ERGONOMICS ASSESSMENTS AND INTERVENTION FOR SHAPING PROCESS OF SHRIMP PASTES PRODUCTION IN SMALL AND MEDIUM ENTERPRISES

by

NURUL FARHANAH BINTI MOHD SALEHUDDIN
(1732422333)

A dissertation submitted in fulfillment of the requirements for the degree of Master of Science (Manufacturing System Engineering)

School of Manufacturing Engineering
UNIVERSITI MALAYSIA PERLIS
2018

ACKNOWLEDGMENT

Bissmillahirrahmanirrahim,

This dissertation becomes a reality with the kind support and help of many individuals. I would like to extend my sincere to all of them.

Foremost, I want to offer this endeavor to our GOD Almighty for the wisdom HE bestowed upon me, the strength, peace of mind and good health in order to finish this dissertation. I would like to express my gratitude towards my family for the encouragement which helped me in completion of this paper. My beloved parents who is always by my side when times I needed them most and helped me a lot in financial support and making this study. I am highly indebted to my lecturer, Mr. Mohd Asyraf bin Che Doi that also assigned as my supervisor during two semesters session 20016/2017.

I also want to thanks the lecturers and staffs of Manufacturing Engineering of UniMap for their support during I complete my project that had given valuable information, suggestions and guidance in the compilation and preparation this paper. My thanks and appreciation also go to my colleague, Aizad, Agilan, Nafea and Zaydoun and people who have willingly helped me out with their abilities.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

WMSDs	Work-related Musculoskeletal Disorders
REBA	Rapid Entire Body Assessment
RULA	Rapid Upper Limb Assessment
OCRA	Occupational Repetitive Action
OWAS	Ovako Working Posture Analysis System
CTD	Cumulative Trauma Disorders
EMG	Electromyography
HTV	Hand-Transmitted Vibration
VWF	Vibration-induced White Finger
WBV	Whole-Body Vibration
ERA	Ergonomics Risk Assessment
NMQ	Nordic Musculoskeletal Questionnaire
ATA	Actual technical Action
RTA	Reference Technical Action
TA	Technical Action

LIST OF SYMBOLS

n_{ATA}	Overall number of actual technical action within a shift
^{n}RPA	Partial reference number of technical actions within as shift
t_C	Cycle time, in second
F_M	Force Multiplier
k_f	Constant of Frequency
P_M	Posture Multiplier
R_{eM}	Repetitive Multiplier
A_M	Additional multiplier
R_{CM}	Recovery multiplier
t_M	Duration Multiplier

PENILAIAN ERGONOMIK DAN INTERVENSI UNTUK PROSES MEMBENTUK BELACAN DALAM PENGELUARAN BELACAN DI PERUSAHAAN KECIL DAN SEDERHANA

