PAPER • **OPEN ACCESS**

Ergonomic Intervention to Improve The Productivity of Brick Press Tool in Small and Medium Entreprise (SME) Akheng Kobar

To cite this article: Lamto Widodo *et al* 2020 *IOP Conf. Ser.: Mater. Sci. Eng.* **847** 012057

View the article online for updates and enhancements.

You may also like

- Redesign of Transjakarta Bus Driver's Cabin
  Dian Mardi Safitri, Nora Azmi, Gurbinder Singh et al.
- Implementation of ergonomics in the management of parking increasing the quality of living parking park in mall Robinson Denpasar city
  I K Sutapa and I M Sudiarsa
- Hazard identification of repetitive truck loading activities in mineral water industry
  Dini Wahyuni, Nismah Panjaitan, Irwan Budiman et al.

This content was downloaded from IP address 114.10.65.77 on 08/04/2023 at 01:23

Ergonomic Intervention to Improve The Productivity of Brick Press Tool in Small and Medium Entreprise (SME) Akheng Kobar

Lamto Widodo[1,2,4], Silvi Ariyanti[3,4], and Andreas Jason[1]

[1]Industrial Engineering Department, Tarumanagara University, Indonesia
[2]Work System Design and Ergonomic Laboratory, Tarumanagara University, Indonesia
[3]Industrial Engineering Department, Mercu Buana University, Indonesia
[4]lamtow@ft.untar.ac.id ; ariyantisilvi41@gmail.com

Abstract. Akheng Kobar is one of the small and medium enterprises (SMEs) that is growing, which produces concrete blocks manually. The brick making process has an ergonomic problem, because the posture of workers in a squatting and bending position for a long time during work. Based on interviews with workers, there were complaints of pain in the back, arms, wrists, calves and thighs. Other complaints include the neck, hands and ankles. In this study, an analysis of initial working conditions, tool design, implementation and results analysis were carried out. Analysis of current conditions using REBA (Rapid Entire Body Assessment), obtained a score of 11, and the JSI (Job Strain Index) analysis score was 39. The results indicate that the process of bricks production must be changed and improved. Furthermore, it was carried out to design a concrete brick press, with the aim of reducing the level of ergonomic risk and increasing productivity. Tool design based on operator complaints, body posture analysis and anthropometric data. Of the several alternatives, obtained the best design alternatives and then made a prototype. Implementation results show a decrease in REBA Score from 11 to 7. Ergonomic Risk Factor decreased from 9 to 5, Job Strain Index scores decreased from 39 to 6.8, and standart time of process decreased by 44,38%.
Keywords: ergonomic, intervention, productivity, REBA, JSI, brick

1. Introduction

Ergonomics is the study of the nature, abilities, and limitations of humans to design a work system so that people can live and work on that system properly [1][2]. Thus the desired goals of the work can be achieved effectively, safely and comfortably. The development of ergonomic tools is needed to reduce musculoskeletal disorders related to work and take into account factory needs [3]. Ergonomics talks about identifying work risks and how to reduce those risks. Applications can be either simple analysis up to modern technology [4], even to the use of expert systems [5]. Previous research was carried out on the work systems of the pressing industry [6], furniture industry [7], welding work stations [8], and public facilities [9] by utilizing the principle of ergonomics to increase work productivity. In this research, a case study was carried out on 'Akheng Kobar' Small and Medium Enterprises, a brick industry located on Jalan Tanjung Raya 2, RT 004, RW 8, Banjar Serasan Sub-district, East Pontianak District, Pontianak City, Kalimantan. This company produces bricks manually, with the type of bricks

Content from this work may be used under the terms of the Creative Commons Attribution 3.0 licence. Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI.
Published under licence by IOP Publishing Ltd

produced are 3 cavity bricks. From the observations of UKM Akheng Kobar, the position of the worker when performing activities is not ergonomic, ie the worker works with the body position squatting and bending. This is because the tools and materials are placed on the floor. The process is done in a long period of time and repeatedly. In this case, it is seen that working conditions are not ergonomic and can be at risk to the physical condition of workers.
This research uses REBA (Rapid Entire Body Assessment) analysis, a method developed in the field of ergonomics and can be used quickly to assess the work position or posture of an operator's neck, back, arms, wrists and feet [10] [11] [12]. Besides this method is also influenced by coupling factors, external loads supported by the body and the activities of workers. Risk categories according to REBA analysis can be seen in Table 1. The results of the REBA assessment show that the work processes are the most risky, and the most dangerous are the pressing and laying processes.

