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DESIGNING OF WORK FACILITY FOR ECOBRICK MATERIAL USING ERGONOMIC INTERVENTION TO REDUCE MUSCOLOSKELETAL DISORDER

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Abstrak.
Kamulyan waste bank is a place to collect the waste from the household around Lowanu Village, Brontokusuman, Mergangsan, Yogyakarta. This waste is distributed to garbage collectors and sorted. Plastic waste that cannot be recycled is used as material for making ecobricks. Ecobricks are materials made from used plastic bottles filled with plastic sachets, plastic bags, and similar materials that are compressed. In making ecobricks, workers perform activities in a sitting position on the floor with both legs folded in and a slightly bent posture. This work attitude causes muscle complaints in the upper and lower neck, upper arm, right elbow, left wrist, and left hand. The purpose of the study was to improve work attitudes to reduce muscle complaints in body parts by designing ergonomic work facilities. This research was conducted with ergonomics intervention on the design of ecobrick plastic compaction work facilities with the Nordic Body Map-VAS Modified Questionnaire. The muscle complaints of the workers' body parts were determined using the Nordic Body Map questionnaire. The results of the study provide a design for compaction of ecobrick plastic materials with dimensions of table length 134.44 cm, table width 66.39 cm, table height 71.63 cm, length of seat mat 41.41 cm, width of seat mat 43.49 cm, height seat 44.51 cm, backrest height 55.5 cm, and backrest width 45.88 cm. Based on the NBM-VAS questionnaire, it shows that the initial condition of pain or pain in the upper neck and lower neck with a moderate pain value is aimed at a scale of 6.5 cm and 7.3 cm to mild pain with a scale of 4.2 cm and 4.3 cm. . Moderate pain in the left wrist and left hand with a scale of 6.1 cm, respectively, to no pain on a scale of 3.1 cm and 3 cm.

Keywords: ecobrick, ergonomic design, nordic body map questionnaire

1. INTRODUCTION

Plastic is a non-organic material that is very difficult to decompose. It takes tens to hundreds of years to decompose with nature. The demand for plastic in Indonesia has increased by an average of 200 tons per year. In 2010, the demand for plastic was 2.4 million tons, and in 2011 it increased to 2.6 million tons [1]. Handling plastic waste can be done in various ways, ranging from household scale to factory scale. The government with the 3R program (Reduce, Reuse, Recycle) waste can be reduced by 30% at 2025, and a specific 70% target for plastic waste in the same year [2].

One way to recycle plastic waste in the household is to make ecobricks. Ecobricks are materials made from used plastic bottles filled with materials such as soil, foam, plastic food wrappers, plastic bags, and other plastic materials [3]. The main purpose of loading ecobricks is to reduce plastic waste which is very difficult to decompose. Another goal is to recycle plastic waste by putting it in the used plastic bottles to add value to other products [4]. The function of ecobricks is to make these plastics last longer and their processing is beneficial for

the benefit of humans in general [5][6]. Ecobricks can be used as a building material to replace bricks, chairs, tables, flower pots and so on. The advantages of ecobricks are that they are strong, durable, and last a long time because of the original nature of the plastic which is water-resistant and not easily decomposed.

The process of compacting the ecobrick plastic begins with inserting pieces of plastic into an empty bottle little by little and then compacting it using a wooden stick, the process is repeated until the bottle is fully filled and has a hard texture. Based on observations on the real system, the average time to compact the plastic pieces into 1 bottle with a volume of 600 ml until it is full, which is 28.97 minutes. The factor that affects the length of time for compaction is because the location of the cardboard where the empty bottles and filled bottles are located is outside the working range.

The work of inserting plastic materials into bottles is done by sitting on the floor without adequate support. The worker's body bends slightly when doing activities that are out of reach and are repeated. This condition causes complaints in the waist. Bending posture is carried out monotonously in a repetitive way with muscle stretches exceeding the limits of maximum movement [7][8] can have the effect of musculoskeletal complaints on workers [9]. Unnatural work attitudes can be caused by equipment that is not in accordance with the size of the user and this results in non-ergonomic work attitudes causing fatigue, feeling uncomfortable, and decreasing work efficiency [10]. An ergonomic concern that frequently encountered at the place of work, especially pertaining to human power and stamina to carry out the work, is a musculoskeletal disorder (MSD) [11][12].