ABSTRAK

Perusahaan kecil dan sederhana (PKS) sering menjadi teras utama ekonomi. Oleh itu, terdapat keperluan pelaksanaan amalan keselamatan di PKS. Salah satu sebab dan masih kurang kesedaran ialah masalah ergonomi. Dalam kajian kes ini, industri berasaskan makanan di PKS, khususnya dalam pengeluaran belacan yang melibatkan pergerakan berulang-ulang bahagian tubuh sepanjang tempoh pengeluaran harian. Objektif pertama kajian ini adalah mengenalpasti dan menilai isu-isu ergonomik dalam pengeluaran belacan. Dua syarikat PKS dipilih untuk kajian ini. Kaedah termasuk soal selidik Nordik Musculoskeletal (NMQ), pemerhatian langsung, temubual, Penilaian Risiko Ergonomi awal (ERA) dan Tindakan Pengulangan Kerja (OCRA) yang digunakan dalam kajian ini. Berdasarkan keputusan NMQ dan ERA awal, ia menunjukkan bahawa salah satu proses dalam pengeluaran belacan yang disebut proses membentuk menyebabkan masalah, misalnya keletihan otot dan kebas tangan tangan kepada pekerja. Penilaian Awal Risiko Ergonomi (ERA) yang dipanggil OCRA digunakan untuk menilai risiko berdasarkan kepada dua sukarela pekerja yang terlibat dalam proses pembentukan dari kedua-dua perusahaan. Ia terdiri daripada dua penilaian iaitu Indeks OCRA dan Senarai Semak OCRA. Keputusan Indeks OCRA menunjukkan Subjek 1 mencatat nilai 6.0 (risiko sederhana), sementara Subjek 2 mencatat 2.90 (risiko yang sangat rendah), sementara dalam keputusan Senarai Semak OCRA, skor Senarai Semak OCRA untuk Subjek 1 adalah 11.43 (risiko cahaya) dan nilai 10.50 untuk Subjek 2. Oleh kerana tujuan kedua kajian ini adalah untuk mengurangkan atau menghapuskan faktor risiko, campur tangan ergonomi dicadangkan dan dilaksanakan. Penekan belacan telah direka dan direka untuk memperbaiki proses pembentukan dan mengurangkan risiko. Alat OCRA digunakan untuk menilai semula tahap risiko selepas campur tangan dilaksanakan. Akibatnya, tahap risiko berjaya dikurangkan dengan menggunakan campur tangan ergonomi yang dicadangkan. Dari Indeks OCRA untuk Subjek 1, nilai 6.0 (risiko sederhana) telah dikurangkan kepada 1.65 (risiko yang boleh diterima), dan untuk Subjek 2, skor nilai Indeks OCRA menurun daripada 2.90 (sangat rendah risiko) kepada 2.02 (risiko yang boleh diterima) . Hasil skor Checklist OCRA juga menunjukkan pencapaian positif. Skor untuk Subjek 1 dari 11.43 (risiko cahaya) telah dikurangkan kepada 5.33 (risiko yang boleh diterima) dan nilai skor 10.50 (risiko yang sangat rendah) untuk Subjek 2 dikurangkan kepada 5.70 (risiko yang boleh diterima). Kesimpulannya, keputusan ini menunjukkan bahawa tahap risiko dalam proses pembentukan telah dikurangkan selepas pelaksanaan penekan belacan. Dapat disimpulkan bahawa campur tangan ini memainkan peranan penting dalam mengurangkan tahap risiko yang terdedah kepada pekerja.

ERGONOMICS ASSESSMENTS AND INTERVENTION FOR SHAPING PROCESS OF SHRIMP PASTES PRODUCTION IN SMALL AND MEDIUM ENTERPRISES

ABSTRACT

Small and medium enterprises (SMEs) are often the core pillar of an economy. Therefore, there is a need for implementation of safety practices in SMEs. One of the reason and still lack of awareness is ergonomics problems. In this case study, a food-based industry in SMEs, specifically in shrimp pastes production which involved the repetitive movements of parts of body throughout daily production period. The first objective of this study is to identify evaluates and assess the ergonomics issues in shrimp paste production. Two SME companies were chosen for this study. Methods include Nordic Musculoskeletal Questionnaire (NMQ), direct observation, interview, initial Ergonomics Risk Assessment (ERA) and Occupational Repetitive Actions (OCRA) were applied in this study. Based on NMQ and initial ERA results, it showed that one of the process in shrimp paste production called shaping process caused problems, for example muscle fatigue and hand numbness to the workers. Advance Ergonomics Risk Assessment (ERA) called OCRA was used to assess the risk based on two voluntarily workers involved in the shaping process from both enterprises. It comprises of two assessments which are OCRA Index and OCRA Checklist. Results of OCRA Index indicate Subject 1 scored the value of 6.0 (medium risk), while Subject 2 scored 2.90 (very low risk), meanwhile, in OCRA Checklist's result, the score of OCRA Checklist for Subject 1 is 11.43 (light risk) and value of 10.50 for Subject 2. Since the second objective of this study is to reduce or eliminate risk factors, the ergonomics intervention was proposed and implemented. The shrimp pastes presser was designed and fabricated to improve shaping process and reduce the risk. OCRA tool was used to reassess the risk level after the intervention was implemented. As a result, level of risk successfully being reduced using the proposed ergonomics intervention. From OCRA Index for Subject 1, the value of 6.0 (medium risk) had been reduced to 1.65 (acceptable risk), and for Subject 2, the value score of OCRA Index declined from 2.90 (very low risk) to 2.02 (acceptable risk). The result of OCRA Checklist score also showed the positive achievement. The score for Subject 1 from 11.43 (light risk) had been reduced to 5.33 (acceptable risk) and the value of score 10.50 (very low risk) for Subject 2 was reduced to 5.70 (acceptable risk). In conclusion, these results showed that the level of risk in shaping process has been reduced after the implementation of shrimp pastes presser. It can be concluded that this intervention plays crucial role in reducing the level of risk exposed to the workers.