Table 1. REBA score and level of MSDs Risk [10]

REBA Score	Risk Level	*Action Level*	Action
1	Negligible risk	0	No action reqiured
2-3	Low risk	1	Change may be needed
4-7	Medium risk	2	Further investigation, change soon
8-10	High risk	3	Investigate and implement change
11-15	Very high risk	4	Implement change

Other methods are also used to assess work risks, namely JSI (Job Strain Index) [13] and ERF (Ergonomic Risk Factor) [14] . JSI is a method used to evaluate work against the risk of musculoskeletal disorders in the Distal Upper Extremity (DUE) section including the elbows, forearms, wrists, and hands. While the ERF assesses any ergonomic factors that can cause work risks which consist of awkward postures, forcing, repetition, vibration, static loading, stress, and extreme temperatures. The results of the JSI and ERF methods also show that pressing is the most dangerous process.

From the results of the preliminary analysis, it was found that the largest score indicating un ergonomic conditions was found in the pressing and laying process. There were worker's complaints of pain in the back, arms, wrists, calves and thighs. Other complaints include the neck, hands and ankles. To solve this problem, an ergonomic intervention is carried out, starting with an ergonomic risk analysis of the initial conditions, designing work tools, implementing the tools and analyzing the results. By using this tool, it is expected to reduce the pain complaints felt by workers as well as to reduce ergonomic work risks.

2. Methods

This research was conducted at Akheng Kobar UKM which produces a brick located in Pontianak with a number of workers is 2 person. These workers carry out activities alternately in the brick press (press) and laying section. The study began with direct observations and interviews with workers. This is to find out physical complaints, work completion time, assessment of body posture scores using REBA, JSI and ERP methods. After that, designing tools, making prototypes and implementing them are carried out. The results of the implementation are the final evaluations which are the conclusions of the research and as a basis for suggestions for improvement in the future.

3. Result and Discussion

The following are the results of direct observations in the field of brick building SME workers. Ergonomics risk factors are most common in the brick pressing process, can be seen in Table 2.

Table 2. Analysis of 'Ergonomic Risk Factor'

No	Activity	Awkward Posture	Force	Reps	Vibration	Static loading	Contact Stress	Extreme Temperature
1	Brick Pressing Process	●	●	●		●	●	●
2	Brick Laying Process		●	●				●

From the results of the calculation of the brick pressing process REBA obtained a score of 11 where the meaning of the value required immediate action because of the very high risk. Meanwhile, the process of brick laying obtained a score of 7. The following are the results of REBA calculations in the three processes that can be seen in Table 3.

Table 3. Calculation results from REBA analysis

Activity	Posture Position	REBA Score
Brick Pressing Process		11
Brick Laying Process		7

