ERGONOMICS EVALUATION OF WORKPLACE AT CAR TYRE SERVICE CENTRE

By

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ABSTRACT

The project title is to evaluate an ergonomic on workplace at car tyre service centre. Too many people are injured while working in automotive workshops. Questionnaire survey on the workers through interview session is used to identify a level of body discomfort area and sources of injury or uncomfortable feelings. Direct observation is performed by "walk through" inspection using digital camera to evaluate and identify ergonomic risk factor based on work activity that has ergonomic stressors present at the workplace. In particular, the application of Rapid Entire Body Assessment (REBA) is used to evaluate exposures to postures, forces and muscle activities that have been shown to contribute to Musculoskeletal Disorders (MSDs). From questionnaire survey findings, the twelve (12) of respondents have body discomfort in the neck (8 each), shoulder (10 each), elbow/forearm (9 each), hand/wrist (11 each), knee (7 each), lower leg (7 each) ankle/foot (4 each) and lower back (9 each). The main sources of injury/uncomfortable feeling in workplace are poor body posture (75%), bending the back (75%), highly repetitive motion (75%), heavy lifting object (83.3%), the long term standing (66.7%), long term squatting (58.3%), bending the neck (66.7%) and high hand force (58.3%). And about 50% reported that poor workplace design was contributed to source of injury while 41.7% reported in use of hand tools. Eight (8) pictures were taken by using digital camera for the eight (8) different tasks to identify the ergonomic physical risk factors. Most of the physical risk factors identified were awkward posture from working with the hands above the shoulders, neck bending, bending the back forward, repeated bending, reaching, squatting and kneeling on the hard surface. Lifting heavy objects more than 10 kg, not wearing a hand gloves and exposed to high hand arm vibration when using high impact wrench (air gun) also contributed to the ergonomic physical risk factor. The REBA analysis showed, mostly in a score of eleven (11), very high risk which require action to be taken immediately. This study also includes controlling, minimizing and eliminating the risks of work-related entire body disorders exposure. There is a two hierarchy of controls that are widely accepted for modifying ergonomic hazards in which are engineering controls and administrative controls. Engineering controls involve changing the workstation layout, selection and use of tools, position of process materials, or work methods used to complete a task. Administrative controls are policies or
practices directed by management that can reduce or prevent exposure to ergonomics risk factors. The study will be useful to ergonomists, researchers, consultants, workshop managers, maintenance workers and others concerned with ergonomics design in workplace.
ABSTRAK