The place in the form of a basin to accommodate plastic pieces is only able to accommodate as much as 300 grams so that you have to repeatedly fill the plastic pieces into the basin. Besides that, tools such as sticks, scissors and other materials are placed irregularly, so it takes time to find them. This kind of work is considered not ergonomic, it is shown that the work attitude is bent, the location of the equipment is not well organized, the distance between the workers and the workers who will use it is far apart [13]. Based on the results of interviews, ecobrick plastic compaction workers complain of feeling uncomfortable when doing their work, workers often feel pain in the neck, shoulders, back, waist, and hands.

2. METHODS

This research was conducted on the design of ecobrick plastic compaction work facilities using the Rapid Entire Body Assessment method and the Nordic Body Map-VAS Modification Questionnaire. The study used an experimental design with the same subject (tby subject design treatment). The sample treatment was carried out in two ways, namely ecobrick plastic compaction workers working in initial conditions and compacting ecobrick plastic with work facilities after design with an ergonomic approach. The decrease in muscle complaints is seen by comparing when working before and after repairing work facilities.

3. RESULTS AND DISCUSSION

3.l. Antropometric Data and Facility layout design

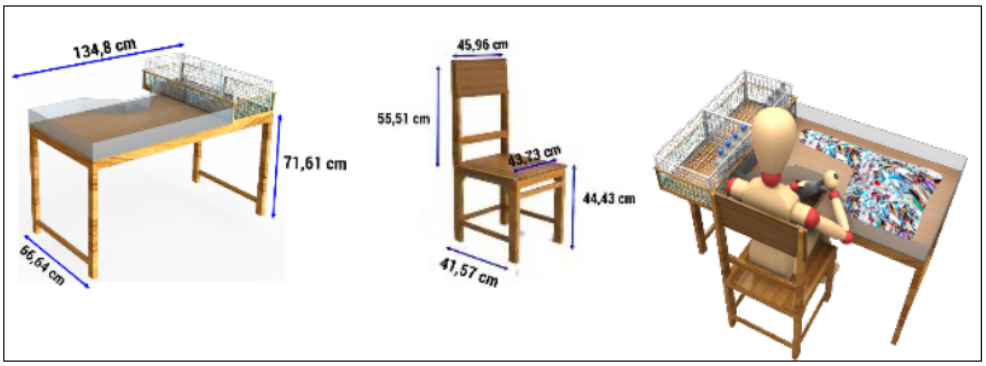
Anthropometric data collection of worker dimensions is used as the basis for the redesign of the ecobrick plastic extinguisher work facility. Anthropometry is a science of certain body dimensions which is very suitable to be applied in the design process [14]. The application of anthropometric data in the redesign of ecobric plastic compaction work facilities is taken from suitable body parts. The design of the facility is expected to provide comfort and safety in carrying out ecobrock compaction activities. The results of the measurement of the subject's anthropometric data are presented in Table 1.

Based on the anthropometric data of workers presented in Table 1, it is then used as a basis for determining the dimensions of the ecobric plastic compaction work facility design. The height of the table is determined by the elbow height in the sitting position (Tsdkd+Tp) which is 71.63 cm using the 50th percentile. The length to 134.44 cm is determined on the basis of the length of the arm span (Prt) using the 5th percentile. The width of 66.39 cm is determined by the basis of arm reach (M) using the 5th percentile. The seat base height of 44.51 cm was determined on the basis of popliteal height (Tp) using the 5th percentile. The seat length of 41.41 cm was determined based on the dimensions of the popliteal length (Pp) with the 50th percentile. The width of the seat base of 43.97 cm is determined on the basis of the dimensions of the hip width (Lp) using the 95th percentile. The seatback height of 55.5 cm is determined based on the dimensions of the sitting shoulder height (Tbd) with the 50th percentile. The seatback width of 45.88 cm is determined based on the dimensions of the shoulder width (Lb) with the 95th percentile. The design of work facilities in the compaction process of ecobric plastic materials in full is shown in Figure 1.

The relationship between the dimensions of the worker's body and the work facilities used have an effect on work attitudes which then have an impact on work comfort. The design of the ecobric plastic compaction work facility is designed to improve the working position more naturally on the basis of the worker's body dimensions using the appropriate percentile [9]. Accuracy in percentile application is the main key in designing work facilities.

