# IDENTIFICATION OF ERGONOMICS RISK FACTOR AND WORK-RELATED PSYCHOSOCIAL USING DOSH RISK ASSESSMENT ON BACKPACK LEAF BLOWER WORKERS

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FACULTY OF ENGINEERING
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**RESEARCH PROJECT SUBMITTED IN FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF ENGINEERING (SAFETY, HEALTH AND ENVIRONMENT)**

**FACULTY OF ENGINEERING**
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# IDENTIFICATION OF ERGONOMICS RISK FACTOR AND WORK-RELATED PSYCHOSOCIAL USING DOSH RISK ASSESSMENT ON BACKPACK LEAF BLOWER WORKERS


## ABSTRACT

Cleaning industry is one of the main sectors that supports national economic growth and cleanliness is an essential element in healthy living. Ergonomic, health and safety awareness is important to make sure the industry excel. There are many type of cleaning service involve in this industry but this study only focus on cleaning workers who uses backpack leaf blower machine. The usage of backpack leaf blower is very popular in cleaning industry because it is time-saving, efficient and mobile. Objective of this study is to identify worker's body part with the experience of ache, pain and discomfort among backpack leaf blower workers. This study also was conducted to assess physical risk factor and psychosocial work factor that causes back pain and body discomfort to backpack leaf blower workers. Ten respondents who works as cleaner in one of a local university was analysed using Ergonomic Risk Assessment (ERA) which was adapted from Guidelines on Ergonomic Risk Assessment at Workplace 2017 by DOSH Malaysia to determine ergonomic risk level of the employees. From the analysis conducted and calculation of Total discomfort score, body parts which are at risk for injury and discomfort on female workers are wrist (right hand) with scores of 20.98%, lower back (18.17%), legs (13%) and shoulders (12.19%). Male workers on the other hand shows that, the body parts with high risk of injury and discomfort is on the shoulders (20.81%) followed by neck (17.59%), right wrist with 17.24% and lower back (16.29%). Factors contribute to risk of injury and discomforts are awkward posture (head bending forward, twisted torso and wrists in flexion position), repetitive motion (uses of hands, fingers, wrists and shoulders intensively), vibration (on hands and all over body) and load carrying activities (working with loads on the back for a long walking distance). From psychosocial aspect lack management control in work schedule rotation, heavy workload, long working hours and management failure are main caused. Employers are responsible to create awareness about ergonomic besides creating procedures and safe work practices which can lessen the pain and discomfort to the workers.



Keywords: Risk Factor, Backpack Blower, Psychosocial, Risk Assessment, Body discomfort

# IDENTIFIKASI FAKTOR RISKO ERGONOMIK DAN PSIKOSOSIAL BERKAITAN KERJA MENGGUNAKAN DOSH RISK ASSESSMENT TERHADAP PEKERJA PEMBERSIHAN MENGGUNAKAN MESIN BEG PENIUP DAUN

## ABSTRAK

Sektor pembersihan merupakan salah satu sektor penting yang menyokong pertumbuhan ekonomi negara dan kebersihan merupakan elemen penting dalam memelihara kesihatan. Demi memastikan sektor ini berkembang dengan baik aspek ergonomik, kesihatan dan keselamatan perlu diberi perhatian. Terdapat pelbagai jenis operator pembersihan yang terlibat di dalam sektor ini. Namun, kajian ini hanya memfokuskan kepada operator pembersihan yang menggunakan mesin mesin beg peniup daun. Penggunaan mesin beg peniup daun semakin menjadi pilihan bagi sektor pembersihan kerana ia diyakini dapat menjimatkan masa pembersihan, efisien dan mudah alih. Objektif kajian ini bertujuan mengenal pasti bahagian tubuh pekerja yang mengalami kesakitan dan ketidakselesaan di kalangan pekerja yang menggunakan mesin beg peniup daun. Kajian ini juga dijalankan untuk mengetahui faktor risiko fizikal dan faktor kerja psikososial yang menyebabkan sakit belakang dan ketidakselesaan badan kepada pekerja yang menggunakan mesin beg peniup daun. Sepuluh orang responden yang bekerja di sektor pembersihan di sebuah Universiti Tempatan telah dianalisa menggunakan *Ergonomic Risk Assessment* (ERA) yang diadaptasi dari *Guideline on Ergonomic Risk Assessment at Workplace 2017* yang diterbitkan oleh DOSH Malaysia bagi menentukan tahap risiko ergonomik pekerja. Dari hasil analisis dan pengiraan *Total Discomfot Score* bagi pekerja perempuan mendapati bahagian badan yang berisiko untuk mendapat kecederaan dan ketidakselesaan ketika menjalankan tugas adalah di bahagian pergelangan tangan (kanan) (20.98%), bahagian belakang (bawah) (18.17%), bahagian kaki (13.00%) dan bahagian bahu (12.19%). Bagi pekerja lelaki pula bahagian badan yang mempunyai kadar kecederaan dan ketidakselesaan yang tinggi adalah di bahagian bahu (20.81%), diikuti oleh bahagian leher (17.59%), bahagian pergelangan tangan (kanan)(17.24%) dan bahagian belakang (bawah (16.29%). Faktor yang menyumbang kepada risiko kecederaan dan ketidakselesaan ini adalah postur yang salah (kepala dibengkokkan ke depan, badan dipusingkan dan pergelangan tangan dalam kedudukan *flexion*), pergerakan berulang (penggunaan tangan, jari, pergelangan tangan dan bahu secara intensif), getaran (getaran pada bahagian tangan dan seluruh badan) dan aktiviti yang perlu membawa beban (bekerja dalam keadaan berjalan dengan bebanan di belakang badan pada jarak yang jauh. Daripada sudut psikososial, pusingan jadual kerja, tugasan yang banyak, jangka masa kerja yang panjang dan kegagalan pengurusan merupakan faktor utama yang menyumbang kepada sakit belakang dan ketidakselesaan badan. Pihak majikan perlu memberi pendedahan mengenai ergonomik disamping menghasilkan prosedur dan amalan kerja yang selamat yang dapat mengurangkan kesakitan dan ketidakselesaan kepada kesihatan pekerja.

Keywords: Faktor risiko, Mesin beg peniup, Psikososial, Penilaian Risiko, Ketidakselesaan anggota badan

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| | | |
|---|---|---|
| AL | : | Action limit |
| CTS | : | Carpal tunnel syndrome |
| DOSH | : | Department of Safety and Health |
| ELV | : | Exposure limit value |
| ERA | : | Ergonomics Risk Assessment |
| HAVS | : | Hand-arm vibration syndrome |
| ISO | : | International Organization for Standardization |
| LBP | : | Lower Back Pain |
| MSD | : | Musculoskeletal disorder |
| NIOSH | : | National Institute for Occupational Safety and Health |
| NIHL | : | Noise induced hearing loss |
| OSHA | : | Occupational Safety and Health Administration |
| PPE | : | Personal protective equipment |
| QEC | : | Quick exposure check |
| REBA | : | Rapid Body Assessment |
| RULA | : | Rapid Upper Limb Assessment |
| SOCSO | : | Malaysia Social Security Organization |
| SSM | : | Suruhanjaya Syarikat Malaysia |
| TWA | | Time-weighted average |
| UiTM | : | Universiti Teknologi Mara |
| WRMSDs | : | Work-related musculoskeletal disorders |
| WRULDs | : | Work-related upper limb musculoskeletal disorders |

## LIST OF APPENDICES

# CHAPTER 1 : INTRODUCTION

## 1.1 Introduction

According to the Suruhanjaya Syarikat Malaysia (SSM) data, the total turnover value of the cleaning company in Malaysia is estimated around RM4.1 billion where RM 1.5 billion comes from government cleaning companies and the rest is from private companies and partnerships. SMM expected that, the total turnover of 30 percent of active private companies and partnerships is 2.6 billion. The contract value based on an average of 86 employees per company contributes RM14,400 per year for each employee of 2,100 company. With an estimated about 284,000 employees and more than one third of the cleaning employees are foreign worker (*Analisis Pekerjaan Industri Pembersihan, Jabatan Pembangunan Kemahiran Kementerian Sumber Manusia* 2011). Thus, cleaning industry is a growing and potentially lucrative service sector because it's provides critical services for individuals, government sector and commercial businesses. The industry requires professionalism, enthusiasm, and awareness of technology and information to continue grow towards a global and integrated service delivery.

The cleaning operator is an industrial or domestic worker who performs cleaning work to obtain payment, where their main task is to carry out cleaning activities (*Analisis Pekerjaan Industri Pembersihan, Jabatan Pembangunan Kemahiran Kementerian Sumber Manusia* 2011). In past few decades, most of the cleaning operators will used sweeper or broom stick in order to clean dry leaves or solid waste in certain area. This traditional method has been widely used inside or outside building where the tools is light, cheap and easy to find. However, the process of cleaning will take longer time and required a lot of employees. In addition, the cleaning operators also will face some risk at dangerous areas such bushes, steep and drain.

In line with the rapid growth of the economy and the advancement of technology in various industries to facilitate the work of managing waste and dry leaves in the cleaning area, backpack leaf blower machines are introduced to public cleaning operators. The backpack leaf blower machines have been widely used due to being efficient in the execution of tasks as well as reduce their time to sweep and clean the dry leaves. In addition, this also will reduce common to associate risk of the cleaning operators from fall or injured during cleaning proses especially at steep or drain area. Although the usage of backpack leaf blower machines showed a significant impact of improvement in cleaning industry, but it's still gave unsatisfactory results especially on associate risk ergonomic factors to the cleaning operators.

According to (Kumar, Ware, Fernandez, Subramanian, & Hunter, 2011) the weight and motor blower unit mounted on the sprayer put physiological and biomechanical stress on the wearer's back. Furthermore, the vibration produced from the machine also generated throughout the body, especially on the back, along the hand and arms that holding the tube. This stress will cause shoulder and back pain towards the cleaning operators if they work more than 2 hours as stated in ergonomic standard operational procedure. In addition, the vibration also will affect along the hand and caused hand shivering. A lot of studies have been done since 1980s to highlight the risk of using backpack leaf blower in order to increase the awareness of safety among the cleaning operators and the company (J. Bobet & R. Norman, 1984).

Recently, study on vibration emitted by backpack blower towards the operator based on the International Standard ISO 5349 showed that prolonged exposure might lead to the risk of hand-arm vibration syndrome (HAVS) (S. A. Gabasa, Razali, As'arry, & Jalil, 2019). Although the study found that the magnitudes of vibration of the backpack blower lower than the exposure limit value (ELV), however the blower may transmit the

vibration to the hand more than the exposure action value. This finding still cannot prove significant effect of vibration emitted by the backpack blower to the associate ergonomics risk factors. Therefore, this study aims to determine ergonomic risk factors, sources of injury and to discover association exists between the physiological factor and body discomfort of public cleaning machine operators that using backpack leaf blower.

## 1.2 Problem Statement

Backpack leaf blower is a widely used instrument for the purpose of cleaning leaves, cleaning debris and small rubbish found in open spaces such as yard, field and street. Backpack leaf blower is a popular choice as it is very effective and efficient in cleaning areas that cannot be reached and handle by other tools such as mountainous, rock, gravelly with minimal effort. According to ((CLCA), 2019) the usage of backpack leaf blowers saves about four to five hours compared with a broom. The task using a broom involves high labour costs and a lot of time.

Excessive use of backpack leaf blower and misapplication by cleaning workers with lack of guidelines, training and knowledge can lead and increase the risk of occupational diseases. Cleaning workers are frequently associated with high rates of musculoskeletal diseases, which is because of the job demands that need usages of physical strength (Jeong, 2017). Furthermore, repeating the same motion every day with awkward body posture will cause great pain as they required high forces to do the task (Weigall, Simpson, Bell, & Kemp, 2005). According to (Sheir-Neiss, Kruse, Rahman, Jacobson, & Pelli, 2003) there is a correlation between the frequency of backpack use, the cause of back pain and the weight of the load.

According to the Annual Report 2017 released by the Malaysia Social Security Organization (SOCSO) (Pertubuhan Keselamatan Sosial, 2017), it showed that the number of accidents reported related to Work Muscular-skeletal Disorders (WMSDs) (was 1,354, which is 436 were female. From these, 412 were claim under Total Disability compensation and 379 under Permanents Disability compensation. The number of invalidity and survivors' cases reported in 2017 for the categories of musculoskeletal system and connective tissue (for example arthritis) was 2138 of which 1035 were recorded under the invalidity and 103 were survivors.

Therefore, this study will help to identify the risks that may cause ergonomic problems arising from physical or psychosocial factors against the operators of public cleaning machines using blower leaf backpack as the main tool. In addition, findings of this study are expected to be used by workers, supervisors, owners of cleaning companies and others concerned to identify and appropriate control measures can be implemented and mitigate ergonomic risk factors in the workplace.

## 1.3 Research Gap

The evaluation of the level of vibration exposure emitted by backpack blowers for Malaysia plantation workers using the International Standard ISO 5349 was carried out by (S. A. Gabasa et al., 2019) and the relationship between backpack blowers and magnitude of vibration has found. This study indicates that when used for more than 7 hours (mist blower) or 5 hours (leaf blower) a day, the vibrations generated from the leaf blower and mist blower to the hand may be greater than the exposure action value set by the European Directive 2002. There are also numerous research and literature reviews conducted related on risk identifications and the effects of backpack use on back pain such as the study of backpack use on children's health (Brackley & Stevenson, 2004),

(Negrini & Carabalona, 2002b) and studies conducted on soldiers (Attwells, Birrell, Hooper, & Mansfield, 2006). It is important to address physical risk factor and physiological risk factor that contribute to body discomfort of public cleaning machine operators that use backpack leaf blower. Thus, from the evaluation the specific hazards from the task can be recognized, apply the correct control measure and ability to understand can minimize the risk of injuries.

## 1.4 Research Objectives

This research has the following objectives:

i. to identify worker's body part with the experience of ache, pain and discomfort among backpack leaf blower workers

ii. to assess ergonomic risk factor and psychosocial work factor that causes back pain and body discomfort to backpack leaf blower workers

## 1.5 Significant of Study

The significant of this study is identification of ergonomic risk of backpack leaf blower workers through the systematic worksite analysis as a method of prevention of WMSDs. Identification of ergonomic risk using Department of Safety and Health (DOSH) risk assessment method will help industry to determine the probability of risk and consequences of risk. Decreasing numbers of occupational injuries will increase safety performances by reducing the cost of medical expenses and composition of occupational diseases. In order to get a more precise and accurate result, these methods are suitable to evaluate ergonomic risk criteria because outlines of this method focus on improvement or intervention during recommendation or planning stage. Physiological and psychological factor of manual handling for employees are required. This assessment will

be used effectively by related industries. Industries can manage the scope of work without incompatibility their limitation and abilities.

Earlier detection of risk can protect workers from chronic injuries that occur after prolonged exposure to the hazards. It also increases the safety, health and welfare among the workers and society. Without this study, only workers will realise on the discomfort working environment and suffer from work related disorders and injuries. The suggestion or issues raised by the workers from the risk assessment will be analyse and recommendation for corrective action will deliver as a reference for employers. This information will be empowering the employees to play a role in ergonomics management.

## 1.6 Scope of Study

The scope of this study encompasses the investigation to identify the ergonomics risk factor and sources of injury or discomfort of backpack leaf blower workers. A total of 10 backpack blower workers doing the cleaning work around the Universiti Teknologi Mara (UiTM) Campus Puncak Alam, Selangor participated in the study. The workers fully involved in the cleaning task using leaf blower machine, from Monday to Saturday, from 7am to 4pm.

