UNIVERSITI PUTRA MALAYSIA

RELATIONSHIP BETWEEN VIBROTACTILE PERCEPTION AND CHEMICAL EXPOSURE AMONG VEHICLE SERVICE TECHNICIANS IN KLANG VALLEY, MALAYSIA

NURUL AIN BINTI ZALI

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By

NURUL AIN BINTI ZALI

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Master of Science

December 2015

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the Master of Science

THE RELATIONSHIP BETWEEN VIBROTACTILE PERCEPTION AND CHEMICAL EXPOSURE AMONG VEHICLE SERVICE TECHNICIANS IN KLANG VALLEY, MALAYSIA

By

NURUL AIN BINTI ZALI

December 2015

Chairman: Assoc. Prof. Shamsul Bahri Md Tamrin, PhD
Faculty: Medicine and Health Sciences

Introduction:
Hazardous chemicals with detrimental effect on the central nervous system are widely used in the vehicle services industry. The use of Vibrotactile Perception Threshold (VPT) as a screening tool for chemical exposure is new in a developing country like Malaysia. Therefore, this inaugural study was conducted in Malaysia to determine the relationship between Vibrotactile Perception Threshold (VPT) and chemical exposure among vehicle service technicians within Klang Valley.

Methods:
Chemical Health Risk Assessment (CHRA) was conducted among vehicle service technicians using standard method from the Department of Occupational Safety and Health (DOSH) Malaysia. HavLab Tactile Vibrometer, UK was utilised to determine the VPT at fingertip for the assessment of peripheral nerve impairment. Questionnaires were used to obtain the respondents' background.

Results:
Results displayed that the Log VPT 31.5 Hz & 125 Hz for workers exposed to chemicals was significantly higher compared to the non-exposed workers (31.5 Hz: $T=4.776$ ($p<0.001$), 125 Hz: $T=4.775$($p<0.001$)). There are significant relationships observed between VPT at Log 31.5 Hz, Log 125 Hz and overall VPT with diesel, mixture of gasoline and benzene, gasoline only, and the use of personal protective equipment.

Conclusion:
The overall VPT model demonstrated that the exposure to organic solvent and the use of PPE have contributed to vibrotactile threshold among vehicle service technicians in Klang Valley.

Keywords: Chemical Exposure, Vibrotactile Perception Threshold, Vehicle Service Technician

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk Master Sains

PERHUBUNGAN ANTARA "VIBROTACTILE PERCEPTION" DAN PENDEDAHAN KEPADA BAHAN KIMIA DIKALANGAN JURUTEKNIK DI PUSAT SERVIS KENDERAAN DI LEMBAH KLANG, MALAYSIA.

Oleh

NURUL AIN BINTI ZALI

Disember 2015

Pengerusi: Prof. Madya. Shamsul Bahri Md Tamrin, PhD
Fakulti: Perubatan dan Sains Kesihatan

Pengenalan:
Bahan kimia berbahaya yang memberikan kesan yang buruk kepada "central nervous system" adalah diguna secara meluas dalam industri servis kenderaan. Penggunaan "Vibrotactile Perception Threshold" (VPT) sebagai alat untuk saringan bagi mengenalpasti kesan pendedahan kepada bahan kimia adalah sesuatu yang baru kepada negara membangun seperti Malaysia. Oleh itu, kajian ini adalah pertama kali dilakukan di Malaysia untuk menentukan perkaitan antara "Vibrotactile Perception Threshold" (VPT) dan pendedahan kepada bahan kimia dikalangan juruteknik di pusat servis kenderaan di Lembah Klang.

Kaedah:
Penilaian risiko kepada bahan kimia dilakukan di kalangan juruteknik dengan menggunakan kaedah yang dikeluarkan oleh Jabatan Keselamatan dan Kesihatan Pekerjaan (JKKP), Malaysia. Manakala, "HavLab Tactile Vibrometer" diguna untuk menentukan VPT yang diuji di hujung jari untuk penilaian kemerosotan saraf peripheral. Borang kaji selidik diguna untuk mendapatkan maklumat mengenai latar belakang responden.

Keputusan:
Keputusan menunjukkan Log VPT 31.5Hz & 125Hz untuk pekerja yang terdedah kepada bahan kimia adalah tinggi jika dibandingkan dengan pekerja yang tidak terdedah kepada bahan kimia (31.5Hz: $T=4.776$ ($p<0.001$), 125Hz: $T=4.775$($p<0.001$)). Terdapat perkaitan yang nyata antara VPT pada Log 31.5Hz, Log 125Hz dan keselurahan VPT dengan diesel, campuran antara gasoline and benzene, gasoline sahaja, dan penggunaan alat perlindungan diri.

