



UNIVERSITI PUTRA MALAYSIA

***THE EFFECT OF HANDS ARM VIBRATION SYMPTOMS AMONG
PALM OIL HARVESTER WITH THE USAGE OF CANTAS MACHINE
IN SELANGOR***

MOHD NORAIMAN BIN MOHD FADZIL

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OIL HARVESTER WITH THE USAGE OF CANTAS MACHINE IN
SELANGOR**

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**Thesis submitted in fulfillment of the requirement for the degree of Bachelor
Science (Environmental and Occupational Health) from the Faculty of Medicine
and Health Sciences, University Putra Malaysia**

DEDICATION

This thesis is dedicated especially to

My beloved parents,

Mohd Fadzil Bin Mohd Idris and Nor Azlinda Binti Mohamed Yusof

and

My siblings

Nurul Husna

Muhammad Akmal

For their support and patience

that made it possible for me to complete my study successfully

ACKNOWLEDGEMENTS

In the name of Allah S.W.T, Most Gracious, Most Merciful, first and foremost I would like to express my gratitude to Allah S.W.T for the entire blessing for completing this research. I would like to thanks my parents and siblings for supporting me throughout the completion of this thesis. I would like to thanks my mother for the blessing and prayer upon my success.

I would also like to express my sincere gratitude to my supervisor, Professor Dr Shamsul Bahri Mohd Tamrin for the guidance, supervision, persistence help, encouragement, advice and supports. Not forgotten, the supporting staff at the faculty, Miss Siti Khatijah Ahmad Ramli for preparing instruments and also staff from Department of Mechanical Engineering, Abang Mohamad Aizuddin Abang Mohamad Mohtar for the calibration and guidance of the instruments needed for this thesis.

I also would like to thanks Department of Occupational Safety and Health (DOSH) officers for the support and help in the data collection. A special appreciation to all respondents participated in this study during the data collection.

Last but not least, to all friends especially Abdurrahman, Saddiq, Ahmad, Aliyu, Ashril, Najiha, Maryam, Suriana, Tahia and to my dearest fiancée Wan Aizatul Syafikah who have directly or indirectly given me support, aided and encouragement throughout the completion of this thesis.

ABSTRACT

THE EFFECT OF HANDS ARM VIBRATION SYMPTOMS AMONG PALM OIL HARVESTER WITH THE USAGE OF CANTAS MACHINE IN SELANGOR

MOHD NORAIMAN BIN MOHD FADZIL

Introduction: A cross sectional study was conducted to determine the effect of hand arm vibration symptoms on 'Cantas' machine among harvester of fresh fruit bunch of palm oil in Selangor as the general objectives. **Objectives:** The specific objectives are to determine the level of occupational vibration exposure, prevalence of hand-arm vibration syndrome and safety level on usage of Cantas machine as well as to determine the ergonomics risk factors and the perception on ergonomics design issues of Cantas machine. **Methodology:** A convenient sampling method approach was used to find those from the list of 104 who had experienced using Cantas machine and are still good in condition- not faulty, still using the machine. Those whose machine were faulty will be only participating on the questionnaire regarding their perception based on their experience on the machine as well as the ergonomics issues on the machine. The respondent which qualify on the criteria (N= 33) that had been set will be further follow up for the quantitative method which is conducted in order to measure the level of vibration produced by their 'Cantas' machine. Questionnaire survey is use as strategy of enquiry for achieving the objectives. For this study, experiments are to investigate the level of vibration and thus give guidance to users on how to use the machine properly as well as understanding the ergonomic risk factors and issues on design on the harvester. Total hand arm vibration and the average daily working time and exposure were calculated using HVM 100 vibration analyzer. **Results and Discussion:** The mean (s.d.) age was 56.23 ± 1.813 years. The mean vibration magnitude was 5.24 ± 1.301 m/s² The mean (s.d) daily vibration exposure for A(8) was 2.30 ± 0.72 m/s² The vibration level for working hours is 2.30 m/s²

and is deemed safe below the Estimated Action Value 2.5 m/s as specified ISO 5349-1. The calculated results show that the time to reach EAV 2.5 m/s A(8) hours is 1.82 hours and time to reach ELV 5.0 m/s A (8) hours is 7.28 hours. The prevalence of HAVS based on reported symptoms through questionnaires was 39.4%. None of them reported persistence in the symptoms. However, there were 60.1% reported on experienced having numbness, 24.2% and none reported on white fingers. This study was done among exposed worker without control group. There were more than 50 times of the occurrence of repetitive work, 26 (86.6%) related to forceful tasks and 13 (43.3%) related to awkward posture of the body especially the hand- arm. The ergonomics risk factor mean score was 2.93 out of a maximum score of 4. Regarding ergonomic design issues the weight and maintenance was at high level, portability, ease of usage, efficiency and difficulty in learning how to operate Cantas machine was at medium level while durability and reachability was on the low level of concern. **Conclusion:** Regular screening for early signs of vibration-related damage is needed even if workers are subject to only moderate vibration exposure as an important part of preventing the aggravation of health problems. Exposure time and magnitude of vibration shows a significant prevalence on developing Hand-arm vibration symptoms. Once exposed the

symptoms are reversible. The workers also gained awareness regarding vibration exposure and safe working procedure on using Cantas machine.

Keywords: Cantas machine, HAVS, vibration, palm oil industry, ergonomic issue,



ABSTRAK
KESAN SIMTOM GETARAN LENGAN TANGAN DIKALANGAN PENGAIT BUAH
MINYAK SAWIT DENGAN PENGGUNAAN MESIN CANTAS DI SELANGOR

MOHD NORAIMAN BIN MOHD FADZIL

Pengenalan: Kajian keratan rentas dilakukan untuk menentukan kesan simtom getaran lengan tangan pada mesin 'Cantas' di kalangan pengait buah minyak sawit di Selangor sebagai objektif umum. **Objektif:** Objektif khusus ialah menentukan tahap pendedahan getaran pekerjaan, kelaziman sindrom getaran tangan dan tahap keselamatan penggunaan mesin Cantas serta menentukan faktor risiko ergonomik dan persepsi mengenai isu reka bentuk ergonomik mesin Cantas. **Metodologi:** Pendekatan kaedah pensampelan mudah digunakan untuk mencari orang dari senarai 107 pengguna yang berpengalaman menggunakan mesin Cantas dan masih baik dalam keadaan - tidak rosak, masih menggunakan mesin. Mereka yang mesinnya rosak akan hanya menyertai soal selidik mengenai persepsi mereka berdasarkan pengalaman mereka pada mesin serta isu-isu ergonomik pada mesin. Responden yang memenuhi kriteria ($N = 33$) yang telah ditetapkan akan terus mengikuti kaedah kuantitatif yang dilakukan untuk mengukur tahap getaran yang dihasilkan oleh mesin 'Cantas' mereka. Tinjauan soal selidik digunakan sebagai strategi penyelidikan untuk mencapai matlamat. Untuk kajian ini, eksperimen dijalankan untuk menyiasat tahap getaran dan dengan itu memberi panduan kepada pengguna mengenai cara menggunakan mesin dengan betul serta memahami faktor risiko ergonomik dan isu-isu mengenai reka bentuk pada penuai. Jumlah getaran lengan tangan dan purata masa kerja dan pendedahan harian dikira menggunakan penganalisis getaran HVM 100. **Keputusan dan Perbincangan:** Purata umur (sishan piawai) adalah 56.23 ± 1.813 tahun. Gegaran getaran minima adalah $5.24 \pm 1.301 \text{ m/s}^2$ Pendedahan getaran harian (sd) bagi A (8) adalah $2.30 \pm 0.72 \text{ m/s}^2$. Tahap getaran untuk waktu kerja adalah 2.30 m/s^2 dan dianggap selamat di bawah Anggaran Nilai Tindakan 2.5 m/s^2 seperti yang ditetapkan ISO 5349- 1. Keputusan yang dikira menunjukkan bahawa masa untuk mencapai EAV 2.5 m/s^2 A (8) jam adalah 1.82 jam dan masa untuk mencapai ELV 5.0 m/s^2 A (8) jam ialah 7.28 jam. Penyebaran HAVS berdasarkan simptom yang dilaporkan melalui soal selidik ialah 39.4%. Tiada seorang pun yang melaporkan keadaan simtom yang berpanjangan. Walau bagaimanapun, terdapat 53% dilaporkan pernah mengalami kekebasan, 23.3% dan 10% pada jari putih. Kajian ini dilakukan di kalangan pekerja terdedah tanpa kumpulan kawalan. Terdapat lebih daripada 50 kali berlakunya kerja berulang, 26 (86.6%) berkaitan dengan tugas yang kuat dan 13 (43.3%) yang berkaitan dengan postur tubuh yang janggal terutamanya lengan tangan. Nilai faktor risiko ergonomik adalah skor 2.93 daripada skor maksimum 4. Mengikut isu reka bentuk ergonomik berat dan penyelenggaraan berada di tahap tinggi, mudah dibawa, kemudahan penggunaan, kecekapan dan kesukaran dalam mempelajari bagaimana untuk mengendalikan mesin Cantas berada pada tahap sederhana manakala ketahanan dan kebolehjadian berada pada tahap rendah kebimbangan. **Kesimpulan:** Pemeriksaan yang kerap untuk tanda-tanda awal kerosakan berkaitan getaran diperlukan walaupun pekerja hanya tertumpu kepada pendedahan getaran sederhana sebagai bahagian penting bagi mencegah masalah kesihatan berlaku. Durasi pendedahan dan magnitud getaran menunjukkan kelaziman penting yang menyumbang kepada simtom getaran tangan.

Sebaik sahaja terdedah simptom boleh diterbalikkan. Para pekerja juga mendapat kesedaran mengenai pendedahan getaran dan prosedur kerja selamat menggunakan mesin Cantas.

Kata kunci: Mesin cantas, HAVS, getaran, industri minyak sawit, isu ergonomik,



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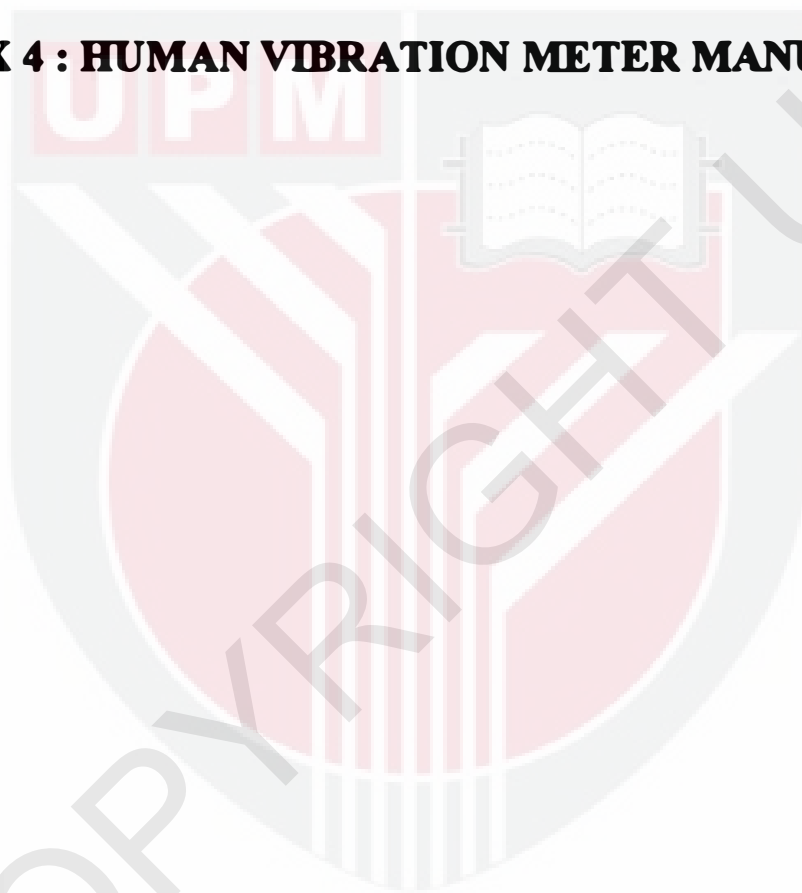
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LIST OF ABBREVIATIONS

A (8)	Daily Vibration Exposure
a_{hv}	Total Vibration
BMI	Body Mass Index
CTS	Carpal Tunnel Syndrome
dB	Decibel
EU	European Union
EAV	Estimated Action Value
ELV	Estimated Limit Value
FFB	Fresh Fruit Bunch
HAV	Hand Arm Vibration
HAVS	Hand Arm Vibration Symptoms
HTV	Hands Tools Vibration
ISO	International Organisation for Standardisation
MPOB	Malaysian Palm Oil Board

NIOSH	National Institute for Occupational safety and Health
PEL	Permissible Exposure Limit
SOP	Standard Operating Procedure



CHAPTER 1

INTRODUCTION

This research starts with an introductory chapter. This chapter will introduce the background of this study, shed light on the relevance of the research problem, and to explain the relevance of this research. This chapter will also outline the research problem, research objectives, research questions, scope of the study, limitation of the study, and an insight into the research methodology. This chapter also outlines the thesis as a whole.

1.1 Background of the Study

1.1.1 Issues on musculoskeletal injury related to manual tools

Occupational hazards have always been the major consideration for most of the industry in present. One of the industry that are important in our country is agriculture. Study had stated that the daily exposure to musculoskeletal injury are of great concern for this industry as most of the worker are still using manual tools in the operation (Chapman, 2001). This shows that the workers in the agriculture industry are more vulnerable to occupational safety and health problems (Solomon, 2002). The fresh fruit bunch (FFB) production per each palm are between 8 to 15 FFB per year weighing approximately 15 to 25 kg each. The production per palm varies depending on the planting substance and age of the palm (Jelani, 2003). The work of lifting heavy FFB using manual tools could

contribute to health problems towards the worker (Walker-Bone & Palmer, 2002). Mass of energy is required for the harvester during the cutting process to ensure that the work done is successful regardless in short or tall palms. On top of that, the worker should be fit enough to the work to get the job done successfully (Jelani, 2003). Most of the hazardous works have to be done by the workers manually because the plantation owner refuse to buy motorized equipment due to its high price. Thus, the problems regarding occupational health in this agriculture sector is common (Khanzode, Maiti & Ray, 2012).

A research had been conducted using QEC system to assess the ergonomics risk factors for Work-related Musculoskeletal Disorders, WMDs. The author's findings show that a very high WMDs risk are affecting the harvesters. The harvester pose WMDs risk especially at back and at shoulder / arm for loading from ground to truck activity. High exposure level for wrist / and in loading from ground to truck, for loading from truck to lorry affected body regions are back and wrist / hand. (Sukadarin, Deros, Ghani, & Ismail, 2013). Fresh fruit bunches (FFB) harvester and loose fruit collectors were the groups that having highest body pain complaints and almost all of them are having low back health problems. (Hashim & Taha, 2012) Management should be the one who responsible to take mitigation measure to solve this issue which pose great impact towards the worker's health. Thus, the first step to tackle this issue is to do risk assessment which main aim of the effort should be to identify hazardous, ergonomics related problems and determine the body parts that are experiencing illness or injury faced by oil palm plantation workers (Djomo & Sikod, 2012). Generally, harvesters perform the same postures in order to cut the FFB or to prune the fronds from a tall palm that is bending of the knees, flexion and extension for back and neck.

1.1.2 Issues on using machinery tools

The use of manual tools is still a norm and become a necessity for them. These oil palm workers prefer traditional tools than the current machinery technology. However, there is also a work unit assisted by the latest machinery technology which is FFB collector. Fresh Fruit Bunches (FFBs) collector is no longer using manual tools such as wheelbarrows due to the existence of the Mechanical Buffalo (Badang) and Mini Tractor Grabber (MTG) machines which help lighten their workload. Yet, the result of the study had also identified that; the technology has also led to body pain and injury. Body pain experienced is not much difference with the workers using fully manual tools. So it becomes an issue to use the technology if it gives more health and safety risks. This should not happen because the purpose of tools being developed is to help and take care of the health and safety of the workers (Imran, Maqbool, & Shafique, 2014).

Since the first report of an association between the use of vibrating hand tools and Raynaud's phenomenon by Loriga (1911) and subsequently by Hamilton (1918). The health effects of Hand-Transmitted Vibration (HTV) exposure with the hand-arm vibration syndrome (HAVS) have been studied widely (Anselm, 2011). The United States National Institute of Occupational Safety and Health (NIOSH) had conducted two reviews on studies of HAVS. The two reviews were done in different parts of the world from 1969 to 19953. The results of both reviews precisely showed a significant association between exposure towards HTV and development of HAVS. Although all studies included in these reviews show significant association between HTV-HAVS but all the reviews were

originated from work done in temperate climate countries only where vascular symptoms were commonly seen among vibration exposed worker (US NIOSH, 1997).

