN TEMPAT DAN SISTEM KERJA
DENGAN INTERVENSI ERGONOMI MENINGKATKAN
KINERJA TUKANG GILING SIGARET KRETEK TANGAN
PADA INDUSTRI ROKOK "X" DI KEDIRI JAWA TIMUR**

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ABSTRAK

Dalam penelitian ini dilakukan intervensi ergonomi terhadap 4 faktor utama yang mempengaruhi kinerja yaitu : (a) intervensi terhadap manusia meliputi perubahan posisi kerja tukang giling SKT dari posisi saling berhadapan menjadi posisi selajur dengan menghadap ke arah yang sama, sikap kerja dari duduk membungkuk menjadi duduk tegak; (b) intervensi terhadap alat kerja meliputi perubahan bentuk, dimensi, ukuran meja dan kursi, tata ruang dan tata letak fasilitas kerja; (c) intervensi terhadap sistem kerja meliputi perubahan tata urutan proses kerja, gerak tangan kanan dan kiri, pemberian istirahat aktif dan perubahan pengambilan tembakau cadong yang semula diambil oleh tukang ketok menjadi diambil oleh tukang giling; (d) intervensi terhadap lingkungan kerja yaitu pemasangan *exhaust* untuk mengatur sirkulasi dan kelembaban udara dalam ruangan giling SKT. Redesain tempat dan sistem kerja dengan intervensi ergonomi mempunyai pengaruh terhadap : (a) penurunan beban kerja dari kategori sedang menjadi ringan; (b) penurunan kelelahan kerja dari kategori sangat lelah menjadi tidak lelah; (c) penurunan keluhan muskuloskeletal dari kategori tinggi (terganggu) menjadi ringan (tidak terganggu); (c) penurunan biaya pengobatan 56,97 %; (d) peningkatan produktivitas kerja 41,47 %; (e) peningkatan penghasilan tukang giling SKT 15,10 %; dan (f) peningkatan keuntungan perusahaan 12,76%. Secara umum redesign tempat dan sistem kerja dapat meningkatkan kinerja tukang giling SKT pada industri Rokok "X" di Kediri Jawa Timur. Untuk itu disarankan agar perusahaan meneruskan redesign tempat dan sistem kerja dengan intervensi ergonomi pada unit-unit yang lain.

Kata kunci : ergonomi, intervensi, kinerja, beban kerja, kelelahan, muskuloskeletal, produktivitas, penghasilan, dan keuntungan

PENDAHULUAN

Industri Rokok "X" di Kediri Jawa Timur menjadi tumpuan penghasilan dari 41.019 orang karyawan dan membayar cukai kepada pemerintah tidak kurang dari US\$ 3,3 miliar / tahun (Anonim, 2004). Pengembangan industri dapat dilakukan dengan upaya peningkatan kinerja sumber daya manusia, menurut Wibowo (2007) kinerja merupakan suatu proses tentang bagaimana pekerjaan berlangsung untuk mencapai hasil kerja. Pulat (1992) dan Grandjean (2000) menyatakan bahwa kinerja akan meningkat bila pekerja dapat memanfaatkan tenaga dengan efektif, mengatur

gerak kerja dan menggunakan metode kerja secara ergonomis. Bridger (1995) dan Sajiyo (2006) menyatakan bahwa kinerja dapat meningkat bila pekerja mempunyai kemampuan ilmu dan ketrampilan yang sesuai dengan bidang kerjanya, terutama ilmu dan ketrampilan tentang fisiologi kerja, tata cara dan sistem kerja.

Identifikasi masalah dalam penelitian ini berdasarkan 8 aspek ergonomi yaitu : status nutrisi (gizi); pemanfaatan tenaga otot; sikap tubuh; kondisi lingkungan; kondisi waktu; kondisi sosial dan budaya; kondisi informasi; dan interaksi antara manusia dengan mesin Corlett (1983) dan (Manuaba, 2003). Dalam intervensi ergonomi dilakukan pendekatan secara sistemik, holistik, interdisipliner dan partisipatori (Manuaba, 2005). Disamping itu teknologi yang digunakan dalam intervensi ergonomi tersebut adalah teknologi yang mempunyai kearifan lokal, dikaji secara komprehensif, sehingga layak secara teknis, ekonomis, ergonomis, sosial budaya, dan ramah lingkungan (Manuaba, 2006).

