



UNIVERSITI PUTRA MALAYSIA

***TESTING AND EVALUATION OF NEWLY DEVELOPED PINEAPPLE
HARVESTING BASKET AMONG PINEAPPLE HARVESTERS IN
JOHOR, MALAYSIA.***

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HARVESTING BASKET AMONG PINEAPPLE HARVESTERS IN JOHOR,
MALAYSIA.**



**BY
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ABSTRACT

TESTING AND EVALUATION OF NEWLY DEVELOPED PINEAPPLE HARVESTING BASKET AMONG PINEAPPLE HARVESTERS IN JOHOR

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Introduction: Pineapple harvesting work contributes to the reporting of musculoskeletal symptoms (MSS) and ergonomic risks. Pineapples are harvested manually in some parts of Malaysia using rattan baskets and workers are exposed to excessive bending, pain and discomfort. **Objectives:** The aim of the study is to test and evaluate the newly developed harvesting basket in terms of the physiological workload, body parts discomfort, perception of the harvesters towards the new basket, and risk level of musculoskeletal disorder (MSDs) associated with harvesting using different type of basket. **Methodology:** This was a cross-sectional study conducted among pineapple harvesters in Muar, Johor. Data of 25 harvesters was collected using questionnaires that consisted of standard scales namely Borg CR-10 Scale to assess body part discomfort of harvesters while using both baskets. The data collection process commenced with the administration of questionnaires and the basket testing simulation process. Fitbit Fitness Smartwatch to measure the heart rate of respondents and were then used to calculate the physiological workload. Rapid Entire Body Assessment (REBA) tool is used to measure the risk level of awkward posture while performing harvesting tasks using both baskets. The perception of harvesters to the use of the new harvesting basket was assessed using a modified questionnaire. The descriptive analysis was used to analyze the perceptions of respondents towards the new basket. Paired t-test was used to analyze the comparison of physiological workload and REBA score of both baskets. Wilcoxon signed-rank test was used to analyze the body parts discomfort while using different types of baskets. **Results and Discussion:** There is a significant differences ($p > 0.001$) between the physiological workload of the harvesters while using the rattan basket (6.6 ± 0.9 Kj-min) and the new basket (5.0 ± 1.1 Kj-min). The discomfort of the harvesters was improved while using new basket compared to the rattan basket. The postural analysis using REBA shows that by using new basket the awkward posture risk level of harvesters reduced from high-risk level (rattan basket) to medium risk level (new basket). Most of the harvesters perceived that the new harvesting basket fulfils harvesters needs. **Conclusion:** The newly developed harvesting basket has the ability to improve pineapple harvesters' work posture, discomfort, and physiological workload during the harvesting process. It has the potential to decrease the number of reported MSS incidents among pineapple harvesters.

ABSTRAK

PENGUJIAN DAN PENILAIAN BAKAL PENUAIAN NENAS YANG BARU DIBANGUNKAN DI KALANGAN PENUAI NENAS DI JOHOR

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Pengenalan: Di Malaysia, tugas kerja di ladang nanas dicirikan oleh postur kerja yang tidak ergonomik, pergerakan yang janggal, kerja berulang-ulang dan angkat berat. Selain itu, proses penuaian bergantung semata-mata pada alat manual, iaitu bakul rotan. Akibatnya, pekerja terdedah kepada lenturan, kesakitan dan ketidakselesaan yang berlebihan. **Objektif:** Matlamat kajian adalah untuk menguji dan menilai bakul penuaian yang baru dibangunkan dari segi beban kerja fisiologi, ketidakselesaan bahagian badan, persepsi penuai terhadap bakul baharu, dan tahap risiko postur janggal menggunakan kedua-dua bakul. **Metadologi:** Ini adalah kajian keratan rentas yang dijalankan di kalangan penuai nanas di Muar, Johor. Data 25 penuai dikumpul menggunakan soal selidik yang terdiri daripada skala piawai iaitu Skala Borg CR-10 untuk menilai ketidakselesaan bahagian badan penuai semasa menggunakan kedua-dua bakul. Proses pengumpulan data dimulakan dengan pemberian soal selidik dan proses simulasi ujian bakul. Fitbit Fitness Smartwatch untuk mengukur kadar denyutan jantung responden dan kemudian digunakan untuk mengira beban kerja fisiologi. Alat Rapid Entire Body Assessment (REBA) digunakan untuk mengukur tahap risiko postur janggal semasa melakukan tugas penuaian menggunakan kedua-dua bakul. Persepsi penuai terhadap penggunaan bakul penuaian baru dinilai menggunakan soal selidik yang diubah suai. Analisis deskriptif digunakan untuk menganalisis persepsi responden terhadap bakul baharu. “paired t-test” digunakan untuk menganalisis perbandingan beban kerja fisiologi dan skor REBA kedua-dua bakul. “Wilcoxon signed rank test” digunakan untuk menganalisis ketidakselesaan bahagian badan semasa menggunakan pelbagai jenis bakul. **Keputusan dan perbincangan:** Terdapat perbezaan yang ketara ($p > 0.001$) antara beban kerja fisiologi penuai semasa menggunakan bakul rotan (6.6 ± 0.9 KJ-min) dan bakul baharu (5.0 ± 1.1 KJ-min). Ketidakselesaan penuai telah dipertingkatkan semasa menggunakan bakul baharu berbanding dengan basket iratan. Analisis postur menggunakan REBA menunjukkan bahawa dengan menggunakan bakul baharu tahap risiko postur yang janggal penuai berkurangan daripada tahap risiko tinggi (bakul rotan) kepada tahap risiko sederhana (bakul baharu). Para penuai merasakan bahawa bakul penuaian baru memenuhi keperluan penuai. Ini disebabkan oleh reka bentuk ergonomik bakul penuaian baharu yang mengurangkan faktor risiko yang berkaitan dengan proses penuaian dan ciri tambahan yang memberikan keselesaan kepada penuai. **Kesimpulan:** Bakul penuaian yang baru dibangunkan mempunyai keupayaan untuk memperbaiki postur kerja penuai nanas, ketidakselesaan dan beban kerja fisiologi semasa proses penuaian. Ia berpotensi untuk mengurangkan jumlah kejadian MSS yang dilaporkan dalam kalangan penuai nanas.

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LIST OF ABBREVIATIONS

| | |
|-------|---------------------------------------|
| AHR | Average heart rate |
| EE | Energy expenditure |
| MSS | Musculoskeletal symptoms |
| MSD | Musculoskeletal disorder |
| REBA | Rapid Entire Body Assessment |
| myGAP | Malaysian Good Agricultural Practice |
| OWAS | Ovako Working Posture Analysis System |
| RULA | Rapid Upper Limb Assessment |

CHAPTER 1

INTRODUCTION

1.1 Background

The pineapple industry contributes significantly to the country's socio-economic development in improving the livelihoods of smallholder farmers through income generation. It contributes to the nation's economic development and other supporting economic activities such as packaging, transportation, and other value-added activities, particularly in Johor. The state of Johor is known as the largest pineapple producer in 2011, with the quantity of production estimated at 80,389.22 metric tons (MPIB, 2011).

MSD has been shown to raise production costs because workers are absent, insurance and medical expenses increase (Kirkhorn et al., 2010). According to the Social Security Organization's (SOCSO) annual report on occupational musculoskeletal disorders from 2011 to 2016, the total number of affected workers kept rising. For one year, the lower back, feet/ankles, and knees were the parts of the body most affected by Musculoskeletal Symptoms (MSS) (Rani et al., 2016). Even though there are a lot of articles about the risk of work-related musculoskeletal disorders in the agricultural field, research on occupational safety and health in the pineapple sector is still minimal. Thus, making it harder to provide information about ergonomics risks in the pineapple industry.

Work in pineapple plantations is strenuous since the pineapple tree is a short-rotation crop that grows low on the ground and reaches a maximum height of 1.5 meters, workers are required to bend their bodies in uncomfortable postures while planting, weeding, processing, harvesting, and land planning, which may result in muscle pain and discomfort (Mohd Tamrin & Aumran, 2014). Additionally, pineapple plantations are still done manually and primarily with hand tools in some part of Malaysia. As a result, workers are constantly at risk of ergonomic hazards such as excessive bending, twisting, and lifting. Harvesting was identified as the task with the most ergonomic risk, exposing workers to severe MSS, in earlier research by Rani et al. (2016) and Ya'acob et al. (2018). Manual harvesting tools consist of a sturdy rattan fruit harvesting basket that weighs 5 kg without its accessories. Non-ergonomic work practices, such as manual loading tasks during pineapple fruit harvesting, significantly exceed standard safe limit thresholds. The awkward posture adopted while carrying out the job with the curt harvesting basket is alarming.

1.2 Problem Statement

Work in pineapple plantations is labor-intensive and requires high physical exertion. The work tasks like harvesting, cultivating, weeding, and land preparation exposed the workers to muscle pain and discomfort. The workers bent their body in positions defined as awkward posture (Mohd Tamrin & Aumran, 2014).

There is no other ergonomically designed harvesting basket in Malaysia in the market thus pineapple harvesting that till depends entirely on a manual tool such as a rattan harvesting basket (Rani et al., 2016). The existing pineapple basket exposed the workers to ergonomic risk factors due to the worker's awkward postures and repetitive movement during harvesting process (Rani et., al 2016). During walking, the workers must bend forward to create remote support for the basket to sit on the waist. Hence, the working posture during carrying and walking through pineapple plantation field using rattan baskets for a prolonged time on the uneven surface affects the shoulder, lower back, and knees. An example of such a task is presented in Figure 1.1. Apart from that, the basket sags down, thus putting pressure on shoulder straps, and these shoulder straps were not fit tight on the worker's shoulder.



Figure 1.1 posture of workers walking and carrying loads using the existing rattan basket

According to Rani et al. 2016, harvesting task at pineapple plantation using rattan harvesting were categorized as high and very high risk. The work task was also considered strenuous as the amount of weight carried by the workers was massive with 50 to 70 kg per basket with a full load and considering that the task is repetitive, cumulatively the workers carry 500 to 600 kg workload in a day (Rani et al., 2016). The weight of a full load basket exceeds the safe limit and ideal lifting load of 23 kg or 51 lbs, as suggested by the National Institute of Occupational Safety and Health (Kamarudin et al., 2013).

Several similar findings were reported that low back pain risks in the agricultural sectors were heavy physical work and awkward postures (Kirkhorn et al., 2013 & Osborne et al., 2012). To harvest the fruit, the workers will cut the fruit from its stalk with a sharp cleaver and toss it over their shoulder to fall into the rattan basket carried on their back. The basket is cylindrical, making the worker's back experienced contact stress. To increase the loading capacity of the basket, the height is often modified. To unload fruits from the basket onto the ground, workers will need to bend forward at the waist at an angle of 60°, which exceed the safe limit of 45° to tip the fruits out as the design of the basket does not allow other options for unloading process (Mezlan et al., 2019). Figure 1.2 presents a photo of pineapple unloading.



Figure 1.2: Unloading of pineapple on the ground.

All the evidence of these non-ergonomic working practices and the risk factors linked to harvesting tasks that led to reporting MSS emphasize the importance of conducting research to objectively assess and analyze the ergonomic risk associated with pineapple harvesting tasks and the need for an alternative harvesting basket to replace the existing rattan basket that is used to potentially reduce the safety and health risks that associated with the harvesting task.

A study by Mezlan and colleagues (2017) had developed an improved harvesting basket that is believed to reduce musculoskeletal symptoms (MSS) and discomfort of pineapple harvester. A latch had been added at the bottom of the improved harvesting basket and it can be opened during the unloading process. However, this improved harvesting basket was not tested by actual pineapple workers. Hence, the actual discomfort and physiological workload of the workers could not be assessed by the

basket simulation that had been carried out (Mezlan et al., 2017). Figure 1.3 shows the developed pineapple harvesting basket developed by Mezlan et al.

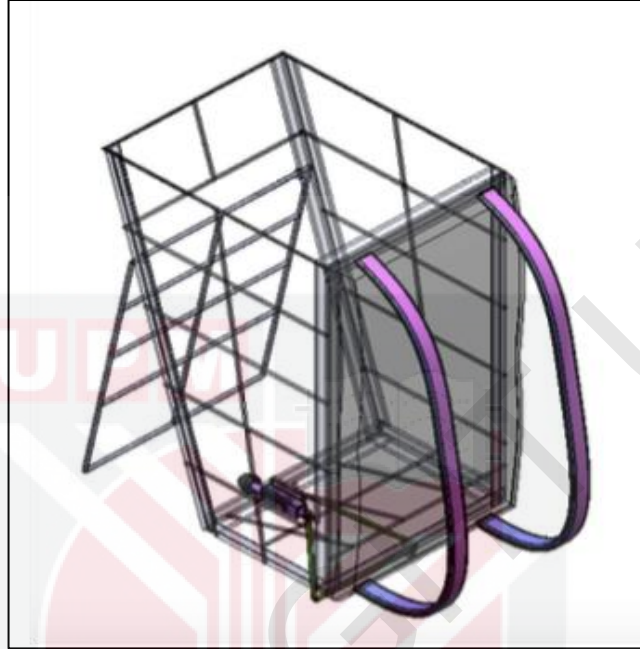


Figure 1.3: Newly developed pineapple harvesting basket by previous researcher

1.3 Study Justification

The pineapple industry in Malaysia is expanding, as Malaysia is one of the world's leading pineapple producers due to its reputation for growing high-quality, golden-yellow fruit. The ergonomics hazard among pineapple plantation workers was significantly high (Mohd Tamrin & Aumran, 2014). Due to uncomfortable and extreme postures when performing most tasks, the workers are prone to musculoskeletal issues such as low back pain. Many activities in a pineapple plantation, such as harvesting, pose ergonomic risks. Based on the ergonomic hazard identification and risk assessment conducted, harvesting is considered a high-risk task. The most strenuous activities are associated with heavy loads during the harvesting process (Rani et al., 2016).

