ANALYSIS THE WORKS BODY POSTURE ON FRUIT HANDLING ACTIVITY IN AGRICULTURE COMPANY (OIL PALM INDUSTRY)

This report is submitted in accordance with requirement of the University Teknikal Malaysia Melaka (UTeM) for Bachelor Degree of Manufacturing Engineering (Hons.)

by

NURATIRAH BINTI KAMARUL AZWAN

B051910062

980405-10-7110

FACULTY OF MANUFACTURING ENGINEERING

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Alamat Tetap:
No 9, Off 32/134 Jln Rezab Buang
Kg Bukit Naga, 40300, Shah Alam
Selangor.

Tarikh: 25 January 2023

Cop Rasmi:
PROF MADYA DR SERI RAHAYU KAMAT
FAKULTI KEJURUTERAAN PEMBUATAN
UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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DECLARATION

I hereby, declared this report entitled “Analysis of the body of the work posture on fruit handling activity in agriculture company (oil palm industry)” is the result of my own research except as cited in references.

Signature : ……………………………………

Author’s Name : NURATIRAH BINTI KAMARUL AZWAN

Date : 25 January 2023

APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of Universiti Teknikal Malaysia Melaka as a partial fulfillment of the requirement for a Degree in Manufacturing Engineering (Hons). The member of the supervisory committee is as follow:

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(PROFESOR MADYA DR SERI RAHAYU BINTI KAMAT)

ABSTRAK

Pekerja yang bekerja dengan Buah tandan segar (BTS) menggunakan alatan pengendalian manual seperti pemuat pancang secara tidak langsung membawa kepada penyebab postur janggal yang berulang termasuk mengangkat lebih dari paras bahu, membongkok dan mengayun dengan agresif. Kajian ini menjelaskan pengalaman pekerja terhadap aktiviti pemuatan menggunakan temu bual atau soal selidik dengan menganalisis postur badan dan bahagian badan yang merasa tidak selesa semasa melakukan proses pemuatan dengan mengangkat Buah tandan segar (BTS) yang ditimbang sekitar 1 hingga 30 kg ke dalam 6 hingga 7 kaki tinggi lori. Setelah itu, data yang direkodkan digunakan untuk mencadangkan mekanisme untuk membantu pekerja dalam memperbaiki postur badan. Kajian ini dinilai daripada perisian CATIA V5 berkenaan postur kerja yang memfokuskan pada pemuat antara postur kerja semasa dan postur selamat secara ergonomik dengan menggunakan RULA. Daripada analisis RULA, lengan kiri dan kanan serta bahagian pergelangan tangan pekerja dikenal pasti paling teruk terjejas. Menurut pengangkatan NIOSH, ujian persamaan menghasilkan RWL dan LI berada pada tahap yang sangat berbahaya di mana indeks pengangkatan mencapai 6.49. Selain itu, pelaksanaan mekanisme yang dicadangkan yang dipanggil penghantar konsep gelongsor atau dikenali sebagai penghantar condong memberi bantuan yang besar kepada pekerja terutamanya pada bahagian badan yang terjejas yang bertambah baik seperti yang direkodkan dalam penilaian RULA. Sebaliknya, persamaan angkat NIOSH baharu merekodkan nilai indeks angkat 1.10 dengan RWL mencapai nilai 13.68 Kg berbanding nilai LI sebelumnya yang melebihi 1 dan had berat disyorkan rendah, RWL yang hanya mencecah 2.31 kg. Penemuan daripada kajian ini menyediakan asas penting untuk penyelidikan lanjut termasuk melengkapkan analisis tambahan seperti REBA atau meneruskan ke peringkat fabrikasi dengan menumpukan perhatian pada pertimbangan reka bentuk dan elemen teknikal yang betul.