Perumusan masalah dalam penelitian ini adalah : (1) apakah ada penurunan beban kerja tukang giling SKT, setelah diterapkan redesain tempat dan sistem kerja dengan intervensi ergonomi ?; (2) apakah ada penurunan kelelahan kerja tukang giling SKT, setelah diterapkan redesain tempat dan sistem kerja dengan intervensi ergonomi ?; (3) apakah ada penurunan keluhan muskuloskeletal tukang giling SKT, setelah diterapkan redesain tempat dan sistem kerja dengan intervensi ergonomi ?; (4) apakah ada peningkatan produktivitas kerja tukang giling SKT, setelah diterapkan redesain tempat dan sistem kerja dengan intervensi ergonomi ?; (5) apakah ada penurunan biaya pengobatan tukang giling SKT, setelah diterapkan redesain tempat dan sistem kerja dengan intervensi ergonomi ?; (6) apakah ada peningkatan penghasilan tukang giling SKT, setelah diterapkan redesain tempat dan sistem kerja dengan intervensi ergonomi ?; dan (7) apakah ada peningkatan keuntungan perusahaan setelah diterapkan redesain tempat dan sistem kerja dengan intervensi ergonomi ?

Secara umum penelitian ini bertujuan untuk mengetahui peningkatan kinerja tukang giling SKT, setelah diterapkan redesain tempat dan sistem kerja dengan intervensi ergonomi. Dan secara khusus penelitian ini adalah : (1) untuk mengetahui penurunan beban kerja tukang giling SKT, setelah diterapkan redesain tempat dan sistem kerja dengan intervensi ergonomi; (2) untuk mengetahui penurunan kelelahan kerja tukang giling SKT, setelah diterapkan redesain tempat dan sistem kerja dengan intervensi ergonomi; (3) untuk mengetahui penurunan keluhan muskuloskeletal tukang giling SKT, setelah diterapkan redesain tempat dan sistem kerja dengan intervensi ergonomi; (4) untuk mengetahui peningkatan produktivitas kerja tukang giling SKT, setelah diterapkan redesain tempat dan sistem kerja dengan intervensi ergonomi; (5) untuk mengetahui penurunan biaya pengobatan tukang giling SKT, setelah diterapkan redesain tempat dan sistem kerja dengan intervensi ergonomi; (6) untuk mengetahui peningkatan penghasilan tukang giling SKT, setelah diterapkan redesain tempat dan sistem kerja dengan intervensi ergonomi; dan (7) untuk mengetahui peningkatan keuntungan perusahaan, setelah diterapkan redesain tempat dan sistem kerja dengan intervensi ergonomi.

MATERI DAN METODE

Penelitian ini melibatkan 36 orang sampel tukang giling SKT, semuanya wanita, dipilih secara acak sederhana dengan kriteria umur 17 – 39 tahun, pengalaman kerja ≥ 1 tahun, berbada sehat dan bertempat tinggal di Kediri Jawa Timur. Penelitian ini merupakan penelitian eksperimen sungguhan jenis *Treatment by Subject Design* dengan rancangan sama subjek (Bakta, 1997 & 2000, Pocock, 1986, dan Zainuddin, 1999).