To achieve the objective of this study, the assessment will be conducted using Ergonomics Risk Assessment (ERA) from the Guidelines on Ergonomics Risk Assessment at Workplace published by DOSH Malaysia (DOSH, 2017). For this study, a proactive and reactive ergonomic risk assessment approach will be used. The proactive approach includes self-assessment by the employee and the reactive approach will include a Level 1- ERA assessment, which is an Initial ERA. The initial ERA involves questionnaires, surveys and checklists. Each risk factor will be identified and will be

completed inside the ERA checklist to identify ergonomic risk factors that may pose a harm to employees.

# CHAPTER 2 : LITERATURE REVIEW

## 2.1 Introduction of Ergonomics

According to the International Ergonomics Association, Ergonomics is a scientific discipline which is the scope focusing of interaction between humans with other elements in a system. Ergonomic also a concern of all profession that by using principles and theory of ergonomics, methods of assessment and related data, effective design to improve human capabilities and optimize system performance. In work environment, ergonomic is necessary because the perspective of ergonomics can be described as simple as fit the job to the workers (Buckle, 2005). Taking into account the ergonomics required employers to take consideration of the capabilities of the workers in occupational perspectives.

Ergonomics is one of important part in safety programs that applied by all industries to accommodate the human capacity in order to increase productivity with less of risk of injury (Brodie, 2008). This program can help the company to determine ergonomic risk factor towards the workers that could lead to musculoskeletal disorder (MSD) and hand arm vibration syndrome (HAVS). Besides, this approach also helps the company to reduce the occupational work disease and indirectly reducing medical costs as well as compensation. Particularly, the cleaning industry also has begun implementing this ergonomic program in order to provide safety and healthy working style that might improve employee productivity. Nowadays, backpack blower machine has been widely used in the cleaning industry especially for cleaning leaves, debris and small rubbish due to its mobility. However, the backpack blower machine can reduce working time, but the possible injury may occur during the cleaning process. Therefore, ergonomic related risk

factor and assessment on backpack leaf blower workers should be identified in order to practice safety and healthy working environment.

## 2.2 Work-Related Musculoskeletal Disorders

Musculoskeletal disorders (MSD) have been categorized into three syndromes, such as carpal tunnel, tendonitis, and HAVS. These disorders mostly due to the same risk factors including excessive force, repetitive movement, awkward body posture, task duration, and, in the case of HAVS, exposure to vibration (Bernard, 1997). Recently, work-related musculoskeletal disorders (WRMSDs) have caused chronic pain and functional impairment as well as reduce employees' productivity. WRMSDs affect human musculoskeletal systems such as muscles, ligaments, tendons, nerves, spinal disc, bursa sacs, and blood vessels. Therefore, work-related musculoskeletal problems such as tendon and trauma disorders of the wrist and hand due to force demands and repetitiveness of work task have affected the worker's safety and health in many workplace and type of occupations (Silverstein, Fine, & Armstrong, 1986).

Furthermore, work-related upper limb musculoskeletal disorders (WRULDs) commonly occur in working condition that using excessive force or overreaching of the hand above the shoulder. WRULDS include risk of neck, hand, wrist, and shoulder. As studied by (Gerr, Letz, & Landrigan, 1991) the WRULDs disease increased due to computer-based technology widely used and ergonomics training start to be implemented to create awareness among the workers. In the healthcare sector, demand on physical tasks including lifting, positioning and transferring patient possibly caused work-related musculoskeletal problems and disability among nurses (Simon et al., 2008). Therefore building construction employees handling of excessive force, repetitive movements, deviation positions and using vibration power tools also contributed to high risk of

WRMSDs (Daruis, M., & Jeyasekaran, 2019). Moreover, in cleaning industries, it was found that higher exposure value of vibration transmitted from the backpack leaf blowers to the hand of the workers could cause HAVS (S. A. A. Gabasa, Md Razeli, As'arry, & Abdul Jalil, 2019).

Lacey, Lewis, and Sim (2007); (Simon et al., 2008) mentioned that the psychosocial work stressors at the workplace had been identified as a new added ergonomic risk for WRMSDs. Hollmann *et al*. in his study regarding nursing home staff members revealed the integration factor between control mental job demand, the physical workload in musculoskeletal symptoms (Hollmann, Heuer, & Schmidt, 2001). Although the presence of individual risk factors is important, the combination of several risk factors within the same task or job also results in a significant increase in the likelihood of the development of an MSD. Therefore, companies are suggested to identify ergonomic related risk factor in order to practice safety and healthy working environment.

## 2.3 Backpack Machine in the Cleaning Industry

Backpack machines have been used since the 1980's especially in agriculture, gardening, landscape and cleaning industry due to the mobility (J. Bobet & R. W. Norman, 1984). In addition, usage of the backpack machines such as grasscutters and blowers also reduces time-consuming in cleaning process compared to a traditional method such as using toe, scissor, sweep and broomstick. In particular, backpack blower machine that equipped with a backpack, fuel tank, nozzle and motorized part as shown in Figure 2.1 has been widely used for cleaning leaves, debris, and small rubbish found in open spaces such as yard, field and street. Backpack leaf blower machine occupied with the harness was carried at the back of the operator. The nozzle part consists of a fan that blows air at high speed to pile up leaves, grass clippings and litter. This equipped fan will

produce a significant volume of air and a pipe conveys it to a nozzle located at the bottom of the throwing pipe. The motorized part will control the power of the blower (Angela Calvo, Preti, Cutini, & Deboli, 2019).

**Figure 2.1 : Picture of backpack blower machine.**

Practical and attractive design for backpack blower machine is essential. However, the machine could produce high levels of noise and able to transmit vibration to operator's body on both back and hand-arm system (S. A. A. Gabasa et al., 2019; Su et al., 2013). The workers also could be possibly getting some injuries while using the backpack blower machine such as bruises, cuts, eye injuries, hearing losses or damage caused by prolonged exposure to the machine, vibration and noise. Every power tool has potential harm and hazard to the workers or user particularly when the unsafe act of workers and unsafe condition for the tools. Many continuous inventions, design process and arranging system and workplace using ergonomics data and techniques to minimize injury and hazard and to improve safety performance. Therefore, some studies have been done to identify sources of injury and ergonomic related risk factor of backpack blower machine operators.

## 2.4 The Hazards of Backpack Blower Machine

Table 2.1 shows several hazard and effect of backpack blower machine usage. The hazards such as loud noise release from the blower, large amount of airborne dust can be produced, emission of toxic gases to the environment form the fuels combustion to operate the blower machine and strong wind from the blower will damage soil and landscape plant nearby.

**Table 2.1 : Hazards and effect of backpack blower machine**

| Hazard | Effect | References |
|---|---|---|
| Noise from backpack blower machine | Cause increase risk of irreversible hearing damage<br>Growth the risk of injury, insufficient sleep, increasing probability of heart attack. affects the gastrointestinal system | (S. A. Gabasa et al., 2019) |
| Generation of large amount of airborne dust | Increase the number and severity of asthma attack<br>Can lead to the bronchitis or any lung disease | (van Kampen, Hoffmeyer, Seifert, Brüning, & Bünger, 2020) |
| Emission of large amount of carbon monoxide, nitrogen oxides, hydrocarbon, and fine particles. | The gas-oil mixtures use are toxic.<br>Excess amount of inhalation can cause cancer and cardiopulmonary disease. | Volckens, Olson, & Hays, 2008) |

| | | |
|---|---|---|
| Damaging to soil and landscape plant | The wind from the blower can cause dehydration and lead-burn, retard new growth, clog leaf pores, and spread disease spores, insect eggs, and weed seeds. | (Fryrear, 1984) |

## 2.5 Ergonomic Risk Factors on Backpack Leaf Blower Workers

An ergonomic risk factor is an exposure towards the awkward position, excessive forceful and sustained exertions, repetitive motion, static and sustained posture, vibration, and contact stress that possible cause of musculoskeletal disorders (MSD) and hand-arm vibration syndrome (HAVS) (Genaidy, Al-Shedi, & Shell, 1993). Since backpack leaf blower machine has been widely used in the cleaning industry, ergonomic related risk factor and work-related on backpack leaf blower workers could be identified by considering workers capacity based on biomechanical, physiological, exposure to vibration, and exposure to noise. According to (Keyserling, 2000), the prevalence, of MSD and HAVS might increase upon exposure to one or more risk factors. However, it is not known at what level the risks become significant.

According to (Kumar et al., 2011), the weight and motor blower unit mounted on the sprayer put physiological and biomechanical stress on the wearer's back. Furthermore, the vibration produced from the machine also generated throughout the body, especially on the back, along the hand and arms that hold the tube. When operating this equipment, another major risk is the use of excessive force while gripping the power switch mechanism to activate the leaf blower machine. This is because according to (Halim et al., 2019), most of the problems are due to the bad design and technology of the imprecise hand tool that can cause pain in the palm and wrist area due to contact stress and awkward

posture. (Ware, Kumar, Fernandez, Subramanian, & Hunter, 2011) agreed by in his study that musculoskeletal disorders in the wrist, hand and shoulder areas could be avoided if the design was prioritized, for example, the use of push to start to activated power hand tools. Operators are also allowed to adjust the level for increase force feed if necessarily without having to adjust it regularly.

### 2.5.1 Biomechanical Risk Factor

Most backpack machine users will face a common problem such as shoulder and low back pain. In 2006, Skaggs *et al*. has reported on a significant association between backpack weight and the occurrence of back pain (Skaggs, Early, D'Ambra, Tolo, & Kay, 2006). It is to be noted that the backpack equipment first needs to be lifted from its initial storage location before strapping it on the back. The weight of the container/unit and storage location among other factors impacts the occurrence of the LBP. In addition, NIOSH 1991 equation has been employed to compute the lifting hazard and also used to compute a recommended weight limit for the container/unit as long as the lift performed follows the limitations of the NIOSH equation (Waters, Putz-Anderson, Garg, & Fine, 1993). After the equipment is strapped on the back, the user bears the load on the shoulder and spine. Therefore, the backpack leaf blower workers also could possible encountered MSD due to the long exposure using the backpack machine type.

Martin and Nelson also demonstrated that the walking patterns of users are affected by the varying weight of the load carried (Martin & Nelson, 1986). The carried load would accentuate the stress imposed on the musculoskeletal structures of the body, particularly the lower extremities during the support phase of each step cycle. From a biomechanical perspective, the maximum disc compressive force should not exceed 3400 N (770 lbs) when handling weights (Waters et al., 1993). Walking with a heavy load on

the back of the body (Heuscher, Gilkey, Peel, & Kennedy, 2010), (Devroey, Jonkers, De Becker, Lenaerts, & Spaepen, 2007) and prolonged load carriage (Simpson, Munro, & Steele, 2011) will result in injuries and discomfort on the back area. As agreed by (Jacobson, Caldwell, & Kulling, 1997) and (Quesada, Mengelkoch, Hale, & Simon, 2000) carrying load while walking also increased foot injury.

Prolonged exposure to gripping and gripping power tools task, increase the risk of work related disorders such as carpal tunnel syndrome disorders (Neumann, Kihlberg, Medbo, Mathiassen, & Winkel, 2002) and (Dong, Barr, Loomer, & Rempel, 2005). According to (Jansen[1] et al., 2013), (Bernard, 1997) and (Eksioglu, 2006) exertion of frequent used of powerful tools increased exposure to work risk factor. In addition to mounting the container on the back, the workers are required to operate the handles and triggers . Inefficient design of these controls could cause awkward postures of the hands, wrist and shoulder and increase the activation force, thus contributing to MSD and HAVS. Therefore, the design of these handles and triggers must be based on published guidelines for hand tool. While (Putz-Anderson et al., 1997). And (Cagnie, Danneels, Van Tiggelen, De Loose, & Cambier, 2007), stated that repetitive same movement on the neck, increase risk on work related disorders on the neck area.

### 2.5.2 Physiological Risk Factor

According to a physiological perspective, carrying the container on the back for long durations may lead to fatigue. Research related to army personnel indicated that increasing the backpack load resulted in increased oxygen uptake, heart rate and pulmonary ventilation (J. Bobet & R. W. Norman, 1984; Borghols, Dresen, & Hollander, 1978). Negrini and Carabalona have reported that carrying backpacks causes fatigue (Negrini & Carabalona, 2002a). They also found a significant relationship between

fatigue and back pain. Waters *et al*. suggest that from a physiological perspective, the maximum energy expenditure should not exceed 4.7 Kcal/min (Waters et al., 1993). The work-rest periods should be evaluated and appropriate schedules should be implemented. (Thetkathuek, Meepradit, & Sa-ngiamsak, 2018) (Biazus, Moretto, & Pasqualotti, 2017) stated that musculoskeletal symptoms such back pain and body discomfort is closely related to the duration of work, high workload and awkward posture.

### 2.5.3 Psychosocial Factors: Job Controls and Job Rotation

(Jansen, Morgenstern, & Burdorf, 2004) and (Hoogendoorn et al., 2001) stated that job strain has been separately associated with both factors which are job demands and job control. Jobs which are high in demands, low in control, and also low in social support at work carry the highest risk of illness. In a study by (Alperovitch-Najenson et al., 2010), found that psychosocial job demands, job dissatisfaction, and the high frequency of job-related problems were predictors of workers compensation claims due to spinal injuries. The study found that significant associations were found for low supervisor support.

According to (Vandergrift, Gold, Hanlon, & Punnett, 2012) their study on 1315 automobile manufacturing workers, respondents with both high physical exposures and poor job control, job demands was associated with a significantly increased risk of incident lower back pain (LBP), increased work demand was protective against the risk of incident LBP for those with high physical exposure and medium to high job power. This information supports that when physical exposure was low, job demand was unrelated to LBP regardless of the level of job control. In another study on salespeople, (Skov, Borg, & Orhede, 1996) determined that demands in work, high competition, lack of control over time, and lack of variation, were significantly associated with neck symptoms. Lack of social support from colleagues and the tendency to feel overworked

were significantly associated with back symptoms. This distinct view concludes that social help from colleagues either require direct assistance with specific tasks or may indirectly increase the skills of the salesman so that they can cope with the job demands.

(Habibi, Pourabdian, Atabaki, & Hoseini, 2012)'s finding based on Emergency Unit Nurses perspectives, the results showed there was a significant relationship between low back discomfort and psychosocial and ergonomics risk factors. Spearman test showed that job control was the only work-related psychosocial factor which had no significant relation with low back discomfort. However, there was a meaningful relationship between low back discomfort and other work concerning psychosocial factors such social support, work demands, job content, ergonomics factors compared to cases without low back discomfort, was recognized. From this study, (Alperovitch-Najenson et al., 2010) and (Vandergrift et al., 2012) agreed that the risk of lower back pain increased with increasing job demands association with lower job support and lower job control**.** (Vandergrift et al., 2012) also supported that job demand was associated with an increased risk of incident LBP during the 1-year follow-up period. While (Skov et al., 1996) and (Habibi et al., 2012) have the same opinion, social support from colleagues and employers had a significant impact on decreased lower back pain due to high job control and soft feel of overworked. (Jorgensen, Davis, Kotowski, Aedla, & Dunning, 2005) agreed that job rotation reduce exposure to risk factors and reducing work-related injuries while (Padula, Comper, Sparer, & Dennerlein, 2017), found that job rotation cannot reduce exposure and possibility to physical risk factor but job rotation will increased job satisfaction for workers.