1.2 Problem Statement

1.2.1 Concern on health issues among workers in plantation

The health problems yield same concern in the oil palm plantation. Exposure to musculoskeletal problems are unavoidable because the workers are actually still using manual handling despite there are already machineries invented and has been adopted. Their preference still on manual tools when harvesting fresh fruit bunch (FFB). (Guan, 2014). The workers are using a chisel for short palms (less than 3m high) while a sickle mounted on a bamboo or aluminum pole for taller palms (Jelani, A. R. Hitam, A., & Jamak, J., 2008).

A national survey conducted in the United Kingdom reported that occupational exposure to HTV was the highest in agricultural, construction and manufacturing industries (Palmer, 2000). In Malaysia, the total number of workers engaged in these industries was 446 368 persons based on the 2010 national labor force statistics reports (Su et al., 2011). Recently, a great concern arises in tropical climate zone which most developing and underdeveloped countries are located in. The working conditions of the workers using vibrating tools in this region were expected to be of not up to the standard. In Malaysia for example for this industry, there is no national legislation and legislative provision on HTV exposure and on maintenance and usage of appropriate vibrating tools,

guidelines by DOSH is the only one that is available even most of the workers were migrant workers who are not covered under national social security schemes (Anselm, 2011).

1.2.2 Success of Malaysia's Oil Palm Industry

Based on Department of Statistics Malaysia, statistics shown that Palm oil and palm oil-based products increased RM206.5 million or 3.2% from RM6.4 billion. Exports of palm oil rose RM645.8 million (+19.8%) due to the increase in export volume of 25.1% as average unit value decreased 4.3% . Figure 1.1 shows the comparison between the monthly production trend of crude palm oil 2016 and 2017. This show that the palm oil industry is making another success on the rising of the production rate. Since the introducing of the 'Cantas' machine by Research and Development team from Malaysia Palm Oil Board, MPOB and as the alternative way to harvest the palm oil fruit in 2007, many of the oil palm farmer could harvest double they could before using 'Cantas' machine (Jelani et al. 2008).

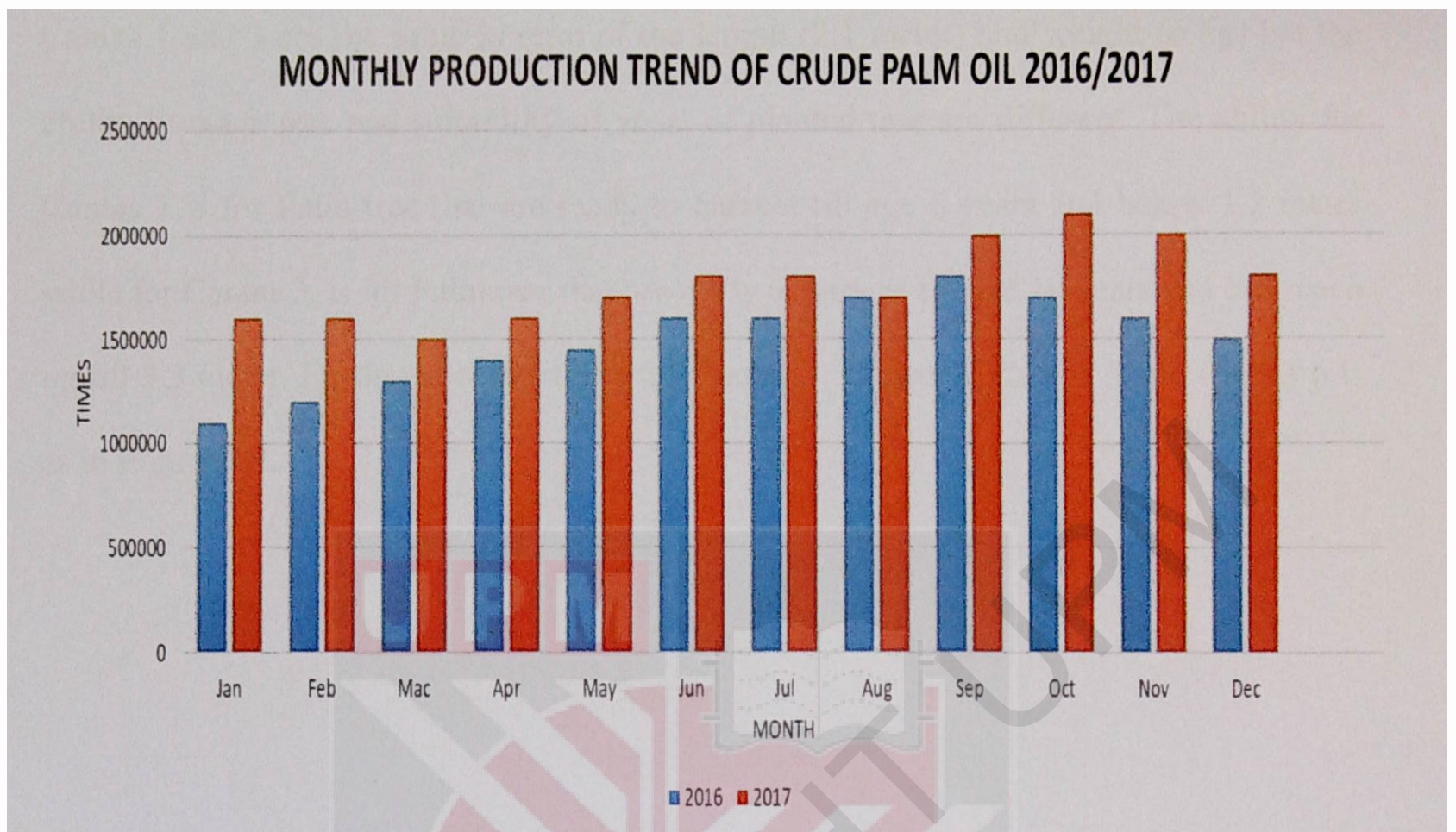


Figure 1.1 Monthly Production Trend Of Crude Palm Oil 2016/2017

(Source : MPOB Official Website)

1.2.3 Usage of Cantas machine as harvesting tools

The specification of the latest model of Cantas machine are varies depending on the length of the pole and type of the cutter. There are currently four types that are being promote widely for the harvester's use. The available Cantas machine in the market are Cantas 1, Cantas 3, Cantas 5 and Cantas 6. It is powered by a small petrol engine and utilize a specially designed C-sickle or chisel as the cutting knife. Only Cantas 1 designed with chisel cutting knife while the others are C-sickle. The design was designed specifically to cut the tough fronds and bunches of the palm oil tree. The specifications of

Cantas 1 and 3 are the same in term of the length (2.1 meter) and weight (6 kg) but the ability to reach tree and suitability of years of planted tree are different. The ability for Cantas 1 is for Palm tree that are ready to harvest till age 6 years and below 1.2 meter while for Cantas 3, is for Palm tree that are ready to harvest till age 10 years and can reach up till 3.3 meter. Further specifications for Cantas 1, Cantas 3, Cantas 5 and Cantas 6 is as in Figure 1.2.



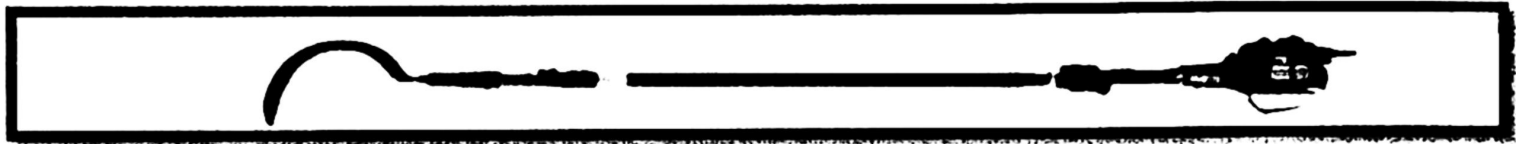
TYPE OF CANTAS MOTORIZED CUTTER



CANTAS 1	CANTAS ADVANCED III
Length	2.1 meter
Weight	6.0 kg
Ability to reach tree	From below 1.2 meter (4 ft)
Suitability of years planed	Palm ready to harvest till age 6 years



CANTAS 3	CANTAS ADVANCED III
Length	2.1 meter
Weight	6.0 kg
Ability to reach tree	From 1.2 meter – 3.3 meter (4 – 11 ft)
Suitability of years planed	Palm ready to harvest till age 10 years



CANTAS 5	CANTAS ADVANCED III
Length	4.6 meter
Weight	7.0 kg
Ability to reach tree	From 2.4 meter – 4.6 meter (8 – 15 ft)
Suitability of years planed	Palm ready to harvest till age 15 years



CANTAS 6	CANTAS ADVANCED III
Length	6.0 meter
Weight	9.0 kg
Ability to reach tree	From 3.0 meter – 6 meter (10 – 20 ft)
Suitability of years planed	Palm ready to harvest till age 18 years

Figure 1.2 The specifications of the types of Cantas Model.

(Source : Official website of E Tani Cantas machine distributer)

The vast usage of the 'Cantas' machine nationwide along with the governance effort to help subsidies RM1000 from the actual price, this machine is no doubt the planter's first choice. Questions arise whether this machine could contribute to hand-arm vibration as there no study being done to measure the vibration level and to determine the threshold level. Besides, to date still no complaint either positive or negative yet regarding the machine whether it is really beneficent or poses any defect to be improved to the harvesters who choose to use it in doubling their productivity.

1.2.4 Health risk on using Cantas machine

Despite the large number of workers engaged in occupations at risk of HTV exposure, the number of cases reported to the Social Security Organisation of Malaysia under the "diseases caused by vibration: disorders of muscles, tendons, bones, joints, peripheral blood vessels or peripheral nerves" was only 89 in 2016 as shown in table 1 (Social Security Organisation Annual Report, 2016). The statistic of HAVS reported were not representing the actual size of the workers in this industry. Could it be possible that there is high incidence of missed diagnosis or reflective of real nonexistence of the condition in the warm environment? Thus, the study of the health effects of HTV exposure in a warm environment is very important to understand the situation and to ensure the appropriate protection of workers using vibrating tools in their daily work.

Table 1.1 Number of Occupational Disease Cases to Agent Causes and Gender 2016

ii. Physical Agents			
	Man	Woman	Total
I. Hearing impairment caused by noise	501	39	540
II. Disease caused vibration (disorders of muscles , tendons, bones, joints, peripheral blood vessels or peripheral nerves)	43	46	89
III. Disease caused by work in compressed air	20	11	31
IV. Disease caused by ionizing radiations	3	-	3
V. Disease caused by heat radiations	-	1	1
VI. Diseases caused by ultraviolet radiations	7	6	13
VII. Disease due to extreme temperature	4	-	4
VIII. Disease caused by other physical agents	507	418	925
Total	1085	521	1606

(Source: Social Security Organisation. Annual Report, 2016)

Successful technology adoption should focus on three main elements which are human, process and technology. Besides these elements, several characteristics of the technology should be considered when adopting new technology, such as simplicity, visibility of results, usefulness towards meeting an existing need and low capital investment. The ergonomic element should be included in the design to achieve ease of use and comfort in harvesting technology. In addition, it will be able to reduce injuries

and increase high productivity. Ergonomics and technology, if properly applied can reduce injuries and give benefit to company on lowering medical costs. Disregarding ergonomic principles will cause inefficiency and pain to the workers. Furthermore, workers are being encouraged to adopt technology that suits their work by implementing ergonomics principles (Kogi & Kawakami, 1997).

1.3 Research Questions

The research questions for this study which were identified from the statements of the problems and background of the study are five (5). These questions are directed to address the issues with regards to determine the effect of hand arm vibration symptoms on 'Cantas' machine among harvester of fresh fruit bunch of palm oil in Selangor. This research seeks to answer the following questions:

- I. What is the vibration level pose by 'Cantas' machine users?
- II. Does the use of 'Cantas' machine contribute to Hands Arms Vibration Syndrome HAVS among Cantas machine users?
- III. What is the permissible exposure limit for the usage of 'Cantas' machine?
- IV. Is there any ergonomics risk factors on the usage of Cantas machine?
- V. What are the perception on ergonomics risk factors issues on the use of Cantas machine?

1.4 Research Objectives

The aim of this research is to determine the effect of hand arm vibration symptoms on 'Cantas' machine among harvester of fresh fruit bunch of palm oil in Selangor. To achieve the aim of this study, the following specific objectives have been defined:

- I. To assess the level of occupational vibration exposure from the usage of Cantas for A(8) working hour.
- II. To determine the prevalence of the Hand Arms Vibration Symptoms among Cantas machine users.
- III. To recommend and propose a safety level for using 'Cantas' machine.
- IV. To determine the ergonomics risk factors on the usage of Cantas machine.
- V. To determine the perception on ergonomics risk factors issues on the use of Cantas machine.

1.5 Significance of the Study

Statistics from Social Security Organization (SOCSO) data record that Malaysian government spends billions of Ringgit Malaysia each year, for solving worker's compensation claims (Hashim & Taha, 2012). Nevertheless, it is also believed there any many cases that have not been reported due to several factors such as they do not know how to claim compensation (Takala, 1999). This issue should not arise because the workers is the key factor for the development of the country and they contributed significantly to the development of the national economy. (Djomo & Sikod, 2012).

Regular screening for early signs of vibration-related damage, even if workers are subject to only moderate vibration exposure, is an important part of preventing the aggravation of health problems. Once exposed, a spontaneous improvement is expected in about half of the workers who have experienced white fingers (Ye et al. 2014). The symptoms are reversible, but some studies suggest that the symptoms become more persistent when they are more pronounced (Kurozawa, 2002). The workers also gained awareness regarding vibration exposure, and some had stated that they had tried to change their behavior to reduce the duration of exposure.

1.6 Scope of the Study

This research is primarily concerned with an investigation into the effect of hand arm vibration symptoms on 'Cantas' machine among harvester of fresh fruit bunch of palm oil in Selangor. The hand arms vibration symptoms on 'Cantas' machine users were identified, the vibration level and safety level of usage the 'Cantas' machine and also the ergonomics risk factors and perception on the ergonomics risk factors issues.

1.7 Definition of Terms

1.71 Conceptual Definition

a) Hand- Arm Vibration (HAV)

Hand- Arm Vibration is defined as the transfer of vibration from a tool to a worker's hand and arm (NIOSH,1997)

b) Hand- Arm Vibration Syndrome (HAVS)

Hand- Arm Vibration Syndrome is a disease that involves circulatory disturbances, sensory and motor disturbances and musculoskeletal disturbances (Su et al. 2011).

Hand- Arm Vibration Syndrome also refers to the condition associated with vibration exposure and the use of hand-held vibrating machines (Elms, 2005)

1.7.2 Operational Definition

a) Hand- Arm Vibration (HAV)

Hand- Arm vibration is the transfer of vibration from a vibrating tool to the worker's hand and arm. It is measured in meters per second squared (m/s^2) using a Human Vibration Meter.

b) Hand- Arm Vibration Syndrome (HAVS)

HAVS were identified using a questionnaire by answering either 'Yes' or 'No'. Having two or more symptoms listed in the questionnaire, such as white finger, tingling or numbness, will be considered as positive HAVS.

1.8 Conceptual Framework

This study is about the palm oil harvester health risk specifically in effects of Hand Arm Vibration symptoms from the usage of Cantas machine. Besides, this study also addresses the issue and ergonomics issues perceived by the harvester on the Cantas machine. The dependent variables are the Hand Arm Vibration symptoms such as tingling, numbness and white finger. The independent variables are the individual factors, occupational factors, ergonomic risk factors plus the perception on the ergonomic design of the Cantas machine.

