UNIVERSITI PUTRA MALAYSIA

MISMATCH OF HARVESTING TOOL DIMENSIONS WITH ANTHROPOMETRIC PARAMETER AMONG PALM OIL WORKERS IN JOHOR.

BY
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ABSTRACT

MISMATCH OF HARVESTING TOOL DIMENSIONS WITH ANTHROPOMETRIC PARAMETERS AMONG OIL PALM WORKERS IN JOHOR.

MOHD AFIQ BIN ISMAIL

Introduction: A cross-sectional study of mismatch between harvesting tool dimensions with anthropometric parameters was done among 145 oil palm workers who use harvesting tool when working. **Objective**: The objective of this study is to determine the mismatch of harvesting tool dimensions with anthropometric parameters. **Methodology**: The purposive sampling method was used to select the respondents based on the inclusive criteria such as male worker, age between 18 to 60 years old and working using harvesting tool. 145 male harvesters were selected to participate in this study. A set of questionnaire consist of 3 parts, social demographic and background information, selected parameters of tool and selected anthropometric data of worker's was administered by interviewing the workers. SECA body meter was used to measure the stature of respondent to match with the length of handle. Then circumference of handle was matched with internal grip circumference of workers measured using wooden cone and measuring tape. All measurements were recorded in centimeter (cm). Socio-demographic data were analyzed using descriptive analysis. Descriptive analysis also was used to determine the mismatch between harvesting tool dimensions with anthropometric parameters. **Results**: The results showed means (SD) for stature was 161.96 (6.03) cm and 14.18 (0.93) cm for internal grip circumference. Then for harvesting tool dimensions, mean (SD) for length of handle was 174.18 (8.43) cm and since the circumference of handle was constant, the mean was 9.2 cm. There was high mismatch between length of handle with stature (93.8%) and circumference of handle with internal grip circumference (100%). **Conclusions**: There was high mismatch of current harvesting tool dimensions with anthropometric parameters. The study showed that the proposed dimensions of harvesting tool have a low mismatch with selected anthropometric parameters.

Keywords: Harvesting tool, Anthropometric parameters, Internal grip diameter, Length of handle, Circumference of handle, Mismatch

ABSTRAK

KETIDAKSESUAIAN CIRI-CIRI ALAT PENUAI DENGAN PARAMETER ANTROPOMETRIK DI KALANGAN PEKERJA LADANG SAWIT DI JOHOR.

MOHD AFIQ BIN ISMAIL

Pengenalan: Satu kajian keratan rentas telah dijalankan dikalangan 145 orang pekerja ladang kelapa sawit yang menggunakan alat untuk menuai. **Objektif**: Obejktif kajian ini adalah untuk menentukan ketidaksesuaian diantara dimensi alat tuaian dengan parameter anthropometrik. **Kaedah**: Persampelan bertujuan telah digunakan untuk memilih responden berdasarkan kriteria-kriteria tertentu iaitu pekerja lelaki, berumur diantara 18 hingga 60 tahun dan bekerja menggunakan alat tuaian. Terdapat 145 penuai telah dipilih untuk menyertai kajian ini. Satu set boring kaji selidik yang mengandungi 3 bahagian iaitu, maklumat latar belakang dan sosial, dimensi alat tuaian tertentu dan data anthropometrik pekerja yang dikawal selia dengan menemu bual pekerja. Meter ukur badan SECA telah digunakan untuk mengukur ketinggian responden untuk disesuaikan dengan panjang pemegang. Ukur lilit pemegang yang disesuaikan dengan ukur lilit genggaman dalaman pekerja diukur menggunakan kon dan pita pengukur. Semua ukuran direkodkan dalam unit centimeter (cm). Taburan data demograpik telah dianalisa dengan menggunakan analisis diskriptif. Analisis diskriptif juga digunakan untuk menentukan ketidaksesuaian diantara dimensi alat tuaian dengan parameter antropometrik. Keputusan: **Keputusan** menunjukkan purata (sisihan piawai) untuk ketinggian adalah 161.96 (6.03) cm dan 14.18 (0.93) cm ukur lilit genggaman dalaman. Seterusnya, untuk dimensi alat tuaian, purata (sisihan piawai) untuk panjang pemegang adalah 174.18 (8.43) cm dan disebabkan nilai ukur lilit pemegang adalah tetap, maka purata adalah 9.20 cm. Terdapat ketidaksesuaian yang tinggi bagi panjang pemegang dengan ketinggian (93.8%) dan ukur lilit pemegang dengan ukur lilit genggaman dalaman (100%). **Kesimpulan**: Terdapat ketidaksesuaian yang tinggi bagi alat tuaian yang digunakan sekarang dengan parameter antropometrik. Kajian menunjukkan dimensi alat tuaian yang dicadangkan mempunyai ketidaksesuaian yang rendah dengan parameter antropometrik yang tertentu.

Kata kunci: Alat tuaian, Parameter antropometrik, Ukur lilit genggaman dalaman, Panjang pemegang, Ukur lilit pemegang, Ketidaksesuaian

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BMI	Body Mass Index
SPSS	Statistical Package for the Social Sciences
cm	centimeter

CHAPTER 1

INTRODUCTION

1.1 Title

Mismatch of harvesting tool dimensions with anthropometric parameters among oil palm workers in Johor.

1.2 Oil palm industry in Malaysia

In 2008, Malaysia produced 17.7 million tonnes of palm oil and was the second largest producer of palm oil, employing more than 570,000 people.

Malaysia is the world's second largest exporter of palm oil. About 60% of palm oil exports from Malaysia are shipped to China, the European Union, Pakistan, United States and India. They are mostly made into cooking oil, margarine, specialty fats and oleochemicals.

The palm oil industry in Malaysia is organized around four segments. The plantations segment includes seed nursery, planting, harvesting, collecting and milling. The second segment includes refining, bulking and trading activities. The remaining two downstream segments are non-food downstream as well as food and health-based downstream. As of 2009, Malaysia has 4.7 million hectares of oil palm plantations, 416 mills, 43 crushers, 51 refineries, 18 oleochemical plants and 25 biodiesel plants. The industry is dominated by large plantation companies (private- and government-linked companies) which hold 60 percent of total plantation land, with a growing level of integration along the value chain.

Harvesting involves the cutting of the bunch from the tree and allowing it to fall to the ground by gravity. Fruits may be damaged in the process of pruning palm fronds to expose the bunch base to facilitate bunch cutting. As the bunch (weighing about 25 kg) falls to the ground the impact bruises the fruit. During loading and unloading of bunches into and out of transport containers there are further opportunities for the fruit to be bruised. The tools being used for harvesting were sickle, palm oil harvesting knives and chisels.

However harvesting is highly physical demanding, arduous and requires extremely high energy in performing their tasks. Hence, this poses farm workers to potential risk of health problems caused by physical hazards, chemical hazards, biological hazards, psychosocial hazards and ergonomic hazards. Ergonomic hazards poses variety of musculoskeletal symptoms (MSS) encompasses the neck, low back pain, osteoarthritis of the hip and knee, upper limb complaints and hand-arm vibration syndrome (Barregard et al., 2003).

The National Institute for Occupational Safety and Health (NIOSH) recognizes that "ergonomics" is a wide-ranging term with various applications. NIOSH has recommended that the term "ergonomic disorders" be replaced with the term "work related musculoskeletal disorders (MSD's)". Example of MSD's including Carpal tunnel syndrome, Trigger finger, De Quervain's disease etc. There are many symptoms associated with MSD's including numbness, tingling, cramping, pain etc (Clagget, 2002). Overall tasks of cutting the bunch would expose harvesters to ergonomics risk factors such as repetitiveness, awkward postures, static muscle loading and forceful exertion (Zhong, 2003). Among the ergonomic factors present in cutting oil palm bunch process include age of the trees, number of area being cut, uneven ground and technique of performing the cutting. However, the main risk factors for MSD's are hands held in fixed position over long periods; repetitive exertions and motion with flexed or hyperextended hand or wrist; pressure at the base of the palm; persistent strain, gripping, jolting, vibration; forearm pronation or supination; and extreme hand and wrist postures (Armstrong and Silverstein, 1987). In addition, psychosocial hazards such as low job dissatisfaction, supervisor rating, psychological demands, decision latitudes and social support were the factors to cause sick leave or disability due to MSDs (Hartman et al., 2006). These hazards were overlooked as the main cause of MSDs.