### 2.5.4 Psychosocial Factors: Management and Stress

As mentioned by (Aman & Abd Shukor, 2015) on his study, the duty of management to ensure employees' efficiency, safety and health. While (Hardison, Behm, Hallowell, & Fonooni, 2014) mentioned that supervisor play an important role as organizer for daily working activities and as an intermediary between employers and employees. As agreed by (Therkelsen & Fiebich, 2003) in safety, interaction in various task within supervisor and workers is important and give a major impact. Lack of attention from employers due job issues will cause workers stress (Woods & Buckle, 2006). According to (Niu, 2010), the negative impact on the health of employees is due to problems caused by the management of the organisation such management of working hours.

(Bernhard, 1997) on his review concluded that psychosocial factors may represent generalized risk factors for musculoskeletal disorders, but it was difficult to determine the relative importance of physical and psychosocial factors. Several research on the relationship between psychological stress with musculoskeletal disorder and others health effect have been proposed. These include an overload of low-threshold motor units and muscle constraints such from prolonged muscle contraction or stress-induced tension aggravating by posture, (Crown, 1978), (Sikorski, Stampfer, Cole, & Wheatley, 1996).

Work-related psychosocial stressing has previously been shown to correlate with the incidence of LBP among professional drivers, such as work satisfaction, stress, mental demands, and insufficient supervision. As stated by (Magnusson, Pope, Wilder, & Areskoug, 1996), (Alperovitch-Najenson et al., 2010) four stressful situations showed a statistically significant association with LBP, which is traffic congestion on the bus route, passenger hostility, inadequate rest period during the working day and lack of accessibility to the bus stop for the descending and ascending of passengers. The author also agreed that the major hypotheses include direct neurogenic effects of psychological

demand on muscle tension and the ensuing biomechanical strain and stress-related endocrine effects on musculoskeletal function. (Vandergrift et al., 2012) on his findings raise concern, physical stress may be one component of the pathway through which psychosocial factors increase the risk of LBP. Alternatively, it may be that job stress does not cause LBP directly but instead aggravates the impact of physical stressors on the lower back.

(Habibi et al., 2012) suggested that negative psychosocial work factors such as stress need to be eliminated or reduced as much as possible. Achieving the perfect job without any negative psychosocial work factors may not be feasible or realistic, given individual, organizational, or technological constraints and requirements. (Skov et al., 1996) argued that people who do not feel well would tend to report more exposures than those who have no symptoms, partly because they perceive their work as stressful because of their symptoms. In the present study validation of self-reports for stress perspective by observation was not possible.

For this sub-topic, (SVENSSON & ANDERSSON, 1989) on his study, agreed that psychological stress contributes to increased tone in musculature, consequently causing increased mechanical strain on spinal structures. While (Davis, Marras, Heaney, Waters, & Gupta, 2002) on his study support that during the observation, increased spinal loading when a lifting task was combined with simultaneous mental processing was attributed to an overreaction of the musculoskeletal system characterized by less controlled movements and increases in muscle co-activation, this concludes the association with lower back pain and stress.

### 2.5.5 Vibration Risk Factor

Segmental vibration, unlike whole-body vibration, it is restricted to the hand-arm system. There is a broad category of injuries associated with the vibration of the upper extremities (the hand-arm system) called HAVS. This is an illness that is cumulative in nature and develops over a period of time (NIOSH, 1989). Other illnesses have similar symptoms and may also be caused by vibration exposure, including Raynaud's syndrome and carpal tunnel syndrome (CTS). Vibration syndromes tend to include injuries to the blood vessels, nerves, bone joints and muscles. In 1989, the National Institute for Occupational Safety and Health (NIOSH) released a recommended standard criteria document for exposure to hand-arm vibration (NIOSH, 1989). These criteria considered the hazards of hand tool operation and recommended various ways to reduce the level of vibration, but did not make specific recommendations for exposure limits. Instead, the recommendation was to use reduction methods to limit hand-arm vibration exposure to a minimum (NIOSH, 1989, 1997). Generally, while selecting a hand tool and equipment, it is necessary to consider the factors that affect the amplitude and frequency of vibration. The exposure risks may be reduced by implementing a specific type of suggested controls such as engineering changes to reduce the vibration or using appropriate personal protective equipment (PPE).

### 2.5.6 Noise Exposure Risk Factor

The motorized part on the back mounted leaf blower also produces noise, which could affect workers' performance. Exposure to noise for a long time can cause either temporary or permanent hearing loss. Noise induced hearing loss (NIHL) is typically experienced in the 3000 to 6000 Hz range and centres around the 4000 Hz frequency (Kroemer, Kroemer, & Kroemer, 2001). Noise induced temporary threshold shift (NITTS) also involves

frequencies in the range of 3000 to 6000 Hz, but it is a temporary shift in the hearing threshold and can last for several hours after exposure. The U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) has established standards to ensure that employers limit worker exposure to excessive noise produced from the backpack leaf blower machine.

OSHA has set the action limit (AL) for noise exposure to a time-weighted average (TWA) of 85 dBA (OSHA, 1998). With a TWA of 85 dBA or higher, the workers are required to implement a hearing conservation program. The monitoring program is involved in noise level measurements, must include audiometric testing and making hearing protection devices available to all exposed workers. The risks of exposure may be reduced by implementing some of the controls such as implementing sound absorbing barriers, job scheduling and use of earplugs or earmuffs.

## 2.6 Ergonomic Risk Assessment on Backpack Leaf Blower Workers

According (Chiasson, Imbeau, Aubry, & Delisle, 2012), various methods can be used to identify and access ergonomic exposure, risk factor related to musculoskeletal disorders related to the work activities and task within a job. These include direct methods, observational methods, self-assessment and psychophysiological methods. The assessment of physical workload factors such as awkward posture, intensity, duration, repetitiveness and force exertion and environmental will define any associated exposure to work-related musculoskeletal risks.

Ergonomics Risk Assessment (ERA) by DOSH Malaysia is an approach to determine the level of ergonomic risk. This approach has defined as identifying, assessing and controlling ergonomics risk factor correlated with job tasks and activities in the workplace. Ergonomic assessments are good methods and approaches that ensure the

health and safety of employees while improving worker performance and law (DOSH, 2017). For this study, an ergonomic risk assessment should also be conducted on the workers via self-assessment musculoskeletal pain/discomfort survey, musculoskeletal assessment, ergonomic risk assessment checklist, and psychosocial risk factors assessment according to Guidelines on Ergonomics Risk Assessment at Workplace published by DOSH Malaysia.

### 2.6.1 Musculoskeletal Pain/Discomfort Survey Self-Assessment

The musculoskeletal pain/discomfort survey self-assessment usually is conducted to identify the feeling of discomfort or pain of workers upon exposure towards ergonomic risk factors for specific periods. Respondents will be asked to thick the checklist containing information of the body parts that feel pain or discomfort as indicated in the survey. For example, an assessment with a questionnaire related to physical workload at video display unit has been tested among 100 persons working on documentation (Karlqvist, Hagberg, Köster, Wenemark, & Anell, 2013; Vandergrift et al., 2012) . The finding indicated that operators using a mouse for at least 5.6 hours per week suffered more symptoms in hand compared to the operator with fewer hours work. Therefore, this self-assessment could possibly reduce the risk factors for upper-limb symptoms occurred.

Commonly, the musculoskeletal assessment will be conducted for all type of ergonomic risk factor using cornel musculoskeletal and hand discomfort questionnaire. The cornel musculoskeletal questionnaire is assessment for whole body parts in general and there are two sets of questionnaires divided for male and female. For example, an assessment has been conducted on 30 students to identify the relation between the angle of cervical and shoulder poster with different weight of backpack (Malik, Vinay, & Pandey, 2017). The result showed that a backpack type bag should not more than 5% of

girl students' body weight and 10% of boy students' body weight due to the postural problems. On the other hand, for hand discomfort questionnaire, also it is divided into the right and left hand where the respondents were asked to thick at the body parts as indicated in the survey. Recently, the survey has been conducted among 100 bank workers to evaluate work-related musculoskeletal problems while using a computer at least 3 hours per day for 6 months (Umar et al., 2019). The most discomfort part of the body is the neck and head, followed by lower back and both right and left shoulder. These finding demonstrated that musculoskeletal problems are common among the workers using the computer.

### 2.6.2 Initial Ergonomics Assessment

Initial ergonomic risk assessment checklist consists of four factors which are awkward posture, repetitive motion, vibration, and forceful exertion as suggested in guidelines on ergonomics risk assessment at the workplace published by DOSH Malaysia. The assessment is observed using a checklist and documented via audio visual tools and capturing images from various perspectives such as front, back and sides. Factors such as body part, physical risk factor and maximum exposure duration of works will be considered and measured during this evaluation process. In the construction industry, the most common problem is the safety and health of the workers where the activities could lead to WRMSD. The ergonomic risk assessment is done among the construction workers using questionnaire checklist, rapid body entire assessment (REBA) and quick exposure check (QEC) ergonomic assessment tool to study risk factors especially in building construction sites (Vachhani, Sawant, & Pataskar, 2016). The analysis and finding showed that the tasks need to redesign due to most of the workers were at high and moderate risks.

### 2.6.3 Psychosocial Risk Factor Assessment

According to (Deeney & O'Sullivan, 2009), psychosocial risks assessment is a method that derived from research involving occupational psychology, and these effective methods are used to measure the risks based on the pathological link of MSDs due to psychosocial risk itself or the resulting combination of risks physical and psychosocial risks. Also, activities or situation that fall under these categories which is emotion, mental well-being, social support, social relation, job control, job demands, job satisfaction, work balance include family environment is characterized as ranges of a psychosocial risk factor for occupational diseases that can be accessed. While (Kristensen, Hannerz, Høgh, & Borg, 2005) indicated that an extensive list of psychosocial risk factors, this including the meaning of work, influence at work, feedback at work, freedom at work, insecurity at work, commitment to the workplace, cognitive demands, sensorial demands, cognitive demands, quality of leadership, role conflicts, role clarity and sense of community.

Psychosocial risk factor assessment questionnaire has been conducted to identify the risk factor that may affect the psychological of the workers such as high workloads, tight deadlines and lack control of the work and working method. Response from the respondent to their work and workplace condition is identified directly through a complaint. The assessment has been conducted among workers using a develop structured questionnaire covering some potential risk factors such as work station, position, break time, job demands, job control, and social support (Eltayeb, Staal, Kennes, Lamberts, & de Bie, 2007). The result showed that neck and shoulder complaints are most commonly reported complaints.

# CHAPTER 3 : METHODOLOGY

## 3.1 Introduction

Ergonomics Risk Assessment (ERA) is an approach to determine the level of ergonomic risk. This approach has define as identifying, assessing and controlling ergonomics risk factor correlated with job tasks and activities in the workplace. Ergonomic assessments are good methods and approaches that ensure the health and safety of employees while improving worker performance and law requirements. In this study, the assessment will be conducted using Ergonomics Risk Assessment from the Guidelines on Ergonomics Risk Assessment at Workplace published by DOSH Malaysia.

## 3.2 Study sampling and coordination of the study

A total of 10 backpack blower workers doing the cleaning work around the UiTM Campus Puncak Alam, Selangor participated in the study. A briefing session will be held with the respondent before the assessment. This session will be used by researcher utterly to understand the standard operating procedures and scope of the task. During the survey process, the researcher will assist the respondents to clearly understand the contents of the survey instruments.

## 3.3 Ergonomics Risk Assessment (ERA)

### 3.3.1 Part 1: Self-assessment Musculoskeletal Pain/ Discomfort Survey

The Musculoskeletal Pain/Discomfort Survey Self-assessment will be conducted to identify the feeling of discomfort or pain during work using a back pack leaf blower machine for 12 months. Respondents were asked to identify which body parts are indicated that they were feeling pain or discomfort. Refer to **Appendix 1** for Self-Assessment Musculoskeletal Pain/ Discomfort Survey Form.

### 3.3.2 Part 2.A: Initial ERA- Musculoskeletal Assessment

The Musculoskeletal assessment will be conducted for all type of ergonomic risk factor. For this study, the Cornel Musculoskeletal and Hand Discomfort Questionnaire will be used. The Cornel Musculoskeletal Questionnaire is used to investigate for whole body parts which is includes two set of questionnaire set for male and female respectively as shown in **Appendix 2A** and **2B**. On the other hand, for Hand Discomfort Questionnaire also it will divided to right and left hand as in **Appendix 2C** and **2D**.

### 3.3.3 Part 2.B: Initial Ergonomics Risk Assessment Checklist

There are four set of assessments will be conducted under the investigation of Initial Ergonomic Risk Assessment Checklist. The assessment should be observed using a checklist and documented using audio visual tools and capturing images from various perspectives such as front, back and sides. Factors such as body part, physical risk factor and maximum exposure duration of works will be considered and measured during this evaluation process. The set of assessments to be conducted are shown as table below:

**Table 3.1 : Set of Initial Era Assessment**

| No. | Ergonomic risk factors | Please refer to |
|---|---|---|
| i | Awkward posture | Appendix 3A |
| ii | Repetitive motion | Appendix 3B |
| iii | Vibration | Appendix 3C |
| iv | Forceful exertion | Appendix 3D |

### 3.3.4 Part 3: Psychosocial Risk Factors Assessment

Psychosocial risk factor assessment questionnaire will be conducted to identify the risk factor that may affect the psychological of the workers. The factor includes high workload demand, tight scheduled to fulfil deadlines and lack control of working procedure at workplace. A questionnaire will be provided to employees to identify other factor association exists between physical and psychosocial work factor with back pain and body discomfort .The psychosocial risk factors assessment questionnaire is as shown in **Appendix 4**.

## 3.4 Analysis Data

Based on the questionnaire and checklists, the score outcomes from the questionnaire and assessment checklist will be analysed separately. The score results from the questionnaire will be analysed in three ways which is counting the symptoms, rating the values, and weighting. By weighting the rating scores, it makes it more easy to identify the discomfort and pain of the body part and to detect the most serious problem. Initial era should be scored based on each factor observed and analysed. The assessment score outcome will be summarized in initial ERA form.