Risk Factor	Rating Criterion	Observation			Multiplier	Left	Right
Intensity of Exertion (Borg Scale - BS)	Light	Barely noticeable or relaxed effort (BS: 0-2)			1	13	13
	Somewhat Hard	Noticeable or definite effort (BS: 3)			3		
	Hard	Obvious effort; Unchanged facial expression (BS: 4-5)			6		
	Very Hard	Substantial effort; Changes expression (BS: 6-7)			9		
	Near Maximal	Uses shoulder or trunk for force (BS: 8-10)			13		
Duration of Exertion (% of Cycle)	< 10%	**Calculated Duration of Exertion** (from inputs below)			0.5	3	3
	10-29%	**User Inputs**	**Left**	**Right**	1.0		
	30-49%	Total observation time (sec.)	1800	1800	1.5		
	50-79%	Single exertion time (sec.)	40	40	2.0		
	≥ 80%	Number of exertions during observation time	37.5	37.5	3.0		
	lculated Duration of Exertion (%)		83.3 %	83.3 %			
Efforts Per Minute	< 4	**Calculated Efforts Per Minute** (from inputs above)			0.5	0.5	0.5
	4 - 8		**Left**	**Right**	1.0		
	9 - 14		1.25	1.25	1.5		
	15 - 19				2.0		
	≥ 20				3.0		
Hand/Wrist Posture	Very Good	Perfectly Neutral			1.0	2	2
	Good	Near Neutral			1.0		
	Fair	Non-Neutral			1.5		
	Bad	Marked Deviation			2.0		
	Very Bad	Near Extreme			3.0		
Speed of Work	Very Slow	Extremely relaxed pace			1.0	1	1
	Slow	Taking one's own time			1.0		
	Fair	Normal speed of motion			1.0		
	Fast	Rushed, but able to keep up			1.5		
	Very Fast	Rushed and barely/unable to keep up			2.0		
Duration of Task Per Day (hours)	<1				0.25	1	1
	1 < 2				0.50		
	2 < 4				0.75		
	4 ≤ 8				1.00		
	> 8				1.50		
Results Key		SI ≤ 3	Job is probably safe			39	39
		3 < SI < 7	Job may place individual at increased risk for distal upper extremity disorders				
		7 ≤ SI	Job is probably hazardous				

Figure 1. JSI evaluation results on the Pressing Process

Job Strain Index (JSI) is done in the brick pressing process, and the brick laying process on the rack. The results obtained in the pressing process are the most dangerous. Calculation of JSI pressing process can be seen in Figure 1.

Brick Press Tool Design

Based on the analysis of REBA, Ergonomic Risk Factor and Job Strain Index that has been done, the highest score obtained in the pressing process. Therefore, product design is focused on reducing the level of risk of physical hazards in the pressing process. The first stage in design is to determine the needs matrix which is obtained from the identification of customer needs to find out what the customer's desires for the product. The need matrix is seen in Table 4.

Tabel 4. Need Matrix

No	Need	level of importance
1	Convenient Ways of Work	5
2	Speed up the Production Process Time	4
3	No Need To Squat For Pressing	5
4	Easy-to-Use	5
5	Reducing Manpower Expenditures when Pressing	4
6	Durability	3

IOP Conf. Series: Materials Science and Engineering **847** (2020) 012057 doi:10.1088/1757-899X/847/1/012057

The next step is to establish technical specifications and target value specifications. The aim is to reveal precise and measurable details about what the product must be able to fulfill. Finally obtained 3 concept design tools as in Figure 2, Figure 3 and Figure 4.

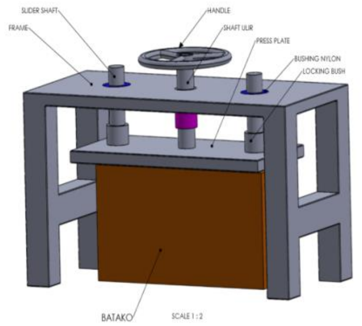


Figure 2. 1st Concept

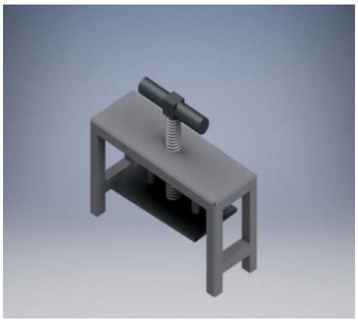


Figure 3. 2nd Concept

Figure 4. 3rd Concept

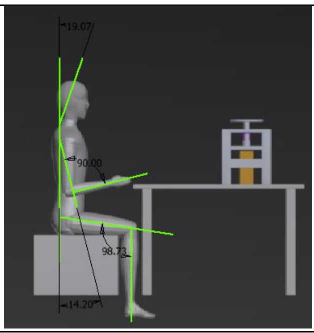
From the 3 concepts, conceptual assessment is carried out to choose 1 final concept that can meet expectations and solutions to overcome existing problems. Based on the results of the concept assessment found that concept 1 is the chosen concept. Conceptual size is based on Indonesian Antopometry data [7]. Following are the dimensions of concept 1 which can be seen in Table 5.