Konklusi:
Model VPT secara keseluruhan menunjukkan pendedahan kepada bahan kimia organic dan penggunaan PPE menyumbang kepada "vibrotactile threshold" dikalangan juruteknik di pusat servis kenderaan di Lembah Klang.

Keywords: Pendedahan Bahan Kimia, "Vibrotactile Perception Threshold", Juruteknik di Pusat Servis Kenderaan

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Thank you all.

I certify that a Thesis Examination Committee has met on 28 December 2015 to conduct the final examination of Nurul Ain binti Zali on her thesis entitled "Relationship between Vibrotactile Perception and Chemical Exposure among Vehicle Service Technicians in Klang Valley, Malaysia" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

Members of the Thesis Examination Committee were as follows:

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the Master of Science. The members of the Supervisory Committee were as follows:

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Signature: _____

Name of Member of Supervisory Committee: **Dr Karmegam a/l Karuppiah, PhD**

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LIST OF ABBREVIATIONS

≥	Equal or more than
<	Less than
%	Percentage
P	Significant value
et al	And others
OR	Odds ratio
SD	Standard deviation
CI	Confidence interval
SPSS	Statistical Package for Social Science
MIDA	Malaysian Development Investment Authority
TIV	Total Industry Volume
OSHA	Occupational Safety and Health Act
DOSH	Department of Occupational, Safety and Health
SOCSO	Social Security Organization
NCTB	Neurobehavioral Core Test Battery
VPT	Vibrotactile Perception Threshold
WHO	World Health Organization
PNS	Peripheral Nervous System
CNS	Central Nervous System
Hz	Hertz
PPE	Personal Protective Equipment
BMI	Body Mass Index
CHRA	Chemical Health Risk Assessment
HAV	Hand Arm Vibration

CHAPTER 1

INTRODUCTION

1.1 Background

1.1.1 Solvents

The exposure to the chemicals especially solvent can cause health effect to the workers or users (Anne et al., 1994). Solvents are widely used in the industrial sector especially in manufacturing and automotive industries.

According to Yutaka (2003), there are more than 100 types of solvents which are widely used in this sector. The numerous solvent exposure will eventually effect to the central nervous system if the exposure through inhalation, dermal and ingestion is not properly controlled.

1.1.2 Automotive Industries

According to Malaysian Development Investment Authority (MIDA), Malaysia is one of the countries in the South East Asia (ASEAN) with high volume of vehicles due to economic stability and high purchasing power. Based on statistic from Malaysian Investment Development Authority (2014), Malaysia showed the third highest total vehicle sales in the ASEAN (Figure 1.1).

In addition to that, according to Malaysia Automotive Association (2014), the passenger vehicle keep increasing yearly aligned with the increasing of the total industry volume (Figure 1.2). Moreover, according to the Ministry of Transport Malaysia (2010), the total motor vehicles in Selangor is the third highest in Malaysia (Figure 1.3).