## 3.5 Flow Chart of Research Methodology

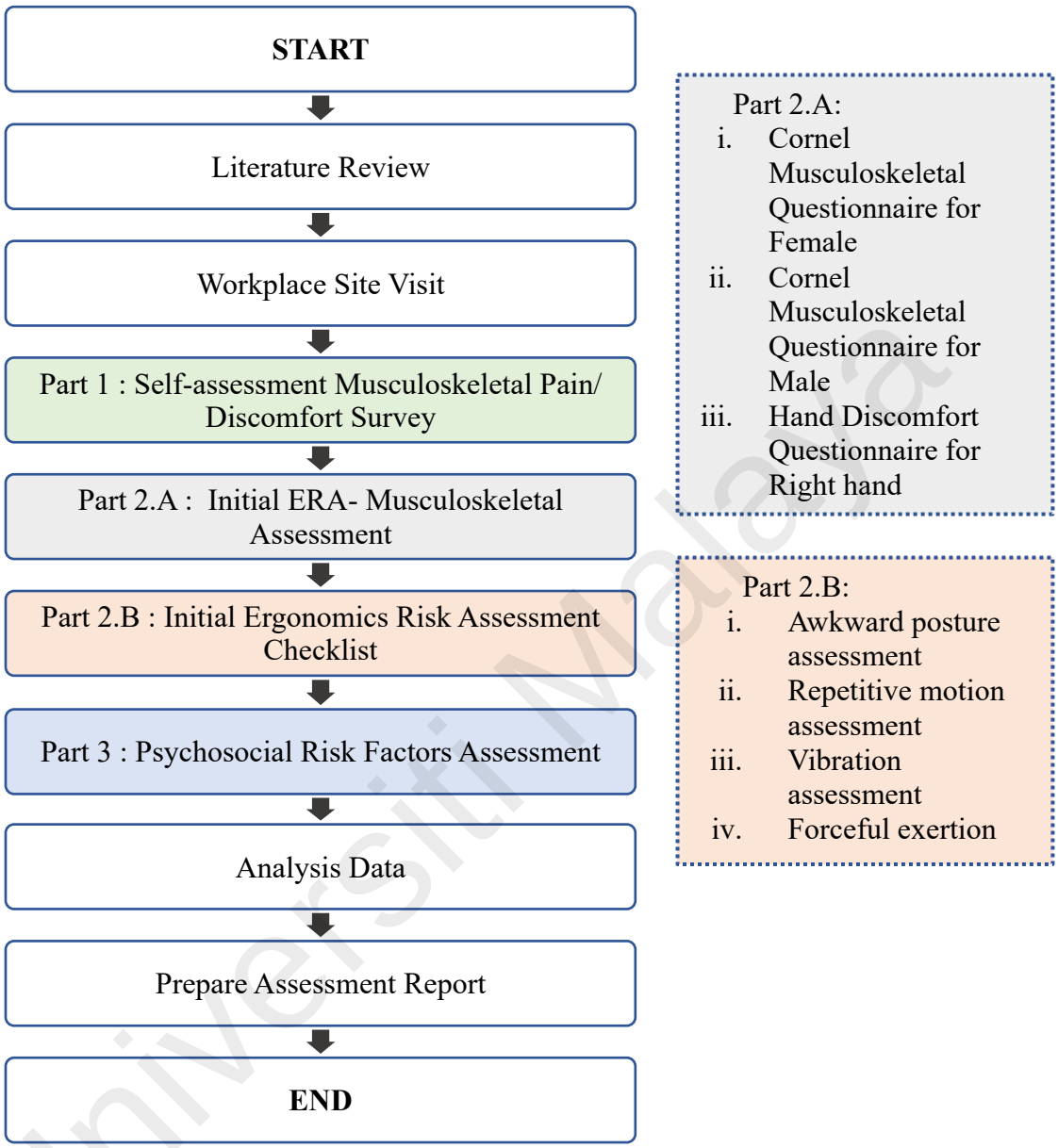


**Figure 3.1 : Flow Chart of Research Methodology**

## 3.6 Gantt Chart of Research Activity

**Table 3.2 : Gantt Chart of Research Activity**

| Activity | Duration (February to January 2021 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2 | 3 | 4 | 5 | 6 | 9 | 10 | 11 | 12 | 1 |
| Search title for research project | | | | | | | | | | |
| Obtain reference materials and detailing the scope | | | | | | | | | | |
| Discussing the title | | | | | | | | | | |
| Study the theory, background, material and previous studies. | | | | | | | | | | |
| Complete literature review | | | | | | | | | | |
| Making methodology | | | | | | | | | | |
| Design Questionnaire and assessment checklist | | | | | | | | | | |
| Site visit and collecting data | | | | | | | | | | |
| Gathering all data and analysis | | | | | | | | | | |
| Draft Final Report | | | | | | | | | | |
| Send research project II report (final draft) | | | | | | | | | | |
| Presentation of the research project | | | | | | | | | | |

# CHAPTER 4 : RESULT

## 4.1 Introduction

This section gives a good indication of expectation from the research. Expected result describes the possible outcome from the beginning until the end of the research. The research starts with classification of Work Muscular-skeletal Disorders (WMSDs) and ergonomic risk factor. The ergonomic risk assessment will be divided into four parts. The assessment consists of Part 1 (Self-assessment Musculoskeletal Pain/ Discomfort Survey, Part 2.A (Initial ERA-Musculoskeletal Assessment), Part 2.B (Initial Ergonomics Risk Assessment Checklist) and Part 3 (Psychosocial Risk Factors Assessment). Therefore, these four part will used the same method which is questionnaire and checklist but results to different exposure of body part, physical risk factor, probability and consequences.

## 4.2 Study Design and Coordination of Study

Questionnaires were distributed to 10 maintenance workers at UiTM, Puncak Alam on the same day. All questionnaires were returned with complete answers. Table 4.1 shows characteristics of the sample. Demographic shows, 50% of the respondents were male and while 50 % were females. There are 3 respondents age less than 30 years old and 3 respondents age between 31 to 40 years old which are 34, 35 and 36 years old. This followed by 4 respondents age more than 40 years old. In addition, duration of employment is 2 years, where their field of work varies with different employers' tenders or contracts.

**Table 4.1 : Respondents Background Based on Demographics**

| Demographic | | Frequency |
|---|---|---|
| **Age** | 20 – 30 years old<br>31 – 40 years old<br>41 -50 years old | 3<br>3<br>4 |
| **Gender** | Female<br>Male | 5<br>5 |
| **Duration of employment** | 2 years | 10 |

Five female employees work with company A, where their designated cleaning area covers from the foot of the hill up to the hill around the student dormitory compound. Another group of cleaning workers is assigned at the main road area and they are supervised by company B where the area is moderately sloped. Working hours are from 7 am to 4 pm. They are given 30 minutes rest 3 times a day, which is from 10.00 to 10.30 am, 12.00 to 12.30 pm, 3.00 to 3.30 pm. Brief information for leaf blower backpack machine use in this study is as below :

**Table 4.2 : Backpack Leaf Blower Machine Information**

| Description | Company A | Company B |
|---|---|---|
| Model | ZENOAH EB6200 | GIANT EB750 |
| Dry Weight (Kg) | 8.6 | 9.5 |
| Fuel Tank Capacity (Litre) | 2.0 | 1.3 |
| Engine Type | Air cooled 2-cycle gasoline engine | Air cooled 2-cycle gasoline engine |

Figure 4.1 and Figure 4.2 shows the cleaning area for company A and Figure 4.3 and Figure 4.4 is the cleaning area for company contractor B. Distance data in kilometers (km) from google maps shows the movement of cleaning workers not less than 3 km per day. The estimated data does not include repetitive, forward or backward movements, small hallways around buildings and cleaning areas.

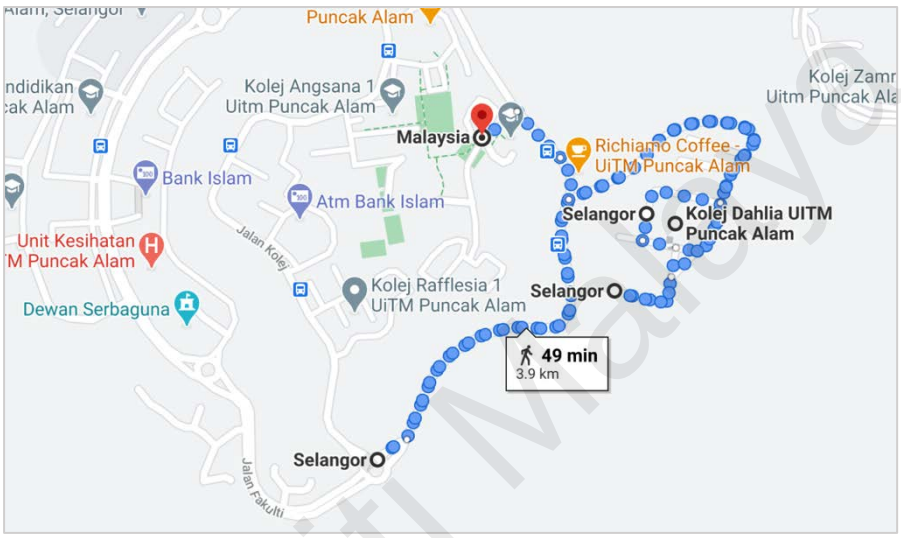


**Figure 4.1 : Cleaning Area For Company A**

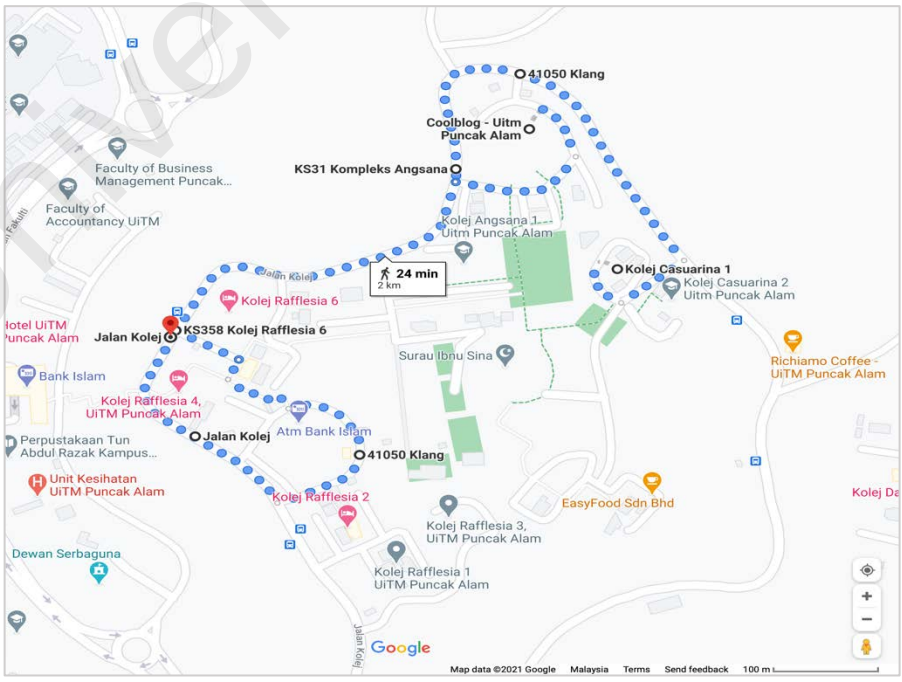


**Figure 4.2 : Cleaning Area For Company A**

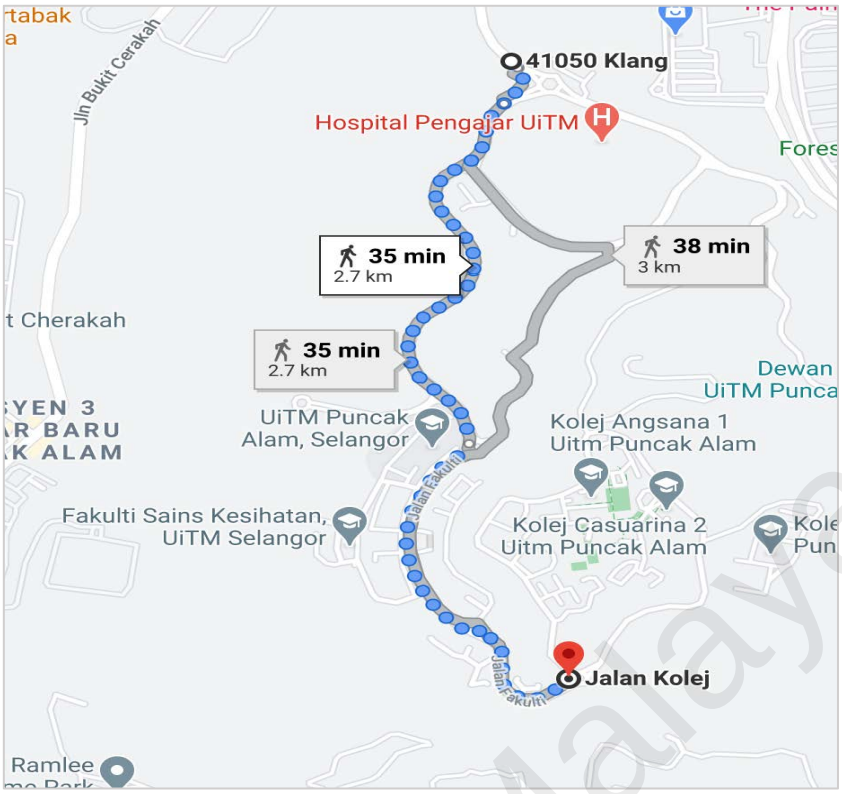


**Figure 4.3 : Cleaning Area For Company B**

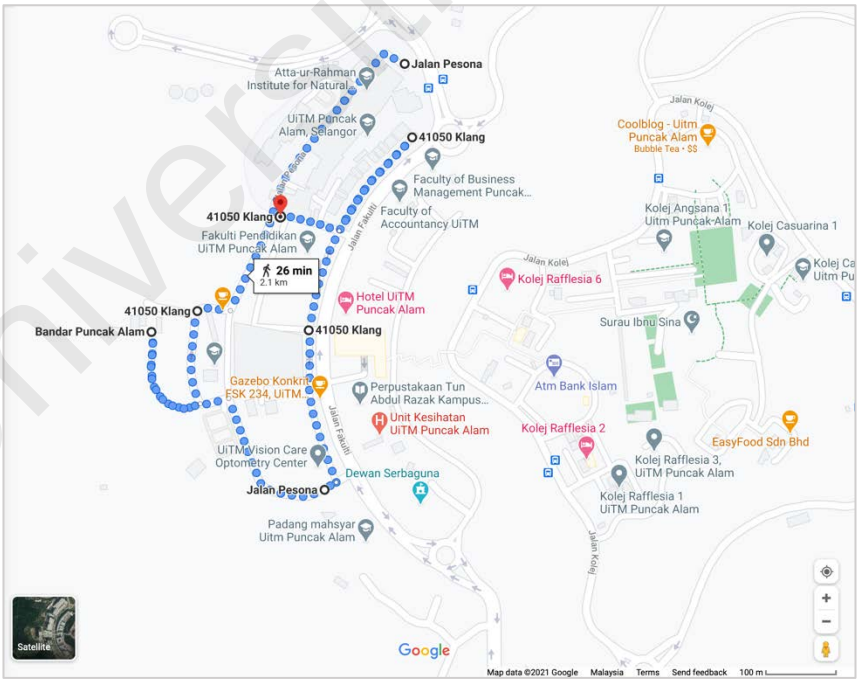


**Figure 4.4 : Cleaning Area For Company B**

## 4.3 Result of Self-assessment Musculoskeletal Pain/ Discomfort Survey

As mentioned in previous chapter, the feeling of discomfort or pain during work using a backpack leaf blower machine is evaluated. 14 body parts were point out in the survey. Table 4.3 presents Self-assessment Musculoskeletal Pain/ Discomfort Survey for female and male which shows, 80% of the respondents felt pain/discomfort in several body part such as shoulders, wrists (right), hands (right) and lower back where they agreed that the pain/ discomfort results from their nature of work. Meanwhile, 7 respondents consist of 5 women and 2 men had pain/discomfort on their feet. Additionally, around half of the respondents had problems on calf area. The data also shows the least pain/discomfort body parts are upper arm, upper back and elbow (right). Overall, all respondents stated that they did not feel any pain/discomfort on the left-hand side.