Additionally, harvesting tasks in pineapple plantations are still performed manually, leaving workers with no other choice. As a result, the workers continued to harvest using the traditional rattan basket, exposing them to MSS risk factors due to the basket's non-ergonomic design. Furthermore, there is a lack of research in Malaysia on agricultural tool developments in pineapple plantations. According to the previous study conducted by Yusoff et., al (2014) on oil palm plantation workers, it is said that the designated ergonomic harvesting tool, which is a chisel, potentially reduces awkward body posture during harvesting activities as compared to the existing device. Indeed, improvement and intervention projects such as tool modification in pineapple plantations should be introduced to mitigate the risk factors associated with MSS experienced by workers. This research is being conducted to test and evaluate a newly designed harvesting basket that can reduce the physiological workload and discomfort

associated with harvesting tasks. The new basket design specification considered several criteria for reducing awkward postures, contact stress on workers' bodies, and reducing workers' heavy load burden to reduce reported MSS in coming years. The development of this new ergonomic knapsack basket would benefit pineapple plantation employees, the Malaysian Pineapple Industries Board (MPIB), the Department of Agriculture (DOA), and the Department of Occupational Safety and Health (DOSH), as they will be able to sustain and increase productivity while also managing the safety and health of all workers (Rani et al., 2016).

Malaysia is on course to become one of the world's largest exporters of pineapple products. According to Star Online, Malaysia previously signed an agreement to export large pineapple products to China weekly, totaling 2,000 tons beginning in early 2015. (Star Online, 2015). According to the National Agro-food Policy, Malaysia is expanding the production areas for commercial fruit such as pineapple and will open a new area of 7,120 hectares by 2020. The opening of the new regions will lead to increases in work demand in the agriculture sector. Thus, this research will help protect the safety and health of workers. This strongly indicates that income from pineapple production and export contributes to Malaysia's economy, and it is necessary to ensure that the sector continues to expand without jeopardizing worker health (Rani et al., 2016).

The outcomes of this research in part will help with the government's aim to increase in the number of farms being accredited with the Malaysia Good Agricultural Practice Scheme or "Skim Amalan Ladang Baik Malaysia (SALM)" which has been introduced by the Department of Agriculture, Malaysia. SALM is specific to the agricultural

activity where it focuses on making farms environmental friendly and ensuring the welfare and safety of workers to ultimately produce high quality product. SALM is based on the Malaysian Standard MS 1784: 2005 Crop Commodities – Good Agricultural Practices (GAP). The application of ergonomic inventions would contribute favorably to the achievement of the standards required by the Malaysian Good Agricultural Practices (myGAP) certification process, which is administered by the Malaysian Department of Agriculture. The myGAP certification programme is a voluntary recognition program for plantations that use good agricultural practices that are environmentally friendly and safeguard the welfare, safety, and health of workers, in addition to generating high-quality products for consumption (Department of Agriculture, 2015).

1.4 Research Question

- i. Can the newly developed harvesting basket reduce the risk level of awkward posture among harvesters while performing work tasks unloading of the pineapple.
- ii. What is the perception of the pineapple harvesters regarding the newly developed pineapple harvesting baskets?
- iii. Can the newly developed harvesting basket reduce the heart rate, energy expenditure, and level of body parts discomfort among pineapple harvesters compared to the rattan harvesting basket?

1.5 Objectives

1.5.1 General Objectives

- i. To test and evaluate the newly developed pineapple harvesting basket among pineapple harvesters in Johor, Malaysia.

1.5.2 Specific Objectives

- i. To obtain the sociodemographic data of the respondents.
- ii. To compare the risk level of awkward posture among the harvesters while performing the unloading process using a existing harvesting basket and a new harvesting basket.

- iii. To compare the harvester's physiological workload while using the rattan harvesting basket and the new harvesting basket.
- iv. To compare the level of discomfort of the harvesters while using the rattan harvesting basket and the new harvesting basket.
- v. To assess the perception of the harvesters regarding the newly developed pineapple harvesting basket.

1.6 Hypothesis

There are significant differences between the heart rate, energy expenditure, and REBA score of the rattan harvesting basket and the newly developed harvesting basket.

1.7 Conceptual and Operational Definition

1.7.1 Pineapple harvesting basket

i. Conceptual Definition

Pineapple harvesting basket is a manual tool used to harvest pineapple. It is made of rattan and weighs 5kg without load (Mezlan et al., 2019).

ii. Operational Definition

The pineapple harvesting baskets used in the study are the current rattan harvesting basket and newly developed harvesting basket.

1.7.2 Muscle discomfort

i. Conceptual Definition

Definitions of discomfort involving the assessment of work-related MSDs often describe uncomfortable sensations (e.g., pain, fatigue, muscle cramping) resulting from experimental tasks (Cameron et al., 1996).

ii. Operational Definition

The level of musculoskeletal discomfort is obtained through the BORG CR-10. Respondents will be asked about the body parts' pain and give a discomfort rating.

1.7.3 Physiological workload

i. Conceptual Definition

Physiological workload measurements comprised of peak heart rate values. From the average values of heart rate, energy expenditure was calculated. (Bhattacharyya et al., 2012).

ii. Operational Definition

The physiological workload is measured by measuring the energy expenditure and working heart rate every minute while workers perform harvesting tasks at the plantation field. Measuring of the heart rate will be performed using a heart rate monitor watch, while energy expenditure will be using the following formula:

$$\text{Energy Expenditure (Kj-min)} = 0.159 \times \text{Average Heart Rate (beats per min.)} - 8.72$$

1.7.4 Awkward posture

i. Conceptual definition

An awkward posture is known to be an ergonomic risk factor. It will increase the compression on the spine, particularly at the lumbar segment that results in low back pain (Bruce, 1997).

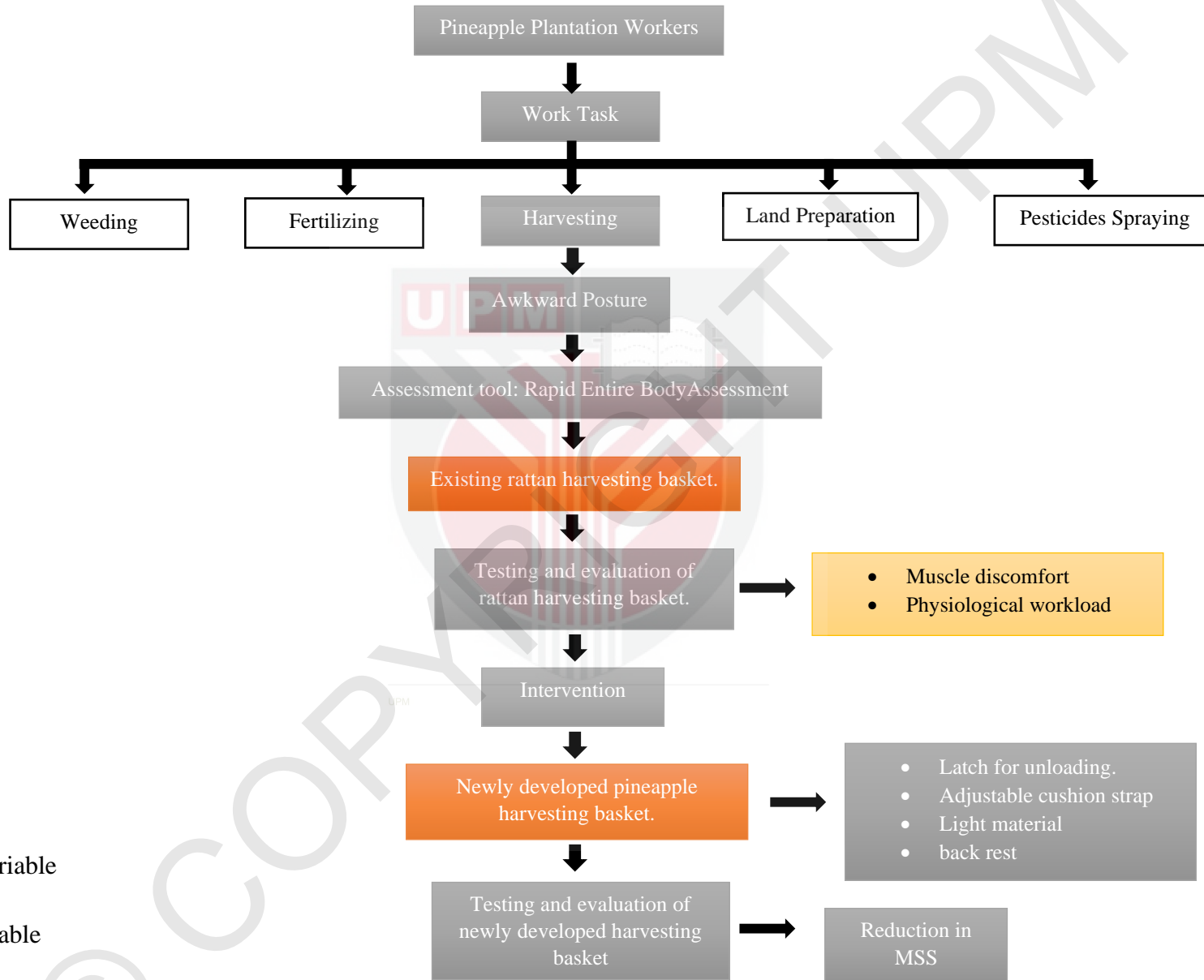
ii. Operational Definition

Awkward posture of the respondents will be measured using an ergonomic assessment tool called Rapid Entire Body Assessment (REBA). The score will evaluate the severity of the risk factor

1.8 Conceptual Framework

Harvesting is one of the main tasks performed by the pineapple plantation workers. The workers are exposed to various ergonomic risk factors such as awkward posture and excessive when performing the task, contributing to musculoskeletal symptoms. The new harvesting basket is lighter, and the strap is comfortable for the workers. The usage of the new harvesting basket for the long run will reduce MSS distribution among the workers. The ergonomic features applied to the newly developed harvesting basket are expected to reduce the ergonomic risk factors exposed by the workers, incredibly awkward posture. To test and evaluate the newly developed pineapple harvesting basket, we measure the physiological workload, the level of discomfort, and the workers' perception while using the new harvesting basket. In this study, the rattan and newly developed harvesting hat the workers use is the independent variable, while the muscle discomfort and the physiological workload are the dependent variables. Figure 1.3 shows the conceptual framework in this study.

Figure 1.3: Conceptual framework



- Independent variable
- Dependent variable
- Scope of study

CHAPTER 2

LITERATURE REVIEW

2.1 Ergonomics in Agriculture

Agriculture is regarded as a job containing high risks in many countries (Fathallah et al., 2010). Due to the nature of the jobs involved in agriculture, ergonomic is essential in preventing and promoting work-related injuries. One of the main goals of ergonomics is the reduction of work-related musculoskeletal disorders. Safety and health sciences are critical factors in the management of agricultural jobs. They can help prevent injuries and promote health. Moreover, most agricultural duties are performed manually, especially in developing countries. Manual handling can create awkward body postures. It is also acknowledged as one of the main risk factors for musculoskeletal disorders. Some agricultural activities are physically demanding and require workers to work long hours of more than 8 hours per day. This is especially true during the planting and harvest seasons. Many farmworkers cannot rest appropriately during these busy times due to their work tasks. This is one of the main reasons many countries face safety-related issues. Generally, farming is acknowledged as a high-risk task, including several kinds of occupational injuries, especially WMSDs. Assuredly, occupational health studies and ergonomic assessments significantly affect the promotion of farmers' health. (Vyas, 2012).

Farmers and agricultural labourers, on the other hand, are susceptible to a variety of illnesses and injuries, including musculoskeletal disorders (MSDs) (Amitabha & Robendranaz, 1992). One of the primary causes of work-related injuries and lost time is workplace musculoskeletal disorders (WMSDs) (Bon and Daim, 2010). Thus, preventing and reducing WMSDs among labourers is a significant ergonomic issue. This issue is so substantial that several nations have made WMSD prevention a national priority (Hosseini et al., 2010). Inadequate understanding of WMSDs is a prominent issue among farmworkers who adopt incorrect postures when performing agricultural tasks like harvesting. It is commonly stated that WMSDs may be prevented with ongoing intervention such as education and the application of correct ergonomic techniques (Krystosik-Gromadziska, 2017). Effective ergonomic methods and approaches can balance worker protections and job demands in the workplace (Petit et al., 2014). To maximise productivity and avoid work-related injury risks, workers must finish their tasks within an acceptable amount of time. WMSDs can be reduced by changing workers' perceptions of work and employing the proper number of workers for the job.

2.2 Prevalence of MSS in Agriculture

Nearly 60% of the working population in developing countries is directly involved in various occupations in the informal or unorganised sectors. The primary reason for this is that economic conditions are constantly changing, and labour is readily available. Musculoskeletal Disorders (MSDs) caused by work are the most common ailment among informal sector employees (Gangopadhyay and Dev 2014). They are symptoms of ergonomic risks and the primary cause of disability among working-age persons. Most of these illnesses are caused by recurrent stress. This might be because the equipment was designed, or the workstations were misdesigned. Whichever rationale exists, the end outcome is the emergence of WMSDs.