The proper matching of machine requirements with the human capabilities is basically necessary for optimum performance of man–machine system. For efficient design/design refinement of machinery/equipment, it is necessary to follow the guidelines and principles of ergonomics, which provide an orientation towards physiological and psychological needs of operators. The design of equipment is always a compromise between the operator's biological needs, which are determined by the ergonomics guidelines, and physical requirements of the machinery/equipment (Das and Grady, 1983; Das and Sengupta, 1996).

1.3 Problem statement

Chisel and sickle have been used for a long time in the history of agriculture. Today, it is still the most common farm tools in agriculture and gardening. Oil palm workers and gardeners constantly use chisel and sickle to cut the bunch of fruit from trees. However, many chisel and sickle handle are not ergonomically designed and require wrist bending, body bending, awkward posture, etc. These factors may cause unexpected injuries, such as carpal tunnel syndrome and musculoskeletal disorder. These injuries are not only painful and may take a long time to cure but also cost a significant amount of money for medical care.

Poor ergonomic hand tool design is a well known factor contributing to biomechanical stresses and increasing the risk of cumulative trauma and carpal tunnel syndrome disorders of workers (Steve, 2002). In this context the hand dimensions is required. Hand anthropometry is useful for determining various aspects of industrial machineries (Claudia et al., 1999) so as to design the equipment and machines for better efficiency and more human comfort. For optimum performance of man–machine system, the proper matching of machine requirements with the human capabilities is necessary. For efficient design or design refinement of equipment, it is necessary to follow the guidelines and principles of ergonomics, which provide an orientation towards physiological and psychological needs of operators. The design of equipment is always a compromise between the operator's biological needs, which are determined by the ergonomics guidelines, and physical requirements of the equipment (Buchholz et al., 1991).

To design any product for human use, human factors engineers/ergonomists have to rely on anthropometric data, otherwise the output product may turn out to be non-ergonomically designed product or the product may turn out to be ergonomically incompatible (Haslegrave, 1986).

1.4 Study justification

No study has been conducted on the mismatch of harvesting tool dimensions with the anthropometric parameters in Malaysia. This study was done to determine the mismatch between harvesting tool dimensions with anthropometric parameters and also to propose the proper measurement that match the workers anthropometry's especially for South East Asian workers. This study is important as the mismatch may lead to much bad risk to the oil palm workers. Usually people are not aware on the importance of matching the harvesting tools with the oil palm workers. But as the result, it may influence the workers' performance and also the side effects they may have in the future.

Besides, the data from this study can be used in the design and/or design modification of harvesting tools to be operated by oil palm workers particularly in Malaysia particularly. Moreover, this study will identify the mismatch of harvesting tools used in the palm oil plantations in Johor that may affect the work performance of the workers and also might cause some health problems due to it.

In designing the harvesting tool, poor design of handle can cause mismatch of handle with operator's hand. The mismatch will cause symptoms associated with MSD's, so the process of designing and selecting the hand tools to provide a better fit for the user lies on the shoulders of human factor engineers.

1.5 Conceptual framework

Figure 1.1 shows the conceptual framework or the overall study problem. This can be used to assist and guide the researcher in implementing the study. Besides, the aim of this study to determine the mismatch between harvesting tool dimensions with anthropometric parameters among oil palm workers in Johor.

From the figure, there were two elements to study, which is harvesting tool dimensions and anthropometric parameters. Harvesting tool dimensions comprise of length of handle and circumference of handle. Then for anthropometric parameters, there were internal grip circumference and stature. Both elements, which are anthropometric parameters and harvesting tool dimensions, were match to each other. Length of handle matched with stature and circumference of handle matched with internal grip circumference.

Then, based on the matching process between harvesting tool dimensions with anthropometric parameters, the mismatch can be determined. If there was mismatch, the respondent will have symptoms associated with musculoskeletal disorders (MSD's) including numbness, tingling, cramping, pain at finger. If there was match between respondent anthropometric with harvesting tool dimensions, it can affect respondent's physiological satisfaction and thus can increase the work and activities performance.

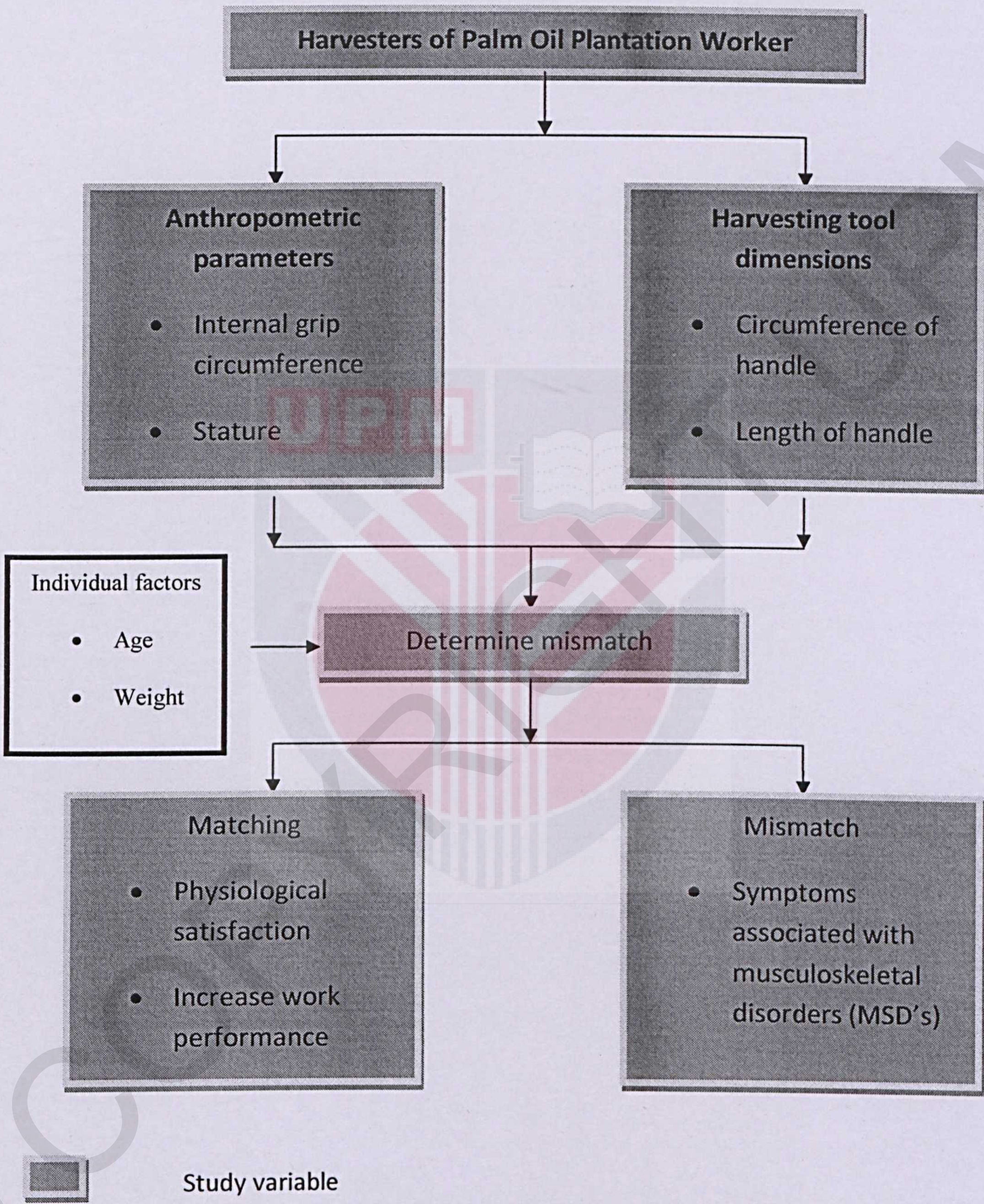

Figure 1.1: Conceptual Framework of mismatch between harvesting tool dimensions with anthropometric parameters

1.6 Research objective

1.6.1 General objective

To determine the mismatch between harvesting tool dimensions and anthropometric parameters of oil palm workers in Johor.

1.6.2 Specific objective

i. To study the socio-demographic data of oil palm workers in Johor.

ii. To determine the comfort score of respondents when using the harvesting tool.

iii. To determine the prevalence of health effects on the upper body of oil palm workers in Johor using harvesting tools.

iv. To measure the selected anthropometric parameters (internal grip circumference, stature) of oil palm workers in Johor.

v. To measure the harvesting tools dimensions (length of handle, circumference of handle) in palm oil plantations in Johor.

vi. To determine the mismatch of harvesting tool dimensions with the selected anthropometric parameters of oil palm workers.

vii. To propose a new harvesting tool dimension based on oil palm workers anthropometric data.

viii. To determine the mismatch between the proposed harvesting tool dimensions with the selected anthropometric parameters.