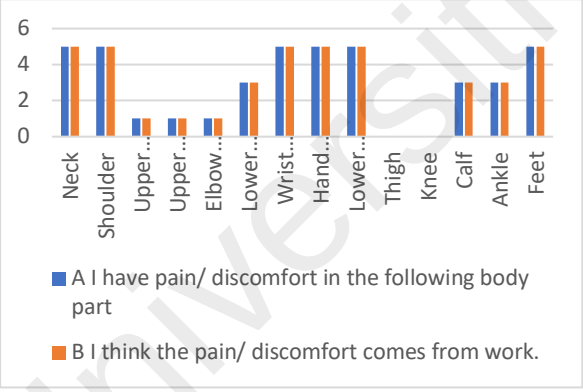


**Figure 4.6 : Female Self-Assessment Musculoskeletal Pain/Discomfort Survey Form**

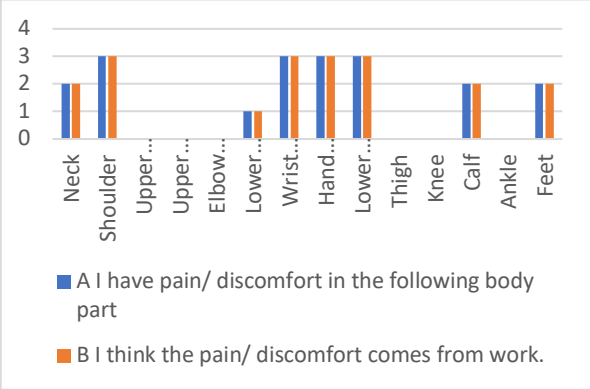


**Figure 4.5 : Female Self-Assessment Musculoskeletal Pain/Discomfort Survey Form**

## Table 4.3 : Self-Assessment Musculoskeletal Pain/ Discomfort Survey for Female and Male

| Body Parts | A | | | B | | |
|---|---|---|---|---|---|---|
| | I have pain/ discomfort in the following body part | | | I think the pain/ discomfort comes from work. | | |
| | No. of Female Worker | No. of Male Worker | % of total | No. of Female Worker | No. of Male Worker | % of total |
| Neck | 5 | 2 | 70 | 5 | 2 | 70 |
| Shoulder | 5 | 3 | 80 | 5 | 3 | 80 |
| Upper back | 1 | 0 | 10 | 1 | 0 | 10 |
| Upper Arm | 1 | 0 | 10 | 1 | 0 | 10 |
| Elbow (Right) | 1 | 0 | 10 | 1 | 0 | 10 |
| Lower arm (Right) | 3 | 1 | 40 | 3 | 1 | 40 |
| Wrist (Right) | 5 | 3 | 80 | 5 | 3 | 80 |
| Hand (Right) | 5 | 3 | 80 | 5 | 3 | 80 |
| Lower back | 5 | 3 | 80 | 5 | 3 | 80 |
| Thigh | 0 | 0 | 0 | 0 | 0 | 0 |
| Knee | 0 | 0 | 0 | 0 | 0 | 0 |
| Calf | 3 | 2 | 50 | 3 | 2 | 50 |
| Ankle | 3 | 0 | 30 | 3 | 0 | 30 |
| Feet | 5 | 2 | 70 | 5 | 2 | 70 |

## 4.4 Result of Initial ERA - Cornel Musculoskeletal Assessment for Female Workers

The score outcomes from the questionnaires can be analysed in 4 ways, first by simply counting the number of symptoms per person, second by summing the rating value of each person, third by weighing the rating scores and lastly by multiplying frequency score. Activity level was determined by calculating the total discomfort score by multiplying frequency score. Respondents assess the frequency of discomfort on a scale of 0 (none), 1.5 (1- 2 times/week), 3.5 (3-4times/week), 5 (every day), 10 (several times every day) and severity of discomfort from 1 (slightly uncomfortable) to 3 (very uncomfortable). Level at which the discomfort interfered with work was scored from 1 (no interference) to 3 (intensely interfere). Total discomfort score was calculated by using the following formula: Discomfort score = frequency x discomfort x interference.

As shown in Table 4.4, discomfort score for wrists (right hand) is the highest with a percentage rate of 20.98%, followed by the lower back (18.17%), both foot (13.0%) and both shoulders (12.19%). Other body part shows a moderate level of discomfort score which is the shoulder (5.23%), forearm (right) with 1.74%, knee (right and left) with total discomfort score of 0.61%, hip/buttock with 0.58%, upper back and upper arm (0.11%). From this assessment there are no discomfort score or less noticeable on the left forearm, left wrist and both thighs for any pain or discomfort.

**Table 4.4 : Total Discomfort Score for Cornel Musculoskeletal Assessment for Female Workers**

| Body parts | Frequency | Discomfort | Interference | Discomfort score | % |
|---|---|---|---|---|---|
| **Neck** | 20 | 8 | 9 | 1440 | 5.23 |
| **Shoulder (Right)** | 30.5 | 10 | 11 | 3355 | 12.19 |
| **Shoulder (Left)** | 30.5 | 10 | 11 | 3355 | 12.19 |
| **Upper back** | 3 | 2 | 5 | 30 | 0.11 |
| **Upper Arm (Rigfht)** | 3 | 2 | 5 | 30 | 0.11 |
| **Upper Arm (Left)** | 3 | 2 | 5 | 30 | 0.11 |
| **Lower back** | 50 | 10 | 10 | 5000 | 18.17 |
| **Forearm (Right)** | 10 | 6 | 8 | 480 | 1.74 |
| **Forearm (Left)** | 0 | 0 | 5 | 0 | 0 |
| **Wrist (Right)** | 37 | 13 | 12 | 5772 | 20.98 |
| **Wrist (Left)** | 0 | 0 | 5 | 0 | 0 |
| **Hip/Buttock** | 8 | 4 | 5 | 160 | 0.58 |
| **Thigh (Right)** | 0 | 0 | 5 | 0 | 0 |
| **Thigh (Left)** | 0 | 0 | 5 | 0 | 0 |
| **Knee (Right)** | 6 | 4 | 7 | 168 | 0.61 |
| **Knee (Left)** | 6 | 4 | 7 | 168 | 0.61 |
| **Lower leg (Right)** | 7.5 | 5 | 8 | 300 | 1.09 |
| **Lower leg (Left)** | 7.5 | 5 | 8 | 300 | 1.09 |
| **Foot (Right)** | 38.5 | 9 | 10 | 3465 | 13 |
| **Foot (Left)** | 38.5 | 9 | 10 | 3465 | 13 |

## Table 4.5 : Female Cornel Musculoskeletal Questionnaire with Number of Workers Effected

| Body Part | How often did you experience with the pain or discomfort? | | | | | How uncomfortable was this? | | | Did this interfere with your ability to work ? | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Never | 1-2 times last week | 3-4 times last week | Once every day | Several times every day | Slightly uncomfortable | Moderately uncomfortable | Very uncomfortable | Not at all | Slightly interfered | Substantially interfered |
| Neck | | 2 | 2 | | 1 | 2 | 3 | | 1 | 4 | |
| Shoulder (Right) | | | 3 | | 2 | 1 | 3 | 1 | | 4 | 1 |
| Shoulder (Left) | | | 3 | | 2 | 1 | 3 | 1 | | 4 | 1 |
| Upper back | 3 | 2 | | | | 2 | | | 5 | | |
| Upper Arm (Rigfht) | 3 | 2 | | | | 2 | | | 5 | | |
| Upper Arm (Left) | 3 | 2 | | | | 2 | | | 5 | | |
| Lower back | | | | | 5 | | 2 | 3 | | 2 | 3 |
| Forearm (Right) | 1 | 2 | 2 | | | 2 | 2 | | 2 | 3 | |
| Forearm (Left) | 5 | | | | | | | | 5 | | |
| Wrist (Right) | | | 2 | | 3 | | 2 | 3 | | 3 | 2 |
| Wrist (Left) | 5 | | | | | | | | 5 | | |
| Hip/Buttock | 2 | 2 | | 1 | | 2 | 1 | | 5 | | |
| Thigh (Right) | 5 | | | | | | | | 5 | | |
| Thigh (Left) | 5 | | | | | | | | 5 | | |
| Knee (Right) | 1 | 4 | | | | 4 | | | 3 | 2 | |
| Knee (Left) | 1 | 4 | | | | 4 | | | 3 | 2 | |
| Lower leg (Right) | | 5 | | | | 5 | | | 2 | 3 | |
| Lower leg (Left) | | 5 | | | | 5 | | | 2 | 3 | |
| Foot (Right) | | | 1 | 1 | 3 | 2 | 2 | 1 | | 5 | |
| Foot (Left) | | | 1 | 1 | 3 | 2 | 2 | 1 | | 5 | |

## 4.5 Result of Initial ERA - Cornel Musculoskeletal Assessment for Male Workers.

From Table 4.6 and Table 4.7, it can be roughly seen that there are several body part which does not suffer or experience any pain or discomfort and does not interfere with their work. Total discomfort score with 0% percentage are upper back, upper arm, left forearm, left wrist, hip/buttock, thigh, knee and lower leg. Body part that scores most discomfort are both shoulder with 20.81%. Next is the neck with a percentage of 17.59%. Right wrist shows discomfort score percentage of 17.24%. Lower back with 16.29% of discomfort score was reported by male workers in the previous week before the assessment was done. Meanwhile, the lowest total discomfort score of 3.23% is on both foot, due to distance of a walk.

**Table 4.6 : Total Discomfort Score for Cornel Musculoskeletal Assessment for Male Workers**

| Body parts | Frequency | Discomfort | Interference | Discomfort score | % |
|---|---|---|---|---|---|
| **Neck** | 8.5 | 6 | 8 | 408 | 17.59 |
| **Shoulder (Right)** | 11.5 | 6 | 7 | 483 | 20.81 |
| **Shoulder (Left)** | 11.5 | 6 | 7 | 483 | 20.81 |
| **Upper back** | 0 | 0 | 0 | 0 | 0 |
| **Upper Arm (Rigfht)** | 0 | 0 | 0 | 0 | 0 |
| **Upper Arm (Left)** | 0 | 0 | 0 | 0 | 0 |
| **Lower back** | 6 | 7 | 9 | 378 | 16.29 |
| **Forearm (Right)** | 3 | 1 | 6 | 18 | 0.78 |
| **Forearm (Left)** | 0 | 0 | 0 | 0 | 0 |
| **Wrist (Right)** | 10 | 5 | 8 | 400 | 17.24 |
| **Wrist (Left)** | 0 | 0 | 5 | 0 | 0 |
| **Hip/Buttock** | 0 | 0 | 5 | 0 | 0 |
| **Thigh (Right)** | 0 | 0 | 5 | 0 | 0 |
| **Thigh (Left)** | 0 | 0 | 5 | 0 | 0 |
| **Knee (Right)** | 0 | 0 | 5 | 0 | 0 |
| **Knee (Left)** | 0 | 0 | 5 | 0 | 0 |
| **Lower leg (Right)** | 0 | 0 | 5 | 0 | 0 |
| **Lower leg (Left)** | 0 | 0 | 5 | 0 | 0 |
| **Foot (Right)** | 5 | 3 | 5 | 75 | 3.23 |
| **Foot (Left)** | 5 | 3 | 5 | 75 | 3.23 |

## Table 4.7 : Male Cornel Musculoskeletal Questionnaire with Number of Workers Effected

| Body Part | How often did you experience with the pain or discomfort? | | | | | How uncomfortable was this? | | | Did this interfere with your ability to work ? | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Never | 1-2 times last week | 3-4 times last week | Once every day | Several times every day | Slightly uncomfortable | Moderately uncomfortable | Very uncomfortable | Not at all | Slightly interfered | Substantially interfered |
| Neck | 2 | 1 | 2 | | | 4 | 1 | | 2 | 3 | |
| Shoulder (Right) | | 3 | 2 | | | 4 | 1 | | 3 | 2 | |
| Shoulder (Left) | | 3 | 2 | | | 4 | 1 | | 3 | 2 | |
| Upper back | 5 | | | | | 5 | | | 5 | | |
| Upper Arm (Rigfht) | 5 | | | | | 5 | | | 5 | | |
| Upper Arm (Left) | 5 | | | | | 5 | | | 5 | | |
| Lower back | 1 | 2 | 2 | | | 1 | 3 | | 1 | 4 | |
| Forearm (Right) | 3 | 2 | | | | 1 | | | 4 | 1 | |
| Forearm (Left) | 5 | | | | | | | | 5 | | |
| Wrist (Right) | 1 | 2 | 2 | | | 3 | 1 | | 2 | 3 | |
| Wrist (Left) | 5 | | | | | | | | 5 | | |
| Hip/Buttock | 5 | | | | | | | | 5 | | |
| Thigh (Right) | 5 | | | | | | | | 5 | | |
| Thigh (Left) | 5 | | | | | | | | 5 | | |
| Knee (Right) | 5 | | | | | | | | 5 | | |
| Knee (Left) | 5 | | | | | | | | 5 | | |
| Lower leg (Right) | 5 | | | | | | | | 5 | | |
| Lower leg (Left) | 5 | | | | | | | | 5 | | |
| Foot (Right) | 3 | 1 | 1 | | | 1 | 1 | | 5 | | |
| Foot (Left) | 3 | 1 | 1 | | | 1 | 1 | | 5 | | |

## 4.6 Result of Hand Discomfort Questionnaire

Hand Discomfort Questionnaire uses Guidelines on Ergonomics Risk Assessment at Workplace published by DOSH Malaysia and is divided into right and left hand. As agreed by all 10 respondents, they had no problems or felt any pain on the left-hand side. This is obvious as they use the right hand and arms to hold the blower tube and since the tube is fixed and not exchangeable. The hand discomfort questionnaire was filled out by the worker and specified which parts of their hand where they felt most discomfort within the last week and whether or not that discomfort had interfered with job performance.

Discomfort score for female workers on the right hand is significantly higher than male. Total percentage are divided to female and male workers. Female worker felt the most discomfort on their wrist (24.48%), index, middle and ring fingers (24.42%) and the base of the thumb (24.11%) as reported in Table 4.8 and Table 4.9 Discomfort score also higher on the thumb (15.33%). Discomfort was less noticeable in the base of palm (7.31%) and on the left pinky and ring fingers (6.35%).

Discomfort score for male workers is expressively less than female worker. For male workers, discomfort score reported less on the base of palm (5.41%), right pinky and ring fingers (9.73%) and in the index, middle and ring fingers (9.73%). Total highest percentage for discomfort score is on the wrist (28.82%), base of the thumb (27.39%) while the thumb scores at 18.92%.

## Table 4.8 : Total Discomfort Score For Hand

| Body parts referred in the questionnaire | Gender | Frequency | Discomfort | Interference | Discomfort score | % |
|---|---|---|---|---|---|---|
| **A**   | Female | 17 | 8 | 12 | 1632 | 22.42 |
| | Male | 4.5 | 5 | 6 | 135 | 9.73 |
| **B**  | Female | 11 | 6 | 7 | 462 | 6.35 |
| | Male | 4.5 | 5 | 6 | 135 | 9.73 |
| **C**  | Female | 15.5 | 8 | 9 | 1116 | 15.33 |
| | Male | 7.5 | 5 | 7 | 262.5 | 18.92 |
| **D**  | Female | 9.5 | 7 | 8 | 532 | 7.31 |
| | Male | 3 | 5 | 5 | 75 | 5.41 |
| **E**  | Female | 19.5 | 9 | 10 | 1755 | 24.11 |
| | Male | 9.5 | 6 | 8 | 380 | 27.39 |
| **F**  | Female | 16.5 | 9 | 12 | 1782 | 24.48 |
| | Male | 10 | 5 | 8 | 400 | 28.82 |

## Table 4.9 : Cornell Hand Discomfort Questionnaire with score (number of workers)

| AREA | Gender | How often did you experience with the pain or discomfort? | | | | | How uncomfortable was this? | | | Did this interfere with your ability to work ? | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Never | 1-2 times last week | 3-4 times last week | Once every day | Several times every day | Slightly uncomfortable | Moderately uncomfortable | Very uncomfortable | Not at all | Slightly interfered | Substantially interfered |
| Area A   | Female | | 1 | 3 | 1 | | 2 | 3 | | | 3 | 2 |
| | Male | 2 | 3 | | | | 5 | | | 4 | 1 | |
| Area B  | Female | | 4 | | 1 | | 4 | 1 | | 3 | 2 | |
| | Male | 2 | 3 | | | | 5 | | | 4 | 1 | |
|  | Female | | 1 | 4 | | | 2 | 3 | | 1 | 4 | |
| | Male | | 5 | | | | 5 | | | 3 | 2 | |
| Area D  | Female | 1 | 3 | | 1 | | 4 | | 1 | 4 | 1 | |
| | Male | 3 | 2 | | | | 5 | | | 5 | | |
| Area E  | Female | | 3 | | 1 | 1 | 2 | 2 | 1 | 2 | 1 | 2 |
| | Male | | 4 | 1 | | | 4 | 1 | | 2 | 3 | |
| Area F  | Female | | 3 | 2 | 1 | | 3 | 3 | | | 3 | 2 |
| | Male | 1 | 2 | 2 | | | 5 | | | 1 | 4 | |

## 4.7 Result of Psychosocial Risk Factor Assessment Questionnaire

Socio-demographic background, working conditions, social lifestyle and medical history are useful information to support this assessment. The questionnaire includes demographic information such as name, gender, weight, education level, hobbies and leisure time activities, occupational information and non-occupational information which consists of previous injury due to accident, medical history, pregnancy and medication prescribed by verified by medical practitioner. All this information is vital in eliminating non ergonomics risk factors that can confound the ergonomics related disorders during assessment.