Tabel 1 Subject anthropometric data

No.	Dimention	Symbol	Average (cm)	Percentile 5	Percentile 95
1.	Shoulder Height In Sitting Condition	Tbdkd	55,5	55,08	55,92
2.	Elbow Height In Sitting Condition	Tsdkd	27,12	22,83	31,4
3.	Popliteal Length	Pp	42,98	41,41	44,55
4.	Popliteal Height	Tp	44,51	41,51	47,35
5.	Shoulder Width	Lsb	41,25	36,62	45,88
6.	Hip Width	Lp	40,64	37,30	43,97
7.	Hand Reach	Jt	69,44	66,39	72,50
8.	Hand Span Length	Prt	146,43	134,44	158,43



Gambar 1. Development of Ergonomic Ecobrick Plastic Compactor Work

3.2. Work Posture before and after Design Improvement

In the initial conditions, the ecobric plastic compaction workers worked with non-ernomic work postures. The worker sits with his legs folded inward (bursila) and his right hand raised up to form a 45°C angle while pushing a stick of plastic material into the bottle. Kriri's hand holds the bottom of the bottle and attaches it to the left thigh. This condition is carried out repeatedly for a long time as shown in Figure 2. Before the design of the plastic compactor is done geometrically, the body posture while working looks unnaturally awkward. This work is done repeatedly, with a lot of strength and in quite a long time.

Gambar 2. Initial Condition Worker Posture

Gambar 3. Worker Posture Design conditions

Physical conditions of work using awkward postures, high repetition, excessive force, static, cold nature of work and strong correlates of vibration cause musculoskeletal disorders [15]. The work activity of compacting ecobricks after applying an ergonomic work facility design, the worker's posture is no longer sitting with folded legs and the position of the hands is at an angle of 90º. The bottom of the bottle is fully supported by the concave and is more natural and comfortable as shown in Figure 3.

3.3. Musculoskeletal complaints

Based on the Nordic Body Map questionnaire, workers in the initial conditions showed complaints of pain in the upper neck, lower neck, upper right arm, left wrist and right hand. The complete pain complaints are shown in Figure 4. In this condition, the workers looked awkward and used their facilities moderately. The incompatibility of work facilities with the size of the worker's body that causes awkward or non-physiological postures [10], such as the conditions of workers in compacting ecobric plastics, may cause injury if not managed ergonomically [16] pain in right hand back pain in left hand.

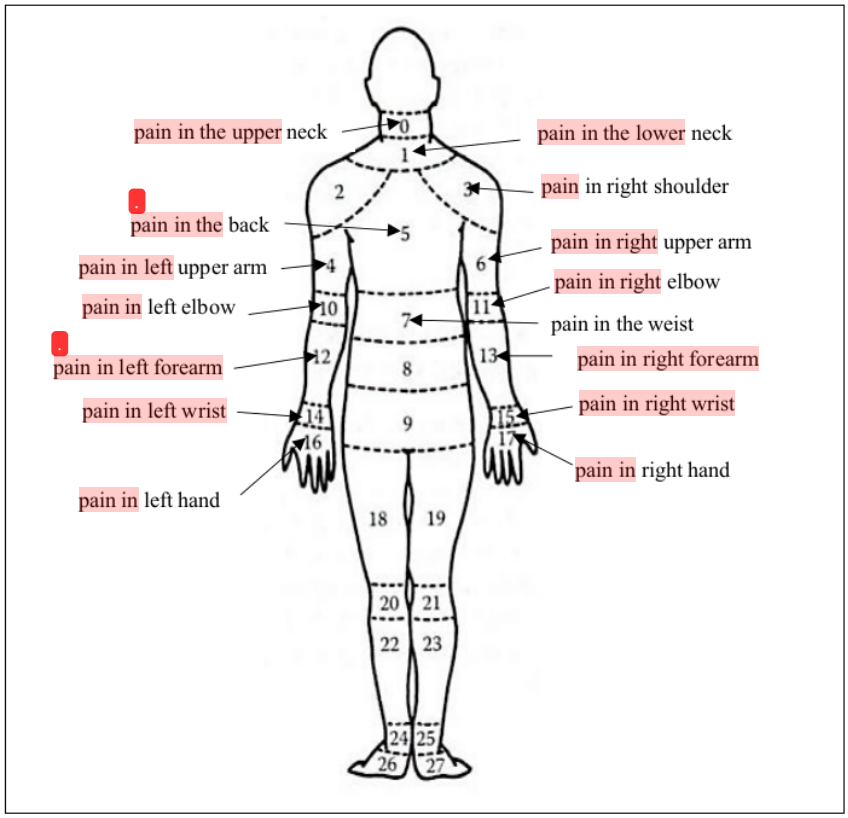


Figure 4. Painful body parts

Complaints on certain body parts can be quantified with a scale model, namely the Visual Analog Scala (VAS). Visual Analog Scale (VAS) which is intended to measure certain pain qualities such as intensity or discomfort [17]. The Visual Analog Scala has recommended categories of no pain on a 0-4 mm scale, mild pain on a 5-44mm scale, moderate pain on a 45-74 mm scale, and severe pain on a 75-100mm scale [18][19]. Some complaints, such as in the Nodic Body Map questionnaire (Figure 4), in the initial conditions indicated the moderate pain category. The complete range of scala analog visual images can be seen in Table 2.