CHAPTER 1 : INTRODUCTION

1.1 Introduction

Chapter 1 is explaining the introduction of ergonomics, including the ergonomic risk and tools. Case study of selected enterprises and project focus, problem statement, objectives, scope and limitations also compacted into this chapter.

1.2 Introduction of Ergonomics

Ergonomics is generally defined as working conditions that can give the impact to the worker's comfort and health, for example lighting, noise, repetitive motion, tool design, machine design and others. In ergonomics' scope especially for its definition, there are variety definitions from researcher's perspective. From research by Srinivasa, & Niraj (2016) view, ergonomic is mainly about linkage between humans, systems of machines, work design and the work environment. Barros, Marçal, & Soares (2015) defined three types of ergonomics named as physical, cognitive and organizational ergonomics.

The explanations of these three types of ergonomics were covered in the study by Geraldo, Vieira, & Balbinotti (2015) as explained in Table 1.1.

Table 1.1:Types of ergonomics (Geraldo, Vieira, & Balbinotti, 2015)

No	Types of Ergonomic	Explanations
1	Physical	The response of human body to physiological workloads.
2	Cognitive	It related to psychological processes, including cognition, attention, perception, memory storage and retrieval. It analyzed the effect these processes have on the relations of humans and other elements within a system.
3	Organizational	Used of existing systems to the maximum advantages in organization, including the structure, policies and processes of the organization. Some of the specific areas are shift work, teamwork, ethics, job scheduling and so on.

The application of ergonomics in workplace is very vital to avoid accidents at work and occupational diseases (Dianat, Kord, Yahyazade, Ali, & Stedmon, 2015). Yu et al. (2012) stated occupational disease or work-related musculoskeletal disorders (WMSDs) studied by have turn into high concern to workforce, employers and governments because of big impact on workers' health and production capacity. Basically, WMSDs are injuries or pain in the body joints, ligaments, muscles, nerve, tendons, and structure that hold limbs, neck and back. It is a degenerative diseases and inflammatory conditions that cause pain and gave impact on normal activities as mentioned by Nurmianto, Ciptomulyono, & Kromodihardjo (2015) and this explanation was supported by Punnett (2013). World Health Organization has acknowledged that WMSDs represented a major occupational problem internationally (Thetkathuek,

Meepradit, & Sa-ngiamsak, 2017). Previous studied stated that National Institute for Occupational Safety and Health (NIOSH) reviewed that WMSDs are one of the greatest occupational health topics today (Boubaker et al., 2014). Root cause of WMSDs to occur is because of poor ergonomics and if these injuries are taken lightly, these will cause the permanent problems (Sain & Meena, 2016).

Thetkathuek, Meepradit, & Sa-ngiamsak (2017) categorized the causes of WMSDs into three factors. The first factor is personal factors, such as gender, age and so on. The other factors is working conditions involving repetitive motions, excessive force, and prolonged work for mostly 9 to 12 hours and awkward posture, for example body bending, kneeling, body or arm twisting, and raising hands above the head. The third factor is the combination of improper working conditions and environment factors such as vibrations, combined with long work hours, may also lead to musculoskeletal symptoms.