As mentioned earlier in section 4.1, there are 3 respondents less than the age of 30, which 3 of them are male and also 3 respondents with the age between 31 to 40 years old. This followed by 4 respondents with the age of more than 40 years old which are 3 female and 1 male. For better understanding of their socio-demographic please refer to Table 4.10 and Figure 4.7. Based on education level, 5 of them did not receive any formal education, 3 of them were in primary level while 2 of them were in secondary education level. For marital status 6 of them are married and 4 of them are not married. The unmarried is all male workers.

**Table 4.10 : Socio-Demographic Background with Working Condition**

| Age group | Gender | Age | Working shift per day per week with leaf blower | Department |
|---|---|---|---|---|
| **Age 20 to 30 Years Old** | Male | 23 | 3 | Jalan Utama |
| | Male | 25 | 3 | Jalan Utama |
| | Male | 30 | 6 | Jalan Utama |
| **Age 31 to 40 Years Old** | Male | 32 | 6 | Jalan Utama |
| | Female | 35 | 6 | Bukit |
| | Female | 36 | 6 | Bukit |
| **Age 41 to 50 Years Old** | female | 41 | 6 | Bukit |
| | Female | 42 | 6 | Bukit |
| | female | 42 | 6 | Bukit |
| | male | 43 | 3 | Jalan Utama |

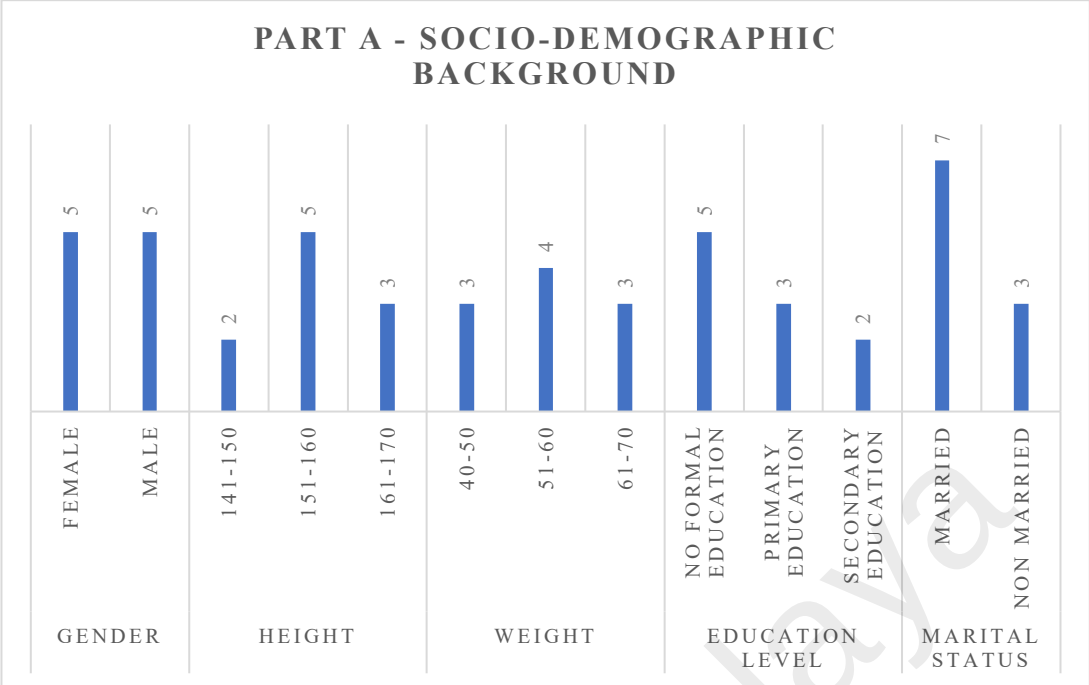


**Figure 4.7 : Part A - Socio-demographic Background**

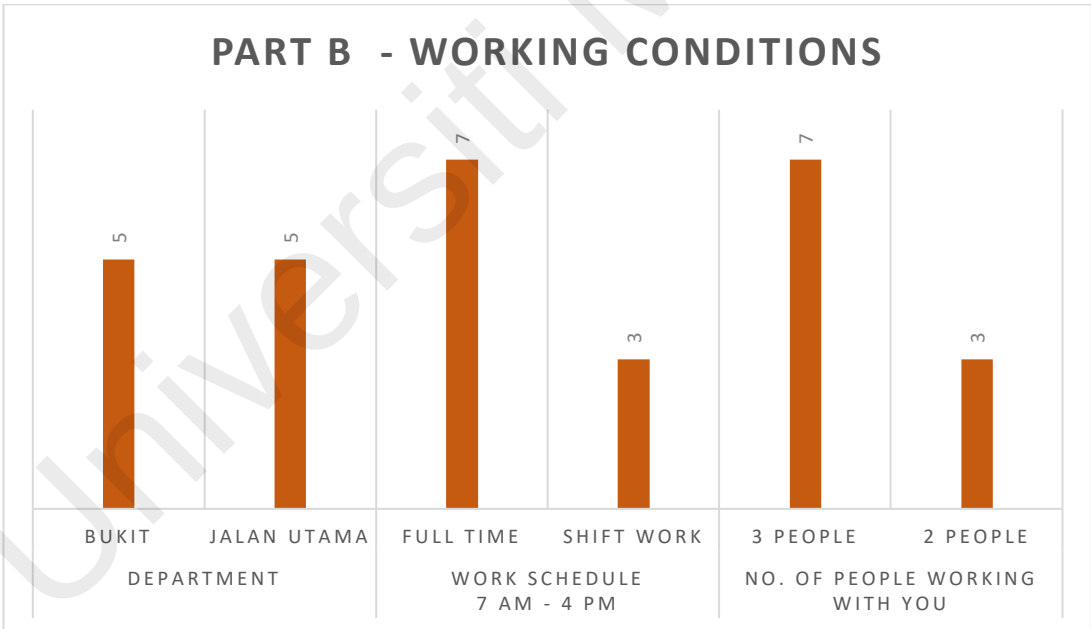


**Figure 4.8 : Part B - Working Condition**

Table 4.10 and Figure 4.8 presents the working conditions of respondents. For a clearer picture, there are two contractor companies involved in this questionnaire. 5 female employees work with company A, where the cleaning area covers from the foot of the hill up to the hilltop near student's dormitory. Working hours are from 7 am to 4 pm. They are given 30 minutes of rest, 3 times a day which from 10.00 to 10.30 am, 12.00 to 12.30 pm and 3.00 to 3.30 pm. For the cleaning workers in the hill area they work in groups of three, but with no work rotation. They just carry out the task as backpack leaf blower only.

For cleaning workers in the main road area they are supervised by company B. They carry out cleaning work on the main road which is quite sloped. A total of 5 male work for 6 days a week, with the same break time, which is three times a day. Two of the workers carried out shift work, where they were assigned to clean the road 3 times (3 days) a week using a backpack leaf blower, while the other 3 days they carried out other work such as sweeping, cleaning and others. However, 3 other workers accomplish street cleaning work full time using a leaf blower backpack.

For Part C - Social/ lifestyles, 7 of them stated that they did not smoke, while 3 others smoked. All smokers are men. For these smoking workers, 1 of them stated that they only smoke between 1 to 5 cigarettes a day, while 3 of them stated they smoke more than 5 cigarettes a day. During leisure time or holidays, 5 respondents spends time browsing the internet, while three of the male employees spending time with sports and another two employees chooses gardening and fishing. As showed in Figure 4.10, all employees are healthy and they do not have any health problems and not taking any medication.

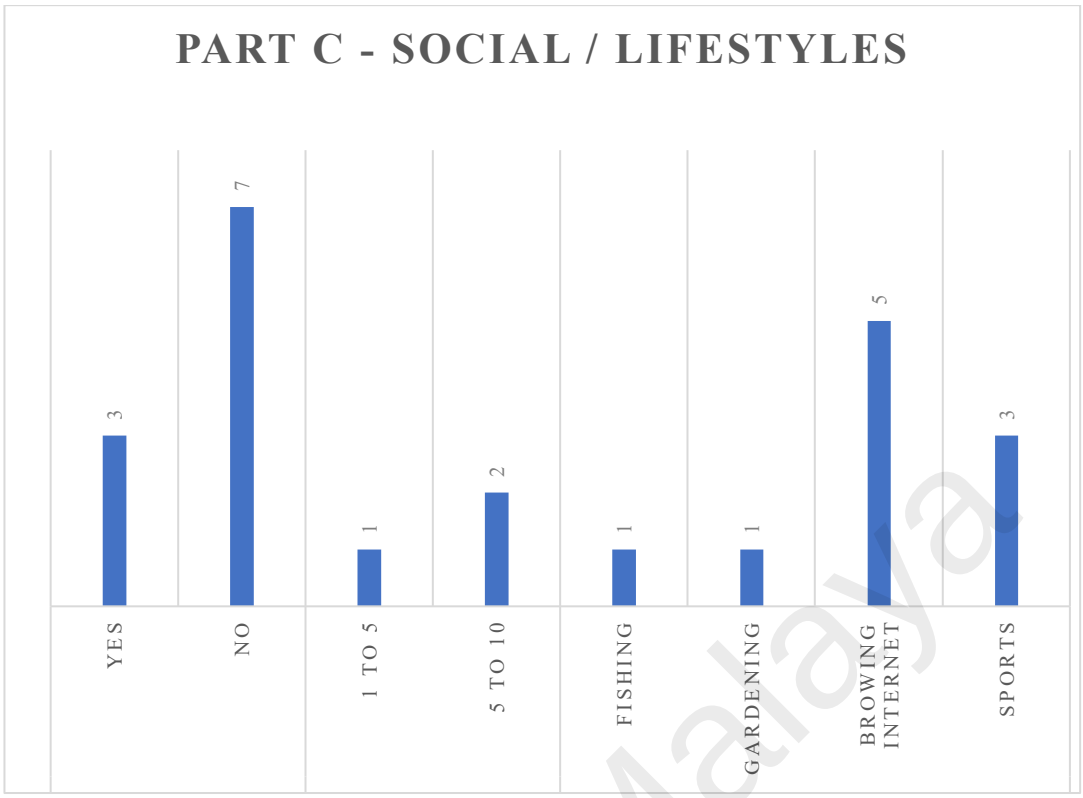


**Figure 4.9 : Part C – Social/ Lifestyles**

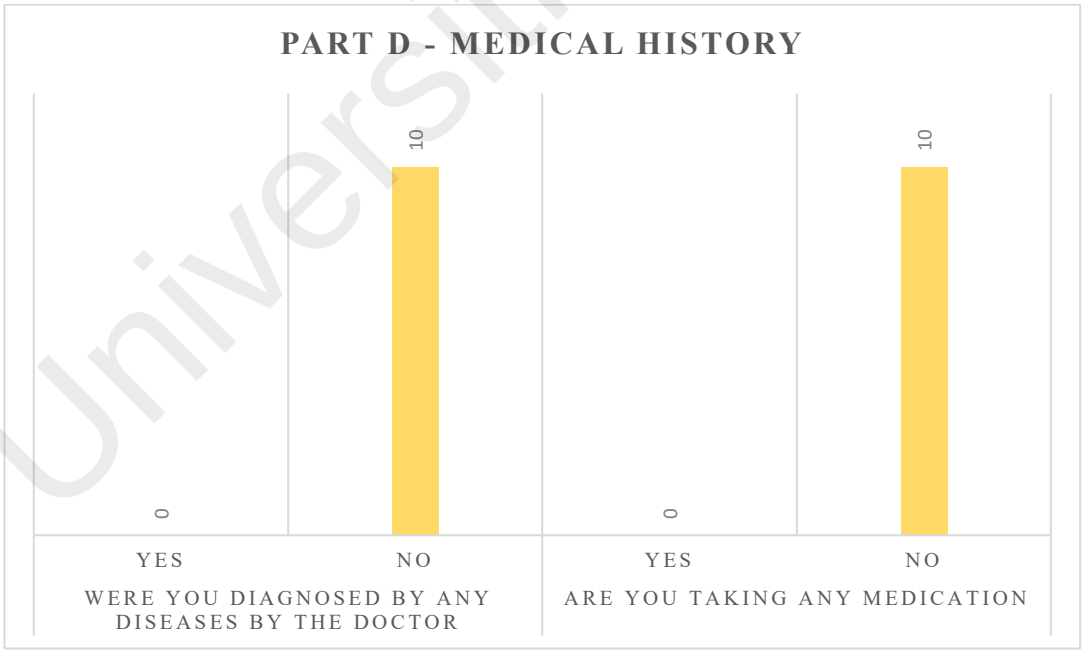


**Figure 4.10 : Part D – Medical History**

## 4.8 Result of Initial Ergonomics Risk Assessment

There are four set of assessments conducted under the investigation of Initial Ergonomic Risk Assessment Checklist such awkward posture, repetitive motion, vibration and forceful exertion. The assessment was observed using a checklist and documented using audio visual tools and capturing images from various perspectives such as front, back and sides.

### 4.8.1 Result of Awkward Posture Assessment

As shown in Table 4.11, all physical risk factor listed that can contribute risk to shoulder does not apply. All shoulder-related tasks when using a backpack leaf blower, does not exceed head level and the shoulder condition is not elevated. In addition, the position of hand level also does not exceed the head and the action of repetitive movements does not occur.

For head positioning, during observation conducted on 10 employees it was found that they will carry out the job in a head position bend downwards with more than 45 degrees for more than 2 hours per day. As seen in Figure 4.12, workers need to bend their head downwards to look onto the road and to carry out the task of blowing leaves or garbage. However, all workers does not work in the position of working with their head bent sideways or their head bent backwards.

As shown in Figure 4.13, the workers does not work with their back bending forward for more than 30 degrees and they also does not work with their back bent sideways. But as we can see, they are working with their hip twisting sideways for more than 2 hours. This is because the workers need to move their body as well as their hand holding the blower tube. This task cannot be performed without body and hand movements on static.

For assessment conducted on the hands, elbows and wrists, observations found that the probability of employees working with wrist flexion or radial deviation for more than 15 degrees is occurred. As seen in Figure 4.11 and 4.14 , workers need to move their hands to the right, left and also to the bottom and there is movement in the wrist to get a comfort position when working. This movement occurs for more than 2 hours a day. No movements like working with sideways arm abduction and working with the arm extended forward for more than 45 degrees occurred.

