Ergonomic Seating Design On Machine Combine Harvester

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***Abstract*—** Ergonomics is usable in work with the human function of balancing the body dimension with a talking device or machine. Its efforts and others are used for exhausting, regulating temperature, light, and humidity to suit the needs of the human body. The design of the seats on the combine harverter machine is very different from the operator, by which how ergonomic with the anthropometric approach. Types and sources of data required in this study are primary data is the first data obtained, Observation of research or observation on the object of study directly to the users of thresher machine (combine harverter). The ideal demonstration results of the engine seats combine to suit the human dimensions of the size for the height of the seats of the footrest, the dimensions of the body called Elbows to the floor (SS) 105.14 cm, Example for seat height , high body dimensions of sand TS) 68.17 cm. Size for different people, for very large body size (PP) 27,00 cm, Size for seat width / bench from right hand polishing spot with left hand, body dimension used from elbow to elbow 42, 50 cm, Size for high chair / stool, very high body dimension Popliteal to the Floor (TP) 42.10 cm, Size for the height of the hand-cradle to the base of the seat, high body height elbows in from the sitting position to the base of the seat (TSk) 27 , 62 cm, and Size width for seating, wide body dimension of the hips (LP) 38.80 cm.

Keywords— ***Design, Anthropometry, Ergonomics***

I. INTRODUCTION

The era of globalization of science and technology is very important in the industrial world is very large. The human factor, defined as a science that relates to the relationship between people with the environment. Science that appears is a mistake made in the work process [1], [14].

Ergonomics is the science of other multidisciplinary learning that bridges some disciplines and professionals, as well as summarizes the information, findings, and principles of each of these scholars. The scholarship distinguishes between physiology, anatomy, psychology, physics, and engineering [14].

Anthropometry is required in the areas of industrial design, clothing design, ergonomics, and architecture. In these areas, statistical data on the distribution of dimensions of the body is required in order to be able to produce the optimal product.

Thresher machine or harverter combine is a machine capable of doing threshing by using machines and machines, then on the same machine as the existing to separate between grains of rice with stems and leaves. Then performed on the machine is the operator remains on the vehicle. (formerly the rear operator). However, that is what you want and match the machine.

The design of the seat on a combination machine is highly dependent on the operator, by which it is designed ergonomically designed with an anthropometric approach, which is indispensable in design as it relates to the dimensions to be used [2]-[5].

II. LITERATURE REVIEW

Ergonomics is the study of human behavior in relation to their work. The purpose of ergonomics research is that humans work in the environment. In short, it can be said that ergonomics is the adjustment of work tasks with the condition of the human body is to reduce the stress that will be faced. Efforts include adjusting the size of the workplace to the dimensions of the body so as not to dispose of, setting temperature, light and humidity aim to fit the needs of the human body [14].

Ergonomics are the factors that influence the success of work. According to the International Ergonomics Association, there are three areas of study in ergonomics. Explanations from the three areas of study are as follows:

1. Physical Ergonomics: related to human anatomy and some anthropometric, physiological, and bio mechanical characteristics associated with physical activity.
2. Cognitive Ergonomics: related to mental processes, such as perception, memory, reasoning, and motor responsiveness, as they affect the interaction between humans and other elements of the system. Relevant topics include mental workload, decision making, skilled performance, human-computer interaction, human

reliability, work stress, and human-computer interaction-related systems and human interaction design.

3. Organizational Ergonomics: deals with the optimization of social, technical systems, including organizational structures, policies, and processes. Relevant topics include communications, resource management crews, design work, teamwork, cooperative work, new work programs, and quality management [3]-[6].

There are several goals to be achieved through the application of ergonomics. The purpose of the application of ergonomics is as follows [7]:

1. Improving physical and mental well-being through prevention of work-related injuries and diseases, lowering physical and mental workload, seeking promotion and job satisfaction.
2. Improving social welfare by improving the quality of social contacts and coordination of work appropriately, to improve social security both during the productive period and after earning.
3. Creating a rational balance between the technical, economic, and anthropological aspects of each work system that is done so as to create quality work and high quality of life.