Tajuk utama kertas projek ini adalah untuk menghuraikan isu ergonomik di tempat kerja terutamanya di pusat servis kenderaan tayar. Kebanyakan pekerja mengalami kemalangan semasa bekerja di bengkel automotif. Soalan kaji selidik pada pekerja melalui seisi perbualan adalah untuk mengenalpasti tahap ketidakselesaan pada badan serta sumber yang menyebabkan kemalangan ataupun ketidakselesaan semasa bekerja. Pemerhatian secara terus digunakan melalui pemeriksaan terus di tempat kerja dengan menggunakan kamera berdigital untuk mengenalpasti faktor risiko ergonomik yang terdapat pada aktiviti kerja di tempat kerja. Oleh itu, pengunaan "Rapid Entire Body Assessment (REBA)" adalah untuk mengenalpasti postur badan, daya dan aktiviti berkaitan dengan otot yang menyumbang kepada "Musculoskeletal Disorders (MSDs)". Melalui keputusan soalan kaji selidik, peratus 12 pekerja mengatakan terdapat masalah yang berkaitan dengan ketidakselesaan badan seperti leher (8), bahu (10), siku (9), tangan (11), lutut (7), kaki (7) jari kaki (4) and bahu belakang (9). Punca utama yang menyebabkan ketidakselesaan di tempat kerja adalah postur badan yang tidak ideal (75%), membungkuk tulang belakang(75%), membuat kerja yang sama dan berulang (75%), mengangkat benda objek yang berat (83.3%), berdiri terlalu lama (66.7%), mencangkung terlalu lama (58.3%), membungkuk leher (66.7%) dan menggunakan daya tangan yang tinggi (58.3%). Sebanyak 50% dilaporkan mengenai rekabentuk tempat kerja turut menyumbang kepada sumber utama kemalangan sementara 41.7% dilaporkan dalam penggunaan alatan tangan. Sebanyak lapan gambar diambil dengan menggunakan kamera digital untuk lapan perbezaan kerja telah pun dikenalpasti untuk pemerhatian tentang faktor risiko ergonomik. Kebanyakan faktor yang risiko ergonomik yang dikenalpasti adalah ketidaksesaianan postur badan dengan tangan melebihi bahu, kebongkokkan leher serta belakang badan, membongkok, mencapai dan mencangkung secara berulangan. Juga termasuk mengangkat benda objek yang berat lebih daripada 10 kg, tidak menggunakan sarung tangan dan terdedah kepada gegaran tangan akibat dari penggunaan alatan berimpak tinggi turut menyumbang kepada faktor risiko ergonomik di tempat kerja. Untuk analisis nilai REBA, kebanyaknya skor adalah sebelas (11) yang bermaksud seseorang itu bekerja dalam keadaan risiko yang tinggi serta perlu diambil tindakan...
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<tr>
<td>REBA</td>
<td>Rapid Entire Body Assessment</td>
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<td>BCPE</td>
<td>Board of Certification for Professional Ergonomists</td>
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<td>IEA</td>
<td>International Ergonomics Association</td>
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<td>RSI</td>
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<td>CTD</td>
<td>Cumulative trauma disorder</td>
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<td>WMSD</td>
<td>Work-related musculoskeletal disorder</td>
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<tr>
<td>MSI</td>
<td>Musculoskeletal injury</td>
</tr>
<tr>
<td>OOS</td>
<td>Occupational overuse syndrome</td>
</tr>
<tr>
<td>OHSCO</td>
<td>Occupational Health and Safety Council of Ontario</td>
</tr>
<tr>
<td>Cal/OSHA</td>
<td>California Department of Industrial Relations</td>
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<td>DOSH</td>
<td>Department of Occupational Safety and Health</td>
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<td>AFT</td>
<td>American Federation of Teachers</td>
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CHAPTER 1
INTRODUCTION

1.1 Introduction

This project presents an ergonomic evaluation of workplace at car tyre service center. Car tyre service centers are considered to be among the most hazardous of automotive environments. Various car tire activities involve handling heavy objects such as installation & replacing a tyre and rim. High force and awkward postures from lifting, lowering, and handling tire may cause Musculoskeletal Disorders (MSDs) due to improper work postures. Many people are injured while working in automotive workshops. The injuries occur from handling heavy or awkward objects, heavy lifting, and prolonged or sustained work in awkward postures. This injury trend occurs across all types of vehicle repair, maintenance or installation work, and on all types of vehicles. (WorkSafe Victoria, 2004).

Ergonomics studies work as it relates to the human body and its limits. The most prevalent ergonomic related injuries are musculoskeletal either from repetition, overload, awkward positions or some combination. Most probably injuries could be a reason an affect on workers performance. Why this study is important? Based on analysis of 'free text' fields in 589 claims in the 3 financial years 1999-2002. The injuries occur from handling heavy or awkward objects, heavy lifting, and prolonged or sustained work in awkward postures.