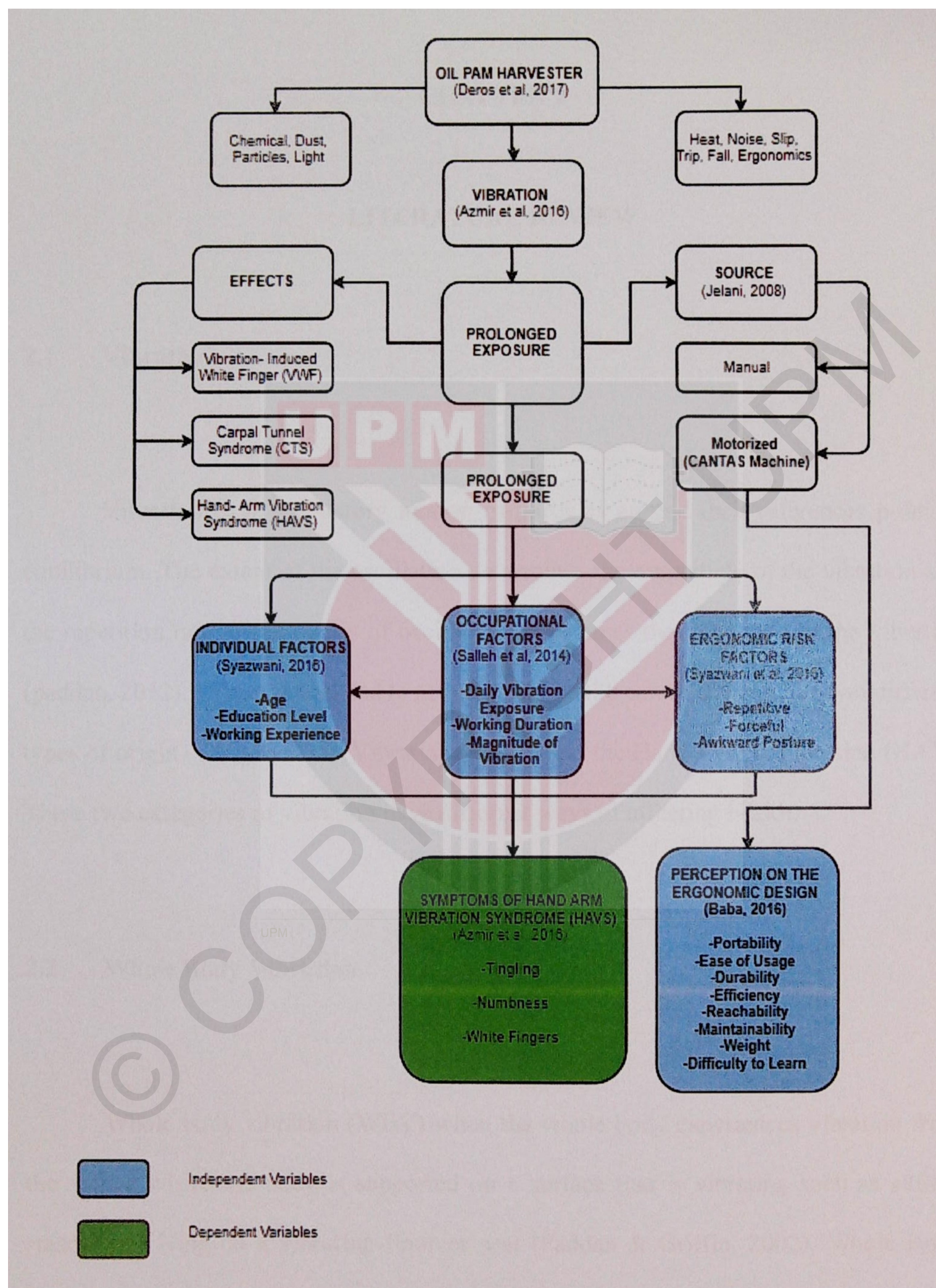


Figure 1.3 Conceptual framework of the study

CHAPTER 2

LITERATURE REVIEW

2.1 Vibration

Vibration is an oscillatory motion of particles around their reference point of equilibrium. The extent of the oscillation determines the magnitude of the vibration and the repetition rate of the cycles of oscillation determines the frequency of the vibration (Paddan, 2012). Vibrations related to occupational health can be divided into two different types of origin – Whole Body Vibration (WBV) and the Hand – Arm Vibration (HAV). These two categories of vibration have different ways of affecting health.

2.2 Whole Body Vibration

Whole body vibration (WBV) when the whole body experiences vibration from the source where the body is supported on a surface that is vibrating such as sitting, standing or lying on a vibrating floor or seat (Paddan & Griffin, 2002). Whole Body Vibration exposures enter the human body through different pathways, such as via the spine while an operator drives a vehicle. The most frequent reported health symptom due to whole body vibration is lower back pain.

Exposure to vibration may be quantified by the magnitude of vibration at the interfaces between the body and the source of vibration. Vibration is measured in three directions – longitudinal (buttocks to head - az), and two transverse directions (chest to back – ax , and right to left side - ay). The axes of translational and rotational vibration are defined by the coordinate system oriented in respect to the body (figure 2.1).

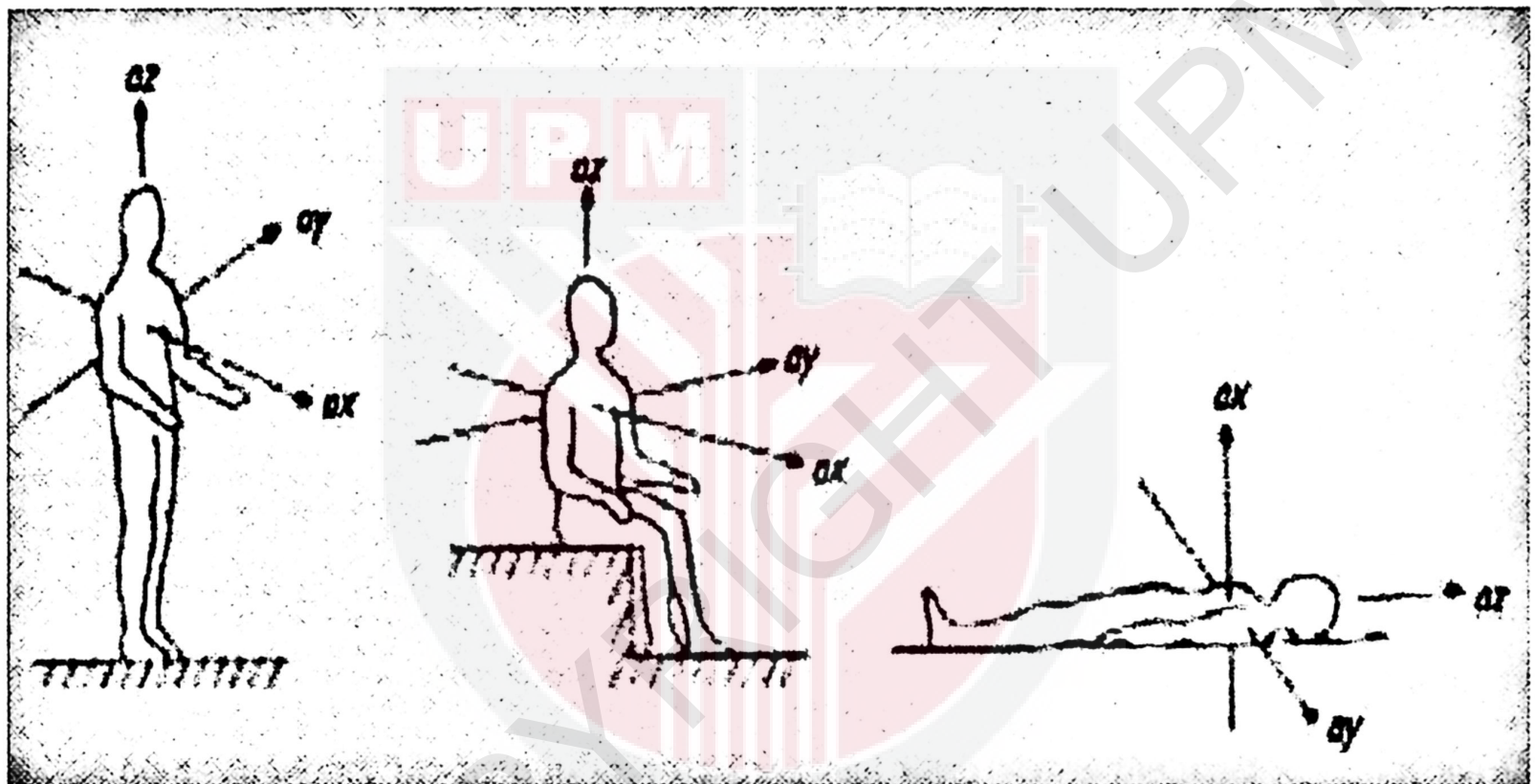


Figure 2.1. Coordinate system to evaluate whole body vibration (Source ISO 2631-1)

Human responses to whole body vibration depends on the frequency of vibration, acceleration (or magnitude) of the vibration and duration that the person is exposed to the vibration. The exposure of a seated subject to WBV of 5 Hz / hour in a sitting position would increase the rate of fatigue in the erector spine muscle (Arora, 2013). In another study, Tamrin et al. (2007) reported that under several frequencies of vibration (1.8Hz, 4.0 Hz and 6.0Hz), there was an inclination of electromyography after 90 minutes of driving simulation.

2.3 Hand- Arm Vibration

Hand arm vibration refer to the local vibration transmitted to the hand and arm by the usage of vibrating hand tools and equipment (Health and Safety Exevutive, 2005). The main purpose of measuring human vibration is as a prevention of health risk and the evaluation of comfort, for example, in a vehicle. The measurement of HAV involves three mutually perpendicular measurements simultaneously in which the axes are denoted as x, y and z. The axes refer to the direction in which the motion moves. The motion of front-to-rear is noted as the x-axis, side-to-side as the y-axis and up-down as the z-axis.

Universally for three simultaneous (triaxial) HAV measurement directions, the acceleration motion moving into and out of the palm is designated as the x-axis acceleration direction; the motion moving back and forth across the hand knuckles is designated as the y-axis acceleration direction; and the motion parallel to the long bones of the forearm is designated as the z-axis acceleration direction. This is illustrated in Figure 2.2.

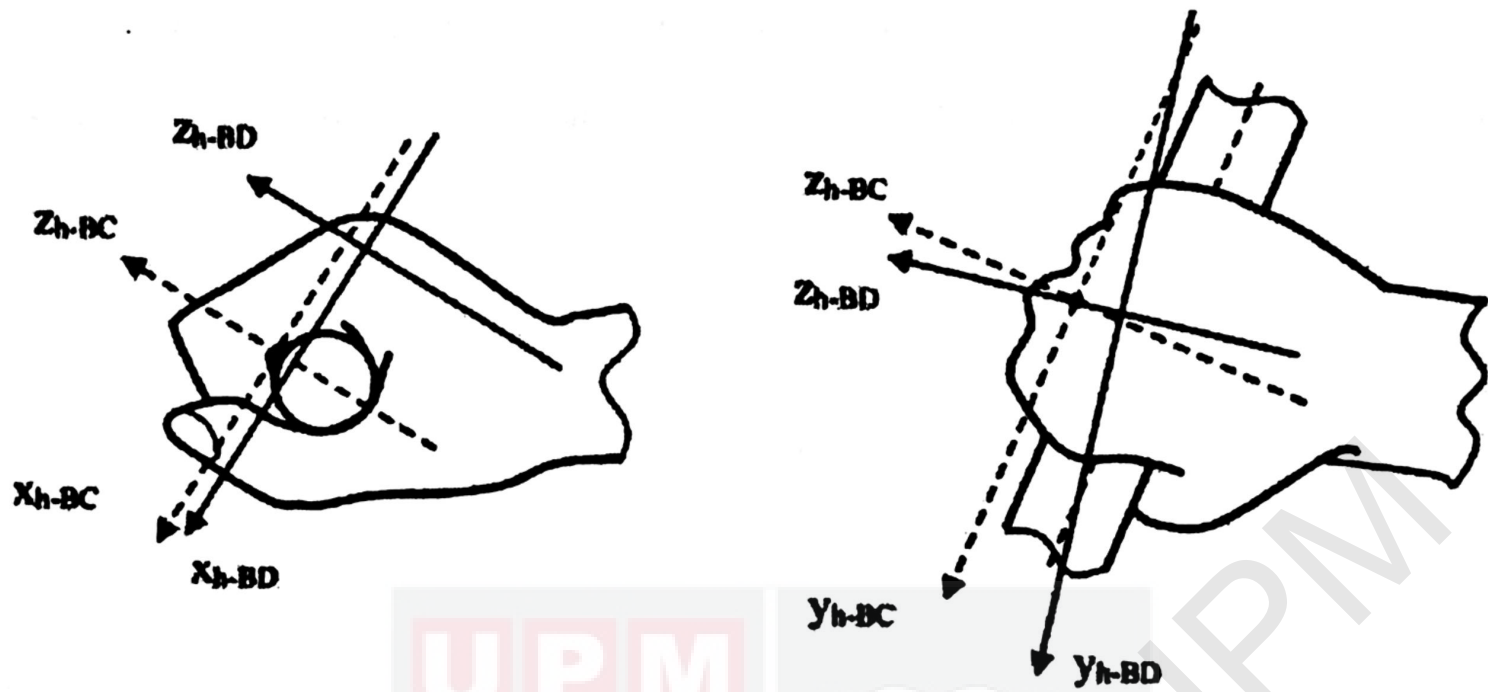


Figure 2.2 Description of Biodynamic and Basicentric Orthogonal Coordinate Axis Systems (Source: ISO 5349-1)

The assessment of vibration is based on the vibration total value (a_{hv}), a quantity defined as the square root of the sum of the squares (r.m.s) of the frequency weighted acceleration values (a_{hv}) determined on three orthogonal axes x, y and z. the vibration total value can be calculated using the equation below:

$$a_{hv} = (a_{hvx}^2 + a_{hvy}^2 + a_{hvx}^2)^{1/2}$$

Equation 2.1

After the evaluation of the vibration total value, the workers exposure to hand arm vibration can be determined by calculating the daily vibration exposure $A(8)$. The daily vibration exposure $A(8)$ is expressed in terms of the 8- hour energy-equivalent frequency-weighted acceleration magnitude in m/s^2 , calculated using the equation below:

$$A(8) = a_{hv}(T/T_8)^{1/2} \quad \text{Equation 2.2}$$

Where;

a_{hv} = Vibration total value

T = the total daily duration of vibration exposure (hours)

T_8 = the references duration of 8 hours

2.3.1 Vibrating tools

The effect of vibrating tools on the hand is related to the tool usage. A study done by the Health and Safety Executives (HSE) in 2008, on the data for the HAVS referral population showed that the tools most frequently used by the HAVS group in Great Britain are the chipping hammer, small angle grinder, road breaker, disc cutter, impact drill and riveting hammer. Most of the referrals in the study came from the construction industry, utilities, manufacturers of basic metals, agriculture and motor vehicle repairs.

In the automobile industry, the most common tools used in the assembly area are impact wrenches. The impact wrench is designed to tighten and loosen bolts and nuts. There are various impact wrenches or nut runners with impact action that are widely and intensively used in the automobile manufacturing and repairs (Xu et al., 2009). The operation of the tools repetitively to resist torque reaction forces and the application of high grip force to maintain the stability due to vibrating tools exposes workers to injury.

2.3.2 Effect of hand- arm vibration

Hand Arm Vibration (HAV) can cause health effects, especially in the hand and arm area as vibration is transferred from vibrating hand- held tools to the hand. The effect of HAV needs to be investigated and controlled as it can cause impairment in the hand and arm that reduces the sensation, which may increase the potential health risk of accidents in the workplace and impair job performances (Carlsson, 2010). The most common effect of HAV is the development of hand arm vibration syndrome (HAVS); a term that is used to define the collective disorders associated with exposure to HAV (Palmer et al., 2000).

The possible symptoms that could happen include any combination of tingling and numbness in the fingers, cannot feel things properly, loss of strength in hands or any sign of blanching. Hand arm vibration can have an acute or chronic effect on the exposed workers. However, most of the studies conducted establish the chronic effect of vibration.

Chronic health effects are usually established in terms of long exposure to hand arm vibration (Griffin and Bovenzi, 2002; Pelmear, 1998). The symptoms from exposure can only be seen after a certain duration of exposure, which is usually after a few years of exposure. White-finger attacks begin in as little as one to two years (latency period) after the start of HAV exposure (Griffin and Bovenzi, 2003).

2.4 Hand Arm Vibration Syndrome

Prolonged exposure to HAV can cause disorders in the upper limbs associated with the use of vibrating hand-held tools. It can affect the blood vessels, nerves, muscles, bones and joints that cause vascular, neurological and musculoskeletal abnormalities occurring in vibration-exposed operators is called Hand-arm vibration syndrome (Bovenzi, 2003).