Research by Rani et al. (2016) on musculoskeletal symptoms risk factors in Malaysia reveals that the prevalence of MSS in the study was high and comparable with other agricultural studies reported in Malaysia and India (Ng et al., 2014 Vasanth et al., 2015). The overall prevalence of MSS was 87.0 %. Approximately 80% of the workers complained of MSS in 2 to 5 parts of the body. The most affected body part was the lower back (64.8%), feet and ankle (53.7%), and knee (52.8%). High MSS prevalence reflects a high burden of disease in the agricultural sector. This has repercussions such as the direct and indirect impact on financial costs apart from work performance (Piedrahita et al., 2004). The findings suggest that, firstly, the prevalence of musculoskeletal symptoms was very high among the study population, and secondly, symptoms frequently occurred at multiple body regions. The high prevalence of musculoskeletal symptoms among agricultural workers in our study generally agrees with previous reports (Luangwilai et al., 2014; Das, 2015; Min et al.,

2016). The findings suggest that such symptoms might have a significant impact on both well-being and performance of employees. (Dianat et al., 2020)

Females were more likely to report work interference of musculoskeletal pain than males. This may have implications for prioritising ergonomic interventions for reducing the prevalence of such symptoms among farmers. The findings reveal that several factors contributed to musculoskeletal symptoms in this occupational group. Therefore, it can be concluded that multiple component interventions involving both the individual and work-related (physical and psychosocial) factors might be needed to decrease the high prevalence of musculoskeletal symptoms among agricultural workers.

2.3 Ergonomic Risk Factors in Pineapple Plantation

Many tasks performed in the pineapple plantations involved ergonomic risks on the low back area; it is difficult to identify which tasks contribute most towards this specific As specified in this study, the most strenuous tasks may arise mainly during the harvesting process. The low back pain may also be linked with excessive bending during the cultivation of shoots and the manual weeding process as these tasks are performed using manual tools. Evidence has shown that farmers were exposed to various dangerous situations like excessive bending, twisting, kneeling, carrying load, squatting, static and awkward stoop postures, repetitive and monotonous work, contributing to multiple MSDs (Gupta, 2013). Working in extreme and awkward posture causes workers to have more exertion that which ultimately leads to overusing and tiredness of muscle (Razak, 2014).

Awkward posture was found in almost all the working processes performed by workers in the pineapple plantation. In the outcome of the REBA exercise, the scores indicated that actions are needed for improvement. According to Hignett and McAtamney (2000), for work activities that fall into high postural risks, immediate investigation and implementation of changes are needed in their work tasks, while for very high postural risk, change must be implemented immediately without any research. The present study indicated that harvesting and land preparation is work tasks that need immediate changes.

The present study by Benos et al. (2020) revealed that prolonged stooping had been investigated in most studies (51.9%). Repetitive movements are a considerable risk factor (29.6%) and are associated with discomfort on the low back, arms, and shoulders. Repetition is very risky because of the very short cycles, which are iterated during the working time. Other study indicated that increasing age was associated with MSS. A survey by Engholm and Holmström (2005) reported that the prevalence of MSS was increased strongly by age. The survey by Weigel et al. (2014) showed the capacity of musculoskeletal farm workers declined as much as 25% between the age of 30 to 65 years, with the most rapid period of reduction starting at the age of 45 years old (Rani et al., 2016). Heavy lifting and Carrying (14.8%) (HCL) plausibly reported in the selected papers. Gender (11.1%) and Body Mass Index (7.4%) (BMI) are also personal characteristics that affect the development of MSDs. Kneeling (11.1%) was also identified, which is very common during agricultural activities and increases the risk of developing chronic knee pain. Also, rarely maintained, and non-ergonomically designed tools, as well as pesticide exposure (7.4%), seem to contribute to musculoskeletal injuries. Another risk factor, however, with more negligible

incidence, was the working hours that demonstrated the need for frequent rest breaks. Finally, warming up, which has widely been examined in sports science to prepare soft tissues for subsequent performance, can prevent the development of MSDs.

A review on ergonomics in agriculture stated the most highly examined manual operation during the last decade was the activity of harvesting (51.9%). The second considered tasks were the load-carrying (11.1%) and the examination of multiple tasks taking place in agriculture (11.1%). Pruning followed (7.4%), with planting, digging, peeling (of pineapples), sorting, and weeding coming next (3.7%), with one study presented for each of them. The content and the dangers in terms of exposure to MSDs. This observation demonstrates that all types of cultivations can cause MSDs to workers.

2.4 Pineapple Harvesting Process

Harvesting is described as the act of removing crops from fields and storing, processing, and consuming them in secure locations. The harvesting process in pineapple plantations in Malaysia still depends solely on manual tools. This is causing the workers to expose to ergonomic risk factors. Pineapples can be harvested when they have shown maturity characteristics, especially on the fruiting eyelids and skin colour. A ripe enough fruit will guarantee quality and meet the market's needs. Pineapples are harvested by cutting off parts of the stalk with a machete. The fruit stalk is sometimes left 6-10 cm long to facilitate handling. The harvested fruit is put in a basket hung on the worker's back. Workers will be required to bend forward at the waist of 60° (as opposed to the safe limit of 45°) to unload the fruits out of the basket due to the design of the basket, which does not allow for any alternative options for the unloading procedure (Rani et al., 2016).

According to recent research conducted on a pineapple plantation in Malaysia, harvesting was the highest risk rating. It is characterised by an awkward trunk posture and vigorous exertion while executing the shoulders, arms, wrists, and hands. This is also because there is no standard knapsack basket for pineapple plantation workers during the harvesting process. Different workers used a variety of knapsack basket designs, and some modified the basket to accommodate more oversized loads, depending on their body's capacity to bear burdens throughout the fruit picking procedure. The minimum weight of a completely loaded knapsack basket with fruits was 50 kilos. Still, with adjustments, the basket can carry up to 70 kilos every session, which can be repeated for up to four hours per day, totalling 500 to 600 kilos of fruits.

Each full-load basket weighed more than the National Institute of Occupational Safety and Health's recommended safe forward lifting load of 23 kg or 51 lbs. (Kamarudin et al., 2013).

2.5 Manual Tool in Agricultural Activity

Manual harvesting is a physically demanding employment that involves various work-related issues, the most common of which are musculoskeletal disorders (MSDs). According to an Indian study, there is an association between awkward postures and traditional tools. It is reported to be a significant risk factor for discomfort in the wrists or hands, fingers, and elbows of manual harvesting employees. The study's findings also highlight the importance of ergonomic interventions to improve the farm working environment, such as designing hand tools to assist farmers in correcting their working postures (JAIN et al., 2018).

The current study, which focuses on risk factors for musculoskeletal problems in pineapple plantations, reveals that harvesting and land preparation are critical job tasks that must be implemented quickly (Rani et al., 2016). This is because the nature of the job required workers to labour in awkward postures for most of the time. Additionally, these two tasks need workers to work with manual the same muscle groups and joints repeatedly used throughout the workday. Physical injuries have been demonstrated to occur because of repetitive motions with awkward postures using the same joints and muscle groups moving in the same motion extremely often and rapidly for an extended period (Ghasemkhani et al., 2006).

As farmers face severe WMSDs, ergonomic evaluation and effective intervention are unavoidable, not only from a human perspective but also from an economic perspective. As a result, modifications to tasks and tools should be made. The ergonomic design of conventional manual tools may be an excellent first step in promoting farm operations and activities. Without a doubt, this adapted equipment aid in preventing certain types of musculoskeletal disorders among farmers.

2.5 Ergonomic Intervention in Agriculture

Given the enormous number of agricultural workers worldwide, ergonomic technologies have been developed, applied, and assessed to reduce the risk of MSDs in the workplace. These initiatives aim to aid the agricultural workforce by optimizing the worker–workplace interaction, upgrading equipment, and finding strategies to avoid employees from being exposed to excessive forces, repetitive movements, and awkward postures. Even small changes translate to significant differences in reported pains throughout systematic ergonomic reports. A characteristic successful example was the use of tubs of smaller size regarding the harvesting of grapes. Another successful, simple ergonomic intervention reduced the space between rungs in orchard ladders (Fathallah et al., 2017).

Moreover, Ramahi and Fathallah (2006), revealed that introducing a long-handled hoe for weeding substantially reduced the flexion of the trunk and, at the same time, this approach proved to be more productive when compared with other weeding

techniques. These research findings show that ergonomic intervention works to reduce MSS risk factors.

Silverstein et al. (2012) conducted ergonomic interventions into ice that the designed tools help reduce the physical load during coffee harvesting. They utilized an ergonomically designed bag in place of the tied basket around the waist during coffee harvesting. Basket users reported pain in a somewhat more significant percentage than bag users. Pranav & Patel (2016) developed an ergonomic tool for manual harvesting of oranges suitable for hilly regions and compared its performance to two existing devices.

The findings demonstrate a considerable reduction of damage quantity and body discomfort combined with the augmented work output. It shows that the ergonomically designed tools in this research were observed to lessen MSDs. Finally, even relatively “small changes” in the design of standard equipment have been observed to make a “big difference” in the reported comfort of workers (Fathallah et al., 2017).

2.6 Physiological Workload

According to Rusnock and Borghetti (2016), the workload is the amount of effort that the operator expends while doing a task, and it can be accessed via physiological or neurological reactions. The classification of physiological workload is based on the working heart rate (Borah, 2015). In some instances, real-time evaluations are possible. Heart rate monitoring is most frequently used in cardiovascular psychophysiology (Turner,1994).

The physiological workload depends on load and trunk and leg postures when working on assembly operations.

According to Chung et al. (2001), the effect of load, leg, and trunk postures on heart rate, oxygen consumption, and subjective rating is significant. All the situations indicated a significant association between heart rate and subjective assessments. In a heavy load status, the heart will beat at 98.46 beats/min and this increase is predominant compared to light quality, where the heart rate is 94.96 beats/min. The position of the trunk is also significant as the heart will increase to 98.76 beats/min when the box is laterally bent but is at 94.66 beats/min in average conditions.

2.7 Muscle Discomfort in Agricultural Activity

Discomfort is the body pain arising because of the working posture and for excessive stress on muscles due to the effort involved in the activities. It is also called overall discomfort. In many agricultural operations, though the work may be within physiological limits, the body discomfort restricts the duration of work depending upon the static loading component involved. Drudgery caused due to bad posture is reflected in terms of postural discomfort experienced by the worker. (Kumari et al., 2018)

A study conducted by Kumari et al. (2018) in India to assess the discomfort level of weeding operation reveals that Body Part Discomfort Scores of the respondents shows

that the female respondents have the highest total BPDS for weeding, i.e., 42.17, followed by the activity of land preparation for which the BPDS was 38.7 whereas for male respondents highest total BPDS was for land preparation i.e., 36.4 followed by sowing and harvesting for which the BPDS was 35.7. It can be interpreted from the data that women experienced more body pain than men in all the activity action in chemicals.

It indicates that the level of muscle discomfort among the respondent is concerning. Most farmers complained to suffer fatigue in the upper back (92.8%), mid-back (93.6%), and lower back (91.8%), respectively. The pattern of trunk movement in high frequent repetitive trunk flexion and may combine with twisting during farming may affect farmers' upper back, mid-back, and lower back. Repetitive trunk motion affects the pattern of trunk muscle coactivity that appeared to be the driving force behind diminished strength and functional capability, and increased spine structural loading that included compression and shear force. (Wolfe et al., 1996). Zautra et al. (2007) declared lifting any object over 8 kg per time will affect low back pain for farmers, which increases intradiscal pressure that can induce annular tears and internal disk disruption resulting in lumbar disc injury.

CHAPTER 3

METHODOLOGY

3.1 Study Design

This study is an experimental study.

3.2 Study Location

Testing and evaluation of the newly harvesting basket will be performed at pineapple plantation in Muar, Johor. Figure 3.1 shows the study location of this study.



Figure 3.1: Study location of this study

3.3 Study Population

The sample population of this study includes male pineapple plantation workers working in Muar, Johor.

3.4 Sampling Duration

The study was conducted from August 2021 to March 2021.

3.5 Sampling Unit

The sampling unit of the study is the male pineapple plantation workers that meet the study's inclusion criteria. The selection criteria are as follows:

3.5.1 Inclusion criteria:

- i. Male aged 18 years old and above with normal Body Mass Index (BMI).
- ii. Workers who have been working at least five years as pineapple workers.
- iii. Full time workers

3.5.2 Exclusion criteria:

- i. Workers who diagnosed with chronic disease.
- ii. Workers who is diagnosed with musculoskeletal disorders.

3.6 Sampling Method

The sampling method used for selection of sampling location and the respondent is purposive sampling. The site was chosen since the area is well-known for producing pineapples, and the harvesting process was carried out using a rattan basket. Furthermore, the willingness of the plantation to give approval for this study being conducted as they had accepted other studies before.

3.7 Sample Size

The total sample for the study was as follow using two means:

$$\text{Formula } n = \frac{2\sigma^2(Z_{1-\frac{\alpha}{2}} + Z_{1-\beta})^2}{(\mu_1 - \mu_2)^2},$$

Mezlan et al., 2017 (Mean overall distribution of energy expenditure using existing and improved basket)

Where:

σ = estimated standard deviation (assumed to be equal to each group)

μ_1 = mean of first population

$$\mu_1 = 6$$

μ_2 = mean of first population

$$\mu_2 = 5$$

$Z_{1-\frac{\alpha}{2}}$ = standard error associated with confidential interval

(Chosen 95% confidential interval = 1.96)

$Z_{1-\beta}$ = standard error associated with power

(Chosen 90% of power = 1.28)

$$n = \frac{2(1)^2(1.96+1.28)^2}{(6-5)^2}$$

$$n = 21$$

$$n = 21 + 20\% \text{ dropout rate}$$

the sample size was 25 subjects.