Anthropometry will provide an explanation if humans will vary in various dimensions of body size depending on age, educational background, gender and so on so that the design of work facilities will also be different. Anthropometry data can be used as a basis in designing work facilities, in this case, especially those related to lecture facilities such as desks and lecture chairs as well as creating tools used to fit human capabilities and limitations. By having the right anthropometry data, a work facility designer will be able to adjust the shape and geometric size of the design product to the shape and size of segments of the user's body parts.

Anthropometry comes from the Latin word anthropometry which means human and metro which means measurement. Thus anthropometry has the meaning of measuring the human body [9], [10]. Here are some definitions of anthropometry from various sources:

a) Anthropometry is a collection of numerical data related to human body characteristics such as size, shape, and strength and application of the data for handling design problems [7].
b) Anthropometry mainly deals with the dimensions of work stations and the arrangement of tools, equipment, and materials [8], [13] .
c) Anthropometry focuses not only on workplace alignment but also how operators can easily access controls and input devices.
d) Anthropometry is the study and measurement of human body dimensions [14].

III. RESEARCH METHOD

The place of research is conducted in Pinrang Regency which is the area of rice granary in Indonesia, and every post-harvest processing of this area is quite a lot that uses thresher machine either in the form of threser and combines harverter.

The sample of research is the users of thresher machine or combine harverter and society that posture able to represent the existing population in South Sulawesi. Body-dimensional measurements related to the design of the seat of the combine harverter machine, the elbows to the floor (SL), the knee to the floor (LL), butt to the abdomen (PP), elbow to elbow (SS), high popliteal (PP), high elbow to seat (TSk), and hip width (LP).

Types and sources of data required in this study primary data are the first data obtained, Observation conduct research or observation on the object of research in the form of direct observation to the users of thresher machine (combine harverter). Secondary data is data obtained from books and previous studies from various sources of reading related to research.

Test statistics used are:

The data uniformity test is uniform if the data is between Upper Control Limit and Lower Control Limit using 95% confidence level and 5% accuracy level.

$$UCL = \bar{x} + 2\,\sigma_x \quad (1)$$

The upper control limit is the highest limit data value in the data uniformity test.

$$LCL = \bar{x} - 2\,\sigma_x \quad (2)$$

The lower control limit is the lowest limit data value in the data uniformity test.

$$\sigma = \sqrt{\frac{\sum(X_1 - X)^2}{N-1}} \quad (3)$$

Standard deviation is the statistical value used to determine how data is distributed in a sample.

$$\sigma_x = \frac{\sigma}{\sqrt{n}} \quad (4)$$

subgroup standard deviation is a measure used to measure the amount or distribution of several data values in a sub group.

Test Data adequacy, good to know enough data or not with condition N ' < N, with 95% confidence level and level of accuracy 5%.

$$N' = \left[\frac{K/S\sqrt{N\sum X_i^2 - (\sum X_i)^2}}{\sum X_i}\right]^2 \quad (5)$$

IV RESULTS AND DISCUSSION

Of the seven dimensions of the body measurements taken in the presentation of anthropometric research results represent only one body dimension and then labeled as follows:

TABLE 1. OBSERVATION DATA BODY DIMENSION HEIGHT HEIGHT (TS)

Sub	Observation data								Σxi	Average
Grup	1	2	3	4	5	6	7	8		
1	70	55	57	73	57	62	65	70	509	63,625
2	69	72	62	62	61	68	66	71	531	66,375
3	75	63	60	68	60	69	66	62	523	65,375
4	58	68	61	69	69	60	60	63	508	63,5
5	67	61	58	67	61	68	54	65	501	62,625
6	69	61	55	73	70	60	71	60	519	64,875
7	79	78	56	63	62	60	54	70	522	65,25
8	79	79	78	65	61	56	60	68	546	68,25
9	78	63	61	67	69	67	66	62	533	66,625
10	62	72	60	62	61	67	70	62	516	64,5
									5208	651