This injury trend occurs across all types of vehicle repair, maintenance or installation work, and on all types of vehicles. These body stressing injuries make up 47% of all reported injuries. The next most common category of injury is slips, trips and falls, usually from floors in substandard condition. (WorkSafe Victoria, 2004). Fatal accidents are devastating and while the young and inexperienced are most at risk, experienced workers, and in some cases employers, have been the victims.
In almost every instance a chain of events is put into place that ultimately leads to tragic consequences. Breaking this chain at an early stage will prevent this outcome. (WorkSafe Victoria, 2004)

Some examples of fatal accidents that have occurred are:-

- Vehicle hoist failed, car fell on mechanic
- Truck was supported on wooden blocks at front with drive wheels in contact with ground engine was started with gearbox in gear while mechanic was underneath
- Tyre fitter was struck by split rim assembly while inflating tire
- Working under an unsupported tipper truck tray was crushed when the hydraulic controls were activated

(WorkSafe Victoria, 2004)

1.2 Problem statement

Car tyre service centers are considered to be among the most hazardous of automotive environments. Various car tire activities involve handling heavy objects such as installation and replacing a tyre and rim. High force and awkward postures from lifting, lowering, and handling tire may cause Musculoskeletal Disorders (MSDs) due to improper work postures.

Awkward postures typically include repeated or prolonged reaching, twisting, bending, working overhead, kneeling, squatting, and holding fixed positions or pinch grips. They may affect various areas of the body such as the hands, wrists, arms, shoulders, neck, back, and knees. The effects of awkward postures are worse if work tasks also involve repetitive motions or forceful exertions. Awkward postures may be caused by using poorly designed or arranged workstations, tools, and equipment and poor work practices. (Cal/OSHA, California Department of Industrial Relations, 1999)
1.3 Objectives of the study

1. To study and identify ergonomic risk factor in car tyre service centre.
2. To identify discomfort level for each body part and source of injury.
3. To evaluate exposures to ergonomic risk factor for different task.

1.4 Scope of Study

In car tyre service centers area there have 3 task of work which are installation & replacing a tyre, tire balancing and rim alignment. In this paper, twelve (12) workers from car tyre service center area involved in this questionnaire survey and interview session. Eight (8) pictures were observed by using digital camera and REBA employee worksheet assessments to identify the most critical working posture when doing a task. Eight (8) different tasks were identified to observe the ergonomic physical risk factors. From the author observation on workplace, it is found that the task of installation & replacing a tyre is most complaint from workers about pains & injuries compare to the tyre balancing and rim alignment task. This is because of the high force and awkward postures from lifting, lowering, and handling tyre may cause Musculoskeletal Disorders (MSDs) due to improper work postures. Due to workers complaint from my first observation, it need be to investigate and identify ergonomic risk factor in the workplace with evaluate exposures to workers postures that has been shown to contribute to Musculoskeletal Disorders (MSDs).

1.5 Limitations of Study

In this report, there are many companies provide a car tyre service and maintenance. After visiting and discussing with manager from 5 companies with letter of permission to conduct a research on workplace, only Piau Joon Tayar Sdn Bhd will be taken as a research reference. Piau Joon Tayar Sdn Bhd is located at Serdang Lama, Selangor. The details of company overview as shown in Appendix 1.
2.1 Ergonomic definition

Ergonomics, as defined by the Board of Certification for Professional Ergonomists (BCPE), "is a body of knowledge about human abilities, human limitations and human characteristics that are relevant to design. Ergonomic design is the application of this body of knowledge to the design of tools, machines, systems, tasks, jobs, and environments for safe, comfortable and effective human use" (BCPE, 1993).

The term ergonomics is derived from the Greek word ergos meaning "work" and nomos meaning "natural laws of" or "study of." The profession has two major branches with considerable overlap. One discipline sometimes referred to as "industrial ergonomics," or "occupational biomechanics," concentrates on the physical aspects of work and human capabilities such as force, posture, and repetition. A second branch, sometimes referred to as "human factors," is oriented to the psychological aspects of work such as mental loading and decision making.

The following points are among the purpose/goals of ergonomics:

- occupational injury and illness reduction
- workers' compensation costs containment
- productivity improvement
- work quality improvement
- absenteeism reduction
The International Ergonomics Association (IEA) defined ergonomics (or human factors) as "the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and a profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance".