3.8 Procedure of data Collection

- i. Respondents were interviewed using a questionnaire to select respondents based on the inclusion and exclusion criteria.
- ii. The respondents were given a Fitbit Fitness smartwatch to monitor the heart rate while using rattan and a new harvesting basket during basket testing simulation. The basket testing simulation started with respondents doing a simulation on the harvesting process for one round. For basket testing, the amount of pineapple collected during harvesting simulation is 20 pineapples for both basket which weight approximately 30-40kg per basket. The respondents also required to complete one round of harvesting process simulation.
- iii. After basket testing simulation for rattan basket is done, the respondents were asked to rest for 10 mins before starting basket testing for a new harvesting basket.

- iv. Meanwhile, researcher administered the questionnaire to ask questions to assess the discomfort that the respondents experienced during harvesting simulation using rattan harvesting basket.
- v. After that, the respondents simulated a harvesting process with a new harvesting basket, and the heart rate was measured.
- vi. After basket testing of the new harvesting basket, the researcher asked questions regarding the perceptions of respondents towards new harvesting basket and body parts discomfort experienced while using the new basket.
- vii. During the simulation of the harvesting process using existing harvesting basket and new harvesting basket, pictures, and videos of unloading of pineapple were taken to proceed with a Rapid Entire Body Assessment to measure the severity of awkward posture among the respondents.

3.9 Study Instrumentation

3.9.1 Newly Developed Harvesting Basket

The newly developed harvesting basket that is invented by previous researchers is used in basket testing simulation to test and evaluate the physiological workload and discomfort experienced by pineapple harvesters (Mezlan et al., 2017)

The new harvesting basket weighs about 4kg which is lighter than the existing rattan harvesting basket. The material used for the new basket is stainless steel to make the basket lighter in weight. The new harvesting basket includes some additional features that aid the harvesters in performing harvesting tasks. Figure 3.2 shows the design of the new harvesting basket. The opening latch installed at the bottom of the basket is

for the unloading of pineapple on the ground to prevent excessive bending compared to rattan harvesting basket. The adjustable shoulder strap and padded back are to give comfort and reduce contact stress. The shape of the basket is trapezoid to reduce contact stress to the back area of the body.



Figure 3.2: The new harvesting basket

3.9.2 REBA (Rapid Entire Body Assessment)

To evaluate the ergonomic risk factor, which is awkward posture among the workers during the unloading of pineapples on the ground, an ergonomic assessment tool which is REBA, is used to measure the risk level for the unloading process of pineapple for rattan harvesting baskets and new harvesting basket. Pictures and video that were taken during harvesting simulation is used to measure the severity and the risk level of the awkward posture risk factor.

Rapid Entire body Assessments were used to evaluate the risk of musculoskeletal disorders associated with harvesting tasks. It uses a systematic process to assess both upper and lower parts of the musculoskeletal system for biomechanical and MSD risks,

a single page worksheet were used to determine required or selected body posture, forceful exertions, type of movements or action, repetition and coupling. Two REBA assessments were performed for the harvesting task, which involved loading and unloading pineapples.

The output of the Rapid Entire Body Assessment tool is the final REBA score which is a single score that represents the level of MSD risk for the job task being evaluated. Minimum score = 1, and maximum score = 15. Figure 3.3 shows the REBA level of MSD risk description and cut points and Figure 3.4 shows the REBA worksheet that is going to use for assessment.

| Score | Level of MSD Risk |
|-------|---|
| 1 | negligible risk, no action required |
| 2-3 | low risk, change may be needed |
| 4-7 | medium risk, further investigation, change soon |
| 8-10 | high risk, investigate and implement change |
| 11+ | very high risk, implement change |

Figure 3.3: REBA level of MSD risk

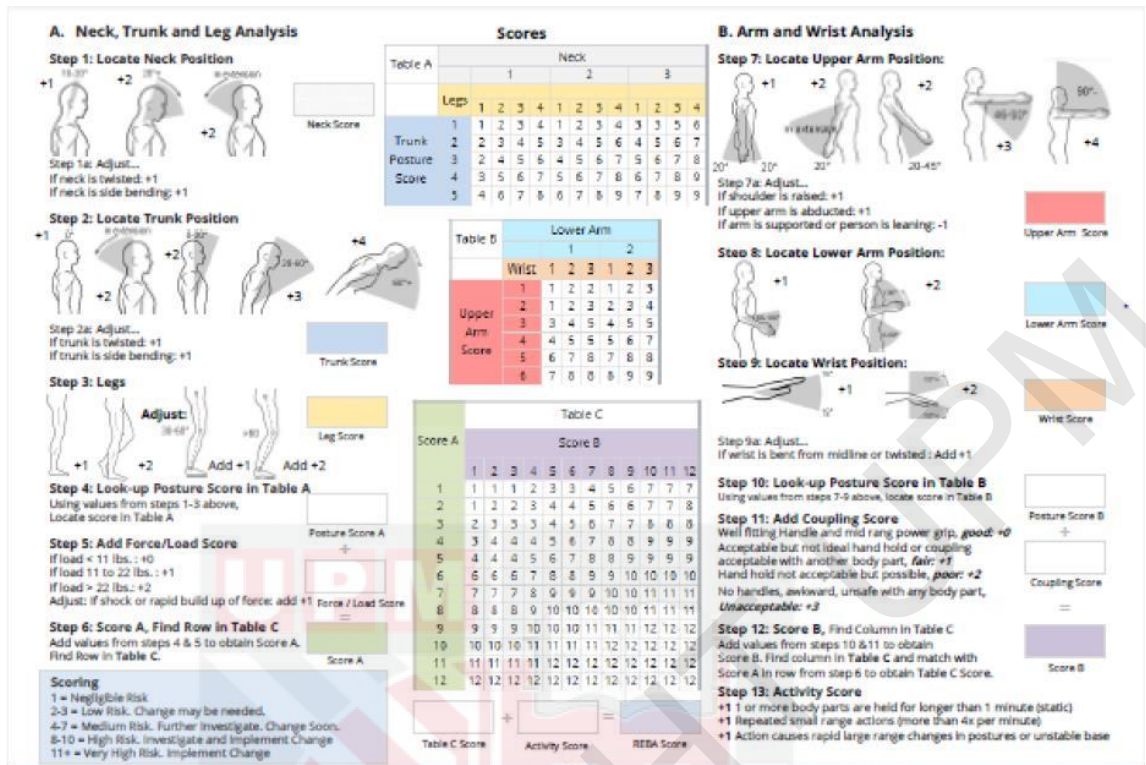


Figure 3.4: REBA worksheet

3.9.3 BORGs CR-10 Scale and body map

The level of discomfort of the workers when using rattan harvesting basket and new harvesting basket is measured using BORGs CR-10. Respondent's response to pain using the harvesting basket is measured using Borg's CR- 10. This Borg rating scale is used to report how strong respondent perception is. It can be exertion, pain, or something else. Figure 3.5 shows BORG CR-10 scale and body map.

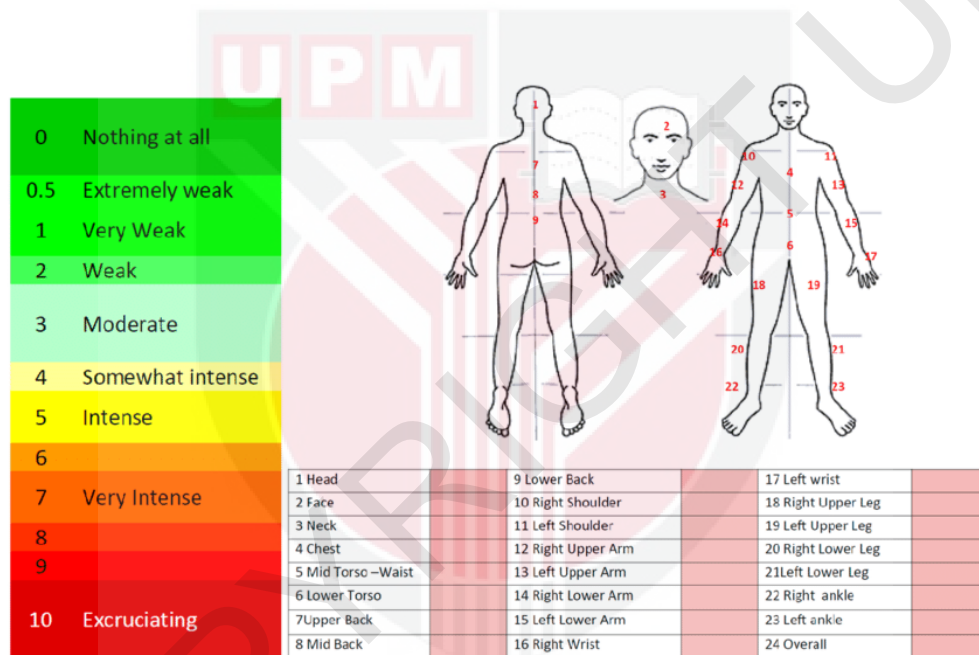


Figure 3.5: BORG CR-10 Scale and body map

3.9.4 Structured Questionnaire

A structured questionnaire is used to obtain the respondents' socio-demographic data and assess the perception of the respondents towards the new harvesting basket.

A structured questionnaire was administered by the researcher. The questionnaires were prepared in Malay and English versions. Respondents may choose which version they prefer to answer. The questionnaire consisted of seven parts as follows:

- i. Section A: Socio-demographic background information such as gender, age, nationality and race,
- ii. Section B: Medical history information.
- iii. Section C: Working information.
- iv. Section D: Perception of the harvester on newly developed harvesting basket.
- v. Section E: The respondents' body parts discomfort when using the prototype harvesting basket using Borg's CR-10 scale.

3.9.4.1 Fitbit Fitness Smartwatch

Fitbit Smartwatch is used to measure the heart rate of the respondents while carrying out the harvesting process using the rattan harvesting basket and new harvesting basket.

The measurement of working heart rate (per minute) while workers perform harvesting tasks at the plantation field will be performed using a heart rate monitor watch. Heart rate is an indicator of cardiac stress due to physical workload. From the average value of heart rate, energy expenditure will be calculated using a specific formula given by Varghese et al. (1994) as follow:

$$\text{Energy Expenditure (Kj-min)} = 0.159 \times \text{Average Heart Rate (beats per min)} - 8.72.$$

3.11 Data Analysis

IBM SPSS (Statistical Package for the Social Sciences) version 25 was used to analyse the data obtained. The respondents' socio-demographic information discomfort and perception of prototype harvesting basket had been analyzed using descriptive analysis. Energy expenditure, heart rate, and physiological workload of rattan and new harvesting basket were analysed using paired t-test/ Wilcoxon-signed rank test. Table 3.6 shows the summary of statistical analysis used based on the objectives of the study.

Table 3.6: Summary of statistical analysis used for this study

| Objectives | Hypothesis | Statistical Analysis |
|---|--|----------------------|
| To obtain the sociodemographic data of pineapple harvesters. | | Descriptive analysis |
| To compare the risk level of awkward posture among the respondents while performing the unloading process using rattan harvesting basket and new harvesting basket. | There is a significant difference between the postural risk score while performing the unloading process using rattan harvesting basket and new harvesting basket. | Paired t-test |
| To assess the perception of the workers regarding pineapple harvesting basket. | The perception of the farmers regarding harvesting baskets is at a satisfactory level. | Descriptive analysis |
| To compare the heart rate of the workers while using rattan harvesting basket and new harvesting basket | There is a significant difference between the heart rate of the workers when using rattan harvesting basket and new harvesting basket | Paired T-test |

| | | |
|---|---|---------------------------|
| To compare the energy expenditure of the workers while using the rattan harvesting basket and new harvesting basket. | There is a significant difference between the energy expenditure of the workers when using rattan harvesting basket and new harvesting basket | Paired T-test |
| To compare the level of discomfort among the workers while using existing rattan harvesting basket and newly developed harvesting basket. | The level of discomfort experienced by the workers is greater while using the rattan harvesting basket compared to the new harvesting basket. | Wilcoxon signed-rank test |

3.12 Quality Control

The quality control used in this study is a back-to-back translation from the English version to the Malay version without changing the actual meaning of the questions. The Fitbit Fitness Smartwatch is reset before taking every measurement, and the instrument is recharged before going to the sampling area.

The questionnaire's validity contents were done in the pre-testing of the questionnaire. The questionnaires were distributed to 10% of the total sample size population among male respondents in UPM that have the similar characteristics with the intended respondents of this study. The identified ambiguous terms during the pre-test were amended to improve the understanding of the respondents while answering the questionnaire.

The questionnaire's reliability was tested using Cronbach's Alpha. The internal consistency in a statistic is measured using Cronbach's alpha and it was suitable to

measure the internal consistency in scales where items had more than two response options (Adomsan & Prion, 2013). The Cronbach's alpha can range from 0 to 1. 0 is the value of α which means there is no relation but when 1 is the value of α , it means the perfect correlation. The value obtained was 0.8.