1.7 Hypothesis

i. There is mismatch between harvesting tools and anthropometric data among oil palm workers in Johor.

1.8 Conceptual definition

i. Internal grip circumference

Maximum inner curvature of the hand at the touching level between tip of the middle finger and thumb.

ii. Stature

The distance from the bottom of the feet to the top of the head in a human body standing erect.

1.9 Operational definition

i. Internal grip diameter

Subject rests his hand on a cone and maximum inner curvature of the hand at the touching level between tip of the middle finger and thumb was recorded. This process was repeated three times and the average was calculated.

ii. Stature

The subjects were asked to stand on a flat surface with their feet closed and body erect while heels, buttocks and shoulders touched the same vertical plane then the height scale SECA body meter was adjusted according to the height of the subject.

CHAPTER 2

LITERATURE REVIEW

2.1 Anthropometry

Anthropometry is the study of the measurement of the human body. Anthropometric data can vary considerably between regional populations. For example, Scandinavian populations tend to be taller, while Asian and Italian populations tend to be shorter. The proper matching of machine requirements with the human capabilities is basically necessary for optimum performance of man–machine system. For efficient design of equipment, it is necessary to follow the guidelines and principles of ergonomics, which provide an orientation towards physiological and psychological needs of operators. The design of equipment is always a compromise between the operator's biological needs, which are determined by the ergonomics guidelines, and physical requirements of the equipment (Das and Grady, 1983; Das and Sengupta, 1996). In this regard, the basic information required is the anthropometric body dimensions of the users of tools and equipments.

2.2 Hand preference

Anthropometric studies have revealed that, in a comparison of the two halves of the body, the values belonging to the right half are different than those of the left half (Laubach et al., 1967; Schell et al. 1985). It is believed that this dissimilarity arises from hand dominance (Ulijazsek et al. 1994). Neumann (1992) has determined right upper extremity length, width and circumference to be significantly higher than the corresponding left upper extremity values. The dominant hand was significantly stronger than the opposite hand, but also fatigued more rapidly. This trend was more pronounced in females than in males.

2.3 Gripping

When gripping an object, the hand exerts a force resulting in a pressure on the hand. This is significant for gripping actions with the fingers which require simultaneous external forces acting upon two or more segments of each of the fingers as they cooperate to produce the desired function (Amis, 1987).

The power grip describes a posture for which the hand is used in an activity where the application of power and/or stability is of primary importance and the need for precision is secondary. This type of grip will be considered in the present work. Industrial workstations with manually-operated machinery and hand tools, such as hammers or power drills, are examples of tools for which a user assumes a power grip.

There are a number of situations in which maximal hand-grip strength references are needed. Maximal grip strength (MGS) has been shown to be a good indicator of overall upper-limb strength (Bohannon, 1998, 2004) or even of the whole neuromuscular system function (Chan et al., 2008). Hand-grip strength is also known to be associated with ability to perform daily living activities (Nybo et al., 2001).

Frederiksen et al. (2002) concluded that "grip strength is a suitable phenotype for identifying genetic variants of importance to mid- and late-life physical functioning". Most of the prediction regression models for MGS use gender, age, weight and/or height either in children, in adults or in aging people (Niempoog et al., 2007; Gunther et al., 2008)

2.4 Health related effect of using hand tool

Overuse injuries such as carpal tunnel syndrome, cumulative trauma disorders (CTDs), musculoskeletal disorders, etc. have been widely documented and represent a significant problem to the Malaysian industries (SOCSO, 1998). Whether these injuries resulted from a single over exertion or micro-trauma over a period of time, the direct and indirect costs of the disorders are very high, causing significant losses in terms of medical costs and poor work rate. Most of these injuries that may be caused by using the tools or workstations are significantly related to manual materials handling. One of the most effective methods to control these injuries due to manual material handling is ergonomics job design (Dempsey, 1998). In order to design a tool or job ergonomically, strength and fitness tests have to be conducted. Grip strength evaluations will reveal mismatches between job demands and capacity of healthy workers.

Carpal tunnel syndrome (CTS), an entrapment of the median nerve at the wrist, is the most commonly encountered neuropathy causing disability (Mondelli M, 2002; Nordstrom, 1997). There has been much debate over the last few decades as to whether it is an occupationally caused or personally attributed syndrome that plays a major role in the development of CTS and in the prevention of the condition (Nordstrom, 1997; Burt, 1999). Many physical factors such as repetitive stress, repetitive bending or twisting of the hands and wrist at work, the use of vibrating tools and physical injury have been noted as occupational risk factors for CTS (Burt, 1999). Personal risk factors associated with CTS are female gender, age, race, pregnancy and various medical conditions including thyroid disease, diabetes, amyloidosis and connective tissue disorders ((Nordstrom, 1997; Karpitskaya, 2002; Kouyoumdjian, 2002).

Past research (Mital, 1991) indicated that tool design may play significant role in the development of work-related disorders in the hand and forearm.

Cumulative trauma disorders (CTS's) reported from hand tool use include nerve entrapment (particularly carpal tunnel syndrome), epicondylitis, peritendinitis of the forearm and tenosynovitis in the wrist and fingers (Kurppa et al., 1979; Armstrong et al., 1982).

The relation between various dimensions of the upper limb like arm, forearm, finger and phalanges and stature has been reported in the numerous related studies.Cumulative trauma, fatigue and biochemical stress resulted from anthropometrically unadapted manual tools and implements to musculoskeletal injuries and disorders. (Sande et al., 2001; Mirka et al., 2002; Boyles et al., 2003)

Studies by Imrhan and Farahmand, (1999) and Radwin et al., (2002) showed that there was a relationship between musculoskeletal injuries and disorders resulting from cumulative trauma and occupational risk factors. It was supported in biomechanics, which relates the Hand Anthropometry (HA) of an individual with the mechanical demands associated with the use of a hand tool.

Hands held in fixed position over long periods; repetitive exertions and motion with flexed or hyper extended hand or wrist; pressure at the base of the palm; persistent strain, gripping, jolting, vibration; forearm pronation or supination; and extreme hand and wrist postures, were risk factors accounting for upper limb cumulative trauma disorder (CTD) (Armstrong and Silverstein, 1987).

2.5 Tools design

The design of safe tools and implements requires anthropometric data as an essential input. In sum, this information is considered a fundamental reference for those involved in the development and manufacture of manual tools and in the selection of appropriate manual implements for specific tasks and populations (Norris and Wilson, 1997).

There are a number of variables and guidelines that must be considered in designing of hand tools (Chang, 1991). These are mainly based on biomechanical principles and include such factors as shape, size, weight, length, thickness, and texture (Chaffin and Anderson, 1991). The few studies that have examined tool handles have primarily looked into force production as a function of the shape of the handle (Cochran, 1988), the type of surface (Lewis, 1987) or the type of texture (Pheasan and OÕNeil, 1975).

Although it is impossible to eliminate all injury potential, many fairly simple design modifications can change an otherwise unsafe tool into a relatively safe one (Woodson, 1981).

For efficient design or design refinement of equipment, it is necessary to follow ergonomics guidelines and principles, which provide an orientation towards physiological and psychological needs of operator. The design of equipment is always a compromise between the operator's biological needs, which are determined by the ergonomics guidelines, and physical requirements of the equipment (Das and Grady, 1983; Das and Sengupta, 1996). Konz (1986) examined bent hammer handles, suggesting that when a tool gripped with a power grip has its working part extended above the hand, and then a curve in the handle may be beneficial.

The size of the grip span of a hand-powered tool has been hypothesized as a ''critical'' factor not only contributing to the CTD risk factors but also performance of the workers (Eksioglu, 1996, 1999).

The use of hand tools that fit users' characteristics is essential for task productivity and prevention of musculoskeletal disorders in industry. An understanding of factors that influence power hand tool operation can be used for establishing safe power hand tool operation conditions and for developing better power hand tool ergonomic guidelines.

2.6 Mismatch

Mismatches between human anthropometric dimensions and equipment dimensions are known to be a contributing factor in decreased productivity, discomfort, accidents, biomechanical stresses, fatigue, injuries, and cumulative traumas. Incorrect workplace design where anthropometric data are ignored can cause psychological discomfort, physical fatigue and could be harmful and damaging in the long term. Therefore, anthropometric data are an essential condition to the design of safe, comfortable and effective machines, tools and workplaces (Das and Grady, 1983; Das and Sengupta, 1996).