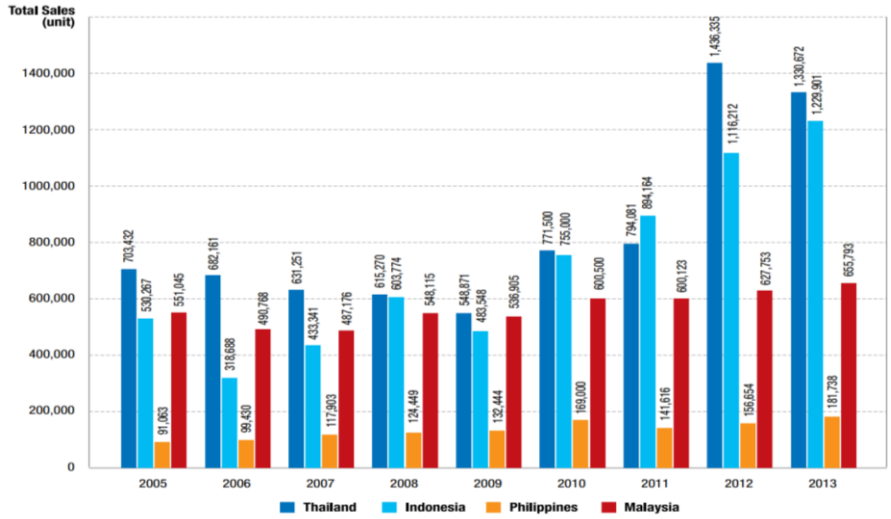
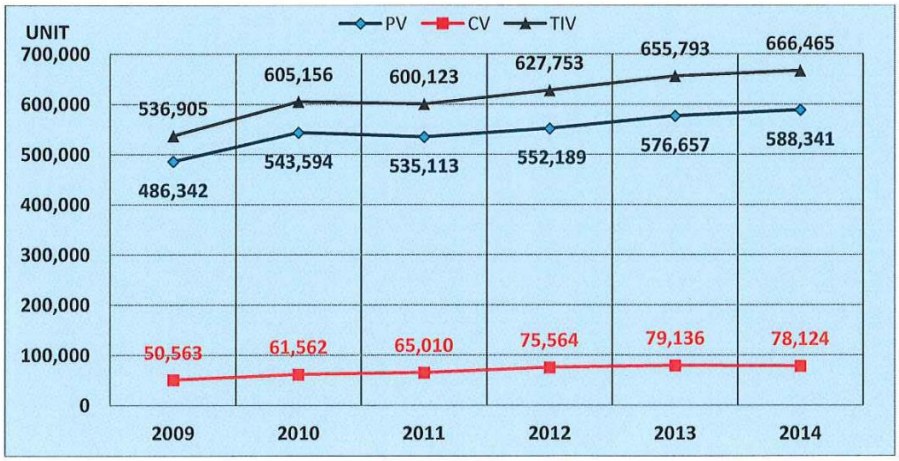


Figure 1.1: Vehicle sales in four major ASEAN countries from 2005 to 2013

(Source: Malaysian Investment Development Authority, 2014)



PV= Passenger Vehicle CV= Company Vehicle TIV= Total Industry Volume

Figure 1.2: Total Industry Volume (TIV) Trend in Malaysia from 2009 to 2014

(Source: Malaysia Automotive Association, 2014)

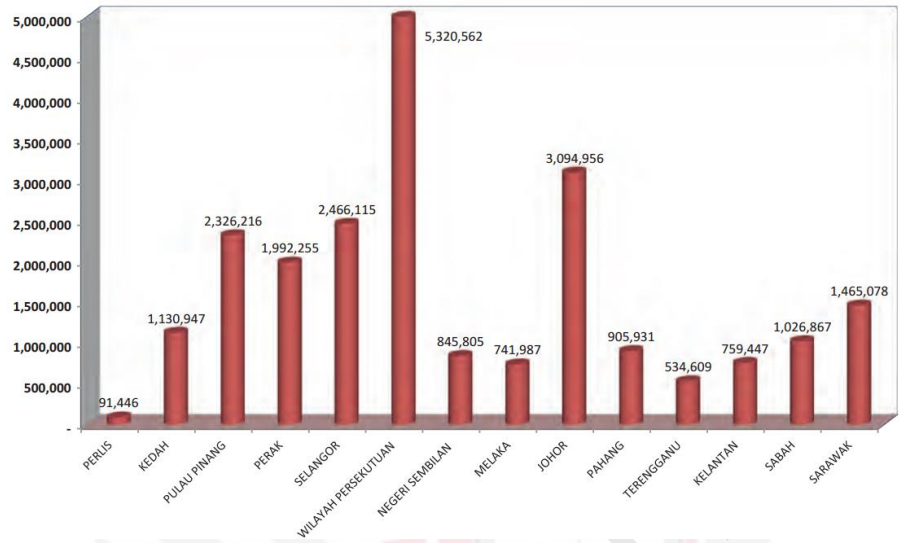


Figure 1.3: Total Motor Vehicles by State in Malaysia in 2012
(Source: Ministry of Transport Malaysia, 2012)

1.1.3 Vehicle Service Industries

The common types of chemicals that are typically used in vehicle service industries are gasoline, diesel and mixture of gasoline and benzene (unleaded gasoline). The exposure to the gasoline, diesel and benzene can cause harm to humans. It may cause significant effect when use the workers use these chemicals in their daily work tasks.

In addition, these chemicals (gasoline, benzene and diesel) are listed as chemicals hazardous to health under the Occupational Safety and Health (Use and Standard of Exposure Chemical Hazardous to Health) Regulation, 2000 in the Malaysia Occupational Safety and Health Act (OSHA) 1994.