3.13 Ethical Consideration

This research proposal will be submitted to Ethics Committee for Research Involving Human Subjects of Universiti Putra Malaysia (JKEUPM) to be reviewed and to receive an acknowledgment. Participation of respondents in this research is voluntary. Respondents have the right not to answer any questions and withdraw from the study at any time, and data that has been obtained prior will be discarded accordingly. The respondents will receive a written consent form for participation agreement during data collection. Before that, all the information gained will be stored and conducted confidentially. The approval letter showed in Appendix 1

CHAPTER 4:

RESULTS

4.1 Sociodemographic Information and Occupational Background of Pineapple Harvesters in Johor

A total of 25 pineapple harvesters were sampled, consisting of Malaysian men adults and non- Malaysian men adults within a range of 20 to 60 years old with an average of 43.45 ± 11.4 years old. There were 92% (n=23) of the respondents are Malaysian. Most of the respondents are already married (80%, n=20) and 20% (n=5) are single. For the education level of the respondents, most of them attained secondary education (52%, n=13) and 40%(n=10) received primary education. There are 12 villages involved in selecting respondents. Overall, less than half of the respondents had worked in pineapple plantations for less than 10 years (48%). Furthermore, about 80% of the respondents had previous employment in various sectors before working in a pineapple plantation. All respondents reported not receiving any training related to pineapple harvesting. The information of sociodemographic information of pineapple harvesters in Muar, Johor is demonstrate in Table 4.1 and occupational background respondents are presented in Table 4.2

Table 4.1 Socio-demographic data of pineapple harvesters in Muar, Johor

| Variables | Frequency (n) | % | Mean \pm SD |
|---------------------------|----------------------|----------|---------------------------------|
| Age (Years) | | | 43.45 \pm 11.4 |
| <29 | 4 | 16 | |
| 30-49 | 10 | 40 | |
| >50 | 11 | 44 | |
| Marital status | | | |
| Single | 5 | 20 | |
| Married | 20 | 80 | |
| Others | 0 | 0 | |
| Education | | | |
| Informal education | 2 | 8 | |
| Primary education | 10 | 40 | |
| Secondary education | 13 | 52 | |
| Tertiary education | 0 | 0 | |
| Location | | | |
| Kg Ulu Semerah | 2 | 8 | |
| Kg Semerah Darat | 2 | 8 | |
| Kg Sri Dalam | 1 | 4 | |
| Kg Parit No. 4, Sg Balang | 3 | 12 | |
| Parit No. 5, Sg Balang | 5 | 20 | |
| Parit No. 1, Sg Balang | 1 | 4 | |
| Parit No.10, Sg Balang | 1 | 4 | |
| Parit Semerah Darat | 3 | 12 | |
| Parit Ulu Semerah | 2 | 8 | |
| Parit Bugis | 2 | 8 | |
| Parit Mislam | 2 | 8 | |
| Parit Bulat | 2 | 8 | |

Table 4.2: Occupational background of the pineapple harvesters

| Work Information | n | (%) |
|----------------------------|----------|------------|
| Previous Employment | | |
| No | 5 | 20 |
| Yes | 20 | 80 |
| Working experiences | | |
| 1-10 years | 12 | 48 |
| 11-20 years | 8 | 32 |
| 21-30 years | 3 | 12 |
| >30 years | 2 | 8 |
| Working status | | |
| Full time | 25 | 100 |
| Harvesting Training | | |
| No | 25 | 100 |

N=25

4.2 Physiological workload of pineapple harvesters using different type of basket

The physiological workload of the respondents is measured from the average heart rate and energy expenditure. The average heart rate of the respondents using rattan harvesting basket is 96.7 ± 5.8 beats per min. For the new harvesting basket, the average heart rate of the respondents is lower than rattan basket which is 89.3 ± 6.6 beats per min. The average energy expenditure of the respondents while using the new harvesting basket (5.0 ± 1.1) is lower than the rattan harvesting basket (6.6 ± 0.9 Kj-min). Results from paired t-test analysis showed there is a significant difference between heart rate and energy expenditure of respondents while using rattan harvesting basket and new harvesting basket where $p < 0.001$. Table 4.3 shows the distribution of heart rate of respondents for one round of basket testing simulation using a different type of basket. Table 4.4 demonstrate the distribution of heart rate and energy expenditure while using old harvesting basket (rattan basket) and new harvesting basket.

Table 4.3: the distribution of heart rate of respondents for one round of basket testing simulation using a different type of basket. (N=25)

| Respondents | Heart rate using Existing Basket (beats per min.) | Heart rate using New Basket (beats per min.) |
|-------------|---|--|
| 1 | 97 | 81 |
| 2 | 91 | 83 |
| 3 | 107 | 98 |
| 4 | 89 | 85 |
| 5 | 96 | 89 |
| 6 | 95 | 90 |
| 7 | 100 | 97 |
| 8 | 93 | 80 |
| 9 | 89 | 84 |
| 10 | 89 | 80 |

| | | |
|----|-----|-----|
| 11 | 103 | 90 |
| 12 | 100 | 90 |
| 13 | 108 | 103 |
| 14 | 95 | 89 |
| 15 | 104 | 98 |
| 16 | 93 | 80 |
| 17 | 100 | 93 |
| 18 | 101 | 97 |
| 19 | 101 | 93 |
| 20 | 86 | 97 |
| 21 | 103 | 93 |
| 22 | 89 | 84 |
| 23 | 87 | 83 |
| 24 | 96 | 90 |
| 25 | 96 | 90 |

Table 4.4: Distribution of heart rate and energy expenditure while using old harvesting basket (rattan basket) and new harvesting basket. (n=25)

| Variables | Mean (SD) | | Mean difference (95% CI) | t-statistics (df) | p-value* |
|--------------------|----------------------------|-----------------------|--------------------------|-------------------|----------|
| | Existing harvesting basket | New harvesting basket | | | |
| Heart rate | 96.7 (5.8) | 89.3 (6.6) | 7.3 (5.97, 8.74) | 10.93 (24) | <0.001* |
| Energy expenditure | 6.6 (0.9) | 5.0 (1.1) | 1.18 (0.86, 1.35) | 9.32 (24) | <0.001* |

*Significant at $p < 0.05$ * Statistic test used was paired t-test. From the average values of heart rate (AHR), energy expenditure (EE) is calculated in the formula as the following $EE \text{ (Kj-min)} = 0.159 \times \text{AHR (beats per min.)} - 8.72$

4.3 Level of the discomfort of the pineapple harvesters while using different type of basket

From the results, it was shown that the new harvesting basket can reduce the discomfort that the respondent was experiencing while harvesting using rattan harvesting basket. For discomfort all body part of the respondents, the new harvesting basket median score for BORG CR-10 is 0.00 (0.5) which is categorized as “nothing at all” denoting that no discomfort or muscle fatigue was experienced from the work task. While for rattan harvesting basket, the median score is 0.5 (1.5) categorized as “extremely weak” means just noticeable muscle fatigue or discomfort. The new harvesting basket showed a difference in median score for BORG CR-10 for waist, shoulder, lower back, and lower leg compared to the median score for rattan harvesting basket. Table 4.5 demonstrate the summary discomfort of body parts of respondents while using two different baskets

Table 4.6 shows the result for the overall distribution of discomfort among respondents while using rattan harvesting basket and the new harvesting basket during one round simulation. The result from the Wilcoxon signed test shows that there is a significant difference between the discomfort for all body parts of respondents while using a different types of harvesting basket where $p < 0.001$. For every body part, the level of discomfort while using different basket show a significant difference for waist ($p < 0.001$), shoulder ($p < 0.001$), lower back ($p < 0.001$) and lower leg ($p < 0.001$) area. Figure 4.1 illustrate the discomfort level of body parts of harvesters when using different type of basket (existing basket and new basket) in basket testing simulation.

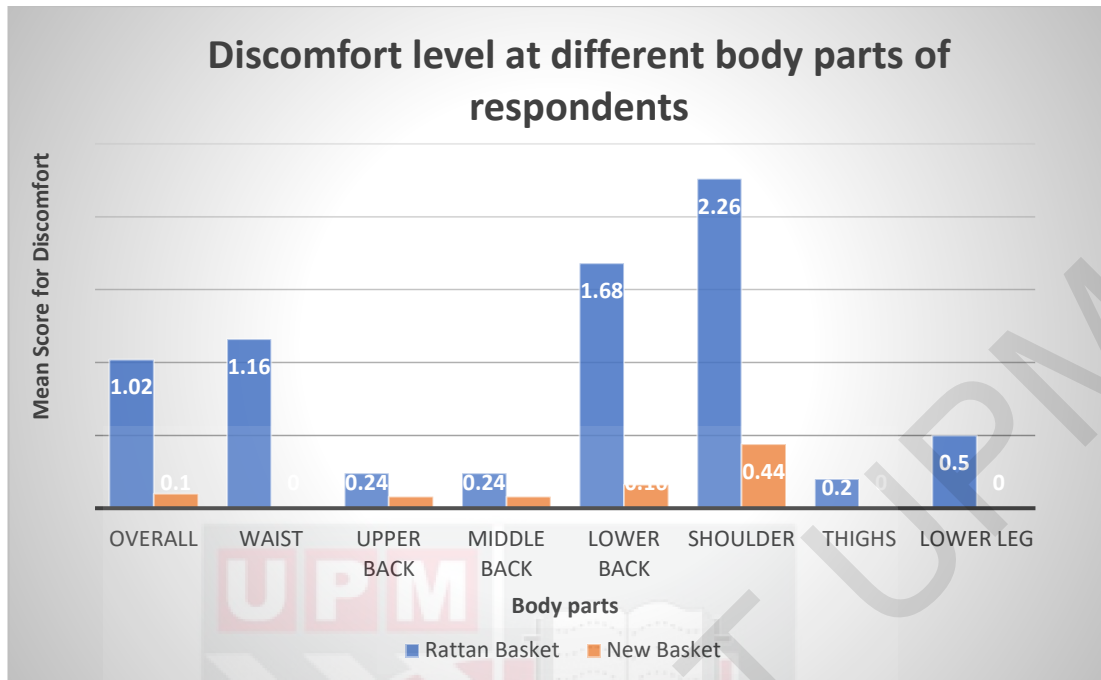


Figure 4.1: the discomfort level of body parts of harvesters when using different type of basket (rattan basket and new basket) in basket testing simulation. (N=25)

*Explanation: 0 indicates “nothing at all” and 10 indicates “excruciating”

Table 4.5: Summary discomfort for every body part of respondents using rattan basket and new basket

| Variable | BORG CR-10 | | | |
|---------------------------|-----------------|--------------------------|-----------------|-----------------------|
| | Frequency n (%) | Rattan Harvesting Basket | Frequency n (%) | New Harvesting Basket |
| Discomfort all body parts | 9 (36) | Extremely weak | 20 (80) | Nothing |
| Waist | 10 (40) | Extremely weak | 25 (100) | Nothing |
| Upper back | 23 (92) | Nothing | 25 (100) | Nothing |
| Middle back | 22 (88) | Nothing | 23 (92) | Nothing |
| Lower back | 14 (56) | Moderate | 23 (92) | Nothing |

| | | | | |
|-----------|---------|----------------|----------|----------------|
| Shoulder | 15 (60) | Moderate | 17 (68) | Extremely weak |
| Thighs | 23 (92) | Nothing | 25 (100) | Nothing |
| Lower leg | 13 (52) | Extremely weak | 25 (100) | Nothing |

Explanation: 0 indicates “nothing at all”, 0.5 indicates “extremely weak” the discomfort is just noticeable. 3 indicates “moderate” is somewhat but not especially hard. It feels good and not difficult to go on.

Table 4.6: Median distribution of discomfort for body parts of respondents using rattan harvesting basket and new harvesting basket. (N=25)

| Variables | Median (IQR) | | z-value | p-value* |
|---------------------------|----------------------------|-----------------------|---------|----------|
| | Existing harvesting basket | New harvesting basket | | |
| Discomfort all body parts | 0.5 (1.00) | 0.204 (.00) | -3.760 | <0.001* |
| Waist | 0.5 (3.0) | .00 (.00) | -3.815 | <0.001* |
| Upper back | .00 (.00) | .00 (.00) | -1.089 | 0.276 |
| Middle back | .00 (.00) | .00 (.00) | -1.414 | 0.157 |
| Lower back | 1.00 (2.50) | .00 (.00) | -4.176 | <0.001* |
| Shoulder | 3.0 (2.00) | 0.5 (0.5) | -4.223 | <0.001* |
| Thighs | .00(.00) | 0.00 (.00) | -1.342 | 0.180 |
| Lower leg | 0.5 (0.50) | 0.00 (.00) | -3.690 | <0.001* |

*Significant at $p < 0.05$ * Statistic test used was Wilcoxon Signed Rank Test

Explanation: 0 indicates “nothing at all” and 10 indicates “excruciating”.

4.4 Evaluation of body postural risk based on the unloading of pineapple using rattan basket and new basket.

For the harvesting process, the work task unloading of pineapple is evaluated by using Rapid Entire Body Assessment (REBA) to assess the postural risk while using the rattan harvesting basket and the new harvesting basket. The assessment was carried out for 25 pineapple harvesters. The evaluation of risk was done based on the video recorded while workers are performing the work task. The risk level was determined based on the obtained score. Table 4.7 demonstrates the summary risk level of awkward posture among the pineapple harvesters while performing the unloading process. For rattan harvesting baskets the result from the assessment indicates that work task unloading of pineapple recognizes as high and very high-risk level. More than half of the respondents (64%, n=16) obtained scores 8-10. Next, for the unloading process while using new the harvesting basket the result of the assessment shows that the work task was categorized as medium risk level where 72% (n=18) of the respondents get REBA score of 4-7.