2.7 Comfort

Grip strength should be considered when tasks are designed in an effort to minimize or eliminate discomfort and injuries of the upper extremities. Studies (Kilbom et al., 1993; Chang et al., 1999; Dempsey et al., 2002) show less discomfort was experienced by using appropriately designed hand tools. This is important as discomfort can lead to musculoskeletal problems on a longer term (Proper et al., 1999). Discomfort in hand tool use seems to be inversely related to productivity (Dempsey et al., 2002; Wu and Hsieh, 2002) and may also reduce job satisfaction (Fellow and Freivalds, 1991). For those reasons, the avoidance of discomfort has been a crucial issue in hand tool design for many years (Dempsey et al., 2004; Kong and Freivalds, 2003; You et al., 2005).

In recent years, approaches have changed and new notions of increased comfort and reduced biomechanical loads with regard to users' functional capacities have been introduced into tool design (Aptel et al., 2002). In the past, the tool was designed to respond to the needs of the greatest possible number of users and had to be as cheap as possible (Aptel et al., 2002).

Therefore, comfort may become an even more important issue in hand tool design with respect to these developments. Manufacturers and hand tool distributors already recognize comfort as a major selling point (Singer, 1999).

2.8 Different population

Many countries have been making great efforts in establishing an anthropometric database for different population groups such as civilians, military personnel, students, and workers. Variation in body dimension among people, between the sexes, and among different races, can make product design problematic. It is impossible to design systems to suit all body types and sizes; it is prudent to deal at least with the important dimensions. Thus, anthropometry should be taken into account. The study by Klamklay et al., 2008 stated that anthropometric data are useful in achieving effective design for high performance and productivity.

Norris and Wilson (1997) and Xiao et al. (2005) pointed out that anthropometric data are essential in order to design safe and efficient workplace, equipment and tools. For example, a hand tool with the trigger designed to fit most male hands comfortably is likely to be too large for most females. It may require the trigger to be squeezed with distal finger segment instead of the middle one, inducing greater strain on the finger tendons.

Okunribido (2000) have compiled data on 18 hand dimensions from rural farm workers in Ibadan, Nigeria, to enable better fitting manual farming equipment. The data from both studies indicate relatively large differences compared to other nationalities. The study done by Dewangat et al., 2005 on few hand anthropometric dimensions for the north eastern region of India; the analysis shows that significant differences exist between male farmers in north east India and those of the central, eastern, southern, and western regions of India. Therefore, significant differences in hand dimensions may also exist between groups within a nation.

CHAPTER 3

METHODOLOGY

3.1 Study design

Cross-sectional was the design of this study which was to determine the mismatch between harvesting tools dimensions with oil palm workers' anthropometric measures. The study was conducted using questionnaires generated and administrated to the workers. The workers' anthropometric data and the dimension of harvesting tool also take to determine the mismatch between harvesting tools dimensions with oil palm worker's anthropometric measures.

3.2 Study location

Oil palm plantations in Johor were the location of this study. There were 5 plantations have been chosen in this study.

3.3 Work process

The work processes at the location were harvesting. Harvesters use chisel to cut the fruit.

3.4 Study population

Harvesters work at palm oil plantations in Johor were the study population.

3.5 Study sample

The assessment was done only onto respondent who meet the inclusion criteria only. A name list of harvesters who work at palm oil plantations in Johor and using harvesting tools in their daily work.

3.6 Sampling unit

A respondent was chosen based on the inclusive and exclusive criteria as below.

The inclusive criteria in the study were:

i. Male worker
ii. Age ranged between 18-60
iii. Working using harvesting tool

The exclusive criteria in the study were:

i. Female worker
ii. Working not using harvesting tool

3.7 Sampling method

The method use in this study was purposive sampling method. The respondent that selected was based on the inclusion criteria which are male worker, age ranged between 18 to 60 years old and working using harvesting tool.

3.8 Sample size

The sample size was determine by using the formula (Kirkwood., 1998) which is :

$$\mathbf{n = \frac{P_1(100-P_1)}{e^2}}$$

Where;

n = sample size

P_1 = prevalence of exposed group

e^2 = standard deviation

At 95% confidence interval and 5% of standard deviation, P_1 is 58% prevalence of injuries related to hand tools in agricultural field in northern India. (Adarsh Kumar et al,. 2007)

$$n = \frac{58(100-58)}{5^2}$$

n= 98 workers

By adding 20% of the sample size for the purpose of accounting any missing data during data collection, then it became:

$$\frac{20}{100} \text{X } 98$$

= 19.6

≈ 20

Therefore the total sample sizes were:

98 + 20

= 118 respondents

3.9 Variables

3.9.1 Independent variable

Anthropometric measurements (stature and internal grip circumference)

3.9.2 Dependent variable

Mismatch

3.10 Data collection

3.10.1 Questionnaires

The questionnaires were administered to each sampling unit. The questionnaire consist 3 parts; 1) Socio-demographic and background information such as name, age, race, occupation (section), work duration, harvest tool using, height, weight, comfortable with tool using now, which dominant hand and history of disease 2) Selected parameters of tool, 3) Selected anthropometric data. The questionnaire is in Indonesian version since the workers were Indonesian.

3.10.2 Measurement of anthropometry data

There were 2 anthropometrics data to measure, stature and internal grip circumference. The stature was measured by using SECA body meter and the data was used to determine the appropriate length of handle for the harvester population in Johor. The 95th percentile of stature data will match with length of handle dimensions. Then, the internal grip circumference was matched with circumference of handle, and 5th percentile of internal grip circumference was used to determine whether the circumference of handle fit the user's circumference or not. Both 5th percentile and 95th percentile was used to ensure that the proposed dimension will match about 95% of oil palm workers in Johor.

3.10.3 Measurement of harvesting tool dimensions

There were 2 harvesting tool dimensions to measure, length of handle and circumference of handle. Both dimensions were measured using measuring tape. Length of handle was paired with respondent's stature and circumference of handle paired with internal grip circumference. The 95th percentile of stature data will match with length of handle dimensions. Then, the internal grip circumference was matched with circumference of handle, and 5th percentile of internal grip circumference was used to determine whether the circumference of handle fit the user's circumference or not. Both 5th percentile and 95th percentile was used to ensure that the proposed dimension will match about 95% of oil palm workers in Johor.