The potential of workers to develop HAVS depends on many factors including the level of acceleration produced by tools, duration of exposure, such as length of time the tool is used and the ergonomics of the tool used (Deros et al., 2017). A study done among Swedish car mechanics showed that HAV is common among the mechanics despite of short daily exposure to vibrating tools (Barregard et al., 2003). The study was done among 806 Swedish car mechanics in which their work involves the use of nut-runners. The intensity of vibration used in this study was based on large survey (Barregard, 2001) of 286 nut-runners used at 26 garages in Sweden. It showed an average weighted acceleration level of 3.5 (SD 0.6) m/s^2 . Although the mean daily exposure to vibration was only 14

minutes per day, clinical examination revealed that neurological symptoms in the h and occurred in 25% of the subjects with a mean exposure duration of 12 years.

2.5 Epidemiology Study

2.5.1 Prevalence of Hand- Arm Vibration Syndrome

In Great Britain, a major national survey of occupational exposure to hand-arm vibration was conducted in the 1980s. The survey was done to estimate the number of workers Great Britain having significant occupational exposure to HAV. The findings showed that more than 400,000 British workers were exposed to the potentially injurious effects of HAV (Kyriakides, 1998). However, another national survey that was conducted in the 1990s was found to have several limitations on the data, such as the sampling was based on a narrow selected list of industries and a restricted range of exposure patterns.

Another survey estimated that 4.2 million men and 667,000 women are exposed to hand arm vibration in their work within one-week period (Palmer et al., 2000). The survey also found that construction, motor vehicle repair and maintenance, manufacture of basic metals, and agriculture were the industries with hand-arm vibration exposure. Based on self-reported exposure time in the survey, it was found that 1.2 million of men

were exposed to vibration exceeding the suggested action level equivalent to 2.8m/s^2 for eight hours.

In the United States of America (USA), the prevalence of HAVS has been reported as being as high as 50% among chipping and grinding users (Burstrom et al., 1998). An epidemiological study in China reported that the prevalence of vibration white finger among workers with vibrating tool use, such as pedestal grinder, rock drill, chipping hammer, chain saw and breaker, ranged between 2.5% to 82.8% (Lin et al., 2005). The prevalence was based on a review of the studies of HAVS in provinces from northern to southern China. It was found that the prevalence of vascular symptoms varied geographically in China being higher in the colder north and north-eastern region.

2.5.2 Studies in Malaysia

Few studies have been conducted in Malaysia pertaining to the issues of HAVS. No specific legislation on vibration concerning specific vibration standards for either hand-arm or whole body vibration could be one of the factors why less attention has been given to this area. However, guidelines provided by the Department of Occupational Safety and Health (DOSH) Guidelines On Occupational Vibration produced in 2003, help employers manage vibration issues in their workplace. However, the implementation is voluntary and is not legally binding, and hence, the implementation in the workplace is not compulsory. The lack of statistics on vibration related disease reported in any industry

also give the impression that vibration is not a significant safety and health issue compared to other occupational related diseases (e.g., chemical exposure or noise exposure).

In the construction industry, a study was done by Su et al. (2009) on the reliability testing of a Malay-translated questionnaire for use in a cross-sectional study on hand arm vibration syndrome among construction workers in Malaysia. The results show that the majority of the translated standardized questions have a good test-retest reliability. It was shown that the kappa coefficient for important questions related to current vibratory tool usage was 0.714.

A study done by Su et al. (2009) to determine the extent of hand transmitted vibration exposure problems among construction workers in Malaysia shows that prevalence of HAVS was 18%. The results also show that the construction workers were exposed to high daily vibration exposure A(8) of 7.52 (SD 2.68) m/s^2 and 9.21 (SD 2.48) m/s^2 respectively, which far exceed the threshold limit value of 5.0 m/s^2 , as adopted in the Guidelines of Occupational vibration by DOSH.

2.5.3 Standards and guidelines

In Malaysia, there is no specific regulation to regulate occupational vibration in the workplace. The Occupational Safety and Health Act 1994 makes it the responsibility

of the employer to ensure the safety and health of the employees in the workplace. However, no standard exposure limit to vibration provided by DOSH was intended to increase the awareness of the employers as well as the employees concerning the effect of the vibration, however, its implementation was only on a volunteer basis.

Various international standards and guidelines have been produced with the intention of addressing the vibration issues. The International Standard, ISO 5349 Part 1 and 2, was used in this study for measurement and evaluation of human exposure to hand-arm vibration or mechanical vibration. The general requirement is specified in Part 1 while Part 2 provides practical guidance for vibration measurement in the workplace. Both Part 1 and Part 2 of the Standard should be used together.

The European Union Directive 2002/44/EC provides guidance on the vibration exposure limits as illustrated in Table 2.1. The purpose of providing exposure limits is for protection of the workers from the risk arising from vibration. Directive 2002/44/EC provides the minimum requirements of exposure value so that manufacturers of machines and employers should make adjustments regarding risks related to vibration exposure.

Table 2.1 Vibration exposure limit values and action values – European Union Directive 2002/44/EC

Criteria	Hand-arm Vibration	Whole Body Vibration
Exposure Action Value	2.5 m/s ²	0.5 m/s ²
Exposure limit	5.0 m/s ²	1.15 m/s ²

2.6 Manual Cutting among harvester

The manual cutting of FFB done by the harvester is a tough job. Harvesters carrying a long and sharp chisel or sickle while walking from tree to tree to cut FFB. Harvesters have very high level exposure at the neck and shoulder. They always have to stretch their body and looked up during harvesting. They are used to extreme neck and trunk flexion during harvesting activity for tall trees. In order to cut fruit, knees and body need to be bend over while hand holding and pushing long-armed sickle firmly. It can be seen that harvester's back posture is in precise position. If the harvester continuously performs this job by using manual tool, it will increase the risk of getting injured. (Syazwani et al, 2016)

2.7 Motorized harvester – Cantas machine

Adopting newly innovated technologies can also solve several problems easily such as reducing the number of foreign workers and increasing time-based efficiency (Jayaselan & Ismail, 2012). Moreover, technology also gives high contribution in giving

better safety and health to the harvester (Hope et al., 1999). This is because without mechanized technology in oil palm plantation, harvesters need to fully operate their work by manual methods such as using chisel and sickle to cut FFB. Overall tasks of harvesting oil palm would expose harvesters to ergonomic risk factors such as repetitiveness, awkward postures, static muscle loading and forceful exertion (Deros et al., 2016). Therefore, by adopting and using technology effectively and efficiently, it will provide the foundation for global competitiveness for Malaysian agriculture.

Presently according to a literature review, there are a total of 192973 harvesters and fruit collectors in Malaysia which include both the local and foreign workers. (Oil Palm Industry Economic Journal, 2011). Approximately about 13783 harvesters in each state in Malaysia. There are a total of 13 registered Oil Palm Company in Selangor under the 'Lembaga Pertanian Negeri Selangor. The available list of user of Cantas machine give a total of 107 users ranging from 2010 -2018 across Selangor. (Soure: MPOB Cantas buyer list). The technology machineries are still in a low level of acceptance and limited application of harvesting technology in industry. Harvester still preferred to use manual handling compared to new existing harvesting technologies. This is in line with the study by Abdullah, Ismail, and A Rahman (2011) which focused on factors impinging farmers to use new agriculture technology. Based on the findings of the study, harvester's perceptions and low levels of education are the two main factors that affect technology adoption among harvester.

The main reasons for non-adoption of technology can be categorized into three aspects, which are human related (Deros et al. 2017), process related (Abdullah, Ismail, and A Rahman 2011) and technology related (Wan Mahmood et al. 2013). Human related aspect is a criterion that focuses on several factors, such as age, level of education and perception. Meanwhile, process related aspect is a category that focuses on implementation after adopting the technology, such as training and extension programs. Technology related aspects are about the tools and machinery itself, such as easy to handle and efficient, low investment, and maintenance. In oil palm industry, some of the common problems come from workplace environment, worker abilities and interrelation human-machine and management programs. Table 1 shows the past studies on technology adoption in oil palm industry and the reasons why harvesters refuse to use existing technologies.

Table 2.2 Studies on technology adoption and the problems

Author(s)	Technology	Problems
Jelani et al. (2003)	Hand-held mechanical cutter	- Vibration
		- Weight 5.5kg
Shuib et al. (2004)	Telescopic and elbow type	- High cost
	arm harvester (for tall palms)	- Difficult to access from palm to palm
Jelani et al. (2008)	Cantas	- Vibration
		- Limited height of reach
Shokripour et al. (2012)	Automatic cutting system	- Heavy, weight 6.3kg
		- Vibration
Jayaselan et al. (2012)	Manipulator automation for	- High cost
	mechanical harvester	- Big and Heavy
Intara et. al. (2013)	Pruner and harvester machinery	- Limited height of reach, 6-12m

Based on the critical literature review, majority of the problems come from technical aspects or technology related, which includes; not user friendly, expensive, heavy, noise, vibration, difficult to access in the plantation and others. To overcome this problem, technologies need a solution from the ergonomic element (Kogi & Kawakami, 1997). The technology must not only concentrate on design, sketching and modeling the

design, fabricate the prototype using suitable material and test the functioning of this machine but most importantly is the design of machinery must have ergonomic features.

Technovation tool and machineries have been widely promoted throughout the country. Although about a decade had passed on from the first time introducing the machine, yet the utilization is still under par. (Mohd Nawi, Md Deros,..& Sukadarin, 2015). The usage of Cantas machine mostly among the government plantation but still there are also using the chisel and sickle to harvest FFB. While the small holder's plantation and private plantation mostly still prefer the usage of chisel and sickle. (Mohd Nawi, Md Deros,..& Sukadarin, 2015).

The arising issues is due to the workers have been comfortable using the manual tools and have been able to work fast as compared to them using new tools. It will be time-consuming for them to familiarize themselves with the new tools. There have been cases of injury, causing them to become fearful in using mechanized tools and machineries. The lack of exposure and training. There have been side effects to their health following the physical state of the machineries and tools, such as vibration and sounds.

The existing technovation tools demonstrate a lot of weaknesses which depicts the primary cause of this issue especially in terms of their non-ergonomic designs. Further study of the aspects of human and environmental factors and physical designs is needed so that boast off ergonomic design characteristics Overall, to ensure that the agriculture industry continues to be active and able to compete with developed countries, the issue of

technovation rejection needs to be in priority concern so that this issue does not become worst-in terms of national agenda and national economic status.



CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter which is the methodological framework, outlines the research methodology that was adopted for the study. The methodology is to justify the strategy of enquiry and outline the research design to be used for the study. It is important for a researcher to make the methodology to be adopted in the research transparent, by explaining in detail the methodology to be used for the research (Bowen, 2005). The approach, philosophy, research choice, strategy of enquiry, and method of analysis selected by the researcher is discussed in this chapter and justified in the context of the research questions and objectives.

A quantitative research method was used for the study. The research design for this study is cross-sectional study which is a type of observational study design. As the investigator, the approach is to not alter the exposure status and the target is to measure the outcome and the exposures in the population, and may study their association. (Maninder, 2016)

3.2 Study Location

This study was conducted in small oil palm plantations resides in the state of Selangor, Malaysia. The list of Cantas buyer that was provided by the MPOB contains a list of 107 harvesters who bought the Cantas machine. There were a total of 33 harvesters from the 9 districts which from the list of 33 there were at least one place represent the district. Figure 3.1 show the site of the study location.



Figure 3.1 Site of study location

Table 3.1 Site of Study location

Location (District in Selangor)	Number
Sabak Bernam	1, 2, 3
Hulu Selangor	4, 5, 6
Kuala Selangor	7, 8, 9
Gombak	10
Klang	11
Petaling	12
Hulu Langat	13, 14
Kuala Langat	15, 16, 17
Sepang	18, 19

3.3 Study Duration

The study was carried out from December 2018 to April 2019. The first stage of data collection was to gather information through questionnaires. The second stage of data collection was the measurement of the vibration (a_{hv}) of the Cantas machine.

3.4 Sampling Design

The aim of the sampling design is to draw a representative sample from the population, such that the result from the sample population can be generalized as a representation of the population (Kreuger & Neuman, 2006). For this research, formula is

use for determining the sample size. The sampling frame for the study comprises of the harvester who use ‘Cantas’ machine in Selangor. the sampling is confined to specific groups of harvester who can provide the desired information and who conform to some criteria set by the researcher. The prevalence of developing vascular disease (HAVS) is 84.3 % (Azmir, Ghazali & Yahya, 2015).

The researcher focuses the study on area in Selangor only considering the time constraints and budget. There are a total of 13 registered Oil Palm Company in Selangor under the ‘Lembaga Pertanian Negeri Selangor. The available list of user of Cantas machine give a total of 107 users ranging from 2010 -2018 across Selangor. (Soure: MPOB Cantas buyer list). Sample size were calculated using the following formula:

Population size(for finite population correction factor or fpc)(<i>N</i>):	107
Hypothesized % frequency of outcome factor in the population (<i>p</i>):	50%+/-10
Confidence limits as % of 100(absolute +/- %)(<i>d</i>):	10%
Design effect (for cluster surveys- <i>DEFF</i>):	1

$$\text{Sample size } n = [DEFF \cdot Np(1-p)] / [(d^2/Z^2_{1-\alpha/2} \cdot (N-1) + p \cdot (1-p))]$$

$$= 30$$

From the calculation, the minimum sample size needed is 30 respondents. In order to reduce the likelihood of refusals and also take into account any missing data during collection, 10% from the total sample size which is 3 persons is added. Thus the sample size is 33.

3.4.1 Selection Criteria

The subject criteria are considered for both inclusion and exclusion as stated below:

3.4.2.1 Inclusion criteria

The inclusion criteria of the study are:

- I. Workers working with vibrating hand-held tools in completing their task
- II. Workers with at least one year working experience using Cantas machine.

3.4.2.2 Exclusion criteria

The exclusion criteria of the study are:

- I. Workers with confirmed medical diseases (e.g.: diabetes, rheumatic disease, contact dermatitis, carpal tunnel syndrome)
- II. Workers who are exposed to neuropathic chemicals.
- III. Workers who have previous hand-arm injury (such as operation in the hand arm area).

3.5 Sampling Method

A convenient sampling method was used in this study. All the available list of user of Cantas machine give a total of 107 users ranging from 2010 -2018 across Selangor were contacted. (Source: MPOB Cantas buyer list). The sample size calculated was 33 and the total number of the population was 107. The convenient sampling method approach was used to find those from the list whose machine are still good in condition- not faulty, still using the machine. Those whose machine were faulty will be only participating on the questionnaire regarding their perception based on their experience on the machine. The respondent which qualify will be further follow up for the quantitative method which is conducted in order to measure the level of vibration produced by their 'Cantas' machine. This is a cross-sectional study of harvester workers covering personal harvesters (small farmer) in the Selangor state of Peninsular Malaysia. The average daily working time is 8 h, from 8:00 to 17:00, depending on the targeted oil palm harvester- area in one day. Approximately 33 users of Cantas machine harvesters were selected for the study. Questionnaire survey is use as strategy of enquiry for achieving these objectives.

For this study, experiments are to investigate the level of vibration and thus give guidance to users on how to use the machine properly. In this experiment the users will grip at point 1 and point 2 to operate the motorised cutter. The grip is at point 1 and point 2 to indicate the left (point 1) and the right hand (point 2) of the user. The measurement was carried out using HVM 100 attached with the tri-accelerometer attached to each grip point as shown in Figure 3.2. The HVM 100 is a useful vibration analyzer to measure vibration. (Ng et al, 2015). Total hand arm vibration, a_{hv} at each point calculated using

square root the summation of a_{hx}^2 , a_{hy}^2 and a_{hz}^2 . Each of the user will be asked to perform a one complete cycle of harvesting one fresh fruit bunch. To do that they will be instructed to harvest two fond (f1 & f2) and one fresh fruit bunch (b) to complete one work cycle. The time to complete the work cycle is measure in seconds. Total hand arm vibrations, a_{hv} were recorded and the daily exposure values (A)8 are calculated using Equation 3.1.

$$A(8) = \sqrt{\frac{1}{T_8} \sum a_{hv_{f1,f2,b}}^2 T_{f1,f2,b} + a_{min}^2 T_{min}} \quad \text{Equation 3.1}$$

$$T_8 = 8 \text{ hour}$$

$a_{hv,f1,f2,b}$ = The mean value of the vibration magnitude from the work done
(one complete cycle)

$T_{f1,f2,b}$ = Total tme taken to complete the cutting operation in one day

a_{min} = The mean arm vibration during idle throttle (from idle in second part)

T_{min} = The amount of time to solve the cutting operation



Figure 3.2 Measurement of vibration using HVM 100 with tri-accelerometer attached to the Cantas machine

3.6 Data collection

After performing the work as prescribed in 3.5, the respondent will then be asked to fill in the questionnaire form. The data is collected by making use of the questionnaire survey.