1.2 Problem Statement

Diesel, gasoline and benzene share the same characteristic which is having long-chain hydrocarbons mixture and primary route of entry is via inhalation. The exposure to long-chain hydrocarbon mixtures associated with a tightness of chest and breathing difficulties and caused Central Nervous System effect (Health Protection Agency, US).

It had been reported by Department of Occupational, Safety and Health (DOSH) (2008 & 2009) that there is an increasing of the total number of investigation cases of diseases caused by chemical agent as shown in Figure 1.4. In addition, according to the Social Security Organization (SOCSO) (2008 & 2009), there is an increasing on the number of occupational diseases and benefit paid according to causal of chemical agent as shown in Figure 1.5.

In 2014, a total of 2648 cases of occupational disease and poisoning have been reported to the Occupational Health Division, DOSH as compared with 2588 cases reported in the year 2013. Second highest case occurred at Selangor (361 cases) for 2014. Out of 2648 cases, 272 cases related to chemical agent.

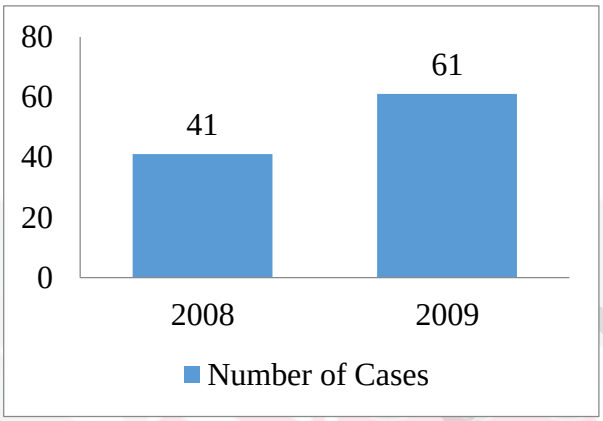


Figure 1.4: Total number of investigation cases of diseases caused by chemical agent
(Source: Department of Occupational, Safety and Health, 2008 & 2009)

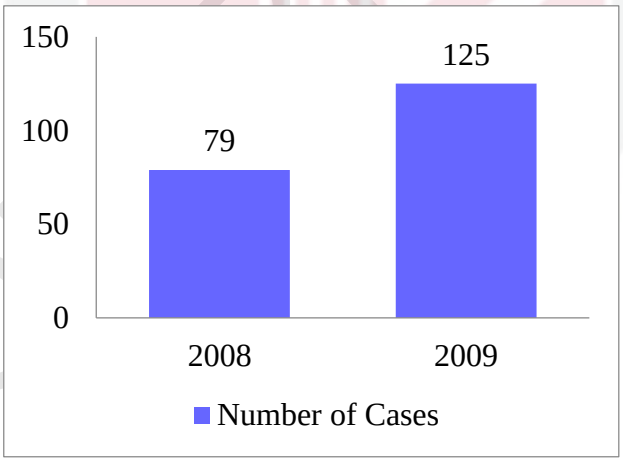


Figure 1.5: Number of occupational diseases and benefit paid according to causal of chemical agent
(Source: Social Security Organization, 2008 & 2009)

According to the study conducted by Rumaizah (2001) on the neurobehavioral study in automotive industries, it was found that the prevalence of neurobehavioral prevalence in automotive industry is 51.7%. According to Department of Statistics Malaysia, the total vehicle service employees in

Malaysia are 209,835 employees. Therefore, the number of possible employees to get the neurobehavioral disease are 108, 485 employees.

Based on the previous study, most of the neurobehavioral effects were measured using Neurobehavioral Core Test Battery (NCTB). The test consists of 7 types of tests which are the Benton Visual Retention Test, Digit Span, Digit Symbol, Pursuit Aiming Test, Trail Making Test, Santa Ana Manual Dexterity Test and Simple Reaction Time Test. According to Norhana (2012), it takes approximately 45 minutes to complete all the test compared to the Vibrotactile Perception Threshold (VPT) which only takes 45 second for one test (Sue & Michael, 2008). Therefore, NCTB takes a longer time to measure the neurobehavioral effect compared than using a VPT Test.

The evaluation of VPT at fingers is one of the basic methods for early detection of peripheral neuropathies in the upper extremities in workers who were exposed to chemical neurotoxic agents (Bovenzi et al., 1997). The VPT method are known to be suitable for screening the neurotoxic effects on peripheral nerves (Anne et al., 1994). However, VPT method is more known for effect due to exposure to vibration. Among the neurological tests for vibration syndrome, vibrotactile perception thresholds (VPT) has proved useful in evaluating sensory nerve impairment and has been measured in many countries (Sakakibara et al., 1996).