Table 5. Final dimension of tool

No	**Description**	**Dimension (cm)**
1	Height	25 cm
2	Width	22 cm
3	Length	49 cm

Analysis of REBA by using 3ds Max software aims to simulate a tool that has already passed the design stage. Based on these simulations, a REBA score of 5 is obtained, which indicates a reduction in the value of risk at work. The 3ds Max simulation can be seen in Table 6.

Table 6. REBA Analisis by using *Software* 3ds Max

No	3ds Max Simulation	Activity	REBA Score
1.		Pressing Process	5

Analysis of Implementation Results

After implementing the work station, Ergonomic Risk Factor analysis is done. The results can be seen in Table 7, where there is a decrease from 9 to 5. The REBA score decreased from 11 to 7. The analysis of the REBA score after implementation can be seen in Table 87. The Job Strain Index (JSI) score decreased from 39 to 6.8, which indicates that the work process is safe. Analysis of JSI scores after implementation can be seen in Figure 5.

Table 7. Ergonomic Risk Factor Analysis After Implementation

No	Activity	Awkward Posture	Force	Reps	Vibration	Static loading	Contact Stress	Extreme Temperature
1	Brick Pressing Process			●				●
2	Brick Laying Process		●	●				●

Table 8. REBA Score after implementation

Activity	Body Position	REBA Score
Pressing Process		7

Risk Factor	Rating Criterion	Observation			Multiplier	Left	Right
Intensity of Exertion (Borg Scale - BS)	Light	Barely noticeable or relaxed effort (BS: 0-2)			1	3	3
	Somewhat Hard	Noticeable or definite effort (BS: 3)			3		
	Hard	Obvious effort; Unchanged facial expression (BS: 4-5)			6		
	Very Hard	Substantial effort; Changes expression (BS: 6-7)			9		
	Near Maximal	Uses shoulder or trunk for force (BS: 8-10)			13		
Duration of Exertion (% of Cycle)	< 10%	Calculated Duration of Exertion (from inputs below)			0.5	3	3
	10-29%	User Inputs	Left	Right	1.0		
	30-49%	Total observation time (sec.)	1800	1800	1.5		
	50-79%	Single exertion time (sec.)	30	30	2.0		
	≥ 80%	Number of exertions during observation time	50	50	3.0		
	Calculated Duration of Exertion (%)		83.3 %	83.3 %			
Efforts Per Minute	< 4	Calculated Efforts Per Minute (from inputs above)			0.5	0.5	0.5
	4 - 8		Left	Right	1.0		
	9 - 14		1.67	1.67	1.5		
	15 - 19				2.0		
	≥ 20				3.0		
Hand/Wrist Posture	Very Good	Perfectly Neutral			1.0	1.5	1.5
	Good	Near Neutral			1.0		
	Fair	Non-Neutral			1.5		
	Bad	Marked Deviation			2.0		
	Very Bad	Near Extreme			3.0		
Speed of Work	Very Slow	Extremely relaxed pace			1.0	1	1
	Slow	Taking one's own time			1.0		
	Fair	Normal speed of motion			1.0		
	Fast	Rushed, but able to keep up			1.5		
	Very Fast	Rushed and barely/unable to keep up			2.0		
Duration of Task Per Day (hours)	<1				0.25	1	1
	1 < 2				0.50		
	2 < 4				0.75		
	4 ≤ 8				1.00		
	> 8				1.50		
Results Key		SI ≤ 3	Job is probably safe			6.8	6.8
		3 < SI < 7	Job may place individual at increased risk for distal upper extremity disorders				
		7 ≤ SI	Job is probably hazardous				

Figure 5. *Job Strain Index* Score after implementation

Evaluation of the results of implementation is also carried out on the production process time. The results show a decrease in working time by 43.38% which can be seen in Table 9. This means that by implementing the use of design tools can increase productivity.