For the last assessment of awkward posture is led and knees areas. As shown in Figure 4.11, there is no condition that need the workers to work in a squat and kneeling position. This job needs to be performed in standing position and requires complete movement of the right hand and leg. The total score for awkward posture is 13, and YES score is 3. As advised by DOSH, advanced assessment does not need to be done (If YES score of 6 and above advanced assessment need to be conducted).

**Table 4.11 : Result for Awkward Posture Assessment**

| Body Part | Physical Risk Factor | Max. Exposure Duration | Please tick (/) | |
|---|---|---|---|---|
| | | | Yes | No |
| **Shoulders** | Working with hand above the head OR the elbow above the shoulder | More than 2 hours per day | | / |
| | Working with shoulder raised | More than 2 hours per day | | / |
| | Work repetitively by raising the hand above the head OR the elbow above the shoulder more than once per minute | More than 2 hours per day | | / |
| **Head** | Working with head bent downwards more than 45 degrees | More than 2 hours per day | / | |
| | Working with head bent backwards | More than 2 hours per day | | / |
| | Working with head bent sideways | More than 2 hours per day | | / |
| **Back** | Working with back bent forward more than 30 degrees or bent sideway | More than 2 hours per day | | / |
| | Working with body twisted | More than 2 hours per day | / | |
| **Hand/Elbow/Wrist** | Working with wrist flexion OR extension OR radial deviation more than 15 degrees | More than 2 hours per day | / | |
| | Working with arm abduction sideways | More than 4 hours per day | | / |
| | Working with the arm extended forward more than 45 degrees OR arm extended backward more than 20 degrees | More than 2 hours per day | | / |
| **Led/Knees** | Work in a squat position | More than 2 hours per day | | / |
| | Work in a kneeling position | More than 2 hours per day | | / |
| **Sub total (Number of tick (s))** | | | **3** | |


**Figure 4.11 : Hand Position When Carrying Out Cleaning Work**


**Figure 4.12 : Head Position When Carrying Out Cleaning Work**


**Figure 4.13 : Back Position When Carrying Out Cleaning Work**

**Figure 4.14 : Hand/Elbow/Wrist When Carrying Out Cleaning Work**

**Figure 4.15 : Motorized Backpack Leaf Blower**

### 4.8.2 Result of Repetitive Motion Assessment

Repetitive motion involves repeated movements of the same groups of muscle and joint. It can be too frequent or repeated over a long duration. In this assessment, the body parts involved are neck, shoulders, elbows, wrists, hands and knees. There are five physical risk factors assessed. It was found that this job involves repetitive sequence movement of the right hand that holds the blower tube for more than 3 hours on each working day. As shown in Table 4.12 and Figure 4.14, all workers used their fingers and wrists as main body parts to move the blower. They need to squeeze the trigger to turn on the power of the blower continuously. Other than that, they continuously lift the load on their shoulder and need to move their shoulders up and down to carry the backpack leaf blower comfortably. Besides that, the movement of arm was also found to be repetitive for more than 1 hour. There is no movement involving heel/base of palm as a "hammer" and knee as a "hammer". The total score for repetitive motion assessment is 5, and YES score is 3. As advised by DOSH, advanced assessment need to be held (for YES score of 1 and above).

**Table 4.12: Result of Repetitive Motion Assessment**

| Body Part | Physical Risk Factor | Max. Exposure Duration | Please tick (/) | |
|---|---|---|---|---|
| | | | Yes | No |
| **Neck, shoulders, elbows, wrists, hands, knee** | Work involving repetitive sequence of movement more than twice per minute | More than 3 hours on a "normal" workday<br><br>OR | / | |
| | Working involving intensive use of the fingers, hands or wrist or work involving intensive data entry (key-in) | | / | |
| | Work involving repetitive shoulder/ arm movement with some pauses or continuous shoulder/ arm movement | More than 1 hour continuously without a break | / | |
| | Work using the heel/base of palm as a "hammer" more than once per minute | More than 2 hours per day | | / |
| | Work using the knee as a "hammer" more than once per minute. | More than 2 hours per day | | / |
| **Sub total (Number of tick (s))** | | | **3** | |

### 4.8.3 Result of Vibration Assessment

Backpack machines produce a vibration that is transmitted to the operator's body and hand. The motorized part of the blowers is mounted on the back as shown in Figure 4.15. From the assessment and as cited in Table 4.13, it is found that all employees have a risk on excessive vibration which they are working with motorized tool without PPE for more than 50 minutes in a hour. Their job involves vibration exposure to the whole body for more than 5 hours in an 8 hours working shift. Other than that, the female workers also complaint excessive body shaking during working shift. The total score for repetitive motion assessment is 4, and YES score is 3. As advised by DOSH, advanced assessment need to be held (for YES score of 1 and above).

**Table 4.13: Result of Vibration Assessment**

| Body Part | Physical Risk Factor | Max. Exposure Duration | Please tick (/) | |
|---|---|---|---|---|
| | | | Yes | No |
| **Hand-Arm (segmental vibration)** | Work using power tools (e.g. battery powered/ electrical pneumatic/ hydraulic) without PPE | More than 50 minutes in a hour | / | |
| | Work using power tools (e.g. battery powered/ electrical pneumatic/ hydraulic) with PPE | More than 5 hours in 8 hours shift work | | / |
| **Whole body vibration** | Work involving exposure to whole body vibration | More than 5 hours in 8 hours shift work | / | |
| | Work involving exposure to whole body vibration combined employee complaint of excessive body shaking | More than 3 hours in 8 hours shift work | / | |
| **Sub total (Number of tick (s))** | | | 3 | |

### 4.8.4 Result of Forceful Exertion Assessment

The assessment of forceful exertion on backpack leaf blower workers involves carrying load was evaluated. There are several factors considered on this assessment which is floor surface, environmental factor, distance and obstacles en route. From observations presented in Table 4.14, this job requires workers to do their work in the open area, elevated area and uneven conditions. It is also found that some of the workers wears inappropriate shoes such as sports shoes and rubber shoes. Other than that, they also work in an environment of extreme temperatures, where they work in an open, uncovered space from 7.00 am to 4.00 pm. The task require them to carry backpack leaf blower, weighing around 8-10 kg and carry it not less than 3 km per day with obstacles such as twigs and dry branches, slopes and others.

**Table 4.14 : Summary of Carrying Activity Assessment**

| Factor | Condition | Outcome |
|---|---|---|
| **Floor surface** | Dry and clean floor in good condition | No |
| | Dry floor but in poor condition, worn or uneven | No |
| | Contaminated/ wet or steep sloping floor or unstable surface or unsuitable footwear | Yes |
| **Other environmental factors** | No factor present | No |
| | One or more factor present (i.e poor lighting condition, extreme temperature) | Yes |
| **Carry distance** | 2 m – 10 m | No |
| | More than 10 m | Yes |
| **Obstacles on routes** | No obstacles and carry route is flat | No |
| | Step slope or up steps or through closed doors or trip hazards using ladders | Yes |

# CHAPTER 5 : DISCUSSION

## 5.1 Discussion for result of Objective (1), Identify Body Pain and Discomfort

Result for objective (1) is to identify worker's body part with the experience of ache, pain and discomfort among backpack leaf blower workers. To identify which part of body felt ache, pain and discomfort, self-assessment musculoskeletal pain and discomfort survey, cornel musculoskeletal questionnaire and hand discomfort questionnaire were conducted on 10 employees, consisting of men and women. From the study that has been conducted, there are some body parts of cleaning workers that are at risk of injuries while operating the backpack leaf blower machine.

### 5.1.1 Self-assessment musculoskeletal Survey and Cornel Musculoskeletal Assessment

Self-assessment musculoskeletal pain and discomfort survey reveals 80% of the respondents felt pain or discomfort on their shoulders, wrists (right), hands (right) and lower back. 70% respondents consisting 5 women and 2 men had pain or discomfort on parts of their feet. Total discomfort score from cornel musculoskeletal assessment for female and male workers provides meticulous information about the level of pain or discomfort experienced by each respondent. Female discomfort score for right wrists is much higher with a percentage rate of 20.98%, lower back (18.17%), shoulders (12.19%), neck (5.23%) and foot (13.00%). Male total discomfort score on the other hand shows, body part with the highest prevalence is both shoulder with total discomfort score of 20.81%, followed by neck (17.59%), right wrist (17.24%), lower back (16.29%) and foot (3.23%). Please refer to Table 5.1 and Figure 5.1 for total discomfort score.

**Table 5.1 : Summary of Total Discomfort Score**

| Body Part | Female | Male |
|---|---|---|
| Lower Back | 18.17% | 16.29% |
| Shoulder | 12.19% | 20.81% |
| Neck | 5.23% | 17.59% |
| Foot | 13.00% | 3.23% |
| Wrist (Right) | 20.98% | 17.24% |

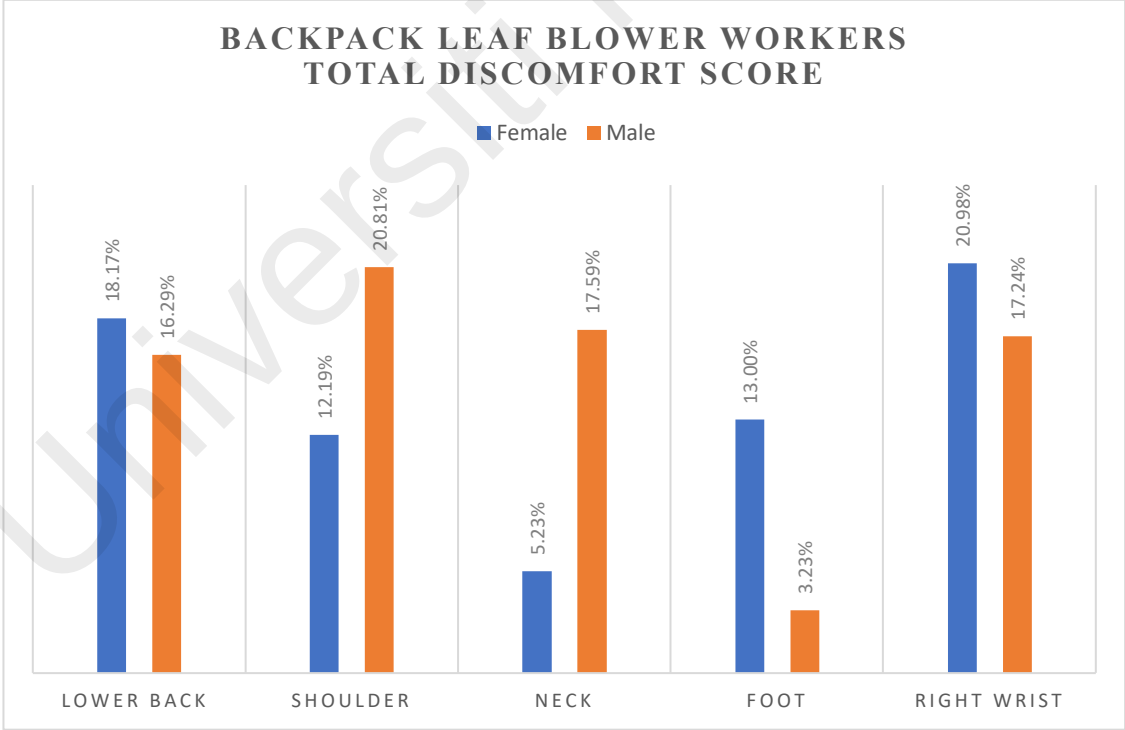


**Figure 5.1 : Backpack Leaf Blower Workers Total Discomfort Score**

### i. Shoulder and Low Back Pain and Discomfort

Backpack leaf blower is a machine that needs to be worn on the back of the body and can be move around freely without worrying about lugging a machine. Backpack leaf blower will be mounted on the back, strapped around the shoulder and require workers to hold blower tube by hand and it will blow out air to move leaves or other debris. As mentioned in chapter 4.2, weighing around 9 to 11 kg, the workers carries the load on their shoulder and spine for a distance of more than 3 km per day. The probability of risk affecting the shoulder and lower back area is high. Total discomfort score from cornel musculoskeletal assessment analysis is higher on the shoulder and low back area. Female discomfort score for lower back is 18.17% and on shoulders is 12.19%, while for male the total discomfort score for shoulder is 20.81% and lower back is 16.29%. Walking with a heavy load on the back was reported as an ergonomic risk factor for lower back pain (Heuscher et al., 2010). (Simpson et al., 2011) in his study on the effect of load mass on posture of recreational female hikers due to prolonged load carriage revealed that discomfort occurs in shoulder, upper back and neck when carrying a 20% or greater of body weight load and there are significant changes at the trunk posture. They also recommend during prolonged walking the backpack load limit should 30% of body weight. However, in this research, the results do not provide enough evidence to support the recommendation that the backpack weight necessarily to be less than 20% or 30% of body weight.

### ii. Foot Pain and Discomfort

As mentioned earlier, blowers and sprayers are mounted on the back with the nozzle tube on the right hand. It is to be noted that the users walk with the sprayers and blowers on their back from place to place. As mentioned in Chapter 4.2, the worker moves slowly

back-and-forth every day from 7 am to 4 pm for almost 3 km will certainly give risk to both foot. Results obtained from this study stated that 70% respondents had pain or discomfort on the feet with total discomfort 13.00% for female and 3.23% for male. Slopes or uneven work environment increase the probability of injury such as falling, sprain and foot injury. Prolonged load carriage and walking in extreme temperature may lead to extreme fatigue to the foot (Knapik, Harman, & Reynolds, 1996) . (Jacobson et al., 1997) mentioned that carrying a load in backpack may contribute to fall risk because it has been reported backpack will decrease lateral balance and stability. Carrying a load also increase foot injury such as parts on lower limb when the load place high stress on the tissues surrounding the lower limb joints (Quesada et al., 2000).

### iii. Hand Pain and Discomfort

Like other high-technology machinery, the backpack leaf blower also requires the function of a hand to operate. However, in this study all respondents used a backpack leaf blower machine that only works on the right hand side. From the hand discomfort survey, the highest discomfort score for female and male is in the wrist area with 24.48% and 28.82% respectively. Discomfort score was also high at the base of the thumb with scores of 15.33% for female and 27.39% for male. The other part of the hand that reported to feel pain and discomfort is at the thumb with a discomfort score of 18.92% for male and 15.33% for female. The design of the blower nozzle itself required cleaning workers to hold the blower at the right side and pointing the front end to the ground at a low angle. They also need to use finger to control air velocity depending on the weight of the debris they trying to removed. Repetitive hand and finger movements over a long period of time causing the hands to feel pain and uncomfortable. Musculoskeletal injuries may occur if hand-powered tools used repetitively and long term (Jansen[1] et al., 2013).

## 5.2 Discussion for result of Objective (2), Physical Risk Factor and Psychosocial Work Factor

Result for objective (2) is to access physical risk factor and psychosocial work factor that causes back pain and body discomfort to backpack leaf blower workers. Result and analysis from Initial Ergonomics Risk Assessment and Psychosocial Risk Factors Assessment has concluded the most injury or discomfort of body occur when a case of excessive physical risk factor and psychosocial factor happened. During a walkthrough, the assessment was observed using a checklist and documented using audio visual tools and images were captured from various perspectives such as front, back and sides. Four set of assessments was conducted under the investigation of Initial Ergonomic Risk Assessment Checklist such as awkward posture, repetitive motion, vibration and forceful exertion. The Initial ERA conducted found that all effects of major injuries or discomfort on the shoulders, low back, neck, wrist and feet was successfully identified.