Intervensi ergonomi dalam redesain tempat kerja meliputi: (a) redesain meja yaitu mengubah ukuran meja yang semula terlalu rendah, berukuran panjang = 222,5 Cm, lebar = 105 Cm dan tinggi = 62 Cm. Di ubah menjadi meja baru berukuran panjang = 120 Cm, lebar = 70,59 Cm dan tinggi = 73,05 Cm; (b) redesain kursi yaitu mengubah ukuran kursi semula terlalu tinggi, berukuran panjang = 200 Cm, kedalaman alas duduk = 23,5 Cm dan tinggi = 48 Cm. Diubah menjadi kursi baru berukuran lebar = 42, 86 Cm, kedalaman alas duduk = 47,46 Cm, tinggi kursi bagian depan = 38,57 Cm, tinggi kursi bagian belakang = 37,07 Cm, tinggi sandaran duduk = 93,69 Cm dan sudut kemiringan sandaran duduk = 5° ; (c) redesain tata ruang giling SKT yaitu mengubah tempat kerja yang semula terbagi menjadi 2 zona dengan lebar lorong (*aisle*) = 60 Cm, diubah menjadi 3 zona dengan lebar lorong (*aisle*) = 75 Cm sesuai dengan jumlah mandor. Dan mengubah tempat Administrasi, Mandor dan Oker, didekatkan pada Kabag. SKT dan pintu keluar, untuk memudahkan dalam koordinasi dan kontrol; (d) pengaturan posisi kerja tukang giling SKT yang semula berposisi saling berhadapan dengan jarak yang relatif dekat, sehingga konsentrasi kerja sering terganggu oleh bau mulut, diubah menjadi berposisi menghadap sama arah; (e) pengaturan sikap kerja tukang giling SKT yang semula bekerja dengan sikap duduk membungkuk, diubah menjadi bekerja dengan sikap duduk tegak; dan (f) pemasangan *exhaust* pada ruang giling SKT yang semula hanya dipasang ventilasi, diubah menjadi dipasang kombinasi antara ventilasi dengan *exhaust*.

Intervensi ergonomi dalam redesain sistem kerja meliputi: (a) pengaturan tata urutan proses kerja yang semula aktivitas giling SKT dominasi oleh gerak tangan kanan, diubah menjadi seimbang dan simetris sehingga aktivitas kerja lebih efektif dan efisien; dan (b) pemberian istirahat aktif yang semula tukang giling SKT bekerja monoton dalam waktu lama (4,5 jam tanpa istirahat), diubah dengan kerja dinamis dan dalam siklus waktu pendek (setiap 1 jam kerja istirahat aktif maksimal 6 menit); (c) pembagian tugas kerja yang semula pengambilan tembakau cadong oleh tukang ketok, diganti oleh tukang giling SKT yang berfungsi sebagai istirahat aktif.

HASIL DAN PEMBAHASAN

Rerata denyut nadi kerja pada kondisi tempat kerja lama $122,94 \pm 4,45$ denyut/menit, pada kondisi tempat kerja baru $97,36 \pm 2,96$ denyut/menit. Hasil *Paired-Samples Test* menunjukkan nilai $Sig.(2-tailed) = 0,000 < 0,025$. Berarti denyut nadi kerja pada kondisi tempat kerja baru lebih rendah dari denyut nadi kerja pada kondisi tempat kerja lama. Rerata peningkatan denyut nadi kerja pada kondisi tempat kerja lama $51,12 \pm 6,43$ %, pada kondisi tempat kerja baru $24,17 \pm 4,20$ % kali/hari. Hasil *Paired Sample Test* menunjukkan nilai $Sig.(2-tailed) = 0,000 < 0,025$. Berarti peningkatan denyut nadi kerja pada kondisi tempat kerja baru lebih rendah dari peningkatan denyut nadi kerja pada kondisi tempat kerja lama.

Rerata jumlah skor jawaban kuesioner kelelahan akhir kerja pada kondisi tempat kerja lama $71,46 \pm 12,51$ dengan rerata skor jawaban $2,86 \pm 0,63$ berarti dalam kategori lelah dan rerata jumlah skor jawaban kuesioner kelelahan akhir kerja pada kondisi tempat kerja baru $44,86 \pm 12,80$ dengan rerata skor jawaban $1,69 \pm 0,47$ berarti dalam kategori tidak lelah. Hasil *Wilcoxon Signed Ranks Test* menunjukkan nilai $Sig.(2-tailed) = 0,000 < 0,025$. Berarti kelelahan akhir kerja pada kondisi tempat kerja baru lebih rendah dari kelelahan akhir kerja pada kondisi tempat kerja lama.