Table 4.8 shows the mean differences in the REBA score between the two baskets. It shows that the average REBA score of the rattan harvesting basket is 10.04 ± 0.79 which falls under the high-risk level. While the average REBA score obtained by the workers while using new harvesting basket is 4.12 ± 0.82 which falls under the medium risk level. The results from a paired t-test showed that there are significant differences between the REBA score for rattan harvesting basket and new harvesting basket as the $p < 0.001$

Table 4.7: Summary risk level of awkward posture for unloading of pineapple while using rattan harvesting basket and new harvesting basket. (n=25)

| Job task | REBA Score | Risk Level | Existing Harvesting Basket | | New Harvesting Basket | |
|------------------------|------------|------------|----------------------------|----|-----------------------|----|
| | | | n | % | n | % |
| Unloading of pineapple | 1 | None | 0 | 0 | 0 | 0 |
| | 2-3 | Low | 0 | 0 | 7 | 28 |
| | 4-7 | Medium | 0 | 0 | 18 | 72 |
| | 8-10 | High | 16 | 64 | 0 | 0 |
| | 11+ | Very High | 9 | 36 | 0 | 0 |

Table 4.8: Mean differences REBA score of unloading process while using rattan basket and new basket. (N=25)

| Variables | Mean (SD) | | Mean difference (95% CI) | t-statistics (df) | p-value* |
|------------|--------------------------|-----------------------|--------------------------|-------------------|----------|
| | Rattan harvesting basket | New harvesting basket | | | |
| REBA score | 10.04 (0.79) | 4.12 (0.82) | 6.1 (5.6, 6.6) | 25.47 (24) | <0.001* |

*Significant at $p < 0.05$ * Statistic test used was paired t-test.

4.5 Perceptions of respondents towards new harvesting basket.

The fifth objective is to assess the perceptions of respondents towards the new harvesting basket. Table 4.8 present the perception of the respondents towards the new harvesting basket. The average estimation of the maximum load that the respondent predicted is 40.0 (6.1) kg and the average estimated time taken to fill the basket is 3.0 (2.0) minutes.

Based on the results of the perception of the respondents towards the new basket, most of the respondents (76%, n=19) agree that the basket fulfills their expectation, and 96% (n=24) respondents think that the new basket fulfilled the harvesters needs. 56% of the harvesters expected that the range price for the new harvesting basket is between RM200-300.

For comfortability, 80% (n=20) agree that the new harvesting basket is comfortable to use, and the shoulder strap installed reduced discomfort during the harvesting process (96%, n=24)

In addition, all of the respondents (100%, n=25) deemed that the new harvesting basket makes harvesting tasks easier and requires less time taken to fill the basket compared to the rattan basket. Most of the respondents 72% (n=18) felt that it can also increase productivity.

Furthermore, approximately 60% (n=15) of respondents disagree that the new basket can fill the same amount of load as a rattan basket. However, most of the respondents (88%, n=22) agree that the new basket is lighter than the rattan basket.

All the respondents perceived that they were willing to buy the new basket if the new basket is commercialized and all of them (100%, n=25) willing to use the new basket for harvesting if they own it. Besides, 92%(n=23) of respondents agree that they can wear the new basket for a long time if they must harvest for a long period of time.

Table 4.9: Perceptions of the pineapple harvesters towards the new harvesting basket (N=25)

| Perception | Frequency (n) | (%) |
|--|----------------------|------------|
| Does fulfil expectation | | |
| Disagree | 2 | 8 |
| Agree | 23 | 92 |
| Does it make harvesting easier | | |
| Disagree | 0 | 0 |
| Agree | 25 | 100 |
| Does it feel comfortable | | |
| Disagree | 5 | 20 |
| Agree | 20 | 80 |
| Increase productivity | | |
| Disagree | 7 | 28 |
| Agree | 18 | 72 |
| Willingness to use | | |
| No | 0 | 0 |
| Yes | 25 | 100 |
| Willingness to buy | | |
| No | 0 | 0 |
| Yes | 25 | 100 |
| New basket feels lighter than rattan basket | | |
| Disagree | 5 | 20 |

| | | |
|---|----|-----|
| Agree | 20 | 80 |
| Less time is taken to fill new basket | | |
| Disagree | 0 | 0 |
| Agree | 25 | 100 |
| Can wear for long time | | |
| Disagree | 1 | 4 |
| Agree | 24 | 96 |
| New basket can fill same amount of load as rattan basket | | |
| Disagree | 15 | 60 |
| Agree | 10 | 40 |
| Shoulder straps reduce discomfort/pain | | |
| Disagree | 2 | 8 |
| Agree | 23 | 92 |
| The basket fulfilled harvesters needs | | |
| Disagree | 10 | 40 |
| Agree | 15 | 60 |
| Expected price | | |
| <RM100 | 3 | 12 |
| RM110-200 | 8 | 32 |
| RM210-300 | 14 | 56 |

CHAPTER 5

DISCUSSION

5.1 Background information

This research was conducted to test and evaluate the newly developed harvesting basket for the pineapple harvesters. The respondents' physiological workload, level of body parts discomfort, the risk level of awkward posture while performing harvesting task, and their perception towards the new harvesting basket is analyzed.

5.2 Physiological workload of respondents using different harvesting basket

In this study, the average heart rate of the respondents while using the new harvesting basket (89.3 ± 6.6 bpm) is lower than the rattan basket (96.7 ± 5.8 bpm). For the new basket, it is categorized as a "very light physiological workload" as the heart rate is below 90 bpm. While the rattan harvesting basket was considered as a "light physiological" workload because the average heart rate was 91 to 105 bpm.

The physiological workload is categorized as "heavy" when the heart rate is 121-135 bpm (Borah & Kalita, 2016). These findings are similar to a previous study conducted by Mezlan et al. (2019), which stated the physiological workload of the respondents categorized as "very light" when using improved basket compared to rattan basket which is a "light" physiological workload. This is due to the new harvesting basket doesn't involve excessive bending to unload the pineapple on the ground.

The new harvesting basket has installed an ergonomic feature which is an opening latch for unloading at the rear of the basket. According to Mezlan et al. (2019), the opening unloading features on newly developed harvesting basket can reduce the ergonomic risk factors associated with excessive bending when harvesting. Additionally, the finding is further supported by a study by Chung et al. (2001), the average heart rate count was higher when the trunk of the body was laterally bent and twisted as compared to when the trunk was not bent and twisted (98.76 beats per minute as opposed to 94.66 beats per minute). This indicates that the opening of unloading features on newly developed harvesting basket can reduce the physiological workload of the harvesters.

Similar findings were also observed by Bhattacharyya, N. & Chakrabarti, D. (2012) who compared the improved ergonomic basket and local one for tea leaf picker and reported that the average working heart rate of the workers while using the improved harvesting basket (96.26 bpm) is lower than existing basket (99.37 bpm) which in line with the result of this study.

The energy expenditure needed by the harvesters while performing harvesting process using the newly developed harvesting (5.0 ± 1.1 kJ/min-1) basket is lower than using rattan harvesting basket (6.6 ± 0.9 kJ/min-1). The physiological workload index for the energy expenditure of the respondents, while rattan basket is categorized as light physiological workload as the value of energy expenditure of falls under 5.1-7.5 kJ/min-1 and for the new basket categorized as “very light physiological workload”

(Borah & Kalita, 2016). The findings of this research was in line with a research by Mezlan et al. (2019) where the energy expenditure needed by the respondents while using an improved harvesting basket is lower than the rattan harvesting basket.

5.3 Risk level of awkward posture using a different type of harvesting basket

The Rapid Entire Body Assessment (REBA) was used in this study as an instrument to evaluate the whole-body postural risk associated with specific work task. The work task that was evaluated is unloading of the pineapple on the ground. From the outcome of the risk assessment, it is found that the unloading process using existing rattan harvesting basket categorized as high (64%, n= 16) and very high-risk level (9%, n=36). A study by Rani et al. (2016) mentioned that unloading process of pineapple is hazardous because the workers had to unload a heavy load that approximately weight 50-70kg and had to bend forward excessively. The postural risk analysis indicates that harvesting process categorized as very high postural risk which the REBA score is more than 10 and actions are needed for improvement.

However, there is a reduction of risk level of unloading process using the new harvesting basket. For new harvesting basket, the risk level is at low (28%, n=7) and medium (72%, n=17). This can be explained by the excessive forward bending at the waist an angle of 60° that is required during unloading the pineapple to the ground when using the existing rattan harvesting basket (Rani et al., 2016) as illustrated in Figure 5.1. The new harvesting basket offers a new feature for unloading process thus reducing the excessive bending while performing the task. Figure 5.2 shows the respondent using the new harvesting basket for unloading of pineapple. This is

believed due the ergonomic design of the new harvesting basket that limit the excessive bending that contributes to the reduction REBA score for new basket.

Similar studies also show a similar finding where in comparing the postural risk using RULA between the new ergonomic design tool and existing tool found that the RULA score for new ergonomic design tool is lower than an existing tool which was able to reduce awkward posture to score 3 categorized as low risk compared to existing chisel score of 7 categorized as high risk (MOHD et al., 2014). The REBA assessment shows that the design of a newly developed harvesting basket can potentially reduce awkward posture compared to the current harvesting basket (rattan) as suggested by Salleh et al. (2019), to eliminate awkward posture among pineapple plantation workers, ergonomic intervention such as mechanization of tools and equipment should be implemented.



Diagram 5.1: Excessive bending during unloading of pineapple using rattan harvesting basket



Diagram 5.2: Body posture of harvesters during unloading of pineapple using new harvesting basket

5.3 Level of discomfort using different harvesting basket

The result of the harvester's discomfort level for rattan and new harvesting basket revealed that the overall body part, waist, lower back, shoulder, and lower leg show a significant difference with $p < 0.001$ (Wilcoxon signed-rank test). The result shows that the level of discomfort for the new harvesting basket is lower compared to the rattan harvesting basket. These findings are similar to previous studies conducted by Mezlan et al. (2017) and Vanderwal et al. (2011) which reveal that the reporting discomfort by the respondents using the ergonomically designed tools is reduced compared to the traditional tool.

The discomfort level for all body parts reduces from 'extremely weak' for rattan harvesting basket to 'nothing at all' for new harvesting basket. 'Nothing at all' indicates that the respondents do not feel any exertion such as muscle fatigue, no breathlessness, or difficulties in breathing while 'extremely weak' denoting that the muscle fatigue/ discomfort is just noticeable. The most affected body part of the respondents while using rattan harvesting basket are the shoulder, waist, and low back area. This is due to the fact that the harvesters had to use their entire body, primarily their waist, shoulders, and lower back, to support the weight of the load.

The results are supported by a similar study by Mezlan et al. (2017), the data for discomfort among the respondents while using a different type of basket revealed that the lower back, upper back, and shoulder have the highest mean for Borg CR-10 scale. The results also highlighted that there is a positive effect on the body part's comfort with the usage of a new harvesting basket. The highest comfort changes can be seen

in the low back and shoulder area which the discomfort level from 'moderate' to 'nothing at all'. This is partly due to the design of a new harvesting basket that includes an opening latch for the unloading process to help mitigate the poor posture, such as excessive bending that the harvesters face when working because it allows harvesters to work while standing.

Following that, an adjustable cushioned shoulder strap and a padded back can help to lessen contact stress on workers' backs while also providing them with comfort (Mezlan et al., 2017). Thus, the new design harvesting basket is proving to be effective in reducing the muscle discomfort experienced by the harvesters while using a rattan harvesting basket. A study by MOHD et al. (2014), showed that the new harvesting tool's design has the potential to eliminate awkward body postures associated with oil palm harvesting as compared to the previous harvesting tool.

However, due to time constraints, the simulation of the harvesting process using a different type of basket was done for one round only. Thus, the result cannot be used to generalize the body discomfort during the pineapple harvesting process.

5.3 Perception of the pineapple harvesters towards new harvesting basket

The new harvesting basket is expected to reduce the harvester's awkward position while unloading fruits, as well as contact stress on workers' body parts and the heavy load burden experienced by workers. The perception of workers towards the new harvesting basket was assessed.

The respondent's satisfaction towards the new harvesting basket was also being assessed. 92% (n=22) of the respondents said that the basket meets their expectation and more than half (60%, n=15) of respondents agreed that the new harvesting basket is suitable and fulfil the harvester's needs as it is lighter in weight and comfortable making the harvesting task easier.

The respondents were also asked about the most important features in harvesting basket, and most of them (64%, n=16) perceived that the weight and material for the harvesting basket are the important features that they look for in a harvesting basket. On the other hand, it was said that the most interesting and favoured feature from the new harvesting basket is the opening latch (92%, n=23). This is due to the ergonomic design of the basket for unloading the pineapple makes the harvesting process a lot easier as they can unload fruits while standing. Because of the design of the rattan harvesting basket that did not have an opening at the bottom, the workers were required to bend excessively to unload the fruit on the ground (Mezlan et al., 2017).

Furthermore, the new harvesting basket is deemed to be lighter than the rattan harvesting basket. For new harvesting basket, it weighs 4kg without load and the rattan harvesting basket weigh 5kg without load (Mezlan et al., 2017). The respondents also perceived (92%, n=23) that the new added features such as the adjustable shoulder strap and padded back are suitable and give comfort to the harvesters while using the basket for the harvesting process, so they deemed that the new harvesting basket is suitable to use for a long period of harvesting process (96%, n=24).

However, 60% (n=15) of the respondents believed that the new harvesting basket is incapable of carrying the same load as the rattan harvesting basket. This is related to the new harvesting basket's design and load capability. The new basket is 30% smaller in size than the previous rattan harvesting basket. This is done to lower the threshold weight to a safer limit, which in turn reduces the heavy load burden on the harvesting basket. The safe limit and ideal forward lifting load according to NIOSH is 25kg. However, there is no safe limit recommended for back lifting.