### 5.2.1 Physical Risk Factor Contribute to Back Pain and Body Discomfort

#### i. Neck, Shoulder and Low Back Risk Factor

Physical risk exposure is identified through the working conditions of the respondents which perceived to contribute as risk factor. The movement of postures that are habitually performed while doing cleaning work is moving slowly back-and-forth with the tube blower in front of the workers. From the observation, the cleaning process require the backpack leaf workers to work with their neck or back to bend more than 45 degrees or more than 2 hours per day due to the to carry out the task and working environment is in uneven condition and slopes.

Awkward posture from working with the back bent forward and carrying a heavy object give contact stress on shoulder and neck of the workers. (Devroey et al., 2007) indicates that it is important to avoid carrying backpack loads above 10% of body weight, since there are substantial differences in pain scores and scores for kinematics. He also thinks that efficient load carriage is closely related to minimal energy consumption and can minimize pressure on the back tissue. The workers also repeating same motion for the neck with little variation every few second for more than 3 hours per day. Lack of recovery time from repetitive job and prolonged neck flexion increase risk of work-related disorders of the neck (Putz-Anderson et al., 1997). As agreed by (Cagnie et al., 2007), neck pain was significantly correlated with consistently repetition of the same movements of hands and finger, the muscles in the neck/shoulder region must act as stabilizers.

### ii. Hand Risk Factor

For wrist area, probability of employees working with wrist flexion or radial deviation of more than 15 degrees occurred when they acquire a comfort position. The slippery texture of the handle forces worker to use more strength and energy to hold the blower tube and this will affect the base of the palm. The design of the handles and triggers require forces and affect hand posture. As mentioned by (Dong et al., 2005) the risk of MSDs such as carpal tunnel syndrome has been associated with gripping and grasping. In addition to adversely affecting the productivity of work, excessive exposure in activities due to high-precision grips and high force will lead to discomfort, muscle fatigue and risk for work-related disorders (Neumann et al., 2002).

Based on epidemiological data by (Bernard, 1997) there is an evidence for an association between highly repetitive task or work involving forceful efforts, in conjunction with other job risk factors and hand or wrist tendinitis. While, (Eksioglu, 2006) indicated that repeated hand grip task and frequently carried out same task for long durations with short breaks are intrinsic in the industry, to protect workers and improve efficiency, it is important to calculate the optimum work-rest (contraction-relaxation) cycles for handgrip tasks. In addition, power from the leaf blower motors causing vibration to the hand-arm area that hold the blower tube. (Hamouda, Rakheja, Dewangan, & Marcotte, 2018) stated that employees who operate hand-held power tools are subject to hand-transmitted vibration at work, which is correlated with numerous hand and arm disorders.

### iii. Vibration Risk Factor

The motorized part on the blowers is located in the back mounted container. The rotating parts of the motor produce vibration, which is transmitted through direct contact with the back and spine to the body. Prolong exposure to the vibration can cause MSD to the backpack leaf blower workers. As reported in Initial ERA, the workers work in an awkward posture for more than 2 hours per day, work in repetitive motion more than 3 hours on each working day and exposed to whole-body vibration for more than 5 hours in 8 hours working shift. Excessive workload causes extreme fatigue and biomechanical stress to body and will cause pain and discomfort. It has been suggested that the workers should use the backpack machine less than 2 hours per day (A. Calvo, Deboli, & Preti, 2016; Kouchakzadeh & Beigzadeh, 2015).

When the workers are exposed to whole-body vibration for short periods, minor hyperventilation and an increase in heart rate can be experienced (Hornick, 1973). While

for the effects of long-term whole-body vibration are increased risk of lumbar injuries, haemorrhoids, hernias, digestive problems and urinary problems (Wasserman, 1976). The International Organization for Standardization (ISO) (ISO 2011) has published several standards on whole-body vibration and segmental vibration. The guidelines for whole-body vibration list the exposure limits in the form of tables for both horizontal and vertical accelerations for frequencies ranging from 1.0 Hz to 80 Hz and for time periods from one minute to 24 hours.

Table 5.2 shows summary of Initial Ergonomic Risk Assessment analysis results which explains condition and position of the employee while performing task.

**Table 5.2 : Summary of Results of The Initial Ergonomic Risk Assessment Analysis**

| Intial Ergonomic Rick Assessment | Body Part | Physical Risk Factor | Exceed Max. Exposure Duration |
|---|---|---|---|
| **Awkward PostureAssessment** | Head | Working with head bent downwards more than 45 degrees | More than 2 hours per day |
| | Back | Working with body twisted | More than 2 hours per day |
| | Hand/Elbow/Wrist | Working with wrist flexion OR extension OR radial deviation more than 15 degrees | More than 2 hours per day |
| **Repetitive Motion Assessment** | Neck, shoulders, elbows, wrists, hands, knee | Work involving repetitive sequence of movement more than twice per minute | More than 3 hours on a "normal" workday or |
| | | Working involving intensive use of the fingers, hands or wrist or work involving intensive data entry (key-in) | |
| | | Work involving repetitive shoulder/ arm movement with some pauses or continuous shoulder/ arm movement | More than 1 hour continuously without a break |
| **Vibration Assessment** | Hand-Arm (segmental vibration) | Work using power tools (e.g. battery powered/ electrical pneumatic/ hydraulic) without PPE | More than 50 minutes in a hour |
| | | Work using power tools (e.g. battery powered/ electrical pneumatic/ hydraulic) with PPE | More than 5 hours in 8 hours shift work |
| | Whole body vibration | Work involving exposure to whole body vibration | More than 5 hours in 8 hours shift work |
| | | Work involving exposure to whole body vibration combined employee complaint of excessive body shaking | More than 3 hours in 8 hours shift work |
| **Carrying Activity Assessment** | Floor surface | Contaminated/ wet or steep sloping floor or unstable surface or unsuitable footwear | Yes |
| | Other environmental factors | One or more factor present (i.e poor lighting condition, extreme temperature) | Yes |
| | Carry distance | More than 10 m | Yes |
| | Obstacles on routes | Step slope or up steps or through closed doors or trip hazards using ladders | Yes |

### 5.2.2 Psychosocial Risk Factor Contribute to Back Pain and Body Discomfort

#### i. High Workloads

Initial ERA also aid to identify the psychosocial factors that cause back pain and body discomfort such as high workload, high job duration, job rotation and management failure. As discussed in chapter 4, this job requires strong physical ability and high mental demand because the task required perceptual activity such thinking and looking. From the result of psychosocial risk factor assessment questionnaire, health condition of all employees is good, with no background of chronic illness, it is very beneficial for workers to adapt with heavy and hazardous equipment such as the backpack leaf blower. Job duration for all workers is 8 hours per day. In that period, they need to lug a backpack leaf blower with weight around 8 to 10 kg and carry for a distance of more than 3 km with many obstacles such as debris, slopes and uneven terrain. This affects psychological as well as physical well-being of the workers.

According to (Thetkathuek et al., 2018) in A Cross-sectional Study of Musculoskeletal Symptoms and Risk Factors in Cambodian Fruit Farm Workers, the highest prevalence of musculoskeletal symptoms were reported on the lower back (38.9% of men and 44.7% of women), followed by upper back (28.3% of men and 28.1% of women) and neck (23.8% of men and 24.2% of women) consisting 861 farmers as respondents. Using the Nordic Musculoskeletal Questionnaire, Hazard Zone Jobs Checklist and Rapid Upper Limb Assessment (RULA), this in-depth study involves job operations using different sprayer equipment such as backpacks pesticide sprayers, methods of spraying using a cars, and stationary pesticide tanks where backpack pesticide sprayers have tank volumes of 8 to 22 litres. Important information obtained from this study found that the risk factors influencing musculoskeletal symptoms are working duration, high work load, plantation area, age and unhealthy working position and motion. On another study conducted by

(Biazus et al., 2017) on relationship between musculoskeletal pain complaints among agriculture workers, using the Nordic Musculoskeletal Questionnaire, a total of 150 farmers were involved in the study. 39.3% of them use backpack spray at least once a week. This study found that there is a high prevalence of musculoskeletal pain for male workers especially on the lower back and shoulder which is closely related to the use of backpack sprayer, tractor and nature of the activities. The characteristic nature of family farming in this study involves the output of monotonous activities involving repetitive motions, extended working hours, rapid speed and lack of rest breaks, as well as multi-activity in the case of family farming and high work load. In summary, the most affected area was the lower back (lumbar), in 71.3% of respondents, shoulder (37.3%), wrists and hands (28.7%), followed by knees, neck, hips and thighs, elbows, ankles and feet and upper back.

### ii. Job Rotation

As reported in the Self-assessment musculoskeletal Survey and Cornel Musculoskeletal Assessment in Table 4.2 and Table 4.3, was found that the total discomfort score for female workers is high. This is because there is no job rotation in the work schedule. The same workers need to do the same task with a limited rest every day. Eventually it will affect the limbs. With uneven terrain work environment, it will contribute to health problem. There is a significant difference in the total discomfort score between employees in company A and company B. There is job rotation for workers in company B, two of the workers carried out shift work, where they were assigned to clean the road 3 times (3 days) a week using a backpack leaf blower, while the other 3 days they carried out tasks such as sweeping, cleaning and others. It was found that employees that was given job rotation suffered less pain or discomfort compared to full time workers.

According to (Howarth, Beach, Pearson, & Callaghan, 2009) job rotation is described as a technique or approach used by management for alternating employees shifting between two or more jobs in order to expose them with different levels of occupational demands and exposure levels. They will have time to recover from fatigue, tiredness and stress on their body. (Jorgensen et al., 2005) on his study with Midwest US manufacturing Company, which had used job rotation in 5 years, found that job rotation was mainly to reduce exposure to risk factors and reducing work-related injuries and to reduce work related injuries, while supervisory decisions and ergonomic analyses were used to select jobs for the rotation scheme. On a systematic review by (Padula et al., 2017), the results of readings and cross-sectional comparisons found that there are important things that need to be considered to ensure the level of successful job-rotation program such as adequate training in each division or process involved.

### iii. Management Failure

Management plays an important role in minimizing the risk of occupational diseases. Management need to provide a good, positive work environment that can improve the quality and performance of work. A study conducted by (Niu, 2010) one aspect of occupational health shows there are three psychosocial aspects such as psychological work demands, decision latitude and social support environment that can have an impact on employee health. In this context, companies need to pay attention and support the cleaning contract employees by providing appropriate job distribution. In addition, among the factors that have a negative impact on the health of employees are problems caused by the management of the organization and also the management of working hours.

In order to ensure the employees perform their duties well, using the right method, training of equipment handling needs to be carried out. This is to reduce injury or pain on the limbs. There are some workers using a backpack leaf blower and working with twisted body position. This repetitive movement will result injuries to the waist and causing low back pain. Lack of training and supervision from time to time will trigger detrimental effect in the future. Management need to consider some parameters such, frequency of use, duration of use, gender, age and effect due to any physical or psychosocial risk factor. As studied by (Woods & Buckle, 2006), there are several problems related to organizational, psychosocial and causes of musculoskeletal ill health have been identified amongst UK cleaners. The causes identified are working in a time pressure situation where they have a high workload, repeated work and lack of work management such as job scheduling and control over jobs. This study involved interviewed on issues related to workload, job, schedules, colleagues, social support from management. According to the results obtained, lack of attention from employer relating work problems, make them feel stressed and tired. The main problem faced is no job rotation in the schedule. All this problems related to job management can affect health problems. As mentioned by (Aman & Abd Shukor, 2015) occupational safety and health performance is an activity where managements are responsible for ensuring the activities and productivity of employees in line with the goals of the organization and give significant impact in employees' health.

# CHAPTER 6 : CONCLUSION

## 6.1 Conclusion

The road cleaning sector is an important sector for the general public. With the main objective, this task aims to keep the road and its environment clean from excessive road dust and debris. This cleaning operation can reduce road accidents, protect pedestrians and sidewalk safety as well. Backpack leaf blower machine is a powerful cleaning machine that is believed to save time if used optimally. As the name implies, this machine needs to carry and strap around shoulder and can be carried anywhere without resistance. However, these powerful machines pose to ergonomic and safety risk that are often overlook.

In this research, a backpack leaf blower machine weighing about 8 to 10 kg lug on the shoulder for a distance of more than 3 km with motorized part of the blower located in the back mounted container, produce vibration that transmitted to whole body and hand. Based on the overall result and analysis, the body parts that are noticeable and easily injured when doing work using are on the right wrists, lower back, foot and shoulders. Guidelines on Ergonomic Risk Assessment at Workplace by DOSH Malaysia is not only used to determine the ergonomic risk level of the employees but it also used to assess ergonomic risk factors that cause occupational pain.

From ergonomics risk assessment result, the physical risk factors that cause pain and discomfort is the excessive use of awkward posture, vibration, and repetitive motion. This risk occurs when carrying a heavy back pack load, working with body twisted to move the blower tube to gather the leaf and to squeeze the trigger to control the engine speed. Therefore, an action needs to be taken to reduce this repetitive and excessive action. To protect safety and health of the employees, it is essential to build a healthy and ergonomic

working atmosphere and reducing the hazard. Employee training and standard operation procedure is also a good way to increased efficiencies in processes and understand the best safety practices.

Besides that heavy workload, long working hours and lack management in work schedule rotation is a main psychosocial risk factor. Negative consequences from psychosocial risk factor may contribute to body pain, discomfort and work-related stress. In order to develop, implement and sustain safety, the management needs to provide the resources needed and continuously monitoring and assessing workload and physical work demands. With some measures on frequency of exposes of risk and evidences, proper job planning, better ergonomic understanding, as well as good communication, employers can provide satisfaction to employees in producing effective work with good quality. A few improvement can be made for future studies such as increasing the sample size to get more accurate result, add more methods to get details information about role expectation, work control, job demand and social interaction, to assess the psychosocial stress factors at workplace by using QPS-Nordic Questionnaire at workplace as the baseline.

## 6.2 Recommendation

To ensure that WRMSD-related illness does not occur while performing tasks using a backpack leaf blower. There are some suggestions that can be considered and implemented by the employers:

### i. Engineering Control

Employers are advised to provide backpack leaf blower with advanced technology such as anti-vibration dampeners to absorb vibration which can minimize the stress on arms and hands. In addition, the use of high-powered and lightweight backpack can

provide maximum comfort to employees. The University also needs to ensure that the contractors provide safety and health protection to their employees as well as constant monitoring from time to time.

### ii. Administrative Control

High workload is a major cause of this discomfort and pain problem, employers are advised to find alternatives to overcome this problem such as running an effective job rotation schedules to balance ergonomics risk among the workers. Reducing the time using back pack leaf blowers also increases a positive psychosocial work environment. Employers also need to provide exposure of ergonomics awareness in the workplace, in addition to provide adequate training to employees so that any accidents can be avoided.

### iii. Personal Protective Equipment

As backpack leaf blower emits a loud and noisy noise, workers are advised to wear suitable hearing protection to prevent hearing loss or damage due to excessive noise exposure. In addition, the use of gloves provides excellent grip with extra function to reduce perspiration can increase user comfort and protect the hands. Other than that, backpacks create high velocity wind streams that can send sand particles and other debris back into the operator's eyes, workers are advised to always wear safety goggles which provide maximum eye protection. High slip resistance shoes with good lining for added breathability and comfort is a must to provide additional protection from hazardous substances anywhere especially on the cleaning area.

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