Ergonomics can be classified into three main areas: Physical Ergonomics, Cognitive Ergonomics and Organizational Ergonomics. Physical ergonomics concerned with human anatomy, anthropometry, physiology and biomechanics. Cognitive ergonomics concerned with mental processes such as perception, memory, reasoning, and motor response. Organizational ergonomics concerned with optimization of sociotechnical systems including their organizational structures, policies and processes.

Ergonomists contribute to the design and evaluation of tasks, jobs, products, environments and systems in order to make them compatible with the needs, abilities and limitations of people. (International Ergonomics Association - IEA)
2.2 Ergonomic injuries and the workplace

Work-related ergonomic injuries can exact a high price from employers and employees in both factory and office environments. Even a few incidents can deal a severe financial blow to small and medium-sized companies. Identifying potential risks and developing and implementing an effective ergonomics program can help reduce injuries and costs (Choobineh, Lahmi, Shahnavaz, Jazani, & Hosseini, 2004).

To identify potential risk factors, employers should look for the following conditions:

- Lengthy periods of repetitive activity.
- Inadequate rest periods between lengthy, repetitive tasks.
- Awkward work positions (extended reaching and overhead work).
- Repetitive heavy lifting and forceful movement.
- Excessive vibration.
- Uncomfortable environmental conditions and a stressful work organization.

These potential risk factors must be eliminated or significantly modified. In many cases, the workers themselves can suggest ways to modify the tasks that will eliminate or reduce the ergonomic stresses. These remedies do not always have to be expensive. Simply modifying a worktable's height, rearranging access to parts, or rotating employees who perform repetitive tasks are but a few ways to minimize certain ergonomic stresses. (Ron Wood, 2005)

Based on analysis of 'free text' fields in 589 claims in the 3 financial years 1999-2002 as shown in figure 1.1. The injuries occur from handling heavy or awkward objects, heavy lifting, and prolonged or sustained work in awkward postures. This injury trend occurs across all types of vehicle repair, maintenance or installation work, and on all types of vehicles. These body stressing injuries make up 47% of all reported injuries. The next most common category of injury is slips, trips and falls, usually from floors in substandard condition. (WorkSafe Victoria, 2004)
• Awkward posture or repetitive strain while using tools
• Handling vehicle parts or heavy objects eg suspension components, batteries, brake assemblies, etc
• Handling objects such as engines, radiators, gearboxes, transmissions, mufflers
  Awkward, repetitive or static posture during maintenance
• Handling other large vehicle parts or heavy objects (except wheels, tyres, engines, radiators, gearboxes and transmissions)
• Handling wheels or tyres
  Handling items such as boxes or containers etc
• Awkward, repetitive or static posture in office, warehouse, amenities - not vehicle related
• Washing a vehicle or vehicle part or detailing vehicle
• Floor, housekeeping, slip or trip while carrying things around
• Pushing or pulling vehicle

Other body stress issues (various minor)

(Sources: Guideline of Workshop Safety, WorkSafe Victoria, 2004)

Figure 2.1: Chart of analysis of 'free text' fields in 589 claims in years 1999-2002.

2.3 Workplace Risk Factors

Certain characteristics of the work setting have been associated with injury. These work characteristics are called risk factors and include:

a) Task Physical Characteristics (primarily interaction between the worker and the work setting)

  Posture
  Force
  Velocity/acceleration
  Repetition
  Duration
  Recovery time
  Heavy dynamic exertion
  Segmental vibration.
b) Environmental Characteristics (primarily interaction between the worker and the work environment)

- Heat stress
- Cold stress
- Whole body vibration
- Lighting
- Noise

c) Other Workplace Risks

The risk factors addressed by industrial ergonomics are a partial list of hazards present in the work setting. Others include:

- Job stress
- Job invariability
- Cognitive demands
- Work organization
- Workload
- Working hours (shift work, overtime)
- Displays and control panels
- Slip and falls
- Fire
- Electrical exposures
- Chemical exposures
- Biological exposures
- Ionizing radiation
- Radiofrequency/microwave radiation.