3.11 Data collection flow (summary)

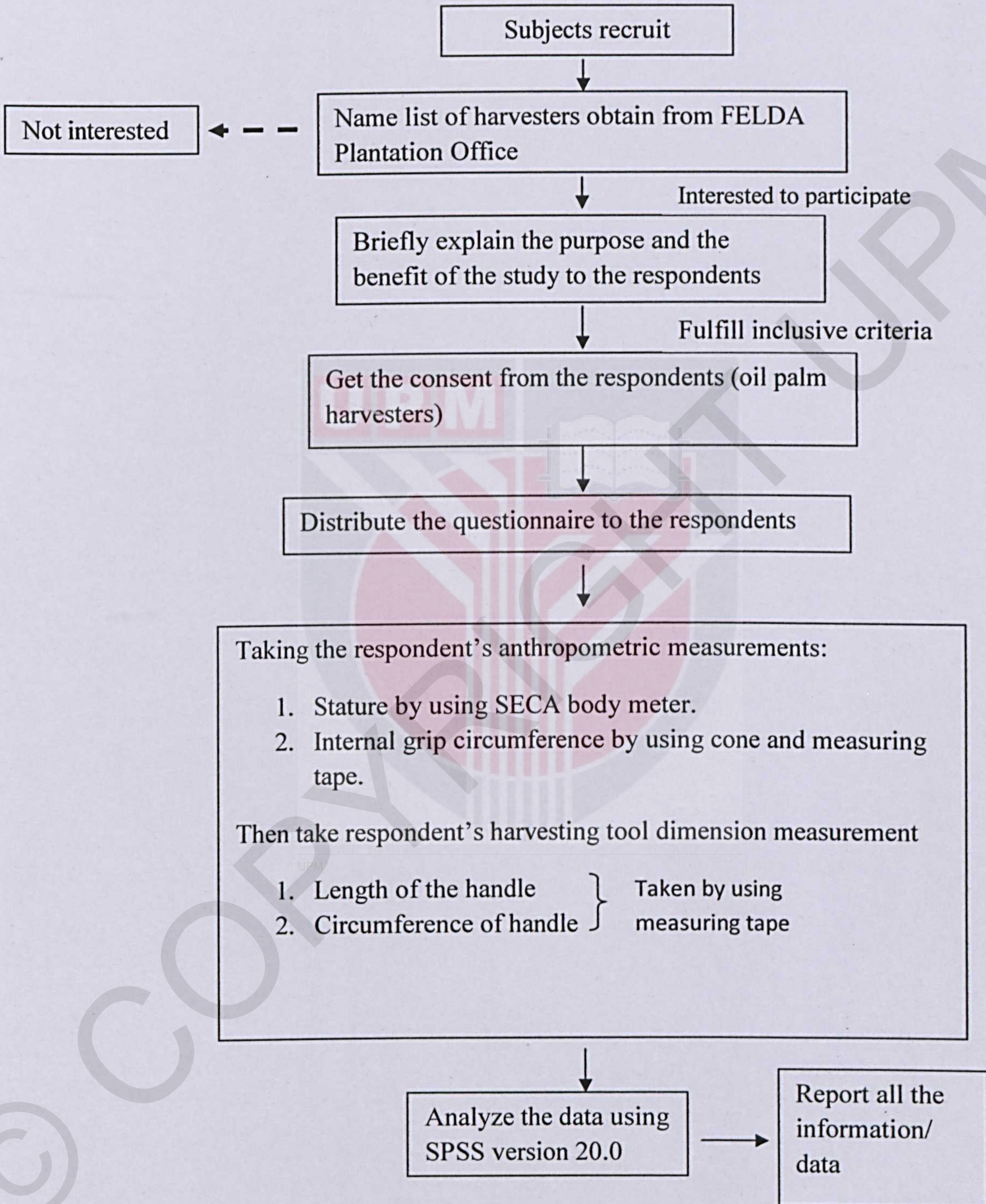

Figure 3.1: Summary of Data Collection

3.12 Study instrumentation

1. A cone and measuring tape were used to measure the internal grip circumference of the hand. For internal grip circumference, subject rests his hand on a cone and maximum inner curvature of the hand at the touching level between tip of the middle finger and thumb is record. This process was repeated three times and the average was taken.

2. The height scale SECA body meter was using to measure the subject's stature. The subjects were asked to stand on a flat surface with their feet closed and body erected while heels, buttocks and shoulders touched the same vertical plane.

To avoid errors, all of these equipments were tested before taking the measurements.

3.13 Quality control

3.13.1 Reliability test

The pre-test questionnaire has been done in order to ensure that the questionnaire is relevant and valid. The pre-test has been done by taking 10%

population have similar criteria to the target population. This is to ensure and test the understanding towards the question among the respondents. The reliability test was analyzing with Alpha (α) Cronbach using SPSS Version 19.0. αCronbachis to determine the internal consistency or average correlation between the variation measurements. The result shows that the reliability is 0.823 indicating good internal consistency.

Table 3.1: Result of Reliabity Test

Alpha Cronbach	Internal consistency
$\alpha \geq 0.9$	Excellent
$0.9 > \alpha \geq 0.8$	Good
$0.8 > \alpha \geq 0.7$	Acceptable
$0.7 > \alpha \geq 0.6$	Quantifiable
$0.6 > \alpha \geq 0.5$	Poor
$0.5 > \alpha$	Unacceptable

3.14 Statistical analysis

The data that have been collected had been analyzed by using SPSS (Statistical Package of Social Sciences) version 20. For the descriptive data such as socio-demographic of the respondents, it was analyzed by using descriptive statistics in percentage, means and standard deviation, ranges, percentiles, maximum and minimum values.

Descriptive analysis was used to measure the selected anthropometric data of palm harvesters and to measure the selected harvesting tool dimensions. The mismatching between anthropometric data and harvesting tool dimensions was also determined by using descriptive analysis.

To determine the mismatch, the previous study that has been done by (Gite and Yadav, 1989) stated that a mismatch is defined any value that is greater than 95% or less than 80% of the reference subject. For example, a mismatch of stature to length of handle as any stature that is either more than 95% or less than 80% of length of handle. Then to establish the sensitivity of the result, result was then changes in the definition of mismatch, a very strict definition of mismatch:

either more than 99% or less than 80% as proposed (Tiwari et al., 2000) was employed in this study to determine mismatch. Based on this study, the proposed measurement for circumference of handle is 12.8 cm. For internal grip circumference measurement less than 12.8 cm was considered as mismatch with circumference of handle. Then, the proposed measurement for length of handle is 172.00 cm. So any stature value that greater than 99% or less than 80% of the proposed measurement value for length of handle was considered as mismatch.

3.15 Study limitation

This research was only to measure the potential mismatch between harvesting tools and anthropometric measures of oil palm workers in palm oil plantations in Johor; therefore, it cannot be representative for the whole Malaysia population.

3.16 Ethical consent

Before data collection was started, permission to carry out the study was requested from the Board of Committee of Ethical, Faculty of Medicine and Health Sciences of University Putra Malaysia. The purposes of the study were explained to the respondent and a participation consent form was signed by the respondent before socio-demographic and working information were collected from the respondent. The identities of the respondents including their personal information were remained confidential and individual statement or description was not going to be stated in any parts of the study or publication.

CHAPTER 4

RESULT AND DISCUSSION

4.1 Socio-demographic Information

145 oil palm workers in Johor participated in this study. From the total respondents, 100% was male. The first objective is to study socio-demographic data of oil palm workers in Johor. There were 7 variables collected which were age, nationality, marital status, height, weight and body mass index (BMI). Regarding table 4.1, the age range of respondents for this research is between 19 years to 55 years. The mean age (SD) is 28.31±7.13 years old. Mostly, the respondent's age is between 20 to 25 years old. Majority of respondents, in a total of 140 (96.6) are Indonesians and the remaining 5 (3.4) are Malaysians. As for marital status, 52 (35.9) of the respondents are single and 93 (64.1) are married. Results from this research found that, the mean (SD) value for the

height of respondents is 161.96± 6.03 cm with the range from 147.0 cm to 186.0 cm and the mean (SD) value for weight is 55.78± 7.02 kg with the range from 43.0 kg to 85.5 kg. Based on the mean of weight and height, for body mass index (BMI), 12 (8.3) are underweight which is at a BMI value less than 18.5, 128 (88.3) are normal and only 5 (3.4) are overweight.

Table 4.1 Distribution of respondents based on social-demographic

Factor	N (%)	Mean±S.D	Range	Min	Max	Median (IQR)
Age		28.31±7.13	36	19	55	27.00
< 20	4 (2.8)					
20-30	90 (62.1)					
31-40	34 (23.4)					
>40	17 (11.7)					
Nationality						
Indonesian	140 (96.6)					
Malaysian	5 (3.4)					
Marital status						
Single	52 (35.9)					
Married	93 (64.1)					
Height		161.96± 6.03	39.00	147.00	186.00	161.50
Weight		55.78± 7.02	42.50	43.00	85.50	55.00
BMI						
< 18.5	12 (8.3)					
18.5-25.0	128 (88.3)					
>25.0	5 (3.4)					

N= 145

4.2 Information regarding harvesting tool and preference

Table 4.2 summarizes the information regarding harvesting tool and user preference while using it. 143 (98.6) out of respondent are using chisel while working and only 2 (1.4) are using sickle. Most of the workers are right-handed 142 (97.9) and only 3 (2.1) are left-handed. The second objective is to determine the comfortable score of respondents when using harvesting tool. When respondents were asked to rate the comfort level when using the harvesting tool, most of the respondents rated the tool was comfortable when used with 41(28.3) of them rated 10 as most comfortable, 25 (17.2) rated 9, 21 (14.5) rated 8, 14 (9.7) rated 7, 19 (13.1) rated 6 and 15 (10.3). Only some of the respondents rated not comfortable when using the tool, 5 (3.4) rated 4, 3 (2.1) rated 3, 1 (0.7) rated 2 and 1 (0.7) rated 1 or less comfortable. The respondents were asked whether they would have a better grip on the handle if the handle was added with a rubber grip and 98 (67.6) said they will feel better if rubber grip was added at the handle and 47 (32.4) do not think so. Then the respondents were asked which handle design (geometry) is much preferable for the tool handle. 138 (95.2) preferred round shape, 3 (2.1) preferred oval and 4 (2.8) preferred rectangle. The respondents were asked about their hand position when using the tools, among the choices of the front, the middle or the end of the handle. Most of them, 133 (91.7) said their hand position is at middle of the handle, 7 (4.8) said at end of the handle and 5 (3.4) at front of the handle.