ABSTRACT

Fresh fruit bunches (FFB) loaders using manual handling tools like loading spikes indirectly leads to repetitive awkward posture including lifting, bending, and swinging. This study explained the experiences of the workers on the loading activities using the interview or questionnaire by analyzing body posture and part of the body that felt discomfort while doing the loading process by lifting the FFB weighted around 1 to 30 kg into the 6 to 7 feet truck. The data recorded was used to suggest mechanisms to aid the workers in improving body posture. This study assessed from CATIA V5 software regarding the working postures that focused on the loaders between the current work posture and ergonomically safe posture by using Rapid Upper Limb Assessment, RULA. From RULA analysis, the left and right arms as well as the wrist part of the workers were identified as the most severe. According to the NIOSH lifting, equation test resulted that the RWL and LI are at a very dangerous level where the lifting index reached 6.49. Apparently, the implementation of the suggested mechanism called slide concept conveyer as well-known as inclined conveyer significantly contributed to the workers' mainly on the affected part of the body which improved as recorded in the RULA assessment. On the other hand, the new NIOSH lifting equation recorded a lifting index value of 1.10 with RWL attaining a value of 13.68 Kg compared to the previous LI value which exceeds 1 and low recommend weight limit, RWL that reached only 2.31 kg. The findings from this study provide a crucial basis for further research including completing additional analyses like REBA or proceeding to the fabrication stage by concentrating on the proper design considerations and technical elements.

DEDICATION

To my parents. Thanks for keep supporting me during my study for this whole time. I dedicate this to my parents, for your constant love and support. Then the supervisor, Professor Madya Dr Seri Rahayu Binti Kamat always guides me along this project journey until successful. Also, my fellow friends that keep me going and help with my frustration, and cheered me up. Thank you, everyone.

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In the name of ALLAH, the most gracious, the most merciful, with the highest praise to Allah I manage to complete this final year project successfully, and also, I would like to express my appreciation with the help of my parent, supervisor, Professor Madya Dr Seri Rahayu Binti Kamat and friends. Not forget to mention, that all previous researchers and authors who indirectly assist me completed this study without fail.

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FFB	-	Fresh fruit bunch
FL	-	Fruitlet
POM	-	Palm oil mills
CPO	-	Crude palm oil
RC	-	Rope-and-cutlass
PH	-	Pole harvester
MSDs	-	Musculoskeletal disorders
REBA	-	Rapid entire body assessment
RULA	-	Rapid upper limb analysis
LI	-	Lifting index
CLM	-	Comprehensive lifting model
HMMA	-	Human musculoskeletal model analysis
MMH	-	Manual Material Handling

CHAPTER 1

INTRODUCTION

1. 1 Background of the study

Malaysia was once a leading producer and exporter of oil palm in the world. In 2005, Malaysia accounted for the biggest percentage of worldwide vegetable oils and fats commerce, (Sumathi et al., 2008). Palm oil growth has accelerated drastically in the last 50 years to fulfill the soaring demand for vegetable oils. Graph 1 represents the change in global production. More latest data for Asia in particular in 2018 amounts to 63.26 million tonnes, as of this article. Malaysia and Indonesia each contribute over 95% of the total. Even though oil palm is grown in small quantities in many nations, the worldwide market is dominated by only two countries: Indonesia and Malaysia. Oil palm production reached 72 million tonnes in 2018. Indonesia produced 57% of the total (41 million tonnes), while Malaysia contributed 27%. (20 million tonnes). It is recorded that these 2 nations influenced world oil palm crop production by 84% approximately, (Ritchie & Roser, 2020).

