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Improvement Of Working Facilities at The Zinc Tile Printing Station with Ergonomic Approach

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ABSTRACT

This study focuses on PT. Bintang Rezeki Maju, a private company that manufactures zinc roof tiles, specifically examining the printing station's critical role in the production process. The printing station directly influences the quality of the produced tiles, making it essential to optimize the work environment for operators. The research employs an anthropometric approach to design new work facilities that align with the physical dimensions of the workers. The proposed specifications include a chair leg height of 45.14 cm, seat length of 45.59 cm, seat width of 32.51 cm, backrest height of 58.26 cm, backrest width of 41.66 cm, and a machine leg height of 68.41 cm. By implementing these ergonomic improvements, the new work facility design aims to enhance operator comfort and reduce complaints related to work conditions at the printing station. The results indicate that tailoring work facilities to the anthropometric dimensions of operators can significantly improve their work experience and productivity, thus ensuring better quality control in the production of zinc tiles.

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1. INTRODUCTION

PT. Bintang Rezeki Maju which is located in the Medan Industrial Estate (KIM) II Mabar, Medan, North Sumatra Province. PT. Bintang Rezeki Maju is a factory engaged in the metal tile industry, the raw material is sheet metal which is directly printed into metal roof tiles. The metal roof tiles produced are distributed to consumers in the Medan and Sumatra islands(Dang, 2017). PT. Bintang Rezeki Maju has 4 work stations, namely printing, dyeing, milling and drying stations. At the printing station, the machine used functions as a sheet metal printer into metal roof tiles(Stein, 2017). The operator is in charge of directly inspecting the products produced by the printing machine on the production floor(Schonberger, 2008).

Problem seen in the operator's sitting position when inspecting the products produced by the printing machine(Schonberger, 2008). The operator works for ± 8 hours of work in a low sitting position without a backrest which can have a greater impact on the spine than the upright standing position(Pope et al., 2002). This can have an effect on the lumbar 3 and lumbar 4 which can lead to curvature of the operator's spine in the long term(Pope et al., 2002).

Problem solving in this study is based on operator complaints obtained from the Standard Nordic Questionnaire (SNQ) based on the questionnaire, it can be seen that the highest complaints are workers(Namnik et al., 2016). Moving on from these complaints, a comfortable working facility

for operators will be designed in accordance with anthropometry(Pheasant & Haslegrave, 2018). Application of Quality Function Deployment (QFD) to find out things that can fulfill the desires, expectations and satisfaction of consumers for several attributes or parameters that are relevant to the design needs of work facilities.

To identify consumer desires which are then translated into technical parameters of product design is Quality Function Deployment (QFD)(Bouchereau & Rowlands, 2000). An analysis related to the feasibility of ergonomics will be implemented to see how far the product design is able to provide added value in terms of comfort that can be felt by consumers when they use the results of the new product design. Ergonomic-anthropometric and biomechanical analysis of the prototype made, it is concluded whether the new design of the bamboo chair really has ergonomic feasibility compared to the existing one.

2. RESEARCH METHOD

This research is included in descriptive research because it aims to describe the problems that exist in the production section and provide suggestions for improvements(Liao et al., 2017).

2.1 Research Instruments

This study used the SNQ instrument, open and closed questionnaires to determine the mode of the variables studied(Ottonello et al., 2002). When designing, measuring body dimensions are also used, such as anthropometer and human body martin(Eston et al., 2009).

2.2 Analysis Solution to problem

Problem solving analysis is carried out on the research results obtained by comparing the data obtained with the theory that underlies it(Maxwell et al., 2017).

3. RESULTS AND DISCUSSIONS

3.1 Application of Anthropometric Data

After obtaining anthropometric data from measurements of all workers, the percentile value will then be determined(Barroso et al., 2005). The percentile values sought are the 5th, 50th, and 95th percentile values. Anthropometric data used in this calculation are the dimensions of shoulder width (LB), sitting shoulder height (TBD), hip girth (LP), popliteal length (PPo), popliteal height (TPo) and sitting elbow height (TSD) The method for determining the percentile value of the anthropometric data is as follows.

Data The dimensions of the shoulder width that have been through the uniformity test, adequacy test and data normality test to determine the percentile value can be seen in Table 5.26.

Table 1. Dimensions Shoulder Width (LB)

Worker	TBD(cm)	Worker	TBD(cm)	Worker	TBD (cm)
1	57	11	62.1	21	58
2	62	12	61	22	61
3	52.2	13	60	23	54
4	63.7	14	57	24	59.4
5	54.3	15	53.8	25	57.5
6	58.1	16	58	26	62
7	58.1	17	58.5	27	58
8	61.5	18	60	28	59
9	62	19	55	29	62
10	62	20	50.3	30	58

The results of the recapitulation of anthropometric data percentile values can be seen in table 2.