Table 4.2 Information regarding harvesting tool and preference

Variable	N	%
Tool use		
Chisel	143	98.6
Sickle	2	1.4
Dominant hand		
Right	142	97.9
Left	3	2.1
Comfortable score		
1 (least comfortable)	1	0.7
2	1	0.7
3	3	2.1
4	5	3.4
5	15	10.3
6	19	13.1
7	14	9.7
8	21	14.5
9	25	17.2
10 (most comfortable)	41	28.3
Recommendation		
Add rubber grip		
Yes	98	67.6
No	47	32.4
Handle design (geometry)		
Round	138	95.2
Oval	3	2.1
Rectangle	4	2.8
Hand position when using tool	7	4.8
At front of the handle	133	91.7
At middle of the handle	5	3.4
At end of the handle		

N = 1

4.3 Prevalence of health effect using harvesting tool

Table 4.3 summarizes the prevalence of health effects using harvesting tools by the oil palm workers in Johor. The third objective is to determine the prevalence of health effects using harvesting tools of upper body among oil palm workers in Johor. 119 (82.1) complained they had hand redness when using the harvesting tool and 26 (17.9) said No. For numbness, 87 (60.0) said Yes that they experienced numbness and 58 (40.0) said No. Other than that, they also complained they experience blisters on their hands. 105 (72.4) said Yes and 40 (27.6) said No. Respondents also complained that they have wounds on their hands when using harvesting tool. 47 (32.4) said Yes and 98 (67.6) said No.

Table 4.3Prevalence of health effect using harvesting tool

Complaints	N	%
Redness		
Yes	119	82.1
No	26	17.9
Numbness		
Yes	87	60.0
No	58	40.0
Blister		
Yes	105	72.4
No	40	27.6
Wound		
Yes	47	32.4
No	98	67.6

N= 145

4.4 Anthropometric measurements

Measurements were done among 145 oil palm workers in Johor. 2 anthropometrics data were taken, which are stature and internal grip circumference. The fourth objective is to measure the selected anthropometric data (stature, internal grip circumference) of oil palm workers in Johor. Table 4.4 summarizes the selected anthropometric measurement of oil palm workers in Johor. Based on that table, mean for stature is 161.96 cm and standard deviation is 6.03. The range for stature is 39.0 cm, the minimum value is 147.0 cm and maximum value is 186.0 cm. There were 3 percentiles taken for anthropometric measurement, 5^{th} percentile, 50^{th} percentile and 95^{th} percentile. For stature measurement, 5^{th} percentile is 152.0 cm, for 50^{th} percentile is 161.5 cm and for 95^{th} percentile is 172.0 cm. Then, for internal grip circumference measurement, the mean is 14.18 cm and standard deviation is 0.93. The range for internal grip circumference is 5.20 cm with minimum value is 11.70 cm and maximum value is 16.90 cm. For 5^{th} percentile of internal grip circumference is 12.80 cm, 50^{th} percentile is 14.15 cm and 95^{th} percentile is 15.59 cm.

Table 4.4: Anthropometric measurement

Variables	Mean ± S.D	Range	Min	Max	5^{th}	50^{th}	95^{th}
Stature	161.96±6.03	39.00	147.00	186.00	152.00	161.50	172.00
Internal grip circumference	14.18±0.93	5.20	11.70	16.90	12.80	14.15	15.59

N= 145

*all measurements in centimeter (cm)

4.5 Dimension of harvesting tool

The next objective is to measure the selected characteristics of harvesting tool (length of handle and circumference of handle) use by oil palm workers in Johor. Table 4.5 shows the dimension of the harvesting tool, which are the length of handle and the circumference of handle. These two characteristics were matched with the palm oil workers anthropometric measurement in order to determine the compatibility of the tool. This match criterion was based on the study by Majid.M et al, (2007). From the table 4.5, the mean length of handle is 174.12 cm with standard deviation 8.43. The range for the length of handle is 44.3 cm with a minimum value of 150.20 cm and maximum value of 194.50 cm. The 5^{th} percentile for the length of handle is 160.20 cm, 50^{th} percentile is 174.00 cm and 95^{th} percentile is 189.30 cm. Since the circumference of the handle is constant, so the mean is 9.2 cm.

Table 4.5: Current tool measurement

Parameter	Mean ± S.D	Range	Min	Max	5^{th}	50^{th}	95^{th}
Length of handle	174.12±8.43	44.3	150.20	194.50	160.20	174.00	189.30
Circumference of handle	9.20±	0.0	9.20				

N= 145

*all measurements in centimeter (cm)

4.6 Mismatch of harvesting tool and anthropometric data

In this study, 2 percentiles were used to propose a new dimension of a harvesting tool handle, 5^{th} percentile and 95^{th} percentile. For the 5^{th} percentile, the value that had been chosen was the lowest value and for the 95^{th} percentile, the value that had been chosen was the highest value. The use of percentile is to ensure that the proposed dimension will match about 95% of oil palm workers in Johor.

Table 4.6 shows the percentile of anthropometric data for oil palm workers in Johor. There are 2 parameters was study, length of handle with stature and circumference of handle with internal grip circumference. Mean for length of handle was 174.41 cm and 95^{th} percentile of stature was chosen to study if there was mismatch between length of handle and 95^{th} percentile of body stature. Then, for circumference of handle, the mean was 9.2 cm and 5^{th} percentile of internal grip circumference was chosen to study if there was mismatch between circumferences of handle with 5^{th} percentile of internal grip circumference. The next objective is to determine the mismatching of the harvesting tool handle with the selected anthropometric data of oil palm workers. Table 4.7 shows there were mismatch for both pairs, which is current length of handle with stature and current circumference of handle with internal grip circumference. For mismatch of length of handle, it can be divided into 3 which low mismatch, matching and high mismatch. Matching is the value that lies between the ranges of 80% to 99% of the stature. Then high mismatch is when the value lies below the matching range that is range below 80% and low mismatch when the value lies in the range above 99%. There were no low mismatch but there were 136 (93.8) high mismatch. Only 9 (6.2) matching were recorded for current measurement of length of handle. Then for circumference of handle, it was 145 (100) mismatch between inner grip circumference with circumference of handle.

Table 4.6 Percentile of anthropometric data

Parameter	Mean ± S.D	Percentile		Anthropometric measurement	Percentile	Value (cm)
		Current	Proposed			
Length of handle	174.41 ± 9.97	100	95	Stature	95	172.00
Circumference of handle	9.2±	100	5	Internal grip circumference	5	12.80

Table 4.7 Mismatch of harvesting tool handle with selected anthropometric data (current)

Parameter	Percentile	Dimension (cm)	Matching (%)
Length of handle	100	189.30	6.2
Circumference of handle	100	9.2	0

4.7 Proposed dimension of harvesting tool

The seventh objective is to propose a new harvesting tool dimension based on the oil palm workers anthropometric data on Malaysian population. Table 4.8 shows the proposed dimension for the length of handle and the circumference of handle of the harvesting tool. For the design of handle, the stature of workers has to be considered. So, 95^{th} percentile of stature was chosen to ensure that the proposed dimension will match about 95% of palm oil workers in Johor. The proposed dimension for length of handle is 172.00 cm. As for the circumference of handle, 5^{th} percentile was chosen also to ensure that the proposed dimension will match about 95% of the oil palm workers in Johor. The proposed dimension for circumference of handle is 12.80 cm. To determine the mismatch between the proposed harvesting tools with the selected anthropometric data is the next objective. Table 4.9 shows the mismatch of harvesting tool handle with selected anthropometric data. For length of handle with the proposed dimension of 95^{th} percentile of stature, there were 64.83% matching, 17.24% low mismatch and 17.93% high mismatch. Then, for circumference of handle with the proposed dimension of 5^{th} percentile of internal grip circumference, it show that the proposed measurement 95.86% match.

Table 4.8 Proposed dimensions

Parameter	Percentile	Proposed dimension (cm)
Length of handle	95	172.00
Circumference of handle	5	12.80

Table 4.9 Mismatch of harvesting tool handle with selected anthropometric data

Parameter	Percentile		Proposed dimension (cm)		Matching (%)	
	Current	Proposed	Current	Proposed	Current	Proposed
Length of handle	100	95	189.30	172.00	6.2	64.83
Circumference of handle	100	5	9.20	12.80	0	95.86

CHAPTER 5

DISCUSSION, CONCLUSION AND RECOMMENDATION

5.1 Discussion

5.1.1 Socio-demographic respondent

The harvesters from 5 palm oil plantations in Johor which are Felda Lok Heng Barat, Felda Lok Heng Timur, Felda Lok Heng Selatan, Felda Bukit Waha and Felda Simpang Waha were selected. A total 145 subjects of the age group ranging from 19 to 55 years were selected and all were male. The mean value for the height of respondents is 161.96 cm with the range from 147.0 cm to 186.0 cm and the mean value for weight is 55.78 kg with the range from 43.0 kg to 85.5 kg. Based on the result, majority of the Body Mass Index (BMI) of oil palm workers was normal 88.3% and only 3.4% of them were obese. Respondent were subject to the inclusive criteria which were male worker, age ranged between 18-

60 years old and working using harvesting tool. It was to avoid any biases in this study by which, the measurement were taken twice and the average was recorded.