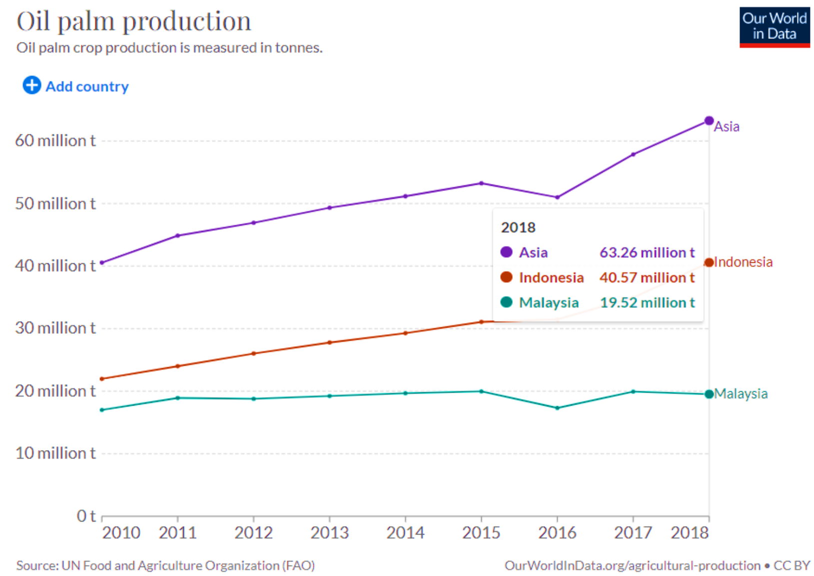

Figure 1. 1: Change in global production, adapted from Food and Agriculture Organization of the United Nations (FAO) by Ritchie, H., & Roser, M. (2020). Oil palm crop change in global production is measured in tonnes. [Image]. Retrieved 10 April 2022, from https://ourworldindata.org/palm-oil.

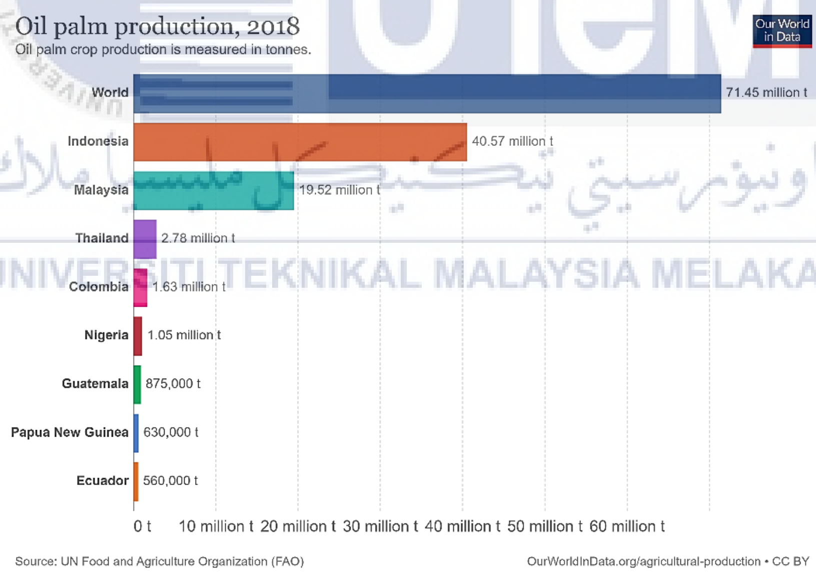

Figure 1. 2: Change in global production in 2018, adapted from Food and Agriculture Organization of the United Nations (FAO) by Ritchie, H., & Roser, M. (2020). Oil palm crop change in global production is measured in tonnes. [Image]. Retrieved 10 April 2022, from https://ourworldindata.org/palm-oil.

Due to the major influence in this oil palm industry, manpower is highly required to carry out the handling to process the palm into the oil. However, the World Bank stated in 2010 that the palm oil industry's workers' occupational safety and health constituted a serious concern to the industry's long-term viability, (UNDP, 2018). Thus, palm oil production particularly palm fruit harvesting is presumed to be a labor-intensive industry, (Nuruly Myzabella, Lin Fritschi, Nick Merdith, 2019).

Kirkhorn et al., (2010) emphasized the relation between ergonomics risk factors and MSDs and agricultural commodities in a review article. Musculoskeletal disorders, MSDs were common in traditional manual harvesting procedures based on the observation, (Guan-Ng et al., 2013). Moreover, the tasks are carried out in a typical oil palm plantation by a team of two workers, fresh fruit bunches, an FFB cutter, and an FFB collector around three cycles/visits per month are executed for each tree, (Guan-Ng et al., 2013). Harvested fruits are then transported by truck to an oil palm mill for oil extraction, where it is loaded individually by a different group of employees known as loaders.