Rerata penyimpangan gerak kepala pada kondisi tempat kerja lama $4,66 \pm 1,77$ kali/hari dan rerata penpenyimpangan gerak kepala pada kondisi tempat kerja baru $1,54 \pm 0,97$ kali/hari. Hasil *Paired Sample Test* menunjukkan nilai $Sig.(2-tailed) = 0,000 < 0,025$. Berarti penyimpangan gerak kepala pada kondisi tempat kerja baru lebih sedikit dari simpangan gerak kepala pada kondisi tempoat kerja lama. Rerata penyimpangan gerak bahu pada kondisi tempat kerja lama $6,14 \pm 1,76$ kali/hari dan rerata penpenyimpangan gerak bahu pada kondisi tempat kerja baru $2,36 \pm 0,59$ kali/hari. Hasil *Paired Sample Test* menunjukkan nilai $Sig.(2-tailed) = 0,000 < 0,025$. Berarti penyimpangan gerak bahu pada kondisi tempat kerja baru lebih sedikit dari pada penyimpangan gerak bahu pada kondisi tempat kerja lama.

Rerata penyimpangan gerak anggota gerak atas pada kondisi tempat kerja lama $2,96 \pm 1,14$ kali/hari dan rerata penpenyimpangan gerak anggota gerak atas pada kondisi tempat kerja baru $0,54 \pm 0,13$ kali/hari. Hasil *Paired Sample Test* menunjukkan nilai $Sig.(2-tailed) = 0,000 < 0,025$. Berarti penyimpangan gerak anggota gerak atas pada kondisi tempat kerja baru lebih sedikit dari pada penyimpangan gerak anggota gerak atas pada kondisi tempat kerja lama.

Rerata skor jawaban NBM akhir kerja $2,83 \pm 0,60$ berarti dalam kategori keluhan tinggi (terganggu) dan rerata skor jawaban $1,14 \pm 0,81$ berarti dalam kategori keluhan ringan (tidak terganggu). Hasil *Wilcoxon Signed Ranks Test* menunjukkan nilai $Sig.(2-tailed) = 0,000 < 0,025$. Berarti keluhan muskuloskeletal pada kondisi tempat kerja baru lebih kecil dari pada keluhan muskuloskeletal pada kondisi tempat kerja lama.

Biaya pembelian obat turun $78,16$ % (dari rerata Rp.1.526,08/orang/hari pada kondisi tempat kerja lama menjadia rerata Rp. 333,33/orang/hari pada tempat kerja baru). Biaya berobat ke alternatif turun $37,75$ % (dari rerata Rp. 1.383,33/orang/hari pada kondisi tempat kerja lama menjadi rerata Rp. 861,08/orang/hari pada kondisi tempat kerja baru). Dan biaya pembelian jamu tradisional turun 56 % (dari rerata Rp.

777,75/orang/hari pada kondisi tempat kerja lama menjadi rerata Rp. 350,00/orang/hari pada kondisi tempat kerja baru).

Rerata jumlah produk bagus meningkat 12,51 % (dari rerata 2.980,84 batang/hari pada kondisi tempat kerja lama menjadi rerata 3.353,89 batang/hari pada kondisi tempat kerja baru). Rerata jumlah produk cacat turun 15,94 % (dari rerata 45,29 batang/hari pada kondisi tempat kerja lama menjadi 38,07 batang/hari pada kondisi tempat kerja baru). Rerata total produk meningkat 12,55 % (dari rerata 3.025,75 batang/hari pada kondisi tempat kerja lama menjadi 3405,93 batang/hari pada kondisi tempat kerja baru. Produktivitas kerja tukang giling SKT meningkat 41,47 % (dari 5,86 % pada kondisi tempat kerja lama menjadi 8,29 % pada tempat kerja baru).