5.1.2 Information regarding harvesting tool and preference

Since all the palm trees in those plantations still in the first stage, that was in the beginning stage and the tree height was between 2 to 3 meter, 98.6% were using chisel when working because the tree height still low. 97.9% of the workers are right-handed and 82.75% of them rated the handle was comfortable when using. Then, they were asked whether apply rubber grip at the handle was necessary or not, and 67.6% said yes because they can have better grip at the handle and can increase their job performance. And they also prefer to have the rubber grip at the hold side of the handle which 91.7% hold at the middle of handle. For better grip also, 95.2% prefer the handle shape is oval compare to oval or rectangle, which give better grip when using.

5.1.3 Prevalence of health effect using harvesting tool

Every tool or equipment that does not match the user will cause many health effects that can decrease the performance using that tool or equipment. It is generally accepted that a mismatch between workers and their tools can cause musculoskeletal discomfort and disorders and lower the productivity.

Studies by Grant et al., (1992), Martin et al.,(1996) and Imrhan and Farahmand, (1999) showed that there was a relationship between musculoskeletal injuries and disorders that resulting from cumulative trauma and occupational risk factors. It was supported in biomechanics, which relates the hand anthropometry of an individual with the mechanical demands associated with the use of a hand tool.

82.1% said they frequent experienced hand redness when using harvesting tool and 60% feel numbness after using harvesting tool. Other than that, 72.4% and 32.4% complained that they have blister and wound at hand respectively. Ayoub et al. (1975) reviewed hand injury statistics and inferred that hand tools cause 9% of all reported disabling injuries, and about 75% of these involved manual tools.

These risk factors can produce internal reactions within the worker's upper limb such as compression of nerves, deformation of tissues or decreased circulation (Martin et al., 1996). Examples of resulting diseases are: tenosynovitis, tendinitis, DeQuervain's syndrome, peritendinitis, carpal tunnel syndrome, ulnar nerve entrapment, perineural fibrosis, posterior interosseous nerve syndrome, and trigger finger (Armstrong and Silverstein, 1987; Moore and Garg, 1994).

Carpal tunnel syndrome is one of the cumulative trauma disorders which can result from using a chisel because these hand tools require wrist bending and gripping. Injuries may occur between the finger tendons and the structure of the carpal tunnel due to tendon inflammation and swelling (Wicken, Lee, Liu and Becker 2004).

In addition, a case study of Northern India reports there are many farm hand tool injuries, involving spades and hoes (Kumar, Singh, Mohan and

Varghese 2008). Spades and shovels are very similar to each other. Both spades and shovels can cause common injuries because they both require gripping. This case study reports that gripping force and postures can cause cumulative trauma disorder (Kumar, Singh, Mohan and Varghese 2008). The gripping forces and postures are essential factors in the project design because ergonomic improvements on this issue can eliminate these types of injuries.

5.1.4 Anthropometry measures

8 body dimensions covering the most hand parts were measured and only one hand dimension which is internal grip circumference relevant to hand tool design was considered. Then the subjects' stature also taken to design hand tool.

Subjects' stature was measured with a height scale SecaBodymeter and for weight, was measured with weighing scale Tanita. Measuring tape was used to measure the internal grip circumference of respondent while they grip the cone. All measurements were made by same measurer and recorded by a few assistants.

While taking the stature measurement, the respondents were asked to stand on a flat surface with their feet closed. The SECA body meter was adjusted according to the height of the respondent. For weight, the respondents were asked to stand straight and look forward, then the measurement was taken twice and the averaged was recorded.

A cone designed locally and specially was used to measure the internal grip circumference of the hand of respondent. Respondents were asked to grip the cone to get maximum inner curvature of the hand at the touching level between tip of the middle finger and thumb. The measurement was taken on the right hand of respondent, since hardly any differences were found between right and left hand (Imrhan et al., 2006).

Accuracy and repeatability of the measurements were achieved by intra-tester reliability test. In addition, pretest measurement and questionnaires was conducted to 10% of the study sample which having the same characteristic and background as the study sample group.

5.1.5 Mismatch

The proper matching of machine requirements with the human capabilities is basically necessary for optimum performance of man–machine system. In order to get efficient design of equipment, it is necessary to follow the guidelines and principles of ergonomics, which provide an orientation towards physiological and psychological needs of operators. The studies (Das and Grady, 1983; Das and Sengupta, 1996) stated that the design of equipment is always a compromise between the operator's biological needs, which are determined by the ergonomics guidelines and physical requirements of the equipment. In this regard, the basic information required is the anthropometric hand dimensions of the users of tools and harvesting tool.

To determine the mismatch, the previous study that has been done by Chaffin and Anderson, (1991) and Panero et al., (1979) stated that a mismatch is defined by any value that is greater than 95% or less than 80% of the reference subject. For example, a mismatch of popliteal to seat height as any seat height that is either more than 95% or less than 80% of the popliteal height. Then to establish how sensitive results are to changes in the definition of mismatch, a very strict definition of mismatch: either more than 99% or less than 80% as proposed by Claudia P et al., 1999 was employed in this study to determine mismatch.

To determine the mismatch between current tool measurements with selected anthropometric measurement, the internal grip circumference was paired with the circumference of handle and the stature was paired with length of handle. For internal grip circumference, the matching is between 10.24 cm to 12.67 cm. Any value that lies in that range was considered as matching, other than that it was considered as mismatch. Then, the matching range for stature was between 137.6 cm to 170.28 cm.

For internal grip circumference, the current grip circumference measurement is 9.2 cm. Then the proposed measurement is 12.8 cm based on the 5^{th} percentile of the subjects' internal grip circumference measurements. So any value less than 12.8 cm was considered mismatch and more than 12.8 cm was considered as matching.

Result indicates the mismatch between current handle tool parameter and anthropometric data of oil palm workers. For length of handle, the mismatch was

93.8 % with stature and circumference of handle showed 100% mismatch with internal grip circumference. It shows that the tool handle was designed not according to ergonomic criteria.

5.1.6 Match or proposed dimension of harvesting tool

In this study, two percentiles were used in proposing new harvesting tool dimension, 5th percentile and 95th percentile. For 5th percentile, value that has been chosen is the lowest value, while for 95th percentile, it is the highest value. The used of percentile is to ensure that the proposed dimensions will match about 95% of oil palm workers.

For handle circumference, 5^{th} percentile of internal grip circumference was chosen and it shown 95.86 % matching with the handle circumference. Then 95^{th} percentile was chosen for length of handle and it shown 64.83 % matching. The handle dimension was matched with the workers anthropometric data based on study by Claudia P et al., 1999 who suggested the matching between tool dimension and anthropometric data should be lies in the range from 80% to 99% of the anthropometric data.

According to Parekh (1980), for the proper grip the longest finger should not touch the palm while holding the handle and at the same time, it should not exceed the internal grip circumference. When optimum diameter for a tool handle is selected, the muscle exert the minimum force needed to hold the tool and perform gripping activities, it reduces the force required for gripping a tool, protects the underlying joint structures and reduces the risk of developing cumulative trauma associated with repetitive task requiring high grip forces and awkward postures. Chaffin and Anderson, 1991 stated that a person's performance (grip strength) and mechanical stress on the upper extremities have direct effect on the shape and size of hand tool.

Bru et al., 2003 indicated that when optimum diameter for a tool handle is selected, the muscle exert the minimum force needed to hold the tool and perform gripping activities, it reduces the force required for gripping a tool, protects the underlying joint structures and reduces the risk of developing cumulative trauma associated with repetitive task requiring high grip forces and awkward postures.

5.2 Conclusion

This study represents the mismatch between harvesting tool dimensions and anthropometric measure among palm oil workers in Johor. According to the data obtained, it may be concluded that the current harvesting tool use by the palm oil workers in Johor was not match the anthropometric data of palm oil workers in Johor.

Due to this mismatch, it was caused health effect especially to the workers' hand such as hand redness, numbness and having blister at hand. These can become risk factors to compression of nerve, deformation of tissues or decreased circulation which can lead to diseases such tenosynovitis, tendinitis, carpal tunnel syndrome, ulnar nerve entrapment and posterior interosseous nerve syndrome.