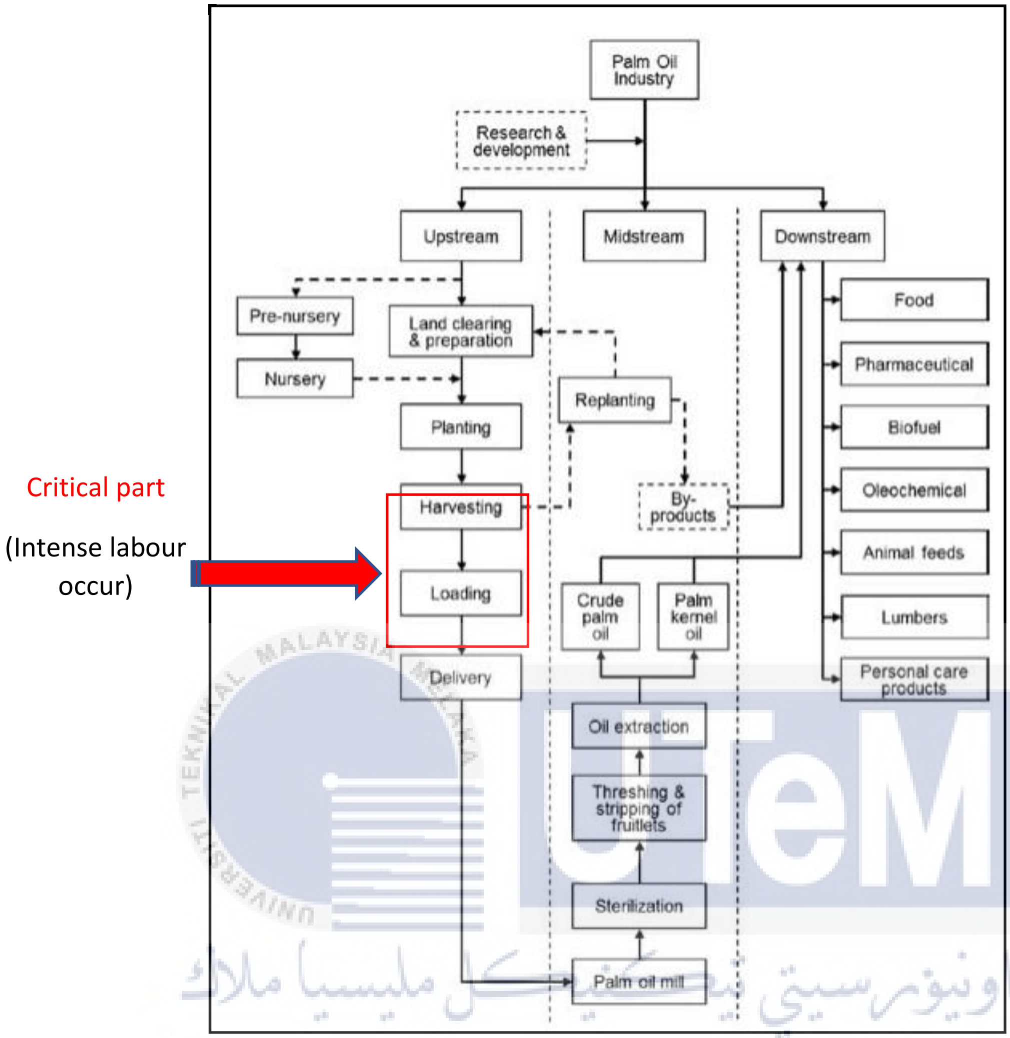

Figure 1. 3: Upstream oil palm plantation process flow chart, as well as the downstream oil palm industry value chain, adapted from Ergonomics of Harvesting Tasks in Oil Palm Plantation by Ng, Y., Bahri, M., Syah, M., Mori, I., & Hashim, Z. (2013). Ergonomics Obser Observation: Harvesting Tasks at Oil Palm Plantation. Journal Of Occupational Health, 55(5), 405-414. https://doi.org/10.1539/joh.13-0017-fs

