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FULL PAPER ACCEPTANCE NOTIFICATION

Reference Number : TICATE-074
Title : Comparison Study about Production Scheduling System from Some Paper Case Studies
Authors : Vania Eliyanti, Lina Gozali, Lamto Widodo and Frans Jusuf Daywin

Dear Mr./Madam

Thank you for your paper submission to Tarumanagara International Conference on the Application of Technology and Engineering 2019.

We are pleased to inform you that your submission is accepted for presentation in TICATE 2019. Due to some outstanding reviews for other submissions, however, the review result is not available for viewing yet. We expect to publish the review results will begin on 12 November 2019, you need to register to conference before 9 November 2019.

In the meantime, we recommend that you check your manuscript to minimize obvious errors, such as formatting and grammatical errors.

If you have further questions, please don't hesitate to contact us. We are looking forward to seeing you at UNTAR. Thank you very much for your cooperation.

Sincerely,

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Preface

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2nd Tarumanagara International Conference on the Applications of Technology and Engineering 2019

Preface

On behalf of the organizing committee of 2nd Tarumanagara International Conference on the Applications of Technology and Engineering (TICATE) 2019, I would like to welcome all delegates to Jakarta, Indonesia with great pleasure. Being held from November 21 to 22, 2019 at Campus I- Jl. Letjen. S. Parman No. 1, Jakarta, the international conference is organized by Universitas Tarumanagara (UNTAR) and technically sponsored by IOP Publisher.

TICATE 2019 has attracted many academicians, scientists, engineers, postgraduates and other professionals from many countries. This conference accepted 215 papers from 7 different countries, those are Australia, Taiwan, India, Malaysia, Japan, Peru and Indonesia. The aim of the conference is to promote exchange of ideas among engineers, researchers, and scientists active in the related areas of technology and engineering.

Our special thank goes to our Rector, Prof. Dr. Agustinus Purna Irawan, who has initiate this international conference, to our Plenary Speakers, Dr.-Ing. Joewono Prasetijo from Universiti Tun Hussein Onn, Malaysia, Prof. Dr. Tjokorda Gde Tirta Nindhia from Udayana University, Indonesia, Prof. Dr. Srikantappa A.S. from Cauvery Institute of Technology, India, and Prof. Dr. Mohd. Zulkifli Abdullah from Universiti Sains Malaysia, Malaysia, and Prof. Yasuyuku Nemoto, Ph.D. from Ashikaga University, Japan.

Our special thank also goes to Tarzan Photo and PT. Astaguna Wisesa as our patrons. Also to all individuals and organizations such as the members of international editorial board, the conference organizers, the reviewers and the authors, for their contribution in making TICATE 2019 as a successful international conference and a memorable gathering event. I am also grateful for the support of publication service of IOP Publisher. We hope that the conference could present you wonderful memories to bring home in addition to new insights and friendship congregated during the event.

We truly value your participation and support for the conference. We hope that you will enjoy TICATE 2019 and culture and tradition in Jakarta.

Dr. Hugeng, S.T., M.T. (SMIEEE)

2nd TICATE 2019
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Designing Press Tool For Carton Finishing Process To Improve Productivity And Efficiency

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Designing Press Tool For Carton Finishing Process To Improve Productivity And Efficiency

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Abstract. Using cardboard as packaging protects the product from damage while at the same time improving its appearance to attract the attention of customers. The packaging company, PT. XYZ, works manually without using machines or tools. As a result, inefficiencies tend to occur because workers waste time and energy. It also has the potential to cause extreme fatigue and workplace accidents. This research is a field of ergonomics research, the aim is to understand the physical complaints of workers, the work sequence of workers, to then design a helper tool and finally evaluate the work posture of workers, before and after repairs. To improve workers 'conditions, researchers collected workers' identities and analyzed their physical complaints using questionnaires, including Nordic Body Map, REBA analysis, OWAS analysis, MFA analysis, and measurement of right and left hand maps in standard time. We also identified workers' needs, initial specifications to conceptualize the design of assistive devices. We obtain the design concept by determining the final specifications and checking the data using CATIA software. The final REBA score after applying the helper press yields a score of 3 on pressing and folding cartons. Improvements also managed to eliminate lifting and lowering activities during the finishing process. Analysis result of the working conditions before and after implementation are as follows; cycle time decreased from 320.23 to 275 seconds (14.12%), normal time decreased from 336.24 to 299.75 seconds (11%), and standard time dropped from 437.11 to 374.69 seconds (14, 3%).