(Ergoweb Inc, 2009)
2.4 Musculoskeletal disorders (MSDs)

Musculoskeletal disorders (MSDs) are injuries of the muscles, nerves, tendons, ligaments, joints, cartilage, or spinal discs. MSDs are not typically the result of any instantaneous or acute event (such as a slip, trip, or fall) but reflect a more gradual or chronic development (Choobineh, Rajaeefard, & Neghab, 2006)

MSD is an umbrella term for a number of injuries and disorders of the muscles, tendons, nerves, etc. Other terms that mean the same as MSD include:

- repetitive strain injury (RSI)
- cumulative trauma disorder (CTD)
- work-related musculoskeletal disorder (WMSD)
- musculoskeletal injury (MSI, MSK)
- occupational overuse syndrome (OOS)
- sprain and strain.

Many body parts can be affected by MSDs. The back is the most common, but the shoulders, neck, elbows, hands and wrists are also frequently involved. MSD-related pain and discomfort have also been reported in the hips, knees, legs and feet.

A number of medical diagnoses are covered by the term MSD, including:

- back pain (many specific diagnoses)
- carpal tunnel syndrome (wrist/hand)
- epicondylitis (tennis or golfer's elbow)
- muscle strain
- rotator cuff disorder or syndrome (shoulder)
- tension neck syndrome
- tendonitis (anywhere in the body)
- tenosynovitis (anywhere in the body)
While different body parts can be affected by these disorders, the symptoms of MSDs are similar no matter where they occur. The symptoms generally include:

- pain with or without movement
- swelling and tenderness
- reduced range of motion and/or stiffness
- tingling and/or numbness in nerve-related injuries or disorders.


The evidence for a relationship between workplace factors and the development of MSDs from epidemiologic studies is classified as shown in Table 2.1
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(Sources: Musculoskeletal Disorders and Workplace Factors, NIOSH, 1997)
2.5 Awkward Postures

Posture affects which muscle groups are active during physical activity. Awkward postures can make work tasks more physically demanding, by increasing the exertion required from smaller muscle groups, and preventing the stronger, larger muscle groups from working at maximum efficiencies. The increased exertion from the weaker, smaller muscle groups impairs blood flow and increases the rate of fatigue (Dartt et al., 2009)

Awkward postures typically include repeated or prolonged reaching, twisting, bending, working overhead, kneeling, squatting, and holding fixed positions or pinch grips. They may affect various areas of the body such as the hands, wrists, arms, shoulders, neck, back, and knees. The effects of awkward postures are worse if work tasks also involve repetitive motions or forceful exertions. Awkward postures may be caused by using poorly designed or arranged workstations, tools, and equipment and poor work practices. (Cal/OSHA, California Department of Industrial Relations, 1999)

The main posture for each joints are shown in figure 2.1 for awkward shoulder and back postures. Figure 2.2 for awkward wrist postures, kneeling and squatting.
Awkward shoulder postures

1. Hands/arms above the shoulder
2. Arms behind the body
3. Elbow/arms away from the body

Awkward back postures

4. Bending the back/trunk forward
5. Bending the back/trunk backward
6. Bending the back/trunk to one side
7. Twisting back/trunk

(Sources: Occupational Health and Safety Council of Ontario - OHSCO, 2007)

Figure 2.2: Awkward shoulder and back postures.
Awkward wrist postures

1. Bending wrist up/down
2. Bending wrist to little finger or thumb side
3. Forearm/palm turned down
4. Forearm/palm turned up
5. Kneeling
6. Squatting

(Sources: Occupational Health and Safety Council of Ontario - OHSCO, 2007)

Figure 2.3: Awkward wrist postures, kneeling and squatting.
2.6 Repetitive Motions