Based on Figure 1.1, the flowchart process illustrated the whole process system and the labeled indicator pointed to the most two common intense labor in palm oil industry activities which are harvesting and loading FFB. Early harvests of FFBs can weigh in a range of 5 kg yet, FFBs from oil palm trees over 15 years old can reach up to 50 kg, (Mutert, 1999). Therefore, the cutter is responsible to separate FFB from the oil palm tree by removing the exposed bunch stem, while the oil palm frond at the base of the trunk is cropped. Then, to obtain the ripe oil palm fruit, cuts are produced by continuously exerting push and pull pressures by the cutter (Guan-Ng et al., 2013).

The height of fruits in the area developed along the height of the oil palm trees can potentially rise around 3 meters above the ground at the age of 6-7 years old while oil palm trees at 25 years old can grow up to 20 meters. As a result, the cutter’s heads in Figure 1.2, automatically lean upward to seek ripe fruits, including the hands and arms extended with the shoulder stretched beyond shoulder level within a longer span of hours. This can cause several risks, for instance, neck disorder due to repetitive, forceful work, static contraction, and extreme working postures, (Salleha & Sukadarina, 2018).

Figure 1. 4: FFB cutter posture during cutting the ripe fruit adapted from International Journal for Research in Emerging Science and Technology by Andhra Pradeh, P. (2015). Manual harvesting of Oil Palm with pole and sickle [Image]. Retrieved 10 April 2022, from https://ijrest.net/downloads/volume-2/issue-7/pid-ijrest-27201509.pdf.

Secondly, after stooping and overreaching to collect loose fruits, FFB collectors in Figure 1.3, endure postural stress, primarily in the lower back, arms and shoulders. When the wheelbarrow is fully loaded, the FFB collector must balance upper and lower body strength to keep the wheelbarrow stable and avoid tripping and spilling, (Guan-Ng et al., 2013). Whilst lifting greater FFBs and maintaining the position while loading FFBs can trigger severe pain owing to recurring awkward postures. Also, pushing the wheelbarrow around an uneven landscape or through extensive surface vegetation on a poorly kept plantation may require more effort.

Figure 1. 5: FFB collector postures gather the fruits, workers in a) and b) are collecting loose fruits on the ground. Worker in c) is pushing the FFB using a wheelbarrow. Workers in d) are unloading the FFB on the ground adapted from Ergonomic observation by Shamsul Bahri, M. (2013). Harvesting tasks [Image]. Retrieved 10 April 2022, from https://www.researchgate.net/figure/FFB-collector-a-and-b-collecting-loose-fruit-scattered-on-ground-by-sweeping-in_fig5_253334976.

Furthermore, the loaders are supposed to lift the FFB in the truck after the harvesting process is completed using a loading spike as shown in Figure 1.4. Despite the various range of size and weight of the palm fruits, a slightly thinner individual is exposed to very high severity of MSDs rather than the individual that has more weight and strength. This loading activity occurs a lot of awkward postures that potentially lead to serious injuries. Loading activity includes repetitive bending, lifting, swinging, and throwing postures that extremely require high strength, skills, and energy. In addition, the palm fruit has a quite sharp body exterior and it causes uncomfortable situations as well as torments the loaders since it is unpreventable to not touches the fruits during lifting. From Figure 1.5, there is the task movement that can cause the risks of musculoskeletal disorders, MSDs.

Figure 1. 6: Loading palm fruit into truck activity adapted from YouTube by Ce Pi, S. (2021). Loading FFB into the truck process [Video]. Retrieved 10 April 2022, from https://www.youtube.com/watch?v=W19hHXsJbqU.