$$\bar{\bar{X}} = \frac{\sum xi}{k} = \frac{651}{10} = 65{,}10$$

$$\sigma_x = \frac{\sigma}{\sqrt{n}} = 5{,}91$$

$$\sigma = \sqrt{\frac{\sum (X_1 - X)^2}{N-1}} = 1{,}87$$

$$UCL = \bar{x} + 2\,\sigma_x = 68{,}84$$

$$LCL = \bar{x} - 2\,\sigma_x = 61{,}36$$

The results of uniformity test data obtained uniform data which on the graph looks the data is between UCL and LCL.

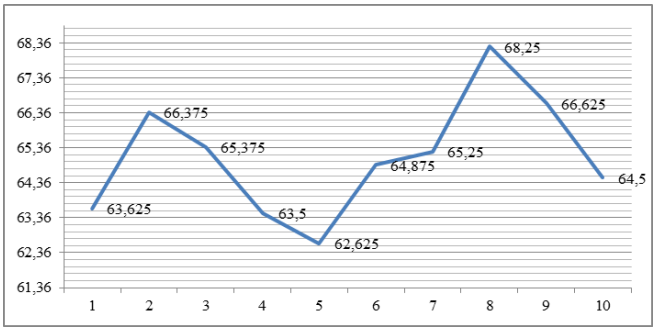

Fig. 1. UCL and LCL

TABLE 2. RESULT OF ANTROPOMETRIC ADEQUACY TEST

No.	Dimension Body	N	$\bar{\bar{X}}$	upper control limit	lower control limit	Infor.
1	Elbow to Floor (SL)	80	100,89	106,06	95,73	Uniform
2	High Heel (TS)	80	65,10	68,84	61,36	Uniform
3	Buttock to Stomach (PP)	80	23,69	27,71	19,66	Uniform
4	Elbow to Elbow (SS)	80	40,04	43,04	37,04	Uniform
5	High Popliteal (PP)	80	37,33	43,13	31,53	Uniform
6	Elbow Height in Position Seated to the base of the seat (TSk)	80	25,17	28,15	22,19	Uniform
7	Hip width (LP)	80	35,16	39,59	30,73	Uniform

While the test data sufficiency obtained results 13, 08 <80 which means N '<N means the data intake 80 dimensional body is sufficient

$$N' = \left[\frac{K/S\sqrt{N\sum X_i^{\,2} - \left(\sum X_i\right)^2}}{\sum X_i}\right]^2 = 13{,}08$$

TABEL 3. RESULT OF ANTROPOMETRIC ADEQUACY TEST

No.	Dimension Body	the amount of data sufficiency		Infor.
		N	N'	
1	Elbow to Floor (SL)	80	10.92	Enough
2	High Heel (TS)	80	16,20	Enough
3	Buttock to Stomach (PP)	80	16,20	Enough
4	Elbow to Elbow (SS)	80	9,26	Enough
5	High Popliteal (PP)	80	13,64	enough
6	Elbow Height in Position Seated to the base of the seat (TSk)	80	59,96	enough
7	Hip width (LP)	80	154,15	enough

Furthermore calculated the percentage test P5%, P50% and P95% as follows:

- P5%

$$P(5) = \bar{x} - 1{,}65\,\sigma_x = 65{,}10 - 1{,}65\,(1{,}87) = 62{,}03\ cm$$

- P50%

$$P(50) = \bar{x} = 62{,}03\ cm$$

- P95%

$$P(95) = \bar{x} + 1{,}65\,\sigma_x = 65{,}10 + 1{,}65\,(1{,}87) = 68{,}17\ cm$$