In repetitive work the same types of motions are performed over and over again using the same muscles, tendons, or joints. The amount of repetition can be affected by the pace of work, the recovery time provided (i.e., number and length of muscle relaxation breaks), and the amount of variety in work tasks. The pace of work may be controlled by the employee performing the task, machines, other employees, or administrative procedures. Examples of jobs involving machine-controlled pace include working on assembly, packaging, or quality-control lines. Work tasks linked to performance or incentives are examples of administratively controlled pace. (Cal/OSHA, California Department of Industrial Relations, 1999)

The risk of injury is greater when repetitious jobs involve awkward posture or forceful exertions. Injuries may also develop when highly repetitive jobs are combined with low-force exertions, such as in light assembly tasks involving the hands, wrists, elbows, and shoulders. For example, having to grip a cutting or trimming tool throughout the entire work task without being able to set it down momentarily to rest the hand. Figure 2.3 are shown the repeatedly lifting boxes. (Cal/OSHA, California Department of Industrial Relations, 1999)

![Repeatedly lifting heavy boxes stresses the same body parts again and again.](image)

(Sources: Cal/OSHA, California Department of Industrial Relations, 1999)

**Figure 2.4: The repeatedly lifting boxes.**
2.7 Forceful Exertions

Force is the amount of muscular effort expended to perform work. Exerting large amounts of force can result in fatigue and physical damage to the body (Holcroft & Punnett, 2009). The amount of force exerted when moving or handling materials, tools, or objects depends on a combination of factors, including the:

- Load shape, weight, dimensions, and bulkiness
- Grip type, position, and friction characteristics
- Amount of effort required to start and stop the load when moving it (i.e., how physically demanding it is to accelerate or decelerate the load)
- Length of time continuous force is applied by the muscles (e.g., the amount of time the load or object is held, carried, or handled without a muscle relaxation break)
- Number of times the load is handled per hour or work shift
- Amount of associated vibration
- Body posture used
- Resistance associated with moving the load (e.g., over rough flooring or with poorly maintained equipment)
- Duration of the task over the work shift
- Environmental temperature
- Amount of rotational force (e.g., torque from tools or equipment)

There are three types of activity that require force as shown in figure 2.4 which are:-

- Force involved in lifting, lowering or carrying
- Force involved in pushing or pulling
- Grip force

(Cal/OSHA, California Department of Industrial Relations, 1999)
Lifting, lowering, or carrying

Lifting, lowering, or carrying an object or person requires force.

Pushing or pulling

Force is needed for pushing or pulling an object.

(Source: Understanding the risks of musculoskeletal injury (MSI), WorkSafeBC, 2001)

Figure 2.5: Three types of activity that require force.
Grip force

Additional grip force is needed in situations such as the following:

- The worker is gripping a small tool.
- The worker is handling slippery or odd-shaped objects that are difficult to hold.
- Objects are too large for a comfortable grip.
- Objects are grasped or handled using a pinch grip instead of a power grip.
- Vibrating tools or equipment is used.
- The worker is wearing heavy or bulky gloves that make gripping more difficult.
- Handles or grip spans are too large or too small.
- The handles on tools have an awkward shape.
- The worker's hands are cold.

(Cal/OSHA, California Department of Industrial Relations, 1999)

Figure 2.5 shows grip force in different work activities.

(Sources: Understanding the risks of musculoskeletal injury (MSI), WorkSafeBC, 2001)

Figure 2.6: Grip force in different work activities.
2.8 Pressure Points (contact stress) and repeated impacts

Pressure points result from the body pressing against hard or sharp surfaces. Certain areas of the body are more susceptible because nerves, tendons, and blood vessels are close to the skin and underlying bones. These areas include the sides of the fingers, palms, wrists and forearms, elbows, and the knees. (Cal/OSHA, California Department of Industrial Relations, 1999)

Repeated impacts occur when using a body part to hit an object. Examples of contact stress or pressure include:

- using hand tools with short handles that dig into hand
- resting your wrist or elbow on the sharp edge of a work surface
- kneeling on a hard or uneven surface
- using your palm, foot or knee as a hammer

(Cal/OSHA, California Department of Industrial Relations, 1999)

Figure 2.6 show local contact stress on hand.