Keywords: Ergonomics, Nordic Body Map, REBA, OWAS, MFA.

1. Introduction

In the production process of cartons, PT. XYZ utilizes manual method without any helping tool for the workers. During the process, workers go through several working steps, including taking the carton, arranging, gluing, combining two sheets of cartons, lowering, pressing, folding, lifting, and moving it as a finalized product. Workers in the finishing process are female workers, who work 8 hours a day. When carrying out the finishing process, workers must lift, bend, and step on the product. As a result, workers have neck pain, back pain, lower back pain, and leg pain. Therefore, it is necessary to improve the conditions of workers at work by reducing the cause of worker complaints.

Literature Review

Ergonomics is a ―systematic scientific discipline that utilizes information regarding characteristics, abilities, and limitations of human beings to design a working system so that people can work well in that system, meaning the aim is achieved through the work, effectively, safely, and comfortably‖ [1]. Nordic Musculoskeletal Questionnaire (NMQ) is a questionnaire that can be used to detect symptoms and musculoskeletal disorder complaints among workers, in which later is developed into Nordic Body Map (NBM) questionnaire [2]. Rapid Entire Body Assessment (REBA) is a method that measures physical complaints of workers, developed by Hignett, Su, and Mc Atamney, Lynn. REBA is implemented to evaluate neck posture, back posture, arms, wrists, and leg of the workers [3]. Ovako Working Analysis System (OWAS) is a method to evaluate and analyze uncomfortable working gestures that potentially lead up to musculoskeletal injury. OWAS is also a method to evaluate posture's load during the work [4]. Muscle Fatigue Assessment (MFA) is used to analyze the most suitable work to evaluate accumulated risk of exhaustion during tasks on job in within an hour or more, as well as regarding the wrong postures or frequency of force that often happen [5].

Map of right and left hand describe all workers' movement when they are doing their job and during their leisure time. This map aims to compare between the job which has to be done by right hand compared to the left. Working time measurement is an attempt to determine the working length that a trained and qualified operator need to finish one job in a specific standard time in the best working environment [1]. Design products consists of several steps, but in this phase, alternative solution in the form of scheme is developed into products or technical object in which its shape, material, and dimension has been determind [6]. The concept selection process consists of two main steps, namely filtering process and evaluation concept using the method developed by Stuart Pugh in 1980s, which is also known as Pugh concept [7].

2. Research Methodology

The methodology is applied specifically on the finishing process of the packaging company. The total amount of workers in the finishing process is 12 people. Data collection is started from interview process regarding their complaints as well as direct observation of the 12 workers' activity. This research employs literature review and field study, specifically a direct observation during the packaging and the finishing process. By doing these methods, researchers are able to identify some problems.

Data needed in this research includes general data (sex, weight, age) and Nordic Body Map questionnaire to obtain the complaints regarding physical pain during and after work. Another data is the documentation of carton combining process, to be analysed using REBA, OWAS, and MFA method. All collected data will be measured using REBA, OWAS, and MFA method. After that, researchers identify consumers' needs to make sure that all products are produced based on customers' needs. After understanding consumers' needs, this research specifies on the initial product by creating necessity metrics to get the need ranks and to make some alternative from every need.

Based on some given alternative, this research analysed the possibilities to obtain the final specification. Concepts, which have been made, will be ruled out using the measuring method of Product Designing and Developing—to get the value percentage from each criterion. This value will be used to create matrix of conceptual evaluation. This matrix results in the concept with the highest value. After choosing the best concept, measurement is done to the final specification of the concept. Measurement is implemented by ergonomics assessment based on products' capacity data for tool designing. Measurement

is important to match the size of the designed helper tool with product dimension. Helper tool design is produced using Autodesk Inventor Professional 2014 software and developed specifically based on workers' needs. During the implementation phase, helper tool design will be directly utilized by the workers so that comparison can be done to compare the condition before and after using helper tool. Final result is concluded based on discussions regarding problems that emerge until the utilization of the new helper tool.