TABLE 4. ANTHROPOMETRIC PERCENTILE TEST RESULTS

No.	Dimension Body	Value Ergonomics, Antropometry (cm)		
		5%	50%	95%
1	Elbow to Floor (SL)	96,65	100,89	105,14
2	High Heel (TS)	62,03	65,10	68,17
3	Buttock to Stomach (PP)	20,38	23,69	27,00
4	Elbow to Elbow (SS)	37,57	40,04	42,50
5	High Popliteal (PP)	32,56	37,33	42,10
6	Elbow Height in Position Seated to the base of the seat (TSk)	22,72	25,17	27,62
7	Hip width (LP)	31,52	35,16	38,80

DISCUSSION

Based on the results of the anthropometry percentile test can be used as an appraisal in the determination of the dimensions of the body to the product designed that is by using 95% percentile which means that in the sampling of 80 respondents in the design of seating on combine harverter machine can be used by the use of the machine about 95% .

The results of statistical tests of anthropometric percentile results obtained in the design of seats on the combine harverter engine obtained results are:

1. Size for seat height from footrest, body dimension used is Elbow to the floor (SS). Percentile used 95% = 105.14 cm.
2. Size for seat height of the rear seat, body dimension used the height of backrest (TS). Percentile used 95% = 68.17 cm. Size for the length of the seat up to the handrails, the dimensions of the body used butt to the abdomen (PP). Percentile used 95% = 27.00 cm
3. Size for seat width / bench from right handholder with the left hand, body dimension used measured from elbow to elbow. Percentile used 95% = 42.50 cm
4. Size for seat height / bench, body dimension used is Popliteal Height to Floor (TP). Percentile used 95% = 42.10 cm.
5. Size for the height of the handlebar to the seat bed, the body dimension used is the elbow height in the sitting position to the seat bed (TSk) Percentile used 95% = 27.62 cm
6. Size for the width of the seat bed, the body dimension used is the width of the hips (LP). Percentile used 95% = 38.80 cm

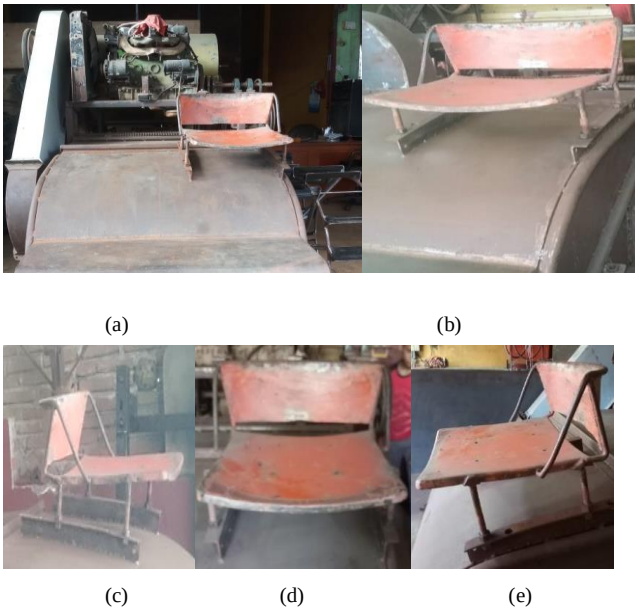

Fig.2. Design of Combine Harverter Machine Seating
(a, b) The overall seating picture
(c) Seat drawing from the left side
(d) Image of the front
(e) Right side image

IV. CONCLUSION

Ideal design result of combine harverter machine suitable with human body dimension that is the size for seat height from footrest, body dimension used is Elbow to the floor (SS) = 105,14 cm, Size for seat height of the rear seat, dimension body used the height of the backrest (TS) = 68.17 cm. Size for the length of the seat up to the hand grip, the body dimension used the buttock to the abdomen (PP) = 27.00 cm, Size for seat width / bench from the right hand handler with the left hand, the body dimension used is measured from the elbow to the elbow . = 42,50 cm, Size for seat height / stool, body dimension used is Popliteal height to Floor (TP) = 42,10 cm, Size for height of palm holder to seat base, body dimension used is elbow height in sitting position up to the base of the seat (TSk) = 27.62 cm, and Size for the width of the seat bed, the body dimension used is the width of the hips (LP) = 38.80 cm.