Local contact stress on the hands occurs when hard or sharp edges of a tool dig into the skin.

(Sources: Understanding the risks of musculoskeletal injury (MSI), WorkSafeBC, 2001)

Figure 2.7: Local contact stress on hand.
2.9 Vibration

Vibration exposure is of concern when it is continuous or of very high intensity. Using vibrating tools as shown in figure 2.7 such as sanders, grinders, chippers, routers, impact guns, drills, chain saws, and circular saws can cause exposure to hand-arm vibration. Tools that are not properly maintained or are inappropriate for the task may increase the amount of hand-arm vibration. These exposures may result in fatigue, pain, numbness, tingling, increased sensitivity to cold and decreased sensitivity to touch in the fingers, hands, and arms. (Cal/OSHA, California Department of Industrial Relations, 1999)

A worker may grip a vibrating tool (such as a sander) more lightly than a non-vibrating tool, using extra force.

(Sources: Understanding the risks of musculoskeletal injury (MSI), WorkSafeBC, 2001)

Figure 2.8: Vibration tool
2.10 **Duration and magnitude**

Duration, or "how long," should be considered along with the four physical risk factors rather than separate from them. The amount of risk depends on how long (the total time in the work day) the worker is exposed to the risk factor. (Wadmana & Kjellberg, 2007). The person looking at risk factors should consider questions about duration for each factor:

- How long is the worker using force (for example, to lift or grip an object)?
- How long does the worker perform a repeated task?
- How long does the worker perform a task with an awkward body posture?
- How long is one part of the body exposed to local contact stress?

Magnitude, or "how much," should also be considered for each risk factor:

- How much force is the worker using?
- How fast is the worker doing the repeated movements?
- How severe is the awkward posture?
- How hard is the edge digging into the skin, causing local contact stress?

(Cal/OSHA, California Department of Industrial Relations, 1999)
CHAPTER 3
METHODOLOGY

3.1 Introduction

The methodology chapter describes the exact steps that will be undertaken to address the research questions. The aim of this chapter is to provide a complete description of the specific steps to be followed, in sufficient detail, and can be used as guidance by other researchers. In this research, five methods were used, literature research, questionnaire survey, observation, posture analysis tools and analyze data. For literature search, it involves reviewing all readily available materials. These materials included internal company information, relevant trade publications, newspapers, magazines, company literature, on-line data bases, and any other published materials.

Questionnaire survey consists of three parts which were mainly focused on personal info, ergonomic problem and others information. These questionnaires were distributed to the workers on workplace during site visit. Observation was the one of method to be used in this work. By using digital camera to observe of Physical Risk Factor Ergonomic, it can be used to evaluate and identify ergonomic stressors in the workplace. Posture analysis tools that were used is Semi-quantitative. Semi-quantitative tools require a more focused screening of specific job risk factors, usually distinguished by risk to a specific body region. Rapid Entire Body Assessment (REBA) method has been selected to analyze the posture. REBA is a postural targeting method for estimating the risks of work-related entire body disorders. By using REBA analysis, it gives a quick and systematic assessment of the postural risks to a worker.

Finally, from the five methods, the data were collected to analyze the result and discussion for the next chapter. Figure 3.1 shows the flow chart of methodology.
Figure 3.1: Flow chart of the methodology
3.2 Questionnaire Survey

The qualitative data obtained from the workers during the interviews provided the basis to develop the study's questionnaire. The questionnaire consisted of 21 questions grouped in three sections: personal info, ergonomic problem and others information. Interviews were conducted with all 12 workers. During the interviews, workers were asked to comment on both positive and negative aspects of their work, not only about their workstations. They also were encouraged to make suggestions for solving any problems that they surfaced (Saurin & Guimaraes, 2008). Figure 3.2 shows the flow chart of questionnaire survey in this research.

![Flow chart of questionnaire survey](image)

**Figure 3.2: Flow chart of questionnaire survey**
APPENDIXES 6: Conference Paper