The questionnaire survey method often has standardized answers that make it simple to compile data. For the purpose of this study, three elements for designing the questionnaire were adopted which include:

- **Determine the questions to be asked.**
- **Select the question type for each question and specify the wording.**
- **Design the question sequence and overall questionnaire layout.**

The issues and questions are determined through a combined process of exploring the literature and thinking creatively. A structured questionnaires design was used in the study. The questionnaires are design in six sections. The first section is about the background of the workers. The second section covers about the hand symptoms. The third section covers about the occupational history. The fourth section covers about social history. The fifth and sixth section covers about ergonomic risk factors and perception of ergonomics related issues. Figure 3.3 summaries the sampling flow that was conducted.

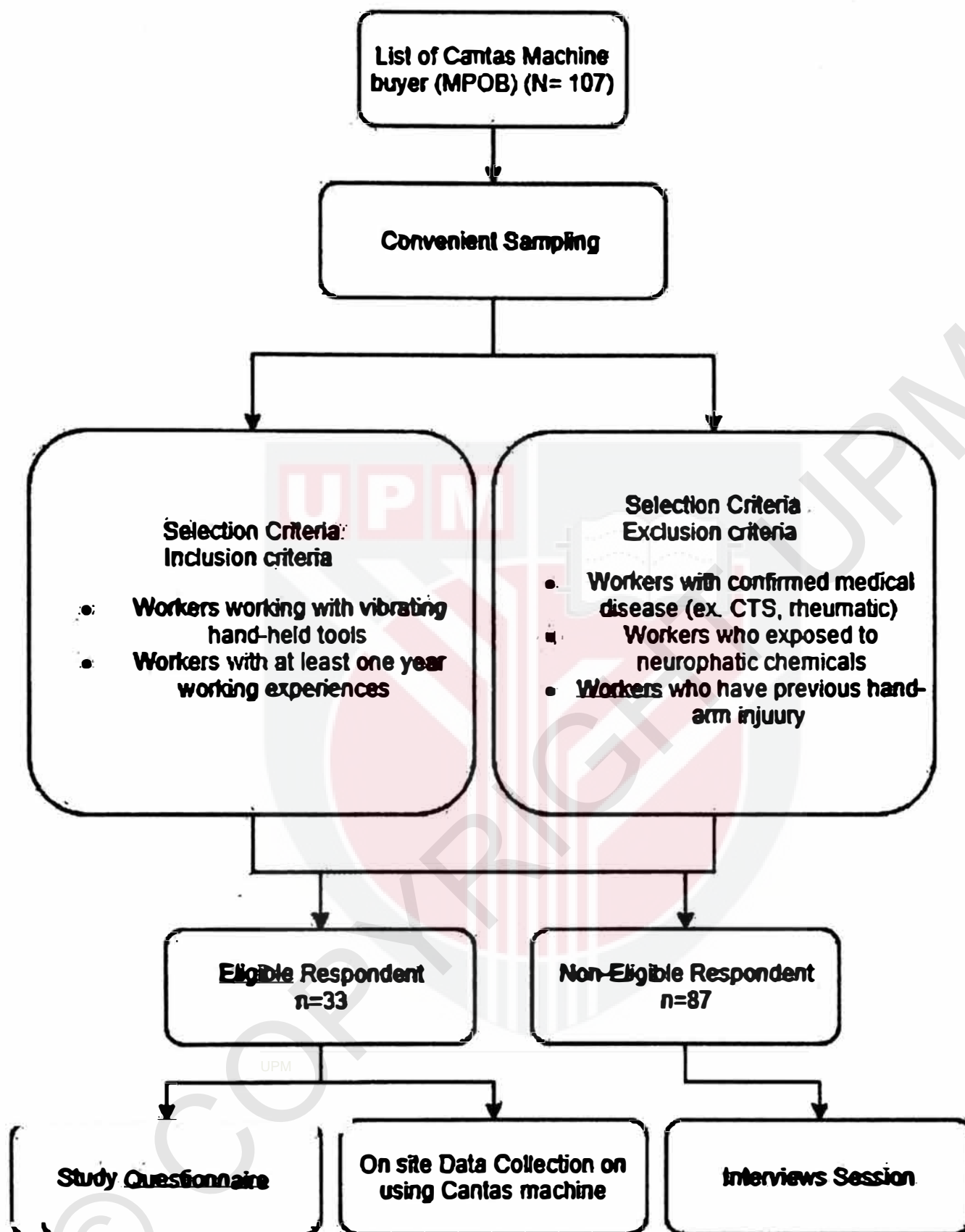


Figure 3.3 Sampling Flow

List of instrumentation use:

- a) Human Vibration Meter 100 (HAVPro)
- b) Questionnaire

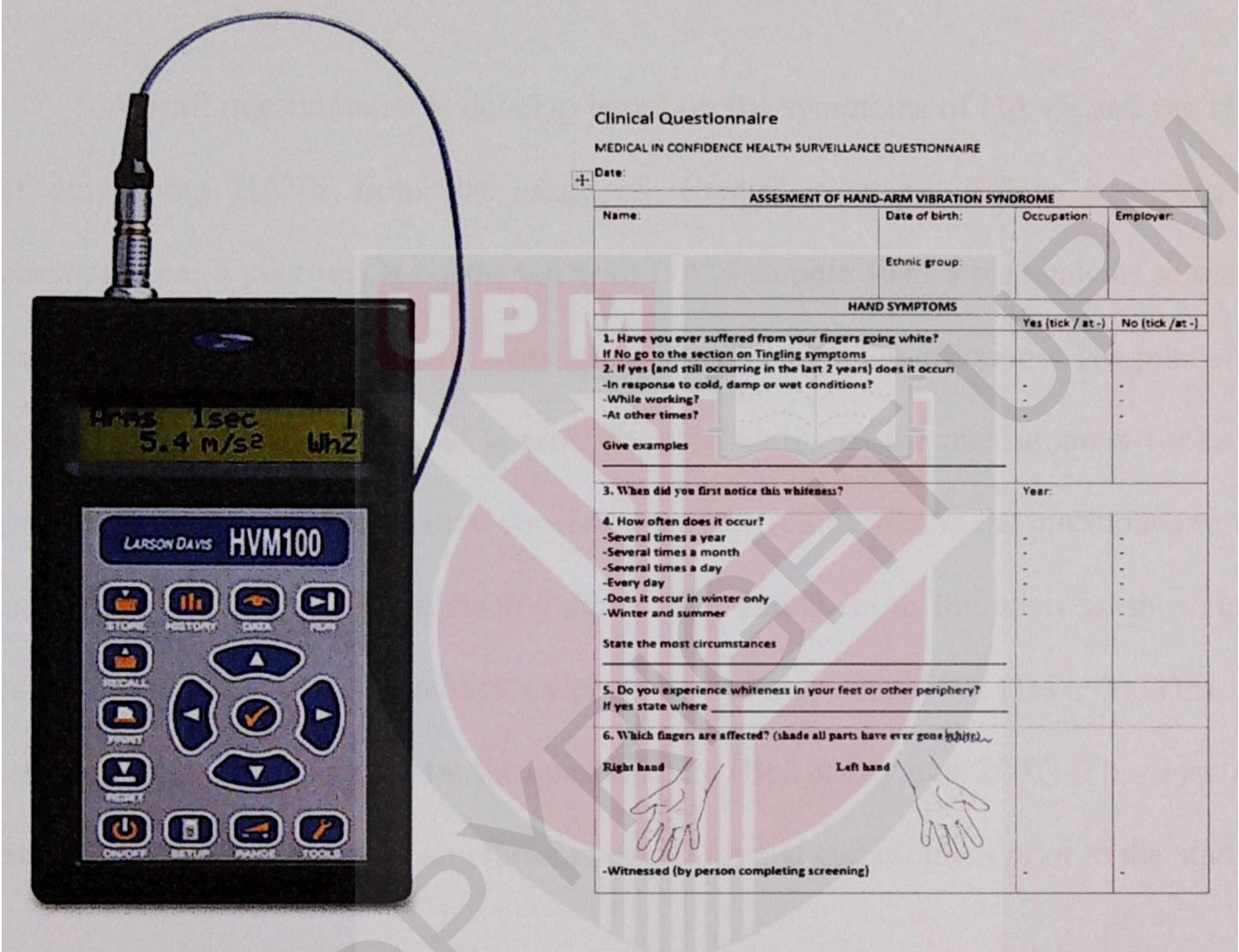


Figure 3.4 HVM 100 & Questionnaire

3.7 Quality Control

3.7.1 Pre-Test

A draft questionnaire is develop based on the symptoms of HAVS and the effect of developing HAVS from the usage of ‘Cantas’ machine. Before finalizing the questionnaire, a pilot test is conducted with (10 % sample size) 5 respondents to ensure that the respondents for the main questionnaire understand the questions. The pilot study is use to test the consistency of internal data, reliability of the measurement scales for y=the variables used. The internal consistency of the scales used in the questionnaire was examined by calculating Cronbach’s alpha. The results from the analysis show good reliability (0.830) with a Cronbach’s alpha value of more than 70% (Table 3). This is to test the soundness of the data for the questionnaire (Bell & Bryman, 2007). The objectives of the pilot study is to detect any flaws in questions and correct them prior to the study.

Table 3.2 Questionability Reliability Test

Pre- test	Number of Questions	Cronbach’s Alpha based on Standardised items	Cronbach’s Alpha
Similar sample population	4	0.829	0.830

3.7.2 Calibration of Hand –Arm Vibration Meter (HAVPro)

Calibration is done to ensure the accuracy and precision of the equipment. The equipment was calibrated using the sensitivity value of the equipment given by the certificate of calibration from the supplier. The equipment was calibrated in the field before and after the measurement to ensure the reliability of the measured data. The calibration results show that the difference between before and after measurements calibration was within 5-6 %. It was concluded that the data was reliable since the differences is less than 10%. The Standard Operating Procedure (SOP) was followed during the measurement process according to HAVPro user manual.

Most of the process involved a very short duration of tool usage; less than 20 seconds per cycle. In order to get reliable measurement data, at least four measurements were necessary to ensure a total averaging time of more than 60 seconds (ISO 5349-2001).

3.8 Data analysis

After data collection, a template for data entry as designed. The data for the research instruments from the questionnaire are scored and quantified. Frequency distribution and descriptive analysis are used to assist the researcher to analyze raw data that were collected. Data analysis was carried out using SPSS version 19.

3.9 Statistical Analysis

The data were coded and recorded carefully before carry entry and analysed using SPSS version 19. The data were analysed in one stage of statistical analysis – univariate. Based on the questionnaire, respondents were categorized as having HAVS if they reported at least two of the symptoms in the questionnaire and were categorized as 1 in SPSS, and 0 for one or no reported symptoms of HAVS.

3.9.1 Univariate

After completing the data entry into the SPSS, descriptive statistical analysis, which included frequency, percentage, mean and standard deviation, was used to summarize and explain the study variable. Descriptive analysis was also used to show the basic statistical data information, such as age, education level, dominant, occupational history and social lifestyle. In this study, descriptive analysis was again used to determine the level of vibration A(8) working hour exposure from the usage of Cantas , to propose the safety level for using Cantas machine and determine the prevalence of the HAVS among the study population and ergonomic risk factors as well as the perception on ergonomics related issues on the use of Cantas machine. The determination of the prevalence rate was needed in order to answer the second objective of the study.

3.9.2 Ergonomic Risk Factors Score

The score system was used to evaluate the ergonomic risk factors. The scores of 1,2,3 and 4 were assigned to the frequency of occurrence, as stated in the questionnaire and the mean of the score was determined. The score of 4, which was the highest score, shows the higher potential of workers exposed to the ergonomic risk factors.

3.9.3 Prevalence Calculation

In order to determine the prevalence of HAVS among respondents for the second objective, descriptive analysis was used. From the questionnaire were categorized into two groups, which was the group having HAVS symptoms and the group of non-HAVS symptoms. Respondents who reported at least two of the three symptoms listed in the questionnaire were considered to be in the HAVS group.

3.10 Ethical Consideration

Written approval was obtained from the Medical Research Ethics Committee of the Faculty of Medicine and Health Sciences, UPM to conduct this study. The management of the respective plantation were informed about the objectives of study, method of data collection, and who could assess the data. The respondents were also briefed about the objectives, method, benefits of study, confidentiality of data and the need for written consent from each respondent before conducting the study to ensure the participation are on voluntary basis.

CHAPTER 4

RESULTS

4.1 Response Rate

A list of total 107 Cantas machine buyers were called from the list of Cantas machine buyer provided by the Department of Research and Innovation of Malaysian Palm Oil Board of Malaysia (MPOB). However, only a total of 33 buyers who is eligible for this research based on the inclusive and exclusive criteria mentioned and give cooperation with the research data collection process. This represent the response rate of 30.8% of the Cantas machine buyer. The others who are not eligible are transferred to other state and not interested in the study are 3 (2.8%), machine is not being used are 20 (19%), machine is faulty 34 (29 %), the contact number given is not in service 9 (8.4 %), and the one who were already passed away 8 (7.5 %).

Table 4.1 List of Cantas machine buyer in Selangor

Cantas machine buyer in Selangor (source: MPOB list of Cantas buyer)	Number of buyer Total = 107 (100%)
Passed away	8 (7.5)
Contact number is not in service	9 (8.4)
Transferred to other state	3 (2.8)
Machine is faulty	34 (29.0)
Machine is not being used	20 (19.0)
Total eligible user	33 (30.8)

4.1.1 Socio –demographic factors of respondents

Table 4.1.1 shows that the majority of the respondent was Malay with 27 persons and there are only 3 Chinese respondent. As for the age of the respondent there was 13.3% age of below 40 years old and 86.7% age higher than 40 years old with maximum and minimum age being 67 and 34 years respectively.

Table 4.1.1 also shows most of the respondents came from a low education level in which 66.7% had primary education while 20% had secondary education and 16.7% had tertiary education or diploma level. As for the working experiences, most of them 19 (57.8%) reported that they had been working for more than 30 years while the other 7

(21.2%) reported of working 21 to 30 years and also the other 7 (21.2%) reported of working between 11 to 20 years.

Table 4.1.1 Distribution of the respondents according to socio-demographic factors

Variables	Frequency	Percentage (%)	Mean	SD
Race				
Malay	30	90.9		
Indian	-	-		
Chinese	3	9.1		
Age (years)				
Less than /equal to 40	4	12.1		
Higher than 40	29	87.9		
Working experiences (years)				
Less than 5	-	-		
5 to 10	-	-		
11 to 20	7	21.2		
21 to 30	7	21.2		
More than 30	19	57.8		
Education level				
Primary	22	66.7		
Secondary	6	18.2		
Tertiary	5	15.1		

N=33

4.1.2 Occupational Background of Respondent

Table 4.1.2 summaries the information regarding the occupational background of the respondents. It shows that more than 80% of the respondent have been working for more than 20 years in this field while another 16.7% of the respondent have been working for more than 15 years. More than 66% of the harvester have been using vibrating tool in previous work. Among the used vibrating tools were grass cutter 36%, chainsaw 16.7%, grinder 10% and sander 6.7%.

The study also found out that none of the harvesters work in shift and work overtime. The harvester's frequency of using Cantas machine for more than 4 hours is 60% and the other rest were less than 4 hours daily. For the tool maintenance, 76.7% of the harvesters did by weekly and another 23.3% did monthly.

Table 4.1.2 Distribution of the respondent according to Occupational History

Variables	Frequency	Percentage
Duration of working years		
More than 5	-	-
More than 10	-	-
More than 15	5	15.2
More than 20	28	84.8
Vibrating tool in previous work		
Yes	20	60.6
No	13	39.4
Vibrating tools		
sander	2	6.1
grinder	3	9.1
chainsaw	5	15.2
grass cutter	10	30.3
None	13	39.4
Frequency of usage (day)		
Less than / equal to 4hours	12	36.4
More than 4 hours	21	63.6
Work in shift		
Yes	-	-
No	33	100

Work overtime		
Yes	-	-
No	33	100
Tool maintenance		
Weekly	26	78.8
Monthly	7	21.2
Yearly	3	9.1
N=33		

4.1.3 Social and Lifestyle of Respondents

Table 4.1.3 shows that most of the respondents were smokers which is 21 (63.6%) while another 12 (36.4%) were non-smoker. From the questionnaire, none (0%) of them took alcohol. The table also shows that majority of the respondent use motorcycle as transportation to go to work as 26 (86.7%) of them using motorcycle and only 4 (13.3%) use car.