In Malaysia, there is no study conducted to determine the relationship between chemical exposure and neurobehavioral effect using VPT method. Therefore, this study will be an inaugural study in Malaysia to determine the relationship between chemical exposure and neurobehavioral effect using VPT method.

1.3 Study Justification

This study will provide the data based on the current prevalence of neurobehavioral effect among those who working in vehicle servicing industries in Malaysia. It is acknowledged that although there are many vehicle service outlets in Malaysia, the effects of the exposure to the chemicals among vehicle service technician has not been highlighted. In Malaysia there is no research on the effects of the chemicals exposure to the chemicals among vehicle service technician.

Even though no cases specifically reported on the effect of chemicals exposure to the neurobehavioral among vehicle service technician in Malaysia, it is suspected that several number of patient suffered neurobehavioral effect cause by exposure to the chemicals (Rumaizah, 2001). Therefore, this study was conducted to determine relationship between vibrotactile perception and chemical exposure among vehicle service technicians in Klang Valley.

The information and results from this study will be used as baseline data for further study. The data can also be used by enforcement bodies such as the Department of Occupational Safety and Health (DOSH) in facilitating them in focusing the enforcement to the correct target group. The study may improve the safety and health of the workers, as it will allow the problem to be detected at early stages (Sakakibara et al., 1996).

1.4 Conceptual Framework

This study is to determine the relationship between vibrotactile perception and chemical exposure among vehicle service technicians in Klang Valley.

The vehicle service technician exposed to the various type of hazard during perform their daily task such as ergonomic hazard, physical hazard, chemical hazard, biological hazard and psychosocial hazard. Among all the those hazards, the only hazards that may give an effect to the central nervous system or specifically peripheral neuropathy that effect the vibrotactile perception threshold are exposure to the vibration and chemical.

In occupational settings, inhalation is ordinarily the most likely route of entry of hazardous substances into the body. Absorption or dermal contact and possibly ingestion (swallowing) of liquid solvents are other potential routes of occupational exposure to chemical agents (Ashley and Harper, 2005).

Inhalation of toxic solvent occurs when the workers are breathing airborne vapors. The vapors may be from the chemical reaction or because of its chemical physical properties.
Absorption of solvents might happen due to direct immersion, splashing, spilling, solvent-soaked clothing and contact with solvent-wet objects. Dermal contact with solvent may dissolve the body's natural barrier of fats and oils causing the skin to be prone to irritation and harm. Ingestion of solvents might occurs when one's fingers, food or cigarette are solvent contaminated, coming into contact with the mouth, lips or tongue. Thus, the workers are swallowing the solvent and contaminating the body (Communication Workers of America (CWA) Occupational Safety and Health Department, 2009).

Inhalation and dermal absorption are the primary routes of solvent uptake into the peripheral blood, which begins within minutes of the onset of exposure (WHO 1985; Engstrom et al., 1978). Solvents will enter the circulatory system and affect the internal organ such as blood, lung, central nervous system, cardio vascular system and renal. Solvents also may damage the peripheral nervous system (PNS) which lead to the peripheral neuropathy.

Peripheral neuropathy is disorder of nerves apart from the brain and spinal cord. Patients with peripheral neuropathy may have tingling, numbness, unusual sensations, weakness, or burning pain in the affected area. Oftentimes, the symptoms are symmetrical and involve both hands and feet. Early symptoms of peripheral neuropathy can be detect using Vibrotactile Perception Threshold (VPT). However, there are several confounding factors that may lead to the peripheral neuropathy such as age, medical history and smoking habits.

Therefore, it is very important to determine the relationships between vibrotactile perception threshold and chemical exposure among vehicle service technicians at the early stage. Figure 1.6 shows the summary of all the factors and the study variables.