3. Results and Discussion
Data Collecting and Processing
This research analyses parts of the body that become source of physical complaints, and the results of Nordic Body Map questionnaire are Back Pain, Pain on right and left arms, Pain on right and left knee, Pain on right and left calves, Neck pain, Pain on upper and lower waist and Pain on right and left thighs. After obtaining the results of the analysis of what causes physical complaints, REBA and OWAS analysis is carried out at 9 finishing process positions, as shown in Figure 1 below:

Figure1. Finishing process positions

Figure 1 shows the positions measured using REBA and OWAS method, and this is the overall scores, as shown at Table 1 below:

Table 1. REBA and OWAS Score inEvery Activity

No.	Working Position	REBA Score	OWAS Score
1	Taking main material from the shelf	6	2
2	Arranging the main material	3	1
3	Gluing the main material	3	1
4	Combining two sheets of main material	3	1
5	Putting the main material on the floor	10	4

6	Pressing the main material by stepping on it	8	2
7	Folding the main material on the floor	8	3
8	Lifting the main material to the top of the table	11	4
9	Moving the final product to the shelf	6	2

After applying OWAS method, this research also uses MFA method to know which body muscle is at the highest risk while doing the work. MFA evaluation is shown in Table 2.

Table 2. MFA Evaluation of Each Activity

No	Work Position	Priority for Change (Region)				Arm/Elbow		Wrists/Hand/ Finger		Legs/Knees		Ankles/Feet/ Toes	
		Neck	Shoulders		Back								
			Right	Left		Right	Left	Right	Left	Right	Left	Right	Left
1	Take material	L	L	L	L	L	L	L	L	L	L	L	L
2	Arrange Material	L	L	L	L	L	L	L	L	L	L	L	L
3	Give away	L	L	L	L	L	L	L	L	L	L	L	L
4	Collate material	L	L	L	L	L	L	L	L	L	L	L	L
5	Material Put down	H	H	H	H	L	L	L	L	H	H	H	H
6	Material Pressing	L	L	L	L	L	L	L	L	L	L	L	L
7	Material Fold up	VH	VH	VH	VH	VH	VH	VH	VH	VH	VH	VH	VH
8	Material Put Up	H	H	H	H	L	L	L	L	H	H	H	H
9	Carry forward	L	L	L	L	L	L	L	L	L	L	L	L

Measuring the right and left arms are also crucial to tell the hand movement during the finishing process. After creating right and left arm map, researchers measure the timing. Time cycle is the time needed from beginning to the end of an activity in a process. This measurement specifically traces the cycle of the finishing process.

By applying time cycle formula, the time cycle of the finishing process is 320.23 seconds. Normal time is the working time that has been measured after adjustment, which is the average time cycle multiply by adjustment factor. Normal time of the finishing process is 336.24 seconds. In standard time, allowance also affects the results of the measurement, as it uses up time for personal needs, fatigue release, and inevitable interruption. Based on the measurement, the standard time of the finishing process is 437.11 seconds.

Data Analysis and Design
We identify consumers' needs to make sure that the products accurately fulfil consumers' inquiry. The identification results become the basis of creating product specification. What the workers needs is later arranged into a Necessity Matrix to obtain need ranks. Workers' needs and product specification is compared and evaluated to attain the most prioritized product specification. This process contributes in the development of the products. From the Screening stage concept selection, the best concept is obtained as in the Figure 2.
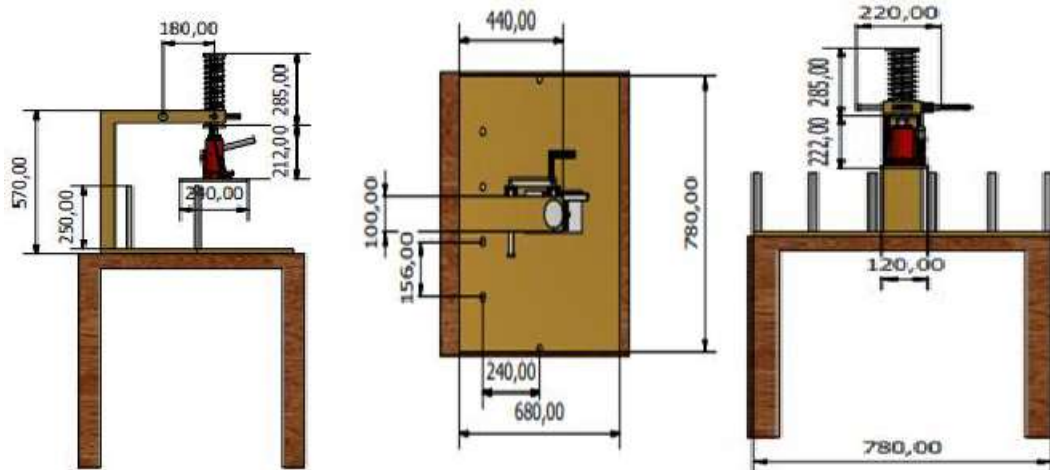
Figure 2. Dimension of the Press Tool

Analysis using images with 3ds Max Software is intended to simulate the process of the designed press tool. Then the REBA score is calculated by using CATIA software, which shows a decrease in the value of risk among workers. The results of the 3ds Max Software analysis are shown in Table 3.