Table 2. Recapitulation of Anthropometric Data Percentile Value

Dimension	P5	P50	P95
LB	33.96	40.28	46.59
TBD	53.09	58.51	63.92
LP	27.84	31.87	35.90
PPo	41.21	45.71	50.20
TPo	40.40	45.57	50.73
TSD	19.43	22.12	24.80

3.2 Determination of Anthropometric Data

a. Determination of Anthropometric Data with the Average Principle

Principledesigns with average body dimensions are used for product users whose majority have average body dimensions or one that is not too different from the other (ranging in the 50th percentile area). Anthropometric data used in this calculation is the dimension of shoulder width (LB)(Wiggermann et al., 2019).

The calculation of the average percentile of anthropometric dimensions can be seen in Table 3.

Table 3. Percentile Calculation of Average Anthropometric Dimensions

Number	LB (cm)	Number	LB (cm)	Number	LB (cm)
1	33.1	11	38.7	21	42.8
2	34.1	12	39	22	43
3	34.5	13	39.2	23	43.1
4	35.2	14	39.6	24	43.5
5	36	15	39.7	25	43.5

Table 4. Calculation of Average Anthropometric Dimensional Percentiles (Continued)

Number	LB (cm)	Number	LB (cm)	Number	LB (cm)
6	36.2	16	41.1	26	44
7	37	17	41.4	27	44.2
8	37.3	18	42	28	45.5
9	38	19	42	29	47
10	38	20	42.4	30	47.5
percentile					**50**
Dimension Value (cm)					**41.6**

The results of the recapitulation of anthropometric data percentile values can be seen in table 5.

Table 5. Recapitulation of Anthropometric Data Percentile Value

Dimension	percentile	Dimension Value (cm)
LB	50	41.66
TBD	50	58.26
LP	50	32.51
PPo	50	45.59
TPo	50	45.14
TSD	50	23

PT. Bintang Rezeki Maju is committed to improving the comfort and welfare of employees, so it is necessary to redesign ergonomic work facilities so that workers are comfortable in doing their jobs. At the initial stage, an analysis of the body parts of workers who often experience complaints is carried out using the SNQ questionnaire, then open and closed questionnaires are distributed to determine the wishes of workers related to the specifications of work facilities that are in accordance with the needs of workers. The mode of the results of the questionnaire is to determine the design of the new work facility. The design of work facilities is determined by the quality function deployment (QFD) method(Tambunan et al., 2020). This method prioritizes the variables or attributes of the work facilities desired by workers by taking into account the technical characteristics of the process of making the work facilities. House of Quality was also created as a tool to find out how important the variables from the specification of work facilities are to workers(Mitra, 2016).

The product specifications of the proposed work facilities to be designed are by taking into account the level of routine work, the working position is done sitting, the lack of comfort in the work position, the problems experienced at work, the shape of the chair that has a seat cushion and backrest, the seat material is made of aluminum and backrest/cushion material of foam.

3.3 Design Proposal

a. Proposed Work Facility Design

Based on the problems above, the work facilities are designed by taking into account the ergonomics in accordance with the anthropometry of the workers(Dianat et al., 2018). The actual work facilities can be seen in Figure 1. and the proposed work facility design can be seen in Figure 6.2.

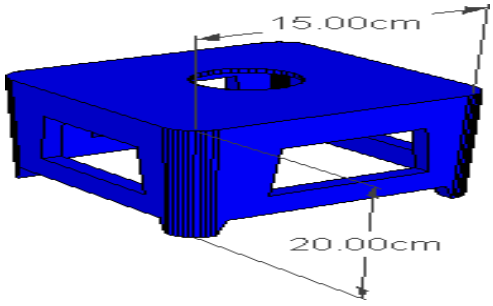

Figure 1. Actual Work Facilities

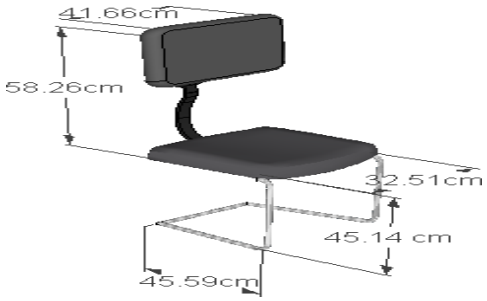

Figure 2. Proposed Work Facility Design

3.4 Comparison of Actual Work Posture and Proposed Work Posture

Comparison of the actual work posture and the proposed work posture can be seen in Figure 3. and Figure 4.