Meanwhile, four workplace factors identified as contributor to WMSDs (Boubaker et al., 2014). The factors are heavy physical work, lifting and forceful movements, bending and twisting (awkward postures) and lastly are whole-body vibrations. There is positive correlation between development of WMSDs and exposure to a specific or a combination of task factors such as posture, force and repetition (Kee & Lee, 2012). This study have found the similar result where the exposure to the task factors lead to WMSDs (Madan & Robert, 2015).

Besides, the researcher reviewed the common physical risk factors cited in most experimental and epidemiological studies included repetitiveness, insufficient recovery time, physical workload, body postures, whole-body vibration and exposure to the extreme temperature. Psychosocial and individual characteristics are also involved (Hembecker, Reis, Konrath, Gontijo, & Merino, 2017).

Dissimilar observational methods assess different type of exposure, for example manual handling, repetitive work and others and the choice or grouping of methods ought to be based on the need of the evaluation and the exposure type (Eliasson, Palm, Nyman, & Forsman, 2017). The advance tools as explained in Table 1.2 developed by the researcher to assess the risk of WMSDs to the workers are so many, but the most common used are:

1) Niosh Lifting Equation
2) Rapid Entire Body Assessment (REBA)
3) Rapid Upper Limb Assessment (RULA)
4) Occupational Repetitive Action (OCRA)

Table 1.2: Ergonomics tools and functions.

No	Tools	Functions
1	Niosh Lifting Equation	Used for manual lifting evaluation (Battini, Persona, & Sgarbossan, 2014).
2	Rapid Entire Body Assessment (REBA)	To assess the whole body and show the fast change of posture (Battini et al., 2014).
3	Rapid Upper Limb Assessment (RULA)	A common tool used for evaluating ergonomic risk of WMSD due to posture, muscle use and force exerted on upper and lower arms, trunk, neck and legs (Meksawi, Tangtrakulwanich, & Chongsuvivatwong, 2012).
4	Occupational Repetitive Action (OCRA)	Evaluation check list of upper limb repetitive movements (Battini et al., 2014)

Broadly speaking, Dianat et al. 2015 stated that WMSDs became serious major health problems in both industrialized and industrially developing countries. This statement can be supported by Lowndes, Heald, & Hallbeck (2015). It is more worrying when Charles, Ma, Burchfiel, & Dong (2017) opined that it is very hard to look into every MSD in a single study since MSDs found in every industrial area and may occur in several parts of the human musculoskeletal system. If this issue is not addressed soon, it may be extended to more serious effect for both workers and industries.

Most of the researchers agreed that WMSDs contributed to the negative impacts. Furthermore, it is now generally acknowledged amongst industrially advanced countries that WMSDs have an effect on workers in most industries and occupations (Yadhu & Rajesh, 2014). The researcher also found that these injuries impose heavy costs on

employers and society. In placing more emphasis, the finding by Lowndes et al. (2015), WMSDs is not only incurred high costs, but it is also result in lost time to the employers to train the new employees. Other negative impacts are it caused workers become sick, low job's quality, and even incapable to continue the work and automatically the efficiency of the company may be down (Sutari, Nugroho, Yekti, Dwi, & Mutiara, 2015). WMSDs potentially increased discomfort, pain, disability and medical costs, as well as lessening employee ethics (Yazdani et al., 2015). Then, it must be avoided because of all workers' compensation claims, WMSDs reported for the highest percentage of costs and permanent disability among workers (Anton & Weeks, 2016).

Therefore, the development of intervention is needed to reduce the frequency of risk factors that contributed to WMSDs (Charles et al., 2017). Recently, the effectiveness of intervention become main concern of researchers and consultants in the discipline worldwide (Ouellet & Vézina, 2014). The idea of an intervention is to control the various musculoskeletal disorders in the work environment (Jones, 2015) . Sutari et al. (2015) viewed that efforts to lessen the risk of WMSDs can be reached in several ways, one of which is efficient for lessening WMSDs are engineering control. In other study, the researcher opined interventions help in enhancing quality of life for employees and reduce the financial losses and medical costs to companies and the economy (Sain & Meena, 2016).