ACKNOWLEDGMENT

The researcher would like to thank the Minister of Research and Technology for Higher Education for the grant awarded to the researcher through the research under the program entitled the Masterplan for Acceleration and Expansion of Indonesia's Economic Development (MP3EI) and University Islamic Makassar in the 2018 fiscal year.

REFERENCES

[1] Ahmad Hanafie, Andi Haslindah, Saripuddin M (2017), Karakteristik Antropometri Pengguna Mesin Perontok Padi (Combine Harverter) Pengelolaan Hasil Panen yang Ergonomis, Prosiding Seminar Nasional Telnologi Indonesia V, hal 52-57, Makassar 12 Juli 2017.

[2] Ahmad Hanafie (2007), Modifikasi Helm Standar Kendaraan Roda Dua Yang Ergonomis Bagi Penguna Telpon Seluler, Jurnal Iltek, Vol. II, Nomor 4, April 2007, Hal 313-319, Fakultas Teknik Univ. Islam Makassar.

[3] Ahmad Hanafie, A.Haslindah, Muh. Fadhli (2015), Pengembangan Mesin Perontok Padi (Combine Harverter) yang Ergonomis Untuk Meningkatkan Produksi, Prosiding Seminar Nasional Tahunan Teknik Mesin Indonesia-XIV, Banjarmasing, 7-8 Oktober 2015.

[4] Ahmad Hanafie, Hammada Abbas, Lawalenna, Sumarni Hami (2016), Study Of Vehicles Utilities And Load-Unloading Facilities Of City Public Transport Based On Ergonomics Assessment, International Journal of Advances in Scientific Research and Engineering (ijasre.net) Volume-1, Issue-3, December – 2016.

[5] Andi Haslindah (2017) Evaluasi Produktivitas Pengolahan Hasil Panen Menggunakan Mesin Thresher dengan Combine Harverter" Ber-ISSN 1907-0772, Vol. 12, No.23, April 2017

[6] Andi Haslindah (2015), Analisa Penyerapan Tenaga Kerja Wanita Pada Pengolahan Pasca Panen Sektor Pertanian Di Kab. Pinrang, Prosiding Seminar Nasional ATIM III 2015, hal 467 – 471, November 2015.

[7] Eko Nurmianto (2007), Ergonomi, konsep dasar & aplikasinya, Penerbit Guna Widya, Jakarta.

[8] Iftikar Z. Sutalaksana; Ruhana A; John H. T (2006), Analisa dan Perancangan Sistem Kerja. Jurusan TI ITB.

[9] Roche; Davila, USA (1972), Dalam bukunya Wignjosoebroto, Sritomo Sritomo (2000), Ergonomi, Studi Gerak & waktu. Penerbit Guna widya, Jakarta.

[10] Sritomo Wignjosoebroto, (2008), Ergonomi, Studi Gerak & waktu. Penerbit Guna widya, Jakarta.

[11]Sritomo Wignjosoebroto, Srigunani, Ahmad Hanafie. (2003), Modifikasi mesin perontok Padi yang Ergonomis. PEI, Yogyakarta.

[12]Sudjana (1989), Metoda Statistika, penerbit Tarsito, Bandung.

[13] Singh, M.. and Karpovich, P.V. (1966), Effect Of Elbow Angle On Flexion Torgue. J.Applied Physiology, v21, p.1435.

[14] Stevenson, M.G. (1989), Principles Of Ergonomics. Center for Safety Science-University Of NSW, Australia

[15] Suradi, H. Abbas, W. Tjaronge, V. Sampebulu, Analysis Production Process Quality Standard Time Brick Light (Autoclave Aerated Concreted/AAC), The 2ND International Symposium on Smart Material and Mechatronics 2015. ISBN : 978-979-17225-8-2. October 26-29, 2015, Engineering Faculty of Hasanuddin University, Gowa Campus. pp.111-114.