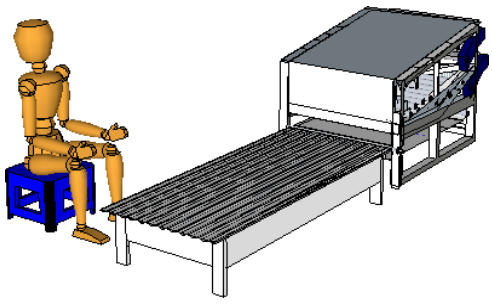

Figure 3. Actual Work Posture

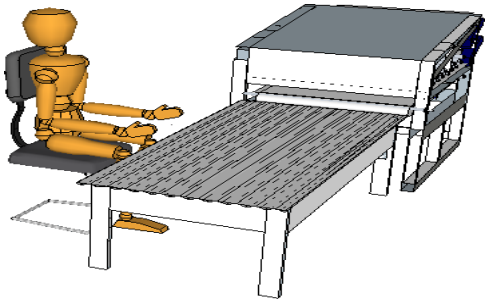

Figure 4. Proposed Work Posture

4 CONCLUSION

After being identified using the Standard Nordic Questionnaire (SNQ), it was found that the pain experienced by the operator at the pressing station was in the back, waist and buttocks. Through anthropometric approach using the 50th percentile, the dimensions of the worker's body at the printing station are obtained as follows: Shoulder Width (LB) 41.66 cm, Sitting Shoulder Height (TBD) 58.26 cm, Hip Width (LP) 32.51 cm, Popliteal Length (PPo) 45.59 cm, Popliteal Height (TPo) 45.14 cm and Sitting Elbow Height (TSD) 23 cm. The proposed improvement of work facilities designed is a work chair, the proposal is obtained after distributing open and closed questionnaires to workers at the printing station. Through the Quality Function Deployment approach, it can be seen the level of relationship between technical variables in the design of work facilities and shows the most important attribute in the design of work facilities, namely the backrest and base material with a degree of importance of 39%. Through an anthropometric approach, the specifications for ergonomic work chairs are obtained, namely the height of the chair legs 45.14 cm, seat length 45.59 cm, seat width 32.51 cm, seat back height 58.26 cm, chair back width 41, 66 cm and the height of the product table leg is 68.14 cm.

REFERENCES

Barroso, M. P., Arezes, P. M., da Costa, L. G., & Miguel, A. S. (2005). Anthropometric study of Portuguese workers. *International Journal of Industrial Ergonomics*, *35*(5), 401–410.

Bouchereau, V., & Rowlands, H. (2000). Methods and techniques to help quality function deployment (QFD). *Benchmarking: An International Journal*, *7*(1), 8–20.

Dang, M.-Q. (2017). Potential of solar energy in Indonesia. *Solar Energy in Indonesia*, *7*, 0–26.

Dianat, I., Molenbroek, J., & Castellucci, H. I. (2018). A review of the methodology and applications of anthropometry in ergonomics and product design. *Ergonomics*, *61*(12), 1696–1720.

Eston, R., Hawes, M., Martin, A., & Reilly, T. (2009). Human body composition. In *Kinanthropometry and exercise physiology laboratory manual: Tests, procedures and data* (pp. 27–77). Routledge.

Liao, Y., Deschamps, F., Loures, E. de F. R., & Ramos, L. F. P. (2017). Past, present and future of Industry 4.0-a systematic literature review and research agenda proposal. *International Journal of Production Research*, *55*(12), 3609–3629.

Maxwell, S. E., Delaney, H. D., & Kelley, K. (2017). *Designing experiments and analyzing data: A model comparison perspective*. Routledge.

Mitra, A. (2016). *Fundamentals of quality control and improvement*. John Wiley & Sons.

Namnik, N., Negahban, H., Salehi, R., Shafizadeh, R., & Tabib, M. S. (2016). Validity and reliability of Persian version of the Specific Nordic questionnaire in Iranian industrial workers. *Work*, *54*(1), 35–41.

Ottonello, M., Benevolo, E., & Zsirai, E. (2002). Nursing care in rehabilitation units: a new questionnaire to determine patient satisfaction. *European Journal of Physical and Rehabilitation Medicine*, *38*(4), 179.

Pheasant, S., & Haslegrave, C. M. (2018). *Bodyspace: Anthropometry, ergonomics and the design of work*. CRC press.

Pope, M. H., Goh, K. L., & Magnusson, M. L. (2002). Spine ergonomics. *Annual Review of Biomedical Engineering*, *4*(1), 49–68.

Schonberger, R. J. (2008). *World class manufacturing*. Simon and Schuster.

Stein, J. A. (2017). Hot metal: Material culture and tangible labour. In *Hot metal*. Manchester University Press.

Tambunan, M. M., Napitupulu, H. L., Rizkya, I., & Syahputri, K. (2020). Design of work facilities using quality function deployment (QFD) and macro ergonomic analysis design (MEAD). *IOP Conference Series:*

Materials Science and Engineering, *801*(1), 12119.
Wiggermann, N., Bradtmiller, B., Bunnell, S., Hildebrand, C., Archibeque, J., Ebert, S., Reed, M. P., & Jones, M. L. H. (2019). Anthropometric dimensions of individuals with high body mass index. *Human Factors*, *61*(8), 1277–1296.