After designing work facilities in the form of work desks and chairs with anthropometric data as the basis for determining the size of the work facility design, there was a change in the work position for the better. The neck and back become more upright, the hands position is better and the legs are not folded anymore. The condition of the worker's post looks more natural, it can be seen in Table 3.

Tabel 2. VAS questionnaire based on Nordic Body Map data Initial Condition

Types of Complaints	Complaint Rate	
	No Pain	Very Pain
Pain in the upper neck	0 — 6,5 cm — 10	
Pain in the lower neck	0 — 7,2 cm — 10	
Pain in right shoulder	0 — 4,0 cm — 10	
Pain in left upper arm	0 — 5,4 cm — 10	
Pain in the back	0 — 4,1 cm — 10	
Pain in right upper arm	0 — 5,8 cm — 10	
Pain in the waist	0 — 4,5 cm — 10	
Pain in left elbow	0 — 3,9 cm — 10	
Pain in right elbow	0 — 5,2 cm — 10	
Pain in left forearm	0 — 3,2 cm — 10	
Pain in right forearm	0 — 4,1 cm — 10	
Pain in left wrist	0 — 6,2 cm — 10	
Pain in right wrist	0 — 4,2 cm — 10	
Pain in left hand	0 — 6,1 cm — 10	
Pain in right hand	0 — 3,9 cm — 10	

Tabel 3. VAS questionnaire based on Nordic Body Map data after intervention

Types of Complaints	Complaint Rate		
	No Pain		Very Pain
Pain in the upper neck	0	4,2 cm	10
Pain in the lower neck	0	4,3 cm	10
Pain in right shoulder	0	3,5 cm	10
Pain in left upper arm	0	4,5 cm	10
Pain in the back	0	3,5 cm	10
Pain in right upper arm	0	4,7 cm	10
Pain in the waist	0	4,2 cm	10
Pain in left elbow	0	3 cm	10
Pain in right elbow	0	3,9 cm	10
Pain in left forearm	0	2,6 cm	10
Pain in right forearm	0	3,4 cm	10
Pain in left wrist	0	3,1 cm	10
Pain in right wrist	0	4 cm	10
Pain in left hand	0	3 cm	10
Pain in right hand	0	3,6 cm	10

After using work facilities with ergonomic designs by paying attention to worker anthropometry, almost all of the pain complaints decreased. This can be seen in table 3, which was moderate pain to a little pain and no pain. The ergonomic design of the facility is able to reduce musculoskeletal complaints of pain in the growing area so that it hurts a little or doesn't hurt at all. The application of ergonomic-based dough kneading work facilities can reduce the musculoskeletal complaints of workers who initially felt very sick in 6 parts of the body and pain in 9 other body parts to become slightly sick and not sick [9].

5. CONCLUSION

Ergonomically based ecobric plastic compaction work facility design application is able to reduce workers' musculoskeletal complaints. The initial condition of pain or pain in the upper neck and lower neck with a moderate pain value indicated on a scale of 6.5 cm and 7.3 cm became mild pain on a scale of 4.2 cm and 4.3 cm. Moderate pain in the left wrist and left hand with a massive scale of 6.1 cm to no pain with a scale of 3.1 cm and 3 cm.

REFERENCES

[1] Surono, U. B. (2013). Berbagai Metode Konversi Sampah Plastik. *Jurnal Teknik*, *3*(1), 32–40.

[2] Hendiarti, N. 2018. Combating Marine Plastic Debris in Indonesia. Dipresentasikan pada *Science to Enable and Empower Asia Pacific for SDGs* (Jakarta, 30 Juli 2018).

[3] Palupi, W., Wahyuningsih, S., Widiyastuti, E., Nurjanah, N. E., & Pudyaningtyas,A. R. 2020. Pemanfaatan Ecobricks Sebagai Media Pembelajaran UntukAnak Usia Dini.Jurnal DEDIKASI:Community Service Reports,2(1), 28–34

[4] Istirokhatun T. Nugraha W. D. (2019). Pelatihan Pembuatan Ecobricks Sebagai Pengelolaan Sampah Plastik Di Rt 01 Rw 05, Kelurahan Kramas, Kecamatan Tembalang, Semarang**.** *Jurnal Pasopati* **.** 'Pengabdian Masyarakat dan Inovasi Pengembangan Teknologi'. Vol. 1, No. 2 . Hal. 85-90.