Table 4.1.3 Social and Lifestyle of respondents

Variables	Frequency	Percentage
Smoking		
Yes	21	63.6
No	12	36.4

Alcohol

Yes	-	-
No	33	100

Transportation

Motorcycle	26	78.8
Car	7	21.2

N= 33

4.2 Occupational Vibration Exposure from usage of Cantas for A(8)

The first objective of the study is to assess the level of occupational vibration exposure from the usage of Cantas for A(8) working hour. A HVM 100 vibration meter was used to assess the vibration level pose by the Cantas machine. Table 4.2 shows that the mean (s.d.) vibration magnitude perceived by the harvester hand is 5.24 m/s² (1.301) and the minimum and maximum is 2.40 m/s² and 7.40 m/s² respectively. Calculation for the daily vibration exposure A(8) shows that the mean (s.d.) is 2.30 m/s² (0.721) and also the minimum and maximum is 0.90 m/s² and 3.90 m/s². The total exposure point is deemed in the Green scale as the mean (s.d.) is 92.33 (56.190) while the minimum and maximum is 13 and 247 points.

Table 4.2 Occupational Vibration Exposure from Usage of Cantas A(8)

Variables	N	Min	Max	Mean	SD
	33				
Vibration Magnitude m/s ² r.m.s		2.40	7.40	5.24	1.301
Daily vibration exposure A(8) (m/s ²)		0.90	3.90	2.30	0.721
Total Exposure Point	13	247	92.33	56.190	
Scale				Green	

4.2.1 Estimation on using Cantas Machine for harvesting for A(8) exposure.

Table 4.2.1 shows the estimation on using Cantas machine for harvesting for 8 hour working exposure A(8). The vibration magnitude m/s² is calculated for minimum (2.40 m/s²), mean (5.24 m/s²) and maximum (7.40 m/s²). The exposure points per hour for minimum and mean is below 100 which depicts below the Estimated Action Value (EAV) , 2.5 m/s² while the maximum exceed the EAV. The time to reach EAV 2.5 m/s² A(8) for minimum , mean and maximum is 8.68 , 1.82 and 0.92 hours. The time to reach Estimated Limit Value (ELV) 5.0 m/s² A(8) for minimum, mean and maximum is >24, 7.28 and 3.65 hours respectively. As for the most important thing to focus in the table is the daily exposure A(8) for minimum and mean is deemed in Green scale which is 0.7 and 2.3 m/s² while the maximum is in yellow scale with 4.2 m/s² which exceed the EAV.

Table 4.2.1 Estimation on using Cantas Machine for harvesting for A(8) exposure.

Vibration Magnitude m/s²	Min = 2.40	Max = 7.40	Mean = 5.24
r.m.s			
Exposure Points per hour	12	110	55
Time to Reach EAV 2.5 m/s²	8.68	0.92	1.82
A(8) (hours)			
Time to Reach ELV 5 m/s²	>24	3.65	7.28
A(8) (hours)			
Partial Exposure m/s² A(8)	0.688	4.2	2.3
Partial Exposure Points	8	283	87
Daily Exposure m/s² A(8)	0.7	4.2	2.3
Total exposure Points	8	283	87
Scale	Green	Yellow	Green

4.3 Prevalence of Hand-Arm Vibration Syndrome

The second objective of the study is to determine the prevalence of hand-arm vibration syndrome among Cantas machine users. Table 4.3 shows the reported symptoms of HAVS such as white fingers, tingling and numbness among the harvester’s past experience. The table shows that there were none for white fingers, 8 (24.2%) for tingling and 20 (60.1%) for numbness. The harvester were also asked whether the syndrome they felt were due to vibrating tool, does it disturbing their job and does the pain persistence.

The results that answered yes for the following questions were 26 (86.7%) due to vibrating tools, 24 (80.0%) disturbing their job and none (0%) reported that the pain persist. From the table it can be seen that most of the harvester do not pose a risky threat for developing Hand-Arm Vibration Syndrome. The result shows the person who were prone to develop HAVS based on their reported past experience was only 13 (43.3%).

Table 4.3 Prevalence of Hand- Arm Vibration Syndrome

Items	Yes	(%)
White fingers	0	0
Tingling	8	24.2
Numbness	20	60.1
Due to vibrating tools	26	86.7
Disturb job	24	80.0
Pain persistence	0	0
Questionnaire (>2 HAV Symptoms)	8	24.2
N= 33		

4.4 Safety Usage Level of Cantas for Harvesting

The third objective is to recommend and propose a safety level for using ‘Cantas’ machine. Table 4.4 illustrates the data on the usage of Cantas for harvesting work daily and also shows the safe level of the harvesters using Cantas. The mean (s.d.) cutting time is 9.233 (3.00) seconds using the Cantas machine while the minimum and maximum cutting time is 4 and 15 seconds. The mean (s.d.) of palm being cut per hour is 39.90 (2.44) while the minimum and maximum palm being cut is 35 and 45 respectively. The mean (s.d.) of amount of fresh fruit bunch (FFB) being harvest is 36.47 (9.35) while the minimum and maximum FFB being harvest is 20 and 54 per hour. The table also sum of the total FFB and palm being cut using Cantas per hour and the results shows the mean (s.d.) is 77.57 (9.05) while the minimum and maximum is 63 and 93 per hour. Mostly the harvesters were in the safe and beware safe level which is 18 (60%) of them in safe level while another 12 representing 40% of the total respondent in the beware safe level.

Table 4.4 Total Daily Cutting Time & Safety level of the Harvester using Cantas

Variables	N (%)	Mean	SD	Min	Max
	33				
Cutting time (seconds)		9.233	3.0021	4	15
Palm		39.90	2.4400	35	45
Fresh Fruit Bunch (FFB)		36.47	9.3500	20	54
Total cut (Palm & FFB)		77.57	9.0500	63	93
(per hour)					
Daily Cutting Time (hours)		1.54	-	0.69	2.59
Time to Reach EAV 2.5 m /s A(8) (hours)		1.82	-	8.68	0.92
Time to Reach ELV 5 m/s ² A(8) (hours)		7.28	-	>24	3.65
Safe (<2.5 m/s ²)	18 (60)				
Beware (>2.5 m/s ²)	12 (40)				
Danger (>5 m/s ²)	-				

4.5 Ergonomic Risk Factors

The fourth objective is to determine ergonomics risk factors on the usage of Cantas machine. Questions related to ergonomic risk factors were also posed to the respondents. Table 4.5 shows that 16 (53.3) reported that there were no occurrence of static posture and another 14 claims that there were 1- 10 times occurrence of static posture. There were also 25 (83.3%) respondents reported that there were more than 50 times of the occurrence of repetitive work, 26 (86.6%) related to forceful tasks and 13 (43.3%) related to awkward posture of the body especially the hand- arm. The overall score for the occurrence of ergonomic risk factors was medium with the overall score of more than 2.5 with 4 as the maximum score.

Table 4.5 Ergonomic Risk Factors Based on Respondents Perception

Ergonomic Factors	Risk Score				Mean (sd)
	1	2	3	4	
Repetitive	-	-	5 (15.1)	28 (84.8)	3.91 (0.29)
Forceful	-	-	4 (12.1)	29 (87.9)	3.88 (0.33)
Awkward	2 (6.1)	9 (27.3)	9 (27.3)	13 (39.4)	3.00 (0.97)
Overall score for ergonomic risk factors					3.60 (0.53)

Note: score 1 indicate low risk, score 4 indicate high risk.

N: 33

4.6 Perception on ergonomic design issues of Cantas machine among Harvester

The fifth objective is to determine the perception on ergonomics risk factors issues on the use of Cantas machine. Table 4.6 shows the overall perception from the harvester who had been using Cantas machine. It contains 8 criteria that is commonly asked to assess a user's perception on a machine. The table shows that the difficulty in learning how to operate Cantas machine was at medium level as the mean (s.d.) was 3.23 (0.831). On portability, ease of usage, and efficiency part, the harvesters state that the Cantas was at medium level as the mean (s.d.) for each was 3.76 (0.821), 3.51 (1.170), 3.63 (0.916) respectively. On the durability and reachability part, the harvesters state that the Cantas was at low level as the mean (s.d.) was 2.98 (0.927) and 2.40 (0.619) respectively. Moreover, the harvester states that Cantas was at high level for the weight and maintenance as the mean (s.d.) was 4.07 (0.818) and 4.71 (0.851) respectively.

Table 4.6 Perception on Ergonomics related issues of Cantas machine among Harvester

Ergonomics Related- Issues	Score (%)					Mean (sd)
	1	2	3	4	5	
Ease of usage	5 (5.7)	12 (13.8)	25 (28.7)	24 (27.6)	21 (24.1)	3.51 (1.170)
Portability	2 (3.4)	33 (37.9)	33 (37.9)	18 (20.7)	18 (20.7)	3.76 (0.821)
Durability	-	31 (35.6)	34 (39.1)	15 (17.2)	7 (8.0)	2.98 (0.927)
Efficiency	-	8 (9.2)	34 (39.1)	27 (31.0)	18 (20.7)	3.63 (0.916)
Reachability	-	58 (66.7)	23 (26.4)	6 (6.9)	-	2.40 (0.619)
Maintainability	-	3 (3.4)	17 (19.5)	32 (36.8)	35 (40.2)	4.71 (0.851)
Weight		1 (1.1)	23 (26.4)	32 (36.8)	31 (35.6)	4.07 (0.818)
Difficulty to learn	2 (2.3)	9 (10.3)	50 (57.5)	19 (21.8)	7 (8.0)	3.23 (0.831)

Note: score 1 indicate low level (poor), score 5 indicate high level (good)
 For *Italic criteria* , score 1 indicate low level (good), score 5 indicate high level (poor)
 N= 87

CHAPTER 5

DISCUSSION

5.1 Summary of the study

A cross-sectional study was carried out from September 2018 to April 2019 across 9 district in Selangor. A total of 30 oil palm harvester, who had bought Cantas with at least two years of working experience using Cantas machine. Data were collected via interview session and questionnaire.

The aim of the study was to identify the effect of HAVS among palm oil harvester with the usage of Cantas machine in Selangor as well as the occupational vibration level pose by harvester, the relationship between the level of vibration with the HAVS, the safety level of usage of the Cantas machine and determining the ergonomics risk factors and perception of the harvester on ergonomics risk factors issues based on experience using the machine. The study conceptualized the HAVS as the dependent variable, which was assessed using questionnaire. The sociodemographic factors, such as age and occupational factors (including daily vibration exposure of 8 hours and service duration) were taken as independent variables. The independent variables were assessed using a

questionnaire (as attached in Appendix 1). The exposure was obtained through calculation from the magnitude of the vibration of the tool measured.

5.2 Occupational Vibration Exposure from usage of Cantas for A(8)

In this study, the level of vibration exposure from usage of Cantas for A(8) working hour as shown in table 4.2 is 2.30 m/s^2 from the vibration magnitude perceived by the harvester hand which is 5.24 m/s^2 . The vibration level is deemed in the Green scale which is safe below the Estimated Action Value 2.5 m/s^2 set by the internationally accepted limit values for hand transmitted vibration (HTV) as specified in the "ISO 5349-1, Mechanical vibration – measurement and evaluation of human exposure to hand-transmitted vibration – Part 1: General requirements" (ISO5349).

The total vibration (a_{hv}) and daily vibration exposure A(8) obtained from this study were higher compared to the previous study done by Md Salleh *et al.* (2014) on skilled worker while lower compared to the unskilled worker on previous study done on usage of Cantas machine. The mean total vibration (a_{hv}) from this study was (mean= 2.30 m/s^2 , range= $2.4 - 7.40 \text{ m/s}^2$) compared to the study of Md Salleh *et al.* (2014) for (skilled worker, mean= 1.98 m/s^2 , range= $10 - 14 \text{ m/s}^2$) and (unskilled worker, mean= 3.37 m/s^2 , range= $10 - 22 \text{ m/s}^2$). Handling tool vibration can pose risk of development of HAVS such as tingling and numbness in the fingers, reduce grip force, less strength of hands and fingers going to blanch and become red and painful to the workers (Md Salleh et al. 2014).

From the observation in the workplace, cutting fronds and bunches using Cantas machine is difficult to analyzed because of the differences in the height of the tree. The higher the height means the older the tree. This study focusses on the tree at approximately 8 – 10 feet height. The harvesters seem to be struggling when cutting fronds and bunches that are stiff. A stiff material needs more force to deform compared to a soft material (Jelani et al. 2018). Thus the harder the surface of contact between the cutter head of Cantas machine with the fronds and bunches, the higher the vibration produced from the increased throttle of the Cantas machine.

In contrast, there are study did by Azmir *et al.* (2016) on grass cutter worker which pose quite similar few characteristics such as daily vibration exposure, A(8) (mean= 4.9 m/s², range= 2.1 – 20.7 m/s²), net weight (weight= 7.8kg) and engine type (engine= 2 stroke) . The vibration magnitude is much or less the same as the vibration poses by Cantas machine among palm oil harvester. However, the big difference among the grass cutter with palm oil harvester is because on the mean duration in cutting duration per day which is 1.54 hours and 5.5 hours per day respectively. Thus the differences in daily vibration exposure A(8) of the grass cutter compare to palm oil harvester which has the higher potential to induce HAVS.

5.3 Prevalence of Hand-Arm Vibration Syndrome

The second objective of this study was to determine the prevalence of hand-arm vibration syndrome among Cantas machine users. The early HAVS was determined using questionnaire method. The percentage obtained provided an indication of whether the respondents in this study were affected by the usage of vibrating tools by having a higher occurrence of symptoms.

Based on the reported symptoms from the respondents through questionnaires the reported HAVS which was determined by respondents who had experienced more than 2 hand arm vibration symptoms among the study population was 43.3%. The percentage of reported prevalence of HAVS obtained from this study was lower compared to previous studies done among hand-arm vibration exposed workers. The study by McGeoch and Gilmour (2000) among 165 workers in a heavy engineering company gave the prevalence of neurological symptoms as being 62%. A study done among 177 vibration exposed workers from multi industries by Cock et al. (2000) gave a prevalence of 40%. And a study among 344 ship yard by Jang et al. (2002) gave a higher prevalence of 78.2%. Another study done by Barregard et al. (2003) among 308 car mechanics in Sweden showed a prevalence of 40% having neurological symptoms after 20 years of exposure.

The symptoms of HAVS obtained from this study was relatively lower compared to other studies, which could be due to several factors linked to exposure conditions, such as short working period with vibrating tools (means= 1.54 hours/day), relatively low daily vibration exposure (mean= 2.30 m/s²) and the intermittency of tool used. The mean daily vibration exposure in this study was below the action level of 2.5 m/s² as provided by EU Directive (2002), which was supported by comparing the vibration level in the above study (2.30 m/s²). For example, the study by Barregard et al. (2003) reported that the workers were exposed to daily vibration exposure of 3.5 m/s², which was higher than this study (2.30 m/s²), while Jang et al. (2002) reported the exposure in total vibration (a_{hv}) of 6.6 m/s², which is also higher than this study ($a_{hv} = 5.24$ m/s²).

There has been intensive work done to investigate the dose–response relationship between the hand-transmitted vibration exposure and vibration white finger (Elms, Poole, and Mason 2005). It was essential to gather a detailed history of the signs and symptoms for assessing or diagnosing HAVS and to estimate the possible staging. Many studies estimate the prevalence based on the answers to questionnaires. However, it has been shown that using both questionnaires and an objective test does not give the same result (Palmear *et al.*, 1992; Olsen *et al.*, 1988).

A study done on car mechanics in Sweden also showed a difference in the prevalence of HAVS, which was 24% reported cold induced white finger, 25% persistent numbness and 13% reduced grip force through the questionnaire (Barregard *et al.*, 2003).

However, after clinical examination consisted of a detailed history of symptoms and other diseases, medication, use of alcohol as well as a timed Allen test, Tinel's and Phalen's test. This shown that the use of a questionnaire alone will give a higher prevalence compared to an objective test or enhancement of the assessment with clinical examination. The difference in prevalence between questionnaires and subjective tests could be due to overestimating by the respondent in answering the questionnaire concerning the symptoms experienced. Therefore, the accuracy of such research relies on the honesty and perception of the respondents in answering the questionnaires concerning the identification of HAVS and other information that was based on questionnaires without diagnosis by a physician. Data from the questionnaires could be subjected to respondent's recall bias. Respondents who are not satisfied with their workload and conditions or with a high tendency to report complaints might lead to overestimating or underestimating the effect of the risk factors (Ando *et al.*, 2000).