Table 9. Comparison of Production Process Time

No	Time Criteria	Before Implementation (sec)	After Implementation (sec)	Percentage of Time Reduction (%)
1	Cycle Time	47.94/ 1 product	56.80/2 products	40.75
2	Normal Time	49.85/ 1 product	59.072/2 Products	40.75
3	Standard Time	64.71/ 1 product	73.272/ 2 Products	43.38

4. Conclusion

In the brick production process, work stations that have the highest ergonomic risk are the pressing process, which is indicated by high REBA, JSI and ERF scores. The design of the tool is carried out to mitigate this risk based on operator complaints, posture analysis and anthropometric data. Implementation results show a decrease in REBA Score from 11 to 7. Ergonomic Risk Factor decreased from 9 to 5, and Job Strain Index scores decreased from 39 to 6.8. Before carrying out the implementation, it is known that the standard time for the pressing process and brick laying is 64.71 seconds for 1 product. After implementing the product, it is known that the standard time for the pressing process and laying of concrete blocks is 73.272 seconds for 2 products. So there was a decrease in working time by 44.38%.

In addition, this study focuses on operator complaints and operator posture, not paying attention to other aspects such as the environment and the detail of the energy required. For further research, it is recommended that these factors be considered, so that the results are more comprehensive.

5. References

[1] IEA 2016 *What is Ergonomic*. International Ergonomic Association, Thônex, Canton of Geneva, Switzerland.
[2] R. S. Bridger 2009 *Introduction to Ergonomic*, 3rd ed. Boca Raton, [Florida] London, [England] New York: CRC Press.
[3] M. Aptel, L. Claudon, and J. Marsot 2002 Integration of ergonomics into hand tool design: Principle and presentation of an example. *Int. J. Occup. Saf. Ergon.*, **8**(1), pp. 107–115.
[4] M. Gašová, M. Gašo, and A. Štefánik 2017 Advanced Industrial Tools of Ergonomics Based on Industry 4.0 Concept. in *Procedia Engineering*.
[5] S. Pavlovic-Veselinovic, A. Hedge, and M. Veselinovic 2016 An ergonomic expert system for risk assessment of work-related musculo-skeletal disorders. *Int. J. Ind. Ergon*.
[6] L. Widodo, S. Ariyanti, and F. A. Kurniawan 2019 Perancangan Stasiun Kerja Ergonomis Pada Stasiun Kerja Pressing CV. Karyamitra Lestari. *J. Ilm. Tek. Ind.*.
[7] L. Widodo, I. W. Sukania, and R. Sugiono 2017 Rancangan Furniture Dan Tata Ruang Dengan Dimensi Terbatas Secara Ergonomis. *J. Ilm. Tek. Ind*.
[8] S. Ariyanti, L. Widodo, M. Zulkarnain, and K. Timotius 2019 Design Work Station of Pipe Welding with Ergonomic Approach. *SINERGI*, 2019.
[9] L. Widodo, A. Adianto, D. Debby, and S. Rohananasution 2019 Ergonomic portable toilet for women in public facilities. in *IOP Conference Series: Materials Science and Engineering*.
[10] S. Hignett and L. McAtamney 2000 Rapid Entire Body Assessment (REBA). *Applied Ergonomics*.
[11] N. A. Ansari and D. M. J. Sheikh 2014 Evaluation of work Posture by RULA and REBA: A Case Study," *IOSR J. Mech. Civ. Eng.*, **11**(4), pp. 18–23.
[12] M. Middlesworth 2014 A Step-by-Step Guide Rapid Entire Body Assessment (REBA). *Ergon. Plus Inc*.
[13] M. ève Chiasson, D. Imbeau, K. Aubry, and A. Delisle 2012 Comparing the results of eight methods used to evaluate risk factors associated with musculoskeletal disorders. *Int. J. Ind. Ergon*.
[14] N. Jaffar, A. H. Abdul-Tharim, I. F. Mohd-Kamar, and N. S. Lop 2011 A literature review of ergonomics risk factors in construction industry. *Procedia Engineering*.