A full load of rattan harvesting basket weighs between 50kg and 70kg, and employees will carry roughly 500-600kg per day, which is considered a dangerous load capacity (Rani et al. 2016). The new harvesting basket can hold a load up to 40kg which still exceeds the safe limit but 30% smaller in size compared to the harvesting basket (Mezlan et al. 2019). The new harvesting basket was developed to lower the MSS risk factor associated with harvesters while also taking into account the productivity of harvesters and their willingness to use the new basket if it were to be made available.

The respondents also were asked to give the recommendation to improve the new harvesting basket. They suggested that the opening of the basket should be larger to avoid pineapples thrown outside of the basket while harvesting. This is because, during the simulation, the pineapple that they harvest were thrown outside of the basket due to the small opening of the basket. Next, they suggest putting padding or cushioned around the wall. This is because the material of the basket is stainless steel thus throwing the pineapple in the basket will affect the quality of the pineapple as some of it might be bruised. All of the respondents (100%, n=25) were willing to buy the basket if improvements have been made to cater for the needs of the harvesters.



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CHAPTER 6

CONCLUSION & RECOMMENDATION

Based on the testing and evaluation of the new basket it was shown that the new basket requires a lower physiological workload, and the level of discomfort body parts of the harvesters was improved compared to the rattan harvesting basket. The results also reveal that there is a significant difference between the physiological workload and discomfort level of the harvesters while using rattan basket and new basket. The study showed that the design of new harvesting basket has the potential to reduce poor posture during harvesting activities compared to rattan harvesting basket. The risk level of postural risk by using REBA checklist indicates that there is a reduction in postural risk level of the harvesters while using new harvesting basket where the risk level for new basket is low and medium risk level, for rattan basket the risk level is high and very high. Most of the respondents expressed satisfaction with the new harvesting basket since it is lighter, more comfortable, and makes harvesting easier than the rattan harvesting basket.

There are various limitations to this study that must be considered. The findings cannot be generalised to other pineapple plantations in Malaysia because the basket testing was simulated and not conducted in a real pineapple harvesting setting, and hence the weight of the load during simulation is different from the everyday load encountered by respondents. Additionally, because the basket testing simulation was conducted in a single round due to time constraints, the data obtained cannot be compared between rounds. As a result, worker discomfort was minor, as the single round harvesting

simulation for each basket takes roughly 5 minutes. Furthermore, because the load carried by each respondent was not consistent, the results may differ as the load carried varied. The new ergonomic harvesting basket should be field-tested to determine its effectiveness and suitability for usage on a pineapple plantation.

The findings of the study can be used to further improve harvesting tools among pineapple harvesters to improve their safety and health and reduce reported cases for MSS among agricultural workers. The application of ergonomic inventions would contribute favourably to the achievement of the standards required by the Malaysian Good Agricultural Practices (myGAP) certification process, which is administered by the Malaysian Department of Agriculture. The myGAP certification programme is a voluntary recognition programme for plantations that use good agricultural practices that are environmentally friendly and safeguard the welfare, safety, and health of workers, in addition to generating high-quality products for consumption (Department of Agriculture, 2015). This research will be a guide to other researchers in developing and improving ergonomic design tools for agricultural workers.

It is recommended for further research to evaluate the design of the new basket based on electrical activities of the muscle using Electromyography (EMG) instruments. It is to estimate the force produced by the muscle using a different type of basket in addition, it is to obtain an index of the rate at which muscle fatigue through the analysis of the frequency of the spectrum. Next, this study only focuses on one ergonomic risk factor which is awkward posture. It is recommended for further research to assess the

other risk factors associated with pineapple harvestings such as repetitive movement and forceful exertion.



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APPENDIX 1:
ETHICAL APPROVAL LETTER

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**ETHICS COMMITTEE FOR RESEARCH INVOLVING HUMAN SUBJECTS
(JKEUPM)
UNIVERSITI PUTRA MALAYSIA**

| | |
|----------------|--|
| Research title | : Testing And Evaluation of Newly Developed Pineapple Harvesting Basket Among Pineapple Plantation Workers In Johor, Malaysia. |
| Study Site | : Shah Alam, Selangor |
| JKEUPM Ref No. | : JKEUPM-2021-451 |
| Researcher | : Siti Nur Alya Binti Suhaimi |
| Supervisor | : Associate Professor Dr Emilia Zainal Abidin |

Documents received and reviewed with reference to the above study:

1. Ethics Application Form, Version 1 dated 25/06/2021
2. Respondent's Information Sheet / Consent (English), Version 2 dated 22/10/2021
3. Proposal (English), Version 2 dated 11/10/2021
4. Questionnaire / Interviews (English), Version 1 dated 25/06/2021
5. Curriculum Vitae of:
 - a. Assoc. Prof. Dr. Emilia Zainal Abidin

The University Research Ethics Committee, Universiti Putra Malaysia (JKEUPM) operates in accordance to the ICH-GCP Guidelines.

Decision by JKEUPM:

- Approved
- Permission MUST BE OBTAINED** from the respective hospitals/ institutions before conducting the research
- Disapproved

Please note that the approval is **VALID UNTIL 22 October 2022**

Researchers should comply with the following:

- I. Complete a Study Final Report upon study completion (Form 3.2).
- II. Ethical approval is required in the case of amendments/ changes to the study documents/ study sites/ study team.
- III. Applicable for Clinical Trial Studies and Clinical interventional Studies only: Progress Report has to be submitted to JKEUPM at every 6 months from the date of approval (Form 3.1). Report occurrences of all Serious Adverse Events (SAEs), Suspected Unexpected Serious Adverse Reaction (SUSARs) and Protocol Deviation/ Violation at all JKEUPM approved sites to JKEUPM. SAEs are to be reported within 15 calendar days from awareness of event by investigator. Initial report of SUSARs are to be reported as soon as possible but not later than



APPENDIX 2: RESPONDENT'S INFORMATION SHEET AND CONSENT



FORM 2.4: RESPONDENT'S INFORMATION SHEET AND INFORMED CONSENT FORM

Please read the following information carefully and do not hesitate to discuss any questions you may have with the researcher.

1. STUDY TITLE

Testing and evaluation of newly developed pineapple harvesting basket among pineapple plantation workers in Johor, Malaysia.

2. INTRODUCTION:

Agriculture sectors are one of the sector that had the highest risk factors of musculoskeletal disorder and pineapple plantation is one of it. Harvesting was found as the task with the highest ergonomic risk exposing workers to musculoskeletal symptoms compared to other work task. For harvesting, manual tool in form of solid rattan fruit harvesting basket is used. Due to non-ergonomic working practices such as manual loading tasks during harvesting process, the workers are vulnerable to ergonomic risk factors such as excessive bending and lifting loads.

This study is to test and evaluate the new harvesting basket that is developed by previous researcher to identify its potential to reduce the safety and health risks associated with the harvesting task while maintaining the productivity of the users.

3. WHAT WILL YOU HAVE TO DO?

You need to use the rattan harvesting basket and new harvesting basket while performing harvesting task, this is to identify ergonomic risk factors associated that is associated with the work task. Researcher will give a heart rate monitor watch to wear while performing their work task. After that, you will need to fill in a questionnaire to gather information on personal background, medical history information, working information, perception on rattan harvesting basket and new harvesting basket, musculoskeletal symptoms and discomfortness while using the new harvesting basket.

4. WHO SHOULD NOT PARTICIPATE IN THE STUDY?

The workers who meets these criteria will not participate in the study:

- Part time workers
- Female
- Have less than 5 years of work experience
- Diagnosed with chronic diseases and musculoskeletal diseases.

5. WHAT WILL BE THE BENEFITS OF THE STUDY:

(a) TO YOU AS THE SUBJECT?

This study will be beneficial to the subject as the new harvesting basket will reduce the discomfortness of the workers while using the basket and the usage of the basket will indirectly reduce the musculoskeletal symptoms of the workers. The health and work productivity of the workers will be increased.

(b) TO THE INVESTIGATOR?

This research will assist the investigator in analyzing the ergonomic risks associated with the pineapple harvesting process. Additionally, the data acquired may be used as a reference for future agricultural ergonomic tool development.

6. WHAT ARE THE POSSIBLE RISKS?

There is no possible risk available in this study.

7. WILL THE INFORMATION THAT YOU PROVIDE AND YOUR IDENTITY REMAIN CONFIDENTIAL?

Yes, the information that you provided and your identity will remain confidential.

8. WHO SHOULD YOU CONTACT IF YOU HAVE ADDITIONAL QUESTIONS DURING THE COURSE OF THE RESEARCH?

You may contact the researcher Siti Nur Alya binti Suhaimi 198323 at 011-31428791 or email at alyasuhaimk@gmail.com or supervisor of this study Prof. Madya Dr Emilia binti Zainal Abidin at 03-89472643 or email at za_emilia@upm.edu.my if you have any queries.

Please initial here if you have read and understood the contents of this page_____

9. CONSENT

I Identity Card No.
address.....

.....hereby voluntarily agree to take part in the research stated above *(clinical /drug trial/video recording/ focus group/interview-based/ questionnaire-based).

I have been informed about the nature of the research in terms of methodology, possible adverse effects and complications (as written in the Respondent's Information Sheet). I understand that I have the right to withdraw from this research at any time without giving any reason whatsoever. I also understand that this study is confidential and all information provided with regard to my identity will remain private and confidential.

I* wish / do not wish to know the results related to my participation in the research

I agree/do not agree that the images/photos/video recordings/voice recordings related to me be used in any form of publication or presentation (if applicable)

* delete where necessary

Signature Signature
(Respondent) (Witness)

Date : Name :
I/C No. :

I confirm that I have explained to the respondent the nature and purpose of the above-mentioned research.

Date Signature
(Researcher)

The logo of Universiti Putra Malaysia (UPM) is centered in the background. It features a shield with a red and white design, including a book and the letters 'UPM' in a red box at the top. A large, faint watermark of the logo and the text '© COPY RIGHT UPM' is overlaid diagonally across the page.

**APPENDIX 3:
PENERANGAN DAN PERSETUJUAN
RESPONDEN**



BORANG 2.4: PENERANGAN DAN PERSETUJUAN RESPONDEN

Sila baca maklumat berikut dengan teliti. Sekiranya anda mempunyai sebarang pertanyaan, sila kemukakan kepada penyelidik.

1. TAJUK KAJIAN

Pengujian dan Penilaian Bakul Penuaian Nanas yang Baru di Kalangan Pekerja Ladang Nanas di Johor, Malaysia.

2. PENGENALAN

Sektor pertanian adalah salah satu sektor yang mempunyai faktor risiko tertinggi gangguan muskuloskeletal dan penanaman nanas adalah salah satunya. Penuaian didapati sebagai tugas dengan risiko ergonomik tertinggi yang mendedahkan pekerja kepada gejala muskuloskeletal berbanding tugas kerja lain. Untuk penuaian, alat manual berupa bakul penuaian buah rotan padat digunakan. Oleh kerana amalan kerja yang tidak ergonomik seperti tugas pemuatan manual semasa proses penuaian, pekerja terdedah kepada faktor risiko ergonomik seperti lenturan dan beban yang berlebihan.

Kajian ini bertujuan untuk menguji dan menilai bakul penuaian baru yang direka oleh penyelidik sebelum ini. Hal ini bertujuan untuk mengenal pasti potensi bakul penuaian yang baru dalam mengurangkan risiko keselamatan dan kesihatan pekerja yang berkaitan semasa menuai.

3. APAKAH YANG PERLU ANDA LAKUKAN?

Anda perlu menggunakan bakul penuaian rotan dan bakul penuaian baru semasa menjalankan tugas penuaian, ini adalah untuk mengenal pasti faktor risiko ergonomik yang berkaitan dengan tugas yang dijalankan. Penyelidik akan memberikan jam tangan monitor denyut jantung untuk dipakai semasa menjalankan tugas. Selepas itu, anda perlu mengisi borang soal selidik untuk mengumpulkan maklumat mengenai latar belakang peribadi, maklumat sejarah perubatan, maklumat kerja, persepsi mengenai bakul penuaian rotan dan bakul penuaian baru, simptom muskuloskeletal dan ketidakselesaan semasa menggunakan bakul penuaian baru.

4. SIAPA YANG TIDAK BOLEH MENYERTA KAJIAN INI?

Pekerja yang memenuhi kriteria ini tidak akan mengambil bahagian dalam kajian ini:

- Pekerja wanita
- Pekerja sambilan
- Pekerja yang mempunyai kurang dari 5 tahun pengalaman bekerja.

- Pekerja yang mempunyai penyakit kronik dan penyakit muskuloskeletal

5. APAKAH FAEDAH MENYERTA KAJIAN INI?

a) KEPADA ANDA SEBAGAI PESERTA?

Kajian ini akan bermanfaat bagi subjek kerana bakul penuaian baru akan mengurangkan ketidakselesaian pekerja semasa menggunakan bakul tersebut. Secara tidak langsung ianya dapat mengurangkan gejala muskuloskeletal di kalangan pekerja. Kesihatan dan produktiviti pekerja juga akan meningkat.

b) KEPADA PENYELIDIK?

Penyelidikan ini akan membantu penyelidik dalam menganalisis risiko ergonomik yang berkaitan dengan proses penuaian nanas. Selain itu, data yang diperolehi boleh digunakan sebagai rujukan untuk rekaan alat ergonomik pertanian pada masa depan.

6. ADAKAH IA BERISIKO?

Tidak ada kemungkinan risiko dalam kajian ini.

7. ADAKAH MAKLUMAT DAN IDENTITI SAYA KEKAL RAHSIA?

Ya, maklumat dan identiti anda akan kekal rahsia.