1.3 Case Study Enterprises and Project Focus

The case study project involved two of Small and Medium Enterprises located in Kuala Perlis. The assessed enterprises are SR Murni Enterprise and Ropisah Ismail

Enterprise. These two enterprises involved and contributed in shrimp paste production. Both of these enterprises are selected to be assessed because they lack of the workers compared to the other enterprises that hired many workers. The backgrounds of each company were tabulated in Table 1.3.

Table 1.3: Information of Enterprises

No	Characteristic	Ropisah Ismail Enterprise	SR Murni Enterprise
1	Name of Owner	Puan Ropisah bt Ismail	Encik Azani bin Abdul
2	Year of Establishment	1995	1996
3	Product	Shrimp Paste (*"Belacan"*)	

Basically, there were four main processes involved in making shrimp pastes in both enterprises as shown in Figure 1.1.

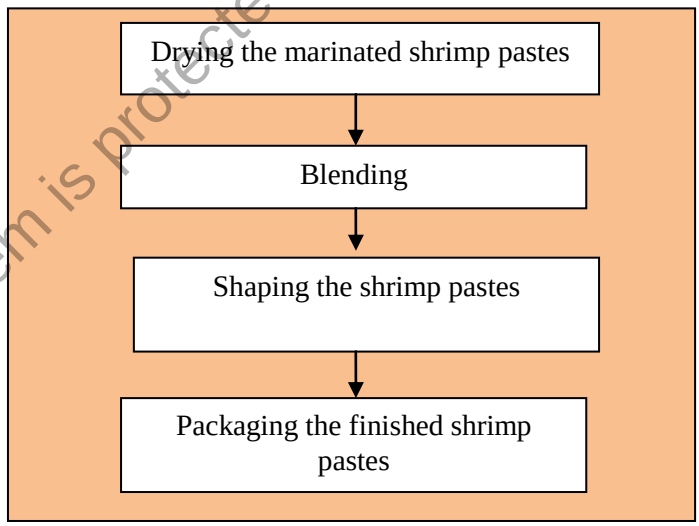

Figure 1.1: Main processes of shrimp pastes

The main focus in this case study is in one of the process involved in shrimp pastes productions, specifically in shaping process at both enterprises. Chapter 3 will discussed the processes more specific and details.

1.4 Problem Statement

In this project at both enterprises, shaping process is one of the processes that obviously show the repetitive work. This is because; the workers needed to shape many pieces of shrimp pastes manually every day. The repetitive activity that takes place within this shaping process is potentially led to work-related musculoskeletal disorder because the motions of body parts repeated frequently for prolonged periods. So, repetitiveness has been identified as one of major risk factor that contributes to musculoskeletal disorder.

However, these enterprises still did not have solution to overcome repetitive movements in shrimp pastes production. According to the interview between researcher and the workers that involved in shaping process of shrimp paste, they complaint that all of them experiencing fatigue and hand numbness after doing this process. To solve this problem, the researcher needed to use appropriate tools to assess the repetitive risk factor and applied ergonomics intervention.

1.5 Objectives

- To identify and assess repetitive activity involved in shaping process using Occupational Repetitive Actions (OCRA) tool.
- To propose and implement ergonomics improvement tool to reduce the repetitive activity in shaping process in shrimp paste production.

1.6 Scope and Limitation

Research scope and limitation must be identified to avoid unnecessary and irrelevant work in the future due to time constraint and topic covered. Therefore, a few items have been identified as the scope of this project:

- The study focus on identifying the ergonomic repetitiveness risk factor and ergonomic intervention in shaping process of shrimp paste production.
- The study was carried out at two of Small and Medium Enterprises (SMEs).

1.7 Summary of Chapter

From this Chapter 1, ergonomics are explained generally as well as its risk factors and tools that involve in accessing the ergonomics risk. The case study enterprises and project focused are explained briefly. Problem statement is generated according to the existing current problem in the selected industry. The objectives also stated in Chapter 1 as a target for this project. The scope and limitation are important to set as barrier to avoid the unnecessary work.