5.4 Safety Usage Level of Cantas for Harvesting

The third objective is to recommend and propose a safety level for using 'Cantas' machine. The safety usage level of the harvester to operate the Cantas machine is shown in Table 4.4. There were no findings on the danger level ($A(8) > 5 \text{ m/s}^2$) as mostly were in the safe and beware level which is 60% ($A(8) < 2.5 \text{ m/s}^2$) and another 40% ($A(8) > 2.5 \text{ m/s}^2$) respectively on the occupational vibrational exposures as specified in the "ISO 5349-1, Mechanical vibration – measurement and evaluation of human exposure to hand-

transmitted vibration – Part 1: General requirements” (ISO5349). On the other hand, the mean time to reach EAV $2.5 \text{ m/s}^2 \text{ A}(8)$ hours is 1.82 hours and time to reach ELV $5.0 \text{ m/s}^2 \text{ A}(8)$ hours is 7.28 while the mean time for daily cutting is deemed below both the EAV and ELV which is 1.54 hours.

Several studies have identified that agriculture industry workers are more vulnerable to occupational safety and health problem (Nawi, Deros, and Nordin 2013). The exposure towards Hand Transmitted Vibration (HTV) from the previous studies done on both the agriculture and occupational industry can be compared. Su *et al* (2011) reported the occupational vibrational exposures for Concrete Breaker ($a_{hv} = 10.02 \text{ m/s}^2$, EAV= 30 min, ELV= 2 hrs), Impact Drill ($a_{hv} = 7.75 \text{ m/s}^2$, EAV=50 min , ELV= 3.33 hrs) and Grinder ($a_{hv} = 5.29 \text{ m/s}^2$, EAV= 1.78 hr , ELV= 7.15 hrs). Another study done reported that the occupational vibrational exposures for Rock Drill ($a_{hv} = 26.0 - 36.4 \text{ m/s}^2$, EAV= 4 - 2 min, ELV= 18 - 9min)(Publication 2012). These findings show that the higher the level of vibration produce by the vibrational machine, the lower the permissible time of daily exposure. The exposure time is a determining factor in the risk assessment of vibration and several studies have demonstrated that there is an increase in both the prevalence and the severity of vibration symptoms with increased hours of total tool use (Burström et al. 1998).

The level of HAV can be reduce through regularly maintenance on the machine, as well as the reduction on daily operation duration, safe working procedure and using an

anti-vibration gloves as the initiatives to be taken by the individual and management part (Azmir et al. 2016). Besides, it is recommended to provide proper guidelines or training for any users before handling any vibrational machine so that less vibration transmission can be transferred to workers when using the machine (Md Salleh et al. 2014).

5.5 Ergonomic Risk Factors

The fourth objective is to determine ergonomics risk factors on the usage of Cantas machine. Table 4.5 shows that 25 (83.3%) respondents reported that there were more than 50 times of the occurrence of repetitive work, 26 (86.6%) related to forceful tasks and 13 (43.3%) related to awkward posture of the body especially the hand- arm. These ergonomics risk factors are believed to have a certain impact on the cause of musculoskeletal disorders in the hand-arm area since numbness does not always follow the vibration exposure profile as it is also associated with the upper extremity musculoskeletal disorders (Handford et al. 2017). A study done among forestry workers showed that although the prevalence of Vibration White Finger decreased, the numbness increased (Sutinen et. al., 2006). In that study, numbness was associated with upper extremity musculoskeletal disorders as metalworkers also performed repetitive and forceful movements that may explain both their neurological and musculoskeletal problems.

Another study reported that vibration- induced stresses, strains and power absorption on joint mechanical stability and muscle activities can affect the part of the hand arm system particularly at the palm, wrist, elbow, forearm and upper arm (Xu et al. 2017). Besides Xu *et al.* (2017) also stated that with the increasing applied hand force there will be increased in the peak frequency of the transmitted vibration frequency. This is because the contact stiffness and system stiffness generally increase with the increase in the applied force. Hand- transmitted vibration exposure may also indirectly affect the development of these Musculoskeletal disorders through increasing of the load, forces or overexertion under the vibration conditions.(Xu et al. 2017).

The response through questionnaire showed that the frequency of ergonomic risk factors performed by the harvesters was more than 77 times per hour. The score of the occurrence of the ergonomic risk factors in Table 4.5 also shows that the overall score was towards high risk as the mean score was 2.93 out of a maximum score of 4. It shows that the harvesters in this study had significantly high exposure to ergonomics risk factors in their job.

5.6 Perception on ergonomic design issues of Cantas machine among Harvester

The fifth objective is to determine the perception on ergonomics risk factors issues on the use of Cantas machine. Table 4.6 shows the overall perception from the harvester who had been using Cantas machine. The most to the least concern issues on ergonomics design issue was address in the study which show that weight and maintenance was at high level, portability, ease of usage, efficiency and difficulty in learning how to operate Cantas machine was at medium level while durability and reachability was on the low level of concern.

Previous study on mechanized tools and technovation machinery in palm oil plantations by Hossain, (2013) that have been several arising issue on utilizing mechanized tools. The issues stated were on the feasibility using manual compare motorized, productivity is higher when using manual compare to motorized, time consuming to learn the new motorized machine, lack of proper training and also there have been reported cases of injury regarding the use of motorized machine, thus also affecting their health. Hossein (2013) also reported the arising issue stated by the management part as they stating that there was issues on decreasing productivity rate, high maintenance cost, health issues of workers and their preference to use manual tool compare to motorized.

Based on the general concept of ergonomics, utilizing technology is supposedly to make the machine fit to the human not the human fit to the machine. A study done in Brazil by Dias *et al.* (2011) strongly believe that with the adoption of technologies among companies in the agri-industry will surely become an indispensable tool for Brazilian agribusiness companies in the coming years. Study done by Deros *et al.* (2017) concludes that targeted fulfilment, assisting criteria and purpose to use affected the acceptance and use technovation tools decision of oil palm workers.

Based on the discussion above it is proved that the technovation in palm oil industry had produced several great potential inventions. These inventions were purposely designed in helping to enhance the overall work performance in industry but still there are arising issues that need to be tackle especially on the ergonomic design issue which is the most vital components in ensuring the use of technovation tools in industry (Deros et al. 2017).

CHAPTER 6

CONCLUSION, LIMITATIONS AND RECOMMENDATIONS FOR FUTURE RESEARCH

6.1 Conclusion

In conclusion, HAVS was prevalent among vibrating hand-held tool users in the palm oil industry which is specifically Cantas machine with the prevalence of 24%. This study shows a low prevalence of HAVS among respondents which is only 39.4%. The findings of this study demonstrate that the level of vibration from the Cantas machine was 5.24 m/s^2 (mean) and in an acceptable range. The recommended safety level for using Cantas is ranging from 1.82 -7.28 hours daily. The only matter on the rejection of Harvester to use Cantas machine was due to the ergonomic risk factor and ergonomics related issue of Cantas machine. The ergonomics risk factor mean score which include awkward posture, repetitive work and forceful tasks was 2.93 out of a maximum score of 4. The weight and maintenance was at high level, portability, ease of usage, efficiency and difficulty in learning how to operate Cantas machine was at a concern level.

6.2 Limitation of the study

There were several limitations to the design of this study. The study focused on the harvester that use Cantas machine design Advanced III only. Therefore, the findings from this group can only be generalized to populations with similar characteristics. The identification of HAVS and some other information were based on questionnaires without diagnosis by a physician. Therefore, the accuracy of research relied on the honesty and perception of respondents in answering the questionnaires. Data from the questionnaires could be subjected to respondent's recall bias. Sometimes the respondents have a tendency to overestimate or under estimate the symptoms.

Many studies related to the effect of vibrating tools have been done in other sector, such as construction (Su et al., 2009), mining (Futatsuka et al., 2005; Nyantumbu et al., 2005) and engineering (McGeoh and Gilmour, 2000). The focus on these sectors could be due to high magnitude of vibrating tool use, number of tools used and also the exposure duration. The effect of vibrating tools towards the health of workers in agriculture industry has been less attention than construction and mining, which limits the references.

It was difficult to determine the actual exposure accurately without interrupting the production. The workers need to do their task as usual without interruption. Any interruption can cause delay and needs to be avoided. The exposure estimates do not represent the actual exposure as cross sectional studied only consider the exposure at the particular time of measurement.

The willingness of the respondent to take part in the study was not encouraging as they already had put a bad perception on the Cantas machine. Particularly for estate plantation, mostly they do have the machine but the workers are not using the machine. They use the manual sickle to harvest. Despite, most of the buyer of Cantas machine is private owner of plantation, so it is very difficult to deal and make appointment as they could not give cooperation due to time constraints and cost constraints. Thus the number of respondent in this study is small compare to other study.



6.3 Recommendations

This study was undertaken as an attempt to identify the effect of using Cantas machine with the development of symptoms of HAVS among harvester. The recommendations to improve the study in future are undertaking many other aspects. One of the aspect is to increase the power of the study by increasing the number of respondents as well as through the cooperation and integration with all related agency in this field especially MPOB, distributor of Cantas machine and Agrobank. Thus with this integration we could come up with a better technovation of Cantas, tackle services work and also come out with better payment method alongside with the available subsidies on Agriculture industry. Besides, the Research and Development team from MPOB could come out with initiatives of developing new Genetic Modified palm oil tree through the use of Genetic Engineering technique. Genetic modification of plants which could be alter is by giving it new favorable characteristics which could ease the harvesting process as well as increasing the productivity and income. The characteristics are shorter tree for easier harvesting, more fruits yield from a tree for higher productivity and if possible the tree yield fruits at the bottom of the tree also for easier harvesting.

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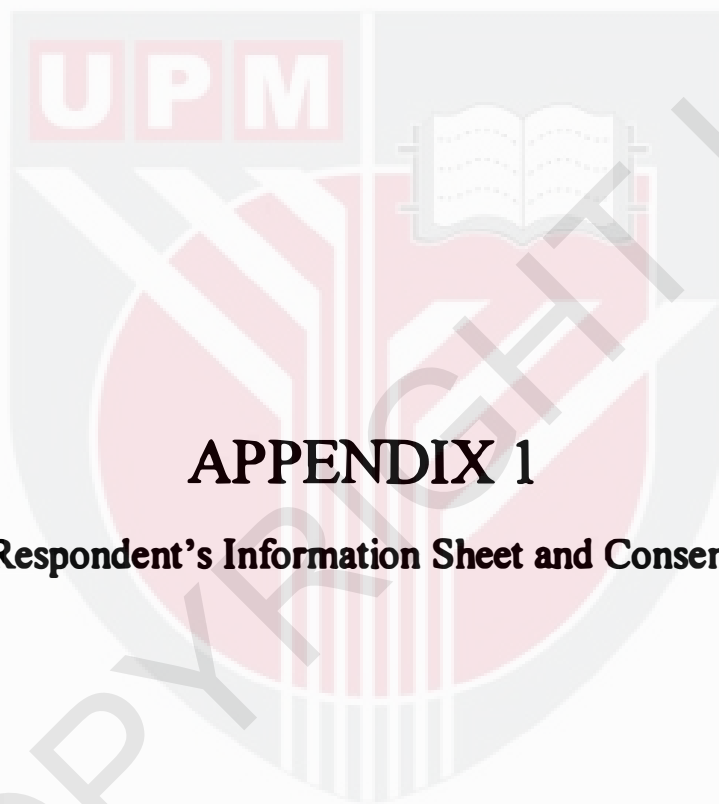
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APPENDIX 1

Respondent's Information Sheet and Consent

UPM



**JAWATANKUASA ETIKA UNIVERSITI UNTUK
PENYELIDIKAN MELIBATKAN MANUSIA (JKEUPM)
UNIVERSITI PUTRA MALAYSIA, 43400 UPM SERDANG,
SELANGOR, MALAYSIA**

FORM 2.4: LEMBARAN MAKLUMAT RESPONDEN DAN BORANG PERSETUJUAN

Sila baca maklumat berikut dengan teliti dan jangan teragak-agak untuk membincangkan sebarang soalan yang anda mungkin ada dengan penyelidik.

1. TAJUK KAJIAN

Hubungkait antara gejala getaran tangan di kalangan penuai minyak sawit dengan penggunaan mesin Cantas di Selangor

2. PENGENALAN:

Sejak diperkenalkan mesin 'Cantas' sebagai cara alternatif untuk menuai buah kelapa sawit pada tahun 2007, ramai petani kelapa sawit boleh menuai dua kali ganda sebelum menggunakan mesin 'Cantas'. Penggunaan mesin 'Cantas' di seluruh negara bersama dengan usaha pemerintahan untuk membantu subsidi RM1000 dari harga sebenar, mesin ini tidak diragukan lagi sebagai pilihan pertama petani. Soalan timbul sama ada mesin ini boleh menyumbang kepada getaran tangan kerana tiada kajian dilakukan untuk mengukur tahap getaran dan untuk menentukan tahap ambang. Tujuan penyelidikan ini adalah untuk menentukan kesan gejala getaran lengan tangan dari penggunaan mesin 'Cantas' di kalangan penuai buah tengah hari (FFB) minyak kelapa sawit di Selangor

3. APA YANG PERLU ANDA LAKUKAN?

Responden akan diminta mengisi borang kaji selidik. Borang kaji selidik perlu dipenuhi dengan maklumat mengenai data sosio-demografi, tempoh kerja, butiran kerja, dan tanda dan gejala-gejala berkenaan Sindrom Getaran Tangan Lengan. Kemudian, penyelidik akan mengukur tahap getaran yang dihantar kepada responden semasa mereka menggunakan mesin menggunakan alat HVM 100 (alat pengukur getaran). **Alat HVM 100 ini akan memberikan maklumat mengenai jumlah getaran yang terhasil daripada mesin Cantas seterusnya memberikan jumlah jam selamat untuk digunakan kepada responden selaras dengan regulasi getaran ISO 5349. Selain itu, alat pengukur genggam tangan juga akan digunakan untuk mengukur kekuatan genggam tangan responden. Kedua-dua alatan yang akan digunakan ini tidak memberi sebarang risiko kepada responden dan selamat dikendalikan. Penglibatan responden dalam kajian ini adalah secara sukarela dan tidak dipaksa sekiranya responden bercadang untuk tidak melibatkan diri dalam kajian.**

4. SIAPA YANG TIDAK AKAN TERLIBATR DENGAN PENGKAJIAN?

Peserta yang memenuhi kriteria ini:

- a. Pekerja perempuan
- b. Kurang daripada satu tahun pengalaman bekerja menggunakan mesin Cantas

5. APAKAH MANFAAT PENGKAJIAN INI?

(a) KEPADA ANDA SEBAGAI SUBJEK?

Responden boleh mencegah dari perkembangan atau berterusan dari sindrom getaran lengan tangan. Responden juga boleh mengetahui status kesihatan mereka

sebagai tindakan penyelidikan ini sebagai pemeriksaan kesihatan awal. Responden juga akan mendapat manfaat dalam membuat cadangan tingkah laku yang selamat di tempat kerja.

(b) KEPADA PENYELIDIK?

Penyelidik berharap bahawa penemuan kajian ini akan menyediakan data berasaskan bukti mengenai persatuan gejala getaran tangan di kalangan penuai minyak sawit dengan penggunaan mesin Cantas. Boleh membantu sebagai rujukan baru pada mesin 'Cantas'. Selain itu, dapat membantu mengintegrasikan penemuan baru untuk meningkatkan teknologi pada mesin 'Cantas' dan menggalakkan keberhasilan penerapan teknologi di kalangan pekerja.

6. APAKAH POTENSI RISIKO MENGIKUTI KAJIAN INI?

Tidak ada kemungkinan risiko fizikal jika mengambil bahagian dalam kajian ini

7. ADAKAH MAKLUMAT YANG ANDA BERIKAN DAN IDENTITI ANDA AKAN KEKAL SULIT?

Semua maklumat dan informasi yang disediakan oleh responden akan kekal sulit

8. SIAPA YANG HARUS ANDA HUBUNGI JIKA ANDA TERDAPAT SEBARANG PERTANYAAN TAMBAHAN SEMASA KURSUS PENYELIDIKAN?

Sekiranya anda mempunyai sebarang pertanyaan, anda boleh menghubungi penyelidik yang bertanggungjawab terhadap kajian atau penyelia penyelidikan ini.