[5] Suminto dan Sekartaji. 2017. *Ecobrick*: solusi cerdas dan kreatif untuk mengatasi sampah plastik. *Jurnal Desain Produk* (Pengetahuan dan Perancangan Produk). Edisi Januari-Juni Vol 3 No 1.

[6] Andriastuti B. T., Arifin, Dan L Fitria L. 2019. Potensi *Ecobrick* Dalam Mengurangi Sampah Plastik Rumah Tangga Di Kecamatan Pontianak Barat. *Jurnal Teknologi Lingkungan Lahan Basah*, Vol. 07, No. 2, Hal. 055 – 063.

[7] Dul, J., Weerdmeester, B. 2008. *Ergonomics for Beginners : A Quick reference Guide*. Third Edition. Boca Raton: Taylor & Francis Group. p. 1 and 69–78.

[8] Tarwaka. 2015. *Ergonomi Industri. Dasar-dasar Pengetahuan Ergonomi dan Aplikasi di Tempat Kerja.* Edisi II dengan Revisi, Cetakan ke 2. Surakarta : Harapan Press.

[9] Budiyanto T., Setiyoso F. A. 2021. Designing An Ergonomic-Based Work Facility Of Dough Stirrer For Kerupuk Cipir Using Rapid Entire Body Assesment (Reba) Analysis To Reduce Muskuloskeletal Complaints And Increase Productivity. Jurnal LOGIC, Journal of Engineering Design and Technology. Vol. 29 No. 2 , p. 87 – 92.

[10] Kroemer, K. H. E., & Grandjean, E. (2009). *Fitting The Task To The Human, Fifth Editione A Textbook Of Occupational Ergonomics*. London: CRC Press.

[11] Adiyanto, Okka, Mohamad Effendi, Rosidah Jaafar, Jeefferie Abd Razak, Muhammad Faishal, Mutia Mulaicin, and Nor Akramin Mohamad. 2022. "Integrated Self-Report and Observational Risk Assessment for Work-Related Musculoskeletal Disorder in Small and Medium Enterprises." *Engineering and Applied Science Research* 49(1):73–80.

[12] Ma'ruf, Farid, Okka Adiyanto, and Hana Fitri Triesnaningrum. 2020. "Analisa Biomekanika Pada Aktivitas Penyetrikaan Studi Kasus Nafiri Laundry Yogyakarta." *Jurnal Ergonomi dan K3* 5(1): 11–19.

[13] Budiyanto T and Yusuf M. 2020. Improvement of Wok Molding Station Increases Work Comfort and Productivity of the Workers. International Journal of Psychosocial Rehabilitation, Vol. 24, Issue 4, hal. 8883-8893. ISSN: 1475-7192

[14] Joshi, Mangesh, and Vishwas Deshpande. 2021. "International Journal of Industrial Ergonomics Identification of Indifferent Posture Zones in RULA by Sensitivity Analysis." *International Journal of Industrial Ergonomics* 83(July):103-123.

[15] Wardana, Marcelly Widya, Sulastri, and Siti Hasanah. 2019. "Penerapan Metode Failure Mode and Effect Analysis (FMEA) Dalam Mengidentifikasi Masalah Keruskaan Produk Pakan Ayam Pada PT. Japfa Comfeed Indonesia, TBK Unit Lampung." *Spektrum Industri* 17(1):1–91.

[16] Dianat, I., Nedaei, M.. *and* Nezami, M.A.M. 2015. The effects of tool handle shape on hand performance, usability and discomfort using masons' trowels. *International Journal of Industrial Ergonomics.* 45 (2015) 13-20

[17] Kelly L. L., Martino S. A., Broderick J. E., and Stone A. A. 2007. A systematic review of measures used to assess chronic musculoskeletal pain in clinical and randomized controlled clinical trials. Natinal Ianstitut of Health. Vol 8(12): 906–913.

[18] Hawker G. A., Mian S, Kendzerska T., and French M. 2011. Measures of Adult Pain: Visual Analog Scale for Pain (VAS Pain), Numeric Rating Scale for Pain (NRS Pain), McGill Pain Questionnaire (MPQ), Short-Form McGill Pain Questionnaire (SF-MPQ), Chronic Pain Grade Scale (CPGS), Short Form-36 Bodily Pain Scale (SF-36 BPS), and Measure of Intermittent and Constant Osteoarthritis Pain (ICOAP). *Journal Arthritis Care & Research.* Vol. 63, No. S11, pp S240–S252.

[19] Jensen M. P., Chen C, Brugger A. M. 2003. Interpretation of visual analog scale ratings and change scores: a reanalysis of two clinical trials of postoperative pain. *J Pain*. 4:407–414

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