Penghasilan tukang giling SKT meningkat 15,10 % (dari rerata Rp. 29.806,39,-/har pada kondisi tempat kerja lama menjadi Rp. 34.308,49,-/hari pada kondisi tempat kerja baru). Keuntungan perusahaan meningkat 12,76 % (dari rerata Rp.179.029.250,40/hari pada kondisi tempat kerja lama menjadi Rp. 201.868.260,00/hari pada kondisi tempat kerja baru). Total biaya redesain tempat dan sistem kerja dengan intervensi ergonomi adalah Rp. 834.600.000,00. Waktu untuk mengembalikan biaya redesain (*Return Of Investment*), dengan biaya penyusutan 10% / bulan, tingkat inflasi 0,75% / bulan (asumsi rerata inflasi Th. 2008) , dan bunga bank 1% / bulan (asumsi bunga tertinggi Th. 2008) adalah 44,07 hari.

SIMPULAN DAN SARAN

Hasil redesain tempat dan sistem kerja dengan intervensi ergonomi pada industri Rokok X di Kediri Jawa Timur disimpulkan sebagai berikut : (1) menurunkan beban kerja dari kategori sedang menjadi ringan; (2) menurunkan kelelahan kerja secara objektif dari kategori lelah menjadi tidak lelah, secara subjektif dari kategori sangat lelah menjadi tidak lelah; (3) menurunkan keluhan muskuloskeletal secara objektif, yang ditandai oleh penurunan penyimpangan gerak kepala 66,94 %, gerak bahu 61,52 % dan gerak anggota gerak atas 81,75 %. Dan Menurunkan keluhan muskuloskeletal secara subjektif dari kategori tinggi (terganggu) menjadi rendah (tidak terganggu); (4) menurunkan biaya pengobatan selama 12 hari (saat dilakukan penelitian) yang ditandai oleh penurunan biaya pembelian obat 78,16 %, penurunan biaya berobat ke alternatif 37,75 % dan penurunan biaya untuk membeli jamu tradisional 54,99 %; (5) meningkatkan produktivitas kerja dari 5,86 % menjadi 8,29 %, penurunan produk cacat dari 1,50 % menjadi 1,12 % (mendekatkan pada harapan perusahaan tentang produk cacat adalah maksimal 1 %). Peningkatan produktivitas ini adalah sebaik-baiknya peningkatan produktivitas, karena *in-put* turun 12,67 % tapi *out-put* naik 11,16 %; (6) meningkatkan penghasilan tukang giling SKT 15,10 % (dari rerata Rp. 29.810,-/hari menjadi Rp. 34.310,-/hari); dan (7) meningkatkan keuntungan perusahaan meliputi i: (a) peningkatan keuntungan perusahaan sebesar 12,77 %; dan (b) tingkat perputaran investasi cukup tinggi, ditandai oleh *Return of Investmen* Redesain (RoI) hanya =

44,07 hari dari modal investasi sebesar Rp. 834.600.000,00. Setelah mencapai RoI perusahaan akan untung sebesar Rp. 520.708.929,23/bulan.

Berdasarkan dari simpulan penelitian, disarankan beberapa hal sebagai berikut : (1) redesain tempat dan sistem kerja dengan intervensi ergonomi, hendaknya menjadi pilihan dan acuan dalam redesain atau desain tempat dan sistem kerja; (2) perlu penelitian lebih lanjut terhadap faktor-faktor lain yang belum diteliti dalam penelitian ini, antara lain pengaruh intervensi ergonomi terhadap kelelahan psikologis, debu, getaran, bau, kesehatan karyawan dan masyarakat sekitar pabrik; (3) perlu penelitian lebih lanjut dengan desain penelitian multivariat, agar bisa mengukur efek parsial dari intervensi, karena penelitian ini hanya mengukur efek kumulatif.

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