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Sila tandatangan di sini_____ jika faham tentang isi kandungan kajian ini_____

9. PERSETUJUAN

Saya No. Kad Pengenalan alamat

..... .. dengan ini secara sukarela bersetuju untuk mengambil bahagian dalam penyelidikan yang dinyatakan di atas * (percubaan klinikal / ubat / rakaman video / kumpulan fokus / berasaskan temubual / soal selidik).

Saya telah dimaklumkan mengenai sifat penyelidikan dari segi metodologi, yang mungkin buruk kesan dan komplikasi (seperti yang tertulis dalam Lembaran Maklumat Responden). Saya faham bahawa saya mempunyai hak untuk menarik diri dari penyelidikan ini pada bila-bila masa tanpa memberi apa-apa sebab. Saya juga faham bahawa kajian ini adalah rahsia dan semua maklumat yang diberikan berkenaan dengan identiti saya akan kekal peribadi dan sulit.

Saya (* ingin / tidak ingin tahu) hasil yang berkaitan dengan penyertaan saya dalam penyelidikan

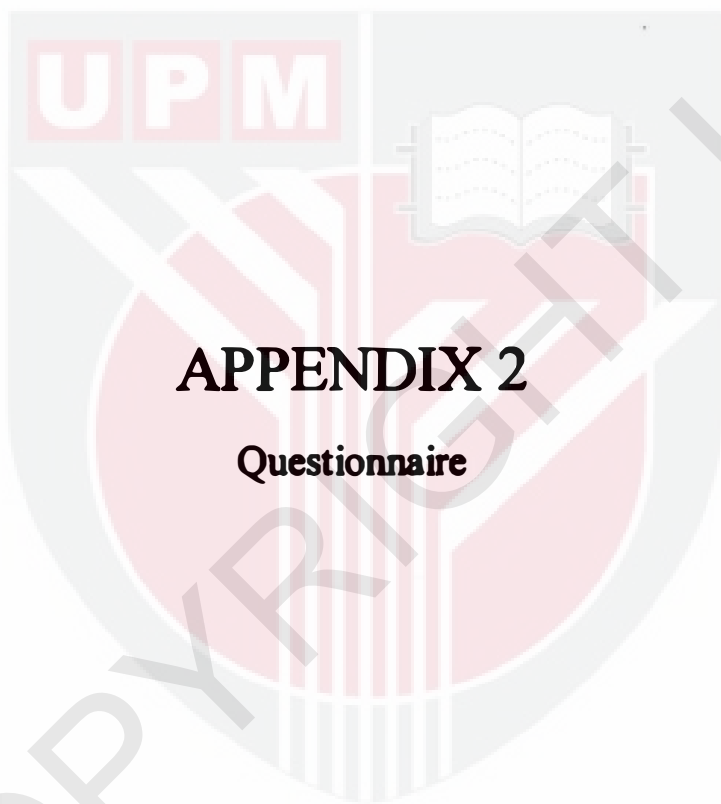
Saya (bersetuju / tidak bersetuju) bahawa rakaman imej / gambar / video / rakaman suara yang berkaitan dengan saya digunakan dalam sebarang bentuk penerbitan atau pembentangan (jika berkenaan)

**Tandatangan: Tandatangan:
(Responden) (Saksi)**

Tarikh : Nama :

Saya mengesahkan bahawa saya telah menjelaskan kepada responden mengenai sifat dan tujuan penyelidikan yang disebutkan di atas.

**Tarikh: Tandatangan
(Penyelidik)**



APPENDIX 2

Questionnaire

UPM

NO.
RESPONDEN

SOAL SELIDIK KAJIAN SINDROM GETARAN TANGAN-LENGAN

BAHAGIAN A : BUTIRAN DIRI

KAJIAN SINDROM GETARAN TANGAN- LENGAN	
1. Nama:	
2. No Tel.(hp):	
3. Umur	
4. Kewarganegaraan	
5. Pengalaman bekerja	a) () < 5 tahun b) () 5-10 tahun c) () 11-20 tahun d) () 21-30 tahun e) () > 30 tahun
6. Bangsa:	a) () Melayu b) () Cina c) () India d) () Others
7. Tahap pendidikan:	a) () Rendah b) () Menengah c) () Sijil d) () Tinggi (Diploma, Ijazah)
8. Tangan Dominan	a) () Kanan b) () Kiri

BAHAGIAN B : SEJARAH PEKERJAAN

1. Majikan anda sekarang :	
2. Berapa lamakah anda telah bekerja dengan majikan sekarang (tahun):	
3. Adakah anda pernah bekerja di Syarikat lain sebelum ini?	0. () Tidak 1. () Ya Jika ya , sila nyatakan jangkamasa (tahun): _____
4. Adakah pekerjaan anda sebelum ini melibatkan penggunaan alatan tangan yang bergetar?	0. () Tidak 1. () Ya Jika ya , sila nyatakan jenis peralatan yang digunakan: _____
5. Apakah alatan tangan bergetar yang anda gunakan di dalam pekerjaan anda sekarang?	1. () CKAT ADVANCED 2. () CANTAS 3 3. () CANTAS 5 4. () CANTAS 6
6. Kekerapan penggunaan	_____ (Jam/ hari) _____ (Hari / 1minggu)
7. Berapa kerapkah peralatan tersebut diselenggara?	1. () Setiap minggu 2. () Setiap bulan 3. () Setiap setahun
8. Apakah anda bekerja mengikut shift?	0. () Tidak 1. () Ya
9. Adakah anda kerap melakukan kerja lebih masa?	0. () Tidak 1. () Ya Jika ya , berapakah purata jumlah kerja lebih masa anda dalam seminggu? _____

BAHAGIAN C : SEJARAH SOSIAL

1. Adakah anda pernah merokok?	0. () Tidak 1. () Ya
2. Adakah anda telah berhenti merokok?	0. () Tidak 1. () Ya Jika ya, berapa lama : _____
3. Adakah anda mengambil minuman beralkohol?	0. () Tidak 1. () Ya
4. Adakah anda mempunyai kerja sampingan di luar waktu kerja anda yang menggunakan peralatan tangan bergetar melebihi satu jam seminggu?	0. () Tidak 1. () Ya

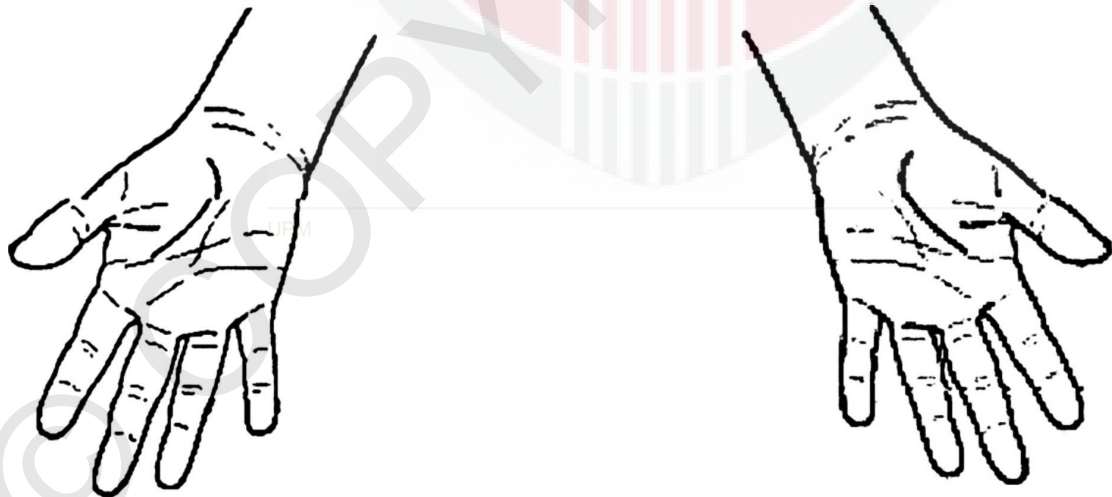
BAHAGIAN D : FAKTOR RISIKO ERGONOMIK

1. Berapa kali dalam satu hari anda bekerja dengan keadaan lengan anda meregang ke Hadapan atau ke belakang tanpa sokongan atau melebihi ketinggian bahu?	0. () Tiada 1. () 1 hingga 10 2. () 10 hingga 50 3. () Melebihi 50
2. Berapa kalikah di dalam satu hari anda bekerja dengan keadaan lengan dan tangan anda : a. Bergerak memusing berulang (repetitive twisting movement) b. Menekan dengan kuat (forceful movement) c. Posisi tangan / genggamaman tidak selesa	0. () Tiada 1. () 1 hingga 10 2. () 10 hingga 50 3. () Melebihi 50 0. () Tiada 1. () 1 hingga 10 2. () 10 hingga 50 3. () Melebihi 50 0. () Tiada 1. () 1 hingga 10 2. () 10 hingga 50 3. () Melebihi 50

BAHAGIAN E : SIMPTOM

1. Warna jari keputihan (whiteness) – Sila tandakan (√/×)	
a. Pernahkah anda mengalami apa-apa perubahan warna pada jari –jari anda pada bila-bila masa? jika (X), sila terus ke Soalan No. 2 jika (V), sila jawab soalan seterusnya	
b. Jikalau anda pernah mengalami warna jari bertukar keputihan, adakah perbezaan warna tersebut mempunyai garisan sempadan yang jelas?	
c. Pada pendapat anda, adakah perubahan warna jari kepada keputihan disebabkan oleh penggunaan alatan tangan bergetar?	
d. Adakah keadaan ini mengganggu kegiatan kerja anda?	
e. Adakah kejadian jari keputihan terjadi secara berterusan?	
f. Jari manakah yang mengalami warna keputihan? (Sila tandakan pada bahagian jari berkenaan pada rajah di bawah)	
tangan kanan  tangan kiri 	

2. Rasa menyucuk-nyucuk (tingling) - (Sila tandakan (√/×))	
a) Pernahkah anda mengalami keadaan di mana jari-jari anda berasa menyucuk – nyucuk sedikit seperti cucukan pin dan jarum? Jika (X), sila terus ke Soalan No. 3, jika (√), sila jawab soalan seterusnya	
b) Pada pendapat anda, adakah kejadian menyucuk-nyucuk ini disebabkan oleh penggunaan alatan tangan bergetar?	
c) Adakah keadaan ini mengganggu kegiatan masa lapang anda?	
d) Adakah keadaan ini mengganggu kegiatan kerja anda?	
e) Adakah serangan jari terasa menyucuk-nyucuk ini berterusan?	
f) Jari manakah yang mengalami perasaan menyucuk-nyucuk? (Sila tandakan pada bahagian jari berkenaan pada rajah di bawah) tangan kanan  tangan kiri 	

3. Rasa kebas (numbness) - [Sila tandakan (√/×)]	
a) Pernahkah anda mengalami keadaan di mana jari-jari anda berasa kebas? Jika (X), SOAL SELIDIK INI TAMAT DI SINI Jika (√), sila jawab soalan seterusnya.	
b) Pada pendapat anda, adakah kejadian rasa kebas pada jari ini disebabkan oleh penggunaan alatan tangan bergetar?	
c) Adakah keadaan ini mengganggu kegiatan masa lapang anda?	
d) Adakah keadaan ini mengganggu kegiatan kerja anda?	
e) Adakah serangan jari merasa kebas ini berterusan?	
f. Jari manakah yang mengalami rasa kebas? (Sila tandakan pada bahagian jari berkenaan pada rajah di bawah)	
tangan kanan tangan kiri 	

BAHAGIAN F : LAMPIRAN HASIL UJIAN

- 1. Berat : _____
- 2. Tinggi : _____
- 3. Terdapat sebarang simptom HAVS?

White finger (Jari keputihan)		Numbness (Kebas)	
Tingling (Menyucuk - nyucuk)		No Symptoms	

(*Sebarang 2 = 1, no symptom = 0)

- 4. Pemeriksaan visual pada jari.

- 5. Adakah anda memandu ke tempat kerja?

0. Tidak

1. Ya

Jika ya, apakah jenis knderaan anda, sila nyatakan:

A) Maklumat Peralatan alat kuasa (power tools)

Perkara	
Model	
Berat	
Jangka hayat	

B) Magnitud percepatan alat:

Alat kuasa	Hasil Pengukuran Magnitud Pecutan HAV						
	Paksi (versi diperbetulkan)				Durasi (saat)	ahw (m/s2)	ahw (8) (m/s2)
	X:						
	Y:						
	Z:						
	Jumlah:						

BAHAGIAN G : PANDANGAN MENGENAI ISU ERGONOMIK BERKENAAN MESIN

Isu Ergonomik	Skor (Tanda (/) pada yang berkenaan)				
	1	2	3	4	5
a) Kebaikan					
1.Mudah digunakan					
2.Mudah alih					
3.Ketahanan					
4.Kecekapan					
5.Ketersampaian					
b) Kelemahan					
6.Penjagaan					
7.Berat					
8.Mudah dipelajari					

Nota: Nilai skor dalam urutan meningkat bermula 1 hingga 5. Bagi soalan bahagian (a) , semakin tinggi nilai skor menunjukkan semakin baik manakala, bagi soalan bahagian (b) semakin rendah nilai skor menunjukkan semakin baik.

SEKIAN, TERIMA KASIH ATAS KERJASAMA ANDA.



APPENDIX 3
Ethical Committee Approval UPM

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

Research title	: Association of Hands Arm Vibration Symptoms Among Palm Oil Harvester with The Usage of Cantas Machine in Selangor
Study Site	: Selangor
JKEUPM Ref No.	: JKEUPM-2018-452
Researcher	: Mohd Noraiman bin Mohd Fadzi
Supervisor	: Prof. Dr. Shamsul Bahri bin Hj Mohd Tamrin

Documents received and reviewed with reference to the above study:

1. Ethics Application Form, Version 1 dated 27/12/2018
2. Respondent Information Sheet & Consent (English), Version 2 dated 25/2/2019
3. Proposal (English), Version 2 dated 25/2/2019
4. Questionnaires/ Interviews (English), Version 1 dated 27/12/2018
5. Curriculum Vitae of:
 - a. Prof. Dr. Shamsul Bahri bin Hj Mohd Tamrin

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

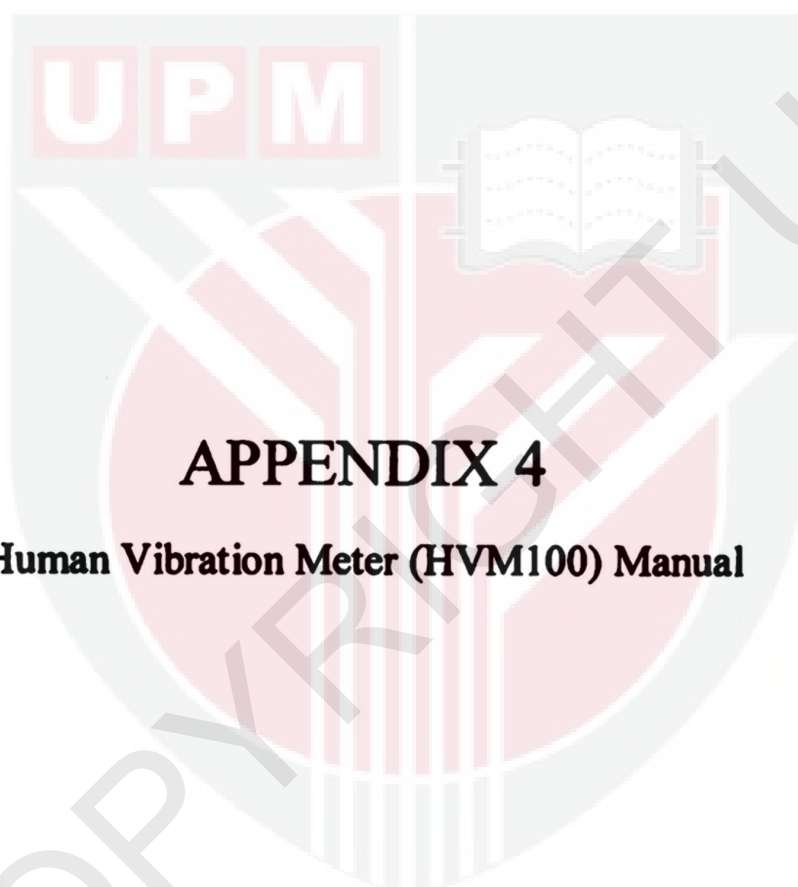
Decision by JKEUPM:

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

Please note that the approval is **VALID UNTIL 14 MARCH 2020**

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.



APPENDIX 4

Human Vibration Meter (HVM100) Manual

Model HVM100
Human Vibration Meter
Manual



LARSON DAVIS
A PCB PIEZOTRONICS DIV.