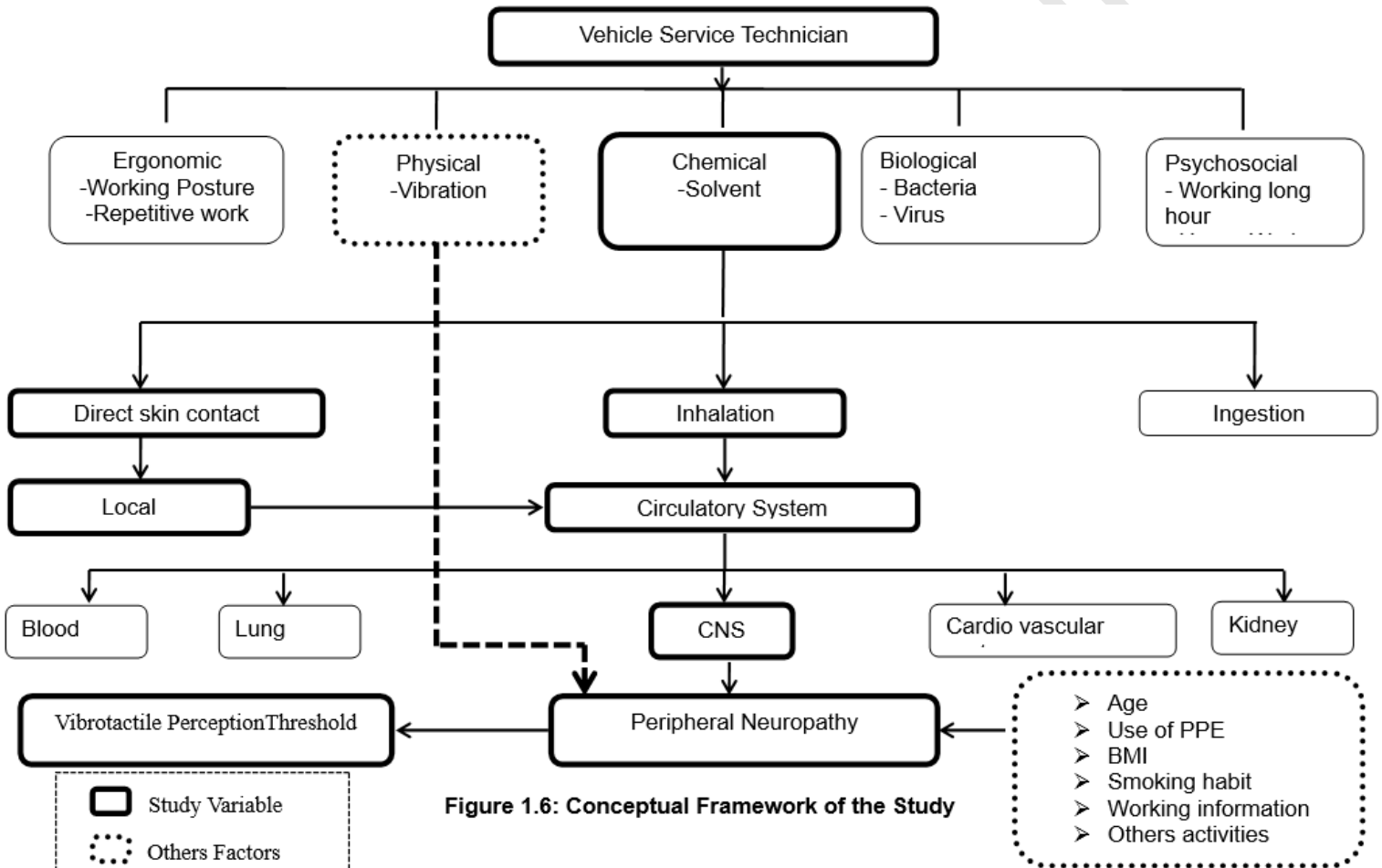


Figure 1.6: Conceptual Framework of the Study

1.5 Objective

1.5.1 General Objective:

To determine relationship between VPT & Chemical Exposure and other factors contributing to VPT among vehicle service technicians in Klang Valley

1.5.2 Specific Objectives:

1. To compare the chemical exposure rating among vehicle service technician in difference service centers.

2. To compare VPT level at 31.5 Hz & 125 Hz among vehicle service technician in different service centers.

3. To compare VPT level at 31.5 Hz & 125 Hz for both of exposed and non-exposed workers

4. To determine relationship between chemical exposures to VPT Level at 31.5 Hz and 125 Hz.

5. To determine the relationship between others factors which are age, use of respirator, score use of PPE, BMI, years of employment, working duration, average overtime per week and exposure to hand arm vibration to the VPT Level at 31.5 Hz and 125 Hz

6. To determine the relationship between overall VPT level & chemical exposure

7. To determine the relationship between overall VPT level with others factors which are age, use of respirator, score use of PPE, BMI, years of employment, working duration, average overtime per week and exposure to hand arm vibration.

8. To determine the overall model of Vibrotactile Perception Threshold

1.6 Hypothesis

1. There is no significant different of chemical exposure rating between workers from different service centers.

2. There is no significant different of VPT level at 31.5 