Commonly affected body part/region (potential MSDs)	Task movement / Ergonomic risk factors	References
Neck disorders	Repetitive work Forceful work Static contraction Extreme working postures	NIOSH (1997); Walker-Bone & Palmer (2002); Rosecrance *et al*. (2006); Davis (2007); Osborne *et al*. (2010); Fathallah (2010)
Shoulder disorders	Repeated or sustained exertions Forceful exertion Awkward or sustained posture (shoulder flexion or abduction	NIOSH (1997); Walker-Bone & Palmer (2002); Rosecrance *et al*. (2006); Davis (2007); Osborne *et al*. (2010); Fathallah (2010)
Elbow disorders such as epicondylitis	Forceful exertion Repetition Extreme postures	NIOSH (1997); Davis (2007); Fathallah (2010)
Hand/wrist tendonitis such as carpal tunnel syndrome	Repetition Forceful exertion Awkward posture	NIOSH (1997); Walker-Bone & Palmer (2002); Davis (2007); Osborne *et al*. (2010); Fathallah (2010)
Low back disorders	Heavy physical work Lifting and forceful movements Bending and twisting (awkward postures) such as stooping Whole-body vibration Static work postures	NIOSH (1997); Walker-Bone & Palmer (2002); Rosecrance *et al*. (2006); Osborne *et al*. (2010); Davis (2007); Fathallah (2010); Lee (2012)
Knee pain (including osteoarthritis)	Kneeling Squatting Prolonged standing	Walker-Bone & Palmer (2002); Davis (2007); Osborne *et al*. (2010); Lee (2012)
Ankle / foot pain	Prolonged standing Static posture	Walker-Bone & Palmer (2002); Davis (2007) Osborne *et al*. (2010)

Figure 1. 7: List of potential MSDs in palm agriculture adapted from State-of-the-Art Review by Xiaopeng, N. (2011). Common Physical Risk Factors of MSDs in the Construction Industry [Image]. Retrieved 10 April 2022, from https://www.researchgate.net/figure/Common- Physical-Risk-Factors-of-MSDs-in-the-Construction-Industry-Adapted-from-Jaffar_tbl1_273503212.

1. 2 Summary problem statement

The harvesting process and loading activity in the oil palm industry can be very exhausting and torturing since the activities involves extreme muscles and strength, in handling the palm fruit. Particularly, FFB loaders using tools like loading spike indirectly leads to repetitive awkward posture including lifting, bending, swinging, holding, etc., Apart from that, the loading truck is usually 6 – 9 feet tall and this factor will be triggering the risks even more possible including those actions that exposes to many types of work-related Musculoskeletal Disorder (WMSDs) where these tasks could cause injuries or long-term pain towards workers due to incorrect posture application. In addition, this issue received less attention due to a lack of research on FFB loaders and less exposure to MSDs risks among the workers. Therefore, this study is to focus more on this particular activity.

1. 3 Objectives

1. To investigate the experiences of the workers on the loading activities using the interview or questionnaire.
2. To analyze the body posture and the part of the body that felt discomfort while doing the loading activities using Delmia software.
3. To redesign the material handling device for improving the body posture and improving worker performance.

1. 4 Scope

Among the activities during palm fruit handling, the observation was focused on fresh fruit bunch, FFB loading work. As the loaders were facing intense workload in daily routine. Some awkward postures need to be analyzed such as bending, lifting, and swinging during transferring the palm fruit onto the truck using the loading spike. The observation will be determined by analyzing the postures and data using Catia, Delmia software, and Microsoft Excel or Minitab. In particular, the Rapid Upper Limb Assessment (RULA) evaluation was used to identify individual exposure to ergonomics risk and to figure out the risk of musculoskeletal disorders (MSD) concerning specific job responsibilities. Other than that, Washington industrial safety and health act, WISHA lifting calculator, or NIOSH lifting equation is also important to conduct ergonomic risk evaluations on a wide range of manual lifting and lowering operations, as well as a screening tool to identify lifting tasks that should be investigated further using the NIOSH Lifting Equation. The Recommended Weight Limit (RWL), which determines the maximum tolerable weight (load) that virtually all healthy personnel could lift throughout an 8-