So to prevent from further bad health effect, there was recommendation of harvesting tool dimensions based on selected anthropometric data which more suitable compare to the current dimensions. Two percentages were used to get these proposed dimensions which are 5th and 95th percentile. Proposed dimensions show the increasing in the percentage of match for length of handle and circumference of handle.

5.3 Recommendation

It is proven that harvesting tool use by oil palm workers in Johor is not ergonomically design. To fit and match majority of the oil palm workers in Johor, this study was proposed two dimensions which are specific on standardize dimensions which based on 5th and 95th percentile of oil palm workers.

The proposed handle circumference based on 5^{th} percentile show 95.86 % of matching between workers' internal grip circumference and circumference of handle. Hand tools need to fit the contours of hand; they need to be held securely with suitable wrist and arm posture, they may be utilizing strength and energy capabilites without over loading the body. For effective use of tools and implements that require workers to maintain a power grip during task performance, adequate space must be provided on the handle (Okunribido, 2000).

Seo and Armstrong (2008) assume that an optimal tool handle diameter (with respect to grip strength) exists when the middle of the thumb tip and the middle of the middle fingertip are aligned parallel to the long axis of a cylindrical handle. In this configuration, it is argued that maximum grip strength can be achieved because the fingertips and thumb tip work together directly against the palm.

Consider the clearance, the proposed value should reduce 1 cm to give proper gripping. By adding the rubber grip approximately 0.7 cm at the holding site of the handle by which also preferred by the workers can give better grip and thus increase the work performance. So the recommended measurement for handle circumference is 12.50 cm and for length of handle is 172 cm.

In addition, this study is only focus on anthropometry measurement to determine the mismatch between harvesting tool dimensions and anthropometric measures, hopefully in further study, the researcher will come out with another factors that contribute to the mismatch such as posting while working using harvesting tool or design of the harvesting tool that can increase the performance and also the health effect related to mismatch between harvesting tool and anthropometric measures.

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APPENDIX 1

EVIDENCE OF APPROVAL ETHICAL BY MEDICAL RESEARCH ETHICS COMMITTEE

APPENDIX 2

INFORM CONSENT AND QUESTIONNAIRE (MALAY VERSION)

FAKULTI PERUBATAN DAN SAINS KESIHATAN
FACULTY OF MEDICINE AND HEALTH SCIENCES
UNIVERSITI PUTRA MALAYSIA, 43400 UPM SERDANG,
SELANGOR, MALAYSIA

BORANG PERSETUJUAN RESPONDEN

TAJUK KAJIAN : KETIDAKSESUAIAN DIANTARA DIMENSI ALAT TUAIAN DENGAN ANTROPOMETRIK PARAMETER DI KALANGAN PEKERJA LADANG SAWIT DI JOHOR.

PENYELIDIK : MOHD AFIQ BIN ISMAIL

Saya…………………………………………………………No.K/P…………………………………

bersetuju/ tidak bersetuju * untuk menyertai kajian bertajuk seperti di atas.

Saya telah membaca dan memahami isi kandungan kajian berdasarkan apa yang telah dinyatakan di dalam 'PENERANGAN KEPADA PESERTA' yang telah dilampirkan bersama surat kebenaran ini dan penerangan tambahan daripada penyelidik.

Saya juga faham bahawa segala maklumat yang diberikan dan segala keputusan yang saya perolehi adalah sulit dan hanya akan digunakan untuk tujuan penyelidikan dan rujukan penyelidik. Saya juga faham bahawa maklumat ini boleh digunakan untuk penerbitan tetapi setiap individu tidak akan dinyatakan identitinya.

Saya faham bahawa saya mempunyai hak untuk menarik diri dan juga mempunyai hak untuk menarik semula keizinan pada bila-bila masa sekiranya perlu apabila merasa tidak selesa pada mana-mana ujian atau aktiviti yang dijalankan oleh penyelidik semasa kajian dijalankan dan tiada sebarang tindakan boleh dikenakan ke atas saya atas tindakan tersebut.

Tandatangan ……………………………………… (Responden)

Tandatangan……………………………………… *(Saksi)*

Tarikh :…………………………………………

Nama………………………………………

No. K/P :………………………………………

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

Tarikh …………………………………

Tandatangan ……………………………………… (Penyelidik)

BAHAGIAN J: KETIDAKSESUAIAN PERALATAN DAN UKURAN ANTROPOMETRI

10.1 Apakah jenis peralatan ladang yang anda gunakan semasa bekerja?

1 ☐ Pahat 2 ☐ Sabit

10.2 Pada pendapat anda, adakah anda selesa menggunakan alatan sekarang?

1 ☐ Ya 0 ☐ Tidak

10.3 Keselesaan bagaimanakah anda rasakan bila memegang peralatan?

1 ☐ selesa

2 ☐ memuaskan

3 ☐ tidak selesa

10.4 Berapa lamakah anda menggunakannya?

1 ☐ kurang 1 tahun 2 ☐ 1-3 tahun 3 ☐ lebih 3 tahun

10.5 Adakah tangan anda pernah mengalami simptom-simptom kecederaan seperti berikut ketika mengendalikan alatan?

	Ya	Tidak
10.5.1 Kemerah-merahan	1 ☐	0 ☐
10.5.2 Kebas	1 ☐	0 ☐
10.5.3 Melecet	1 ☐	0 ☐
10.5.4 Luka	1 ☐	0 ☐

10.6 Apakah tangan dominan anda?

1 ☐ Kanan 2 ☐ Kiri

10.7 Jika diberi pilihan, apakah ciri –ciri bagi alatan yang anda ingin gunakan pada masa hadapan?

10.6.1 Diameter	1 ☐ Kecil	2 ☐ Sederhana	3 ☐ Besar
10.6.2 Panjang	1 ☐ Pendek	2 ☐ Sederhana	3 ☐ Panjang
10.6.3 Ukur lilit	1 ☐ Kecil	2 ☐ Sederhana	3 ☐ Besar

10.8

UKURAN PADA TANGAN PEKERJA (cm)

	1	2	3	Purata
Ukur lilit genggaman dalaman (Internal grip circumference)				
Ketinggian (Stature)				

10.9

UKURAN PADA PERALATAN LADANG (cm)

	1	2	3	Purata
Panjang pemegang (length of handle)				
Ukur lilit pemegang (handle circumference)				

APPENDIX 3

PHOTOGRAPH OF RESEARCH STUDY

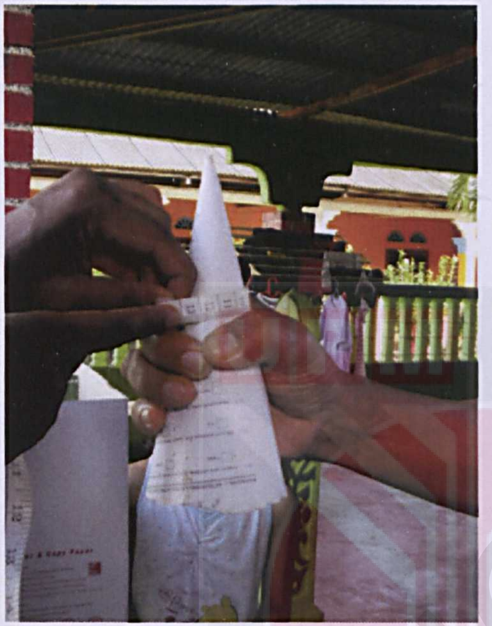

Figure 1: Measuring respondent's internal grip circumference

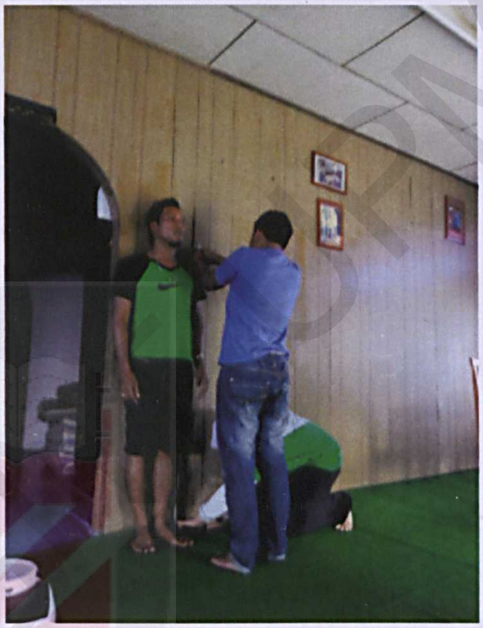

Figure 2: Measuring respondent's stature.