8. SIAPA YANG SAYA PERLU HUBUNGI SEKIRANYA SAYA MEMPUNYAI SOALAN TAMBAHAN SEMASA MENGIKUTI PENYELIDIKAN INI?

Anda boleh menghubungi penyelidik iaitu Siti Nur Alya binti Suhaimi di talian 013-3539662 atau email di alyasuhaimk@gmail.com atau penyelia penyelidikan ini Prof. Madya Dr. Emilia binti Zainal Abidin di talian 03-89472643 atau email di za_emilia@upm.edu.my jika terdapat sebarang pertanyaan.

Sila tandatangan di sini sekiranya anda telah membaca dan memahami kandungan halaman ini _____

9. PERSETUJUAN

Saya..... No Kad Pengenalan.
beralamat.....

.....dengan ini bersetuju untuk mengambil bahagian secara sukarela dalam penyelidikan yang tersebut di atas *(kajian klinikal/percubaan ubat-ubatan/rakaman video/kumpulan sasaran/temuduga/ soal selidik).

Saya telah diberi penjelasan secara menyeluruh mengenai penyelidikan ini dari segi metodologi, risiko dan komplikasi (seperti tertulis pada Helaian Penerangan Responden). Saya memahami bahawa saya berhak menarik diri dari penyelidikan ini pada bila-bila masa tanpa memberi sebarang alasan. Saya juga memahami bahawa sebarang maklumat yang berkaitan identiti saya akan dirahsiakan.

Saya* berminat / tidak berminat untuk mengetahui keputusan kajian yang melibatkan saya.

I setuju/tidak bersetuju untuk imei/gambar/rakaman video/ rakaman suara digunakan dalam apa jua bentuk penerbitan atau pembentangan. (sekiranya berkaitan).

*potong yang tidak berkenaan

Tandatangan Tandatangan
(Responden) (Saksi)

Tarikh : Nama :
No. K/P:

Saya mengesahkan bahawa saya telah menerangkan kepada responden ini sifat dan tujuan penyelidikan yang tersebut di atas.

Tarikh Tandatangan
(Penyelidik)



APPENDIX 4: QUESTIONNAIRE

RESPONDEN ID

| | | | | |
|--|--|--|--|--|
| | | | | |
|--|--|--|--|--|



UPM
UNIVERSITI PUTRA MALAYSIA
BERILMU BERBAKTI

Borang Soal Selidik untuk
Pengujian dan Penilaian Bakul Penuaian Nanas yang Baru
di Kalangan Penuai Nanas di Muar, Johor

Tarikh:

| | | | | | |
|--|--|--|--|--|--|
| | | | | | |
|--|--|--|--|--|--|

Sukacita dimaklumkan bahawa anda telah terpilih untuk mengambil bahagian dalam kajian in. Segala maklum balas anda adalah dijamin sulit. Tiada sesiapa di luar pasukan kajian akan mempunyai akses kepada maklumat anda. Tiada huraian individu akan dibuat pada mana-mana bahagian di dalam kajian atau penerbitan.

Soal selidik ini mengandungi 6 bahagian dan hanya perlu mengambil 5 hingga 10 minit untuk menjawab soal selidik.

Kerjasama anda amat dihargai.

Terima Kasih

Arahan: Sila jawab soalan di bawah dengan menandakan kotak atau menulis di ruang yang disediakan.

BAHAGIAN 1: LATAR BELAKANG SOCIO-DEMOGRAFI

- 1.1 Umur : _____ tahun
- 1.2 Jantina: Lelaki Perempuan
- 1.3 Kewarganegaraan: Warganegara Bukan warganegara, sila nyatakan: _____
- 1.4 Bangsa: Melayu Cina
 India Lain-lain, sila nyatakan: _____
- 1.5 Status perkahwinan: Bujang Berkahwin Bercerai
- 1.6 Jumlah bilangan anak: _____
- 1.7 Pendidikan:
 Tiada pendidikan formal Sekolah rendah (7-12 tahun)
 Sekolah menengah (13-17 tahun) Pendidikan tinggi (>18 tahun)

BAHAGIAN 2: MAKLUMAT SOSIAL / GAYA HIDUP

2.1 Penggunaan nikotin

2.1.1 Adakah anda merokok?

Ya Tidak Telah berhenti

2.1.2 Jika **Ya**, berapakah bilangan batang rokok?

2 batang atau kurang 3-5 batang 6-9 batang 10 batang atau lebih

2.2 Aktiviti masa lapang

2.2.1 Apakah hobi anda masa lapang?

| | | | | | |
|--------------------------|---------|--------------------------|---------------|--------------------------|---------------------------------|
| <input type="checkbox"/> | Membur | <input type="checkbox"/> | Memancing | <input type="checkbox"/> | Bersukan |
| <input type="checkbox"/> | u | <input type="checkbox"/> | g | <input type="checkbox"/> | Lain-lain, sila nyatakan: _____ |
| <input type="checkbox"/> | Berkebu | <input type="checkbox"/> | Melayar | | |
| <input type="checkbox"/> | n | <input type="checkbox"/> | i Internet | | |

2.2.2 Adakah anda melakukan hobi tersebut secara kerap? (**Kerap** ialah lebih 4 kali sebulan)

Ya Tidak

BAHAGIAN 3: MAKLUMAT PEKERJAAN

3.1 Maklumat pekerjaan terdahulu

3.1.1 Pernahkah anda bekerja di tempat lain sebelum ini?

Ya Tidak

3.1.2 Jika **Ya**, sila nyatakan di bawah:

| Jenis Pekerjaan | Waktu bekerja (jam) | Tempoh bekerja (tahun) |
|-----------------|---------------------|------------------------|
| | | |
| | | |

* sila nyatakan 2 pekerjaan yang paling lama (*jika ada*)

3.2 Maklumat pekerjaan sekarang

3.2.1 Berapa lamakah tempoh pekerjaan anda sebagai penuai?

Tarikh mula bekerja: _____

3.2.2 Adakah anda pernah bekerja di bahagian lain di ladang ini?

Ya Tidak

3.2.3 Jika **Ya**, sila nyatakan bahagian tersebut: _____

3.2.4 Adakah anda perlu menghadiri latihan untuk menjadi penuai?

Ya Tidak

3.3 Nyatakan tempoh bekerja anda.

| | | |
|--------------------------|---------------|-----------------------------|
| <input type="checkbox"/> | Sepenuh masa | Jumlah waktu bekerja: _____ |
| <input type="checkbox"/> | Separuh masa | Jumlah waktu bekerja: _____ |
| <input type="checkbox"/> | Bekerja shift | Jumlah waktu bekerja: _____ |

3.4 Adakah anda melakukan pekerjaan lain di luar waktu bekerja?

Ya, sila nyatakan: _____

Tidak



BAHAGIAN 4: MAKLUMAT SEJARAH KESIHATAN

5.1 Maklumat kesihatan umum

5.1.1 Adakah anda pernah mengalami sebarang kecederaan atau kemalangan sepanjang hidup?

Ya, sila nyatakan: _____ Tidak

5.1.2 Apakah rawatan yang diambil?

- Mendapatkan rawatan daripada doktor
- Berurut seara tradisional
- Mengambil ubat-ubatan tradisonal
- Lain- lain, sila nyatakan _____

5.2 Maklumat kesihatan berkaitan pekerjaan.

5.2.1 Adakah anda pernah mengalami sebarang kecederaan atau kemalangan semasa bekerja?

Ya, sila nyatakan: _____ Tiada

5.2.2 Adakah kecederaan itu berkait dengan penuaian nanas?

Ya Tidak

5.2.3 Adakah anda pernah di diagnosis mengalami penyakit berkaitan musculoskeletal?

Ya Tidak

BAHAGIAN 5(i): BORG CR-10 SCALE (Pre)

Sila nyatakan tahap ketidakselesaian untuk nombor 1 hingga 24 mengikut skala yang diberikan.

| | | | | | |
|-----|-----------------|-------------------|-----------------------|---------------------|--|
| 0 | Tiada | | | | |
| 0.5 | Tersangat lemah | | | | |
| 1 | Sangat lemah | | | | |
| 2 | Lemah | | | | |
| 3 | Sederhana | | | | |
| 4 | Agak kuat | | | | |
| 5 | Kuat | | | | |
| 6 | | | | | |
| 7 | Sangat kuat | | | | |
| 8 | | | | | |
| 9 | | | | | |
| 10 | Tersangat kuat | 1 Kepala | 9 Belakang Bawah | 17 Pergelangan Kiri | |
| | | 2 Muka | 10 Bahu Kanan | 18 Paha Kanan | |
| | | 3 Tengkok | 11 Bahu Kiri | 19 Paha Kiri | |
| | | 4 Dada | 12 Lengan Atas Kanan | 20 Betis Kanan | |
| | | 5 Pinggang | 13 Lengan Atas Kiri | 21 Betis Kanan | |
| | | 6 Bawah Badan | 14 Lengan Bawah Kanan | 22 Buku Lali Kanan | |
| | | 7 Belakang atas | 15 Lengan Bawah Kiri | 23 Buku Lali Kiri | |
| | | 8 Belakang Tengah | 16 Pergelangan Kanan | 24 Keseluruhan | |

BAHAGIAN 5(ii): BORG CR-10 SCALE (Post)

Sila nyatakan tahap ketidakselesaian untuk nombor 1 hingga 24 mengikut skala yang diberikan.

| | | | | | |
|-----|-----------------|-------------------|-----------------------|---------------------|--|
| 0 | Tiada | | | | |
| 0.5 | Tersangat lemah | | | | |
| 1 | Sangat lemah | | | | |
| 2 | Lemah | | | | |
| 3 | Sederhana | | | | |
| 4 | Agak kuat | | | | |
| 5 | Kuat | | | | |
| 6 | | | | | |
| 7 | Sangat kuat | | | | |
| 8 | | | | | |
| 9 | | | | | |
| 10 | Tersangat kuat | 1 Kepala | 9 Belakang Bawah | 17 Pergelangan Kiri | |
| | | 2 Muka | 10 Bahu Kanan | 18 Paha Kanan | |
| | | 3 Tengkok | 11 Bahu Kiri | 19 Paha Kiri | |
| | | 4 Dada | 12 Lengan Atas Kanan | 20 Betis Kanan | |
| | | 5 Pinggang | 13 Lengan Atas Kiri | 21 Betis Kanan | |
| | | 6 Bawah Badan | 14 Lengan Bawah Kanan | 22 Buku Lali Kanan | |
| | | 7 Belakang atas | 15 Lengan Bawah Kiri | 23 Buku Lali Kiri | |
| | | 8 Belakang Tengah | 16 Pergelangan Kanan | 24 Keseluruhan | |

BAHAGIAN 6: PERSEPSI TERHADAP BAKUL MENUAI BAHARU

(i) **Pra-soal selidik mengenai bakul penuaian nanas yang baru direka bentuk.**

9.1 Pada pendapat anda, apakah berat beban penuh nanas yang boleh dibawa dalam bakul penuaian nanas baru?

9.2 Berdasarkan pengalaman anda, berapa lama (masa) yang anda perlukan untuk memenuhkan bakul penuaian nanas baru?

9.3 Pada pendapat anda, selain daripada menukar kepada alat jentera, apakah ciri – ciri yang perlu ada pada bakul nanas untuk memudahkan tugas/kerja anda?

| | | Sila jawab dalam skala 1 (Tidak Setuju) hingga 10 (Sangat Setuju) | | | | | | | | | |
|-----|--|---|---|---|---|---|---|---|---|---|----|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 9.4 | Adakah bakul kami memenuhi jangkaan anda? | | | | | | | | | | |
| 9.5 | Adakah bakul kami membuat proses penuaian lebih mudah? | | | | | | | | | | |
| 9.6 | Adakah anda berasa selesa menggunakan bakul kami? | | | | | | | | | | |
| 9.7 | Adakah anda berfikir penggunaan bakul nanas baru meningkatkan produktiviti kerja anda? | | | | | | | | | | |

9.8 Apa yang paling anda sukai tentang bakul baru penuaian nanas?

9.9 Bagaimanakah kita dapat meningkatkan bakul kami untuk memenuhi keperluan anda?

9.10 Adakah anda ingin menggunakan bakul baru jika disediakan?

9.11 Adakah anda sanggup membeli bakul baru untuk membantu anda dengan kerja penuaian? Jika Ya, berapakah harga mampu milik yang anda cadangkan?

9.12 Adakah anda mempunyai sebarang komen, soalan atau kebimbangan lain mengenai bakul kami?

| (ii) Post-soal selidik mengenai bakul penuaian nanas yang baru direka bentuk. | | Sila jawab dalam skala 1 (Tidak Setuju) hingga 10 (Sangat Setuju) | | | | | | | | | |
|--|---|---|---|---|---|---|---|---|---|---|----|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 9.13 | Bakul itu lebih ringan berbanding keranjang biasa. | | | | | | | | | | |
| 9.14 | Tugasan kerja menjadi lebih mudah selepas menggunakan bakul kami. | | | | | | | | | | |
| 9.15 | Masa yang diambil untuk memuatkan dan memunggah nanas dikurangkan | | | | | | | | | | |
| 9.16 | Saya merasa selesa memakai bakul berbanding bakul biasa. | | | | | | | | | | |
| 9.17 | Bakul boleh mengisi jumlah beban yang sama dari bakul biasa. | | | | | | | | | | |
| 9.18 | Saya boleh memakai bakul untuk masa yang lebih lama berbanding bakul biasa. | | | | | | | | | | |
| 9.19 | Tali bakul mengurangkan kesakitan pada bahu. | | | | | | | | | | |
| 9.20 | Bakul memenuhi keperluan penuai. | | | | | | | | | | |
| 9.21 | Saya ingin menggunakan bakul ini semasa penuaian. | | | | | | | | | | |

TERIMA KASIH





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