Table 3. REBA Analysis Results (by using 3ds Max and CATIA software)

	Activity	Activity
	Product Folding Process	Product Pressing Process
Figure of the Pressing Helper Tool	REBA score: 3	REBA score: 3

Implementation and Improvement Analysis

As the helper tool is created, this research documented the tool as shown in Table 3, the pictures of the pressing helper tool. Using the pressing helper tool also affect the overall REBA score. Furthermore, OWAS method is also utilized to figure out whether there is a decrease after implementation. OWAS score is shown in Table 4.

Table 4. REBA Score of Each Activity After Implementation

No.	Working Position	REBA score	OWAS score (category)
1	Taking the material from the shelf	1	1171(1)
2	Arranging the material	3	3121(1)
3	Gluing the material	3	3121 (1)
4	Combining two sheets of the materials	2	3121 (1)
5	Pressing the material	3	1221 (1)
6	Folding the material on the floor	3	3121 (1)
7	Moving the final product to the shelf	1	1171 (1)

Analysis of right and left hands map is also implemented to get the movement of the workers' hands when they do the finishing process after implementation. We obtain time cycle at 275 seconds. As for the normal time, the working time that considers some adjustment factors by multiplying the average time cycle and the adjustment factor, is at 299.75 seconds. The results of the standard time measurement of the finishing process after implementation is at 374.96 seconds —which results in the decrease of percentage of time cycle as much as 28.13 percent, normal time at 25.93 percent, and standard time at 28.57 percent. The production of carton packaging after using the pressing tool have also improved from 25 pieces to 30 pieces for one-time production.

4. Conclusion

Based on complaint analysis using Nordic Body Map questionnaire, we found several physical complaints throughout the finishing process. Workers complained of having back pain, left shoulder pain, right shoulder pain, left knee pain, right knee pain, left calf pain, right calf pain, neck pain, upper waist pain, lower waist pain, left thigh pain, and right thigh pain. Those complaints are received from the total 12 workers in the factory.

Helper tool is designed based on the complaints, by understanding its causes and solutions coming from workers who work at the finishing process. We determine the specification of the workers' needs and use concept clarification tree to get design concepts. Alternative specification designs are filtered by using Pugh selection concept. Dimensional shape of the design is adjusted based on the products' size dimension.

Body posture analysis using REBA method before improvement in the activity of lowering the product to the floor, pressing the product, folding the product, and lifting the product to the table is 10, 8, 9, and 11 each. After implementation, there is a decrease in the pressing and folding activity with score 3 for each. Whereas, in the activities of lowering and lifting the product gain 0 score because workers no longer have to do the activities. Therefore, activities in the finishing process have lowered from 9 to 7 activities. Results of the measurement and analysis of the working condition before implementation is time cycle at 320.23 seconds, normal time at 336.24 seconds, and standard time at 437.11 seconds. After the implementation, time cycle is at 275 seconds, normal time at 299.75 seconds, and standard time at 374.69 seconds.

References

[1]   Sutalaksana, Iftikar Z., Ruhana A dan Jann H. Tjakraatmadja. 2006. Teknik Perancangan Sistem Kerja. Bandung: Penerbit ITB.

[2]   Kuorinka, I., Jonsson B., Kilbom A., Vinterberg H., Biering-Srensen F., Andersson G., Jørgensen K. (1987). *Standardised Nordic Questionnaires for The Analysis of Musculoskeletal Symptoms. Applied Ergonomics*, Vol 18, pp. 233-237.

[3]   Hignett, Sue dan McAtamney Lynn. 2000. *Rapid Entire Body Assesment (REBA).Applied Ergonomics*. 31.201 − 205.

[4]   Karhu and Harkonen. 1981. *Observing Working Posture in Industry: Example of OWAS Application. Applied Ergonomics*.12(1), p. 13 − 7.

[5]   Bridger, R. S. 2005. *Introduction to Ergonomics*. 2 jil. Singapore: McGraw-Hill Book co.

[6]   Ulrich, K. T dan Eppinger, S.D 2001. Perancangan dan Pengembangan Produk. New York: McGraw-Hill, Inc.

[7]   Pugh, Stuart.1990.*Total Design*, Addison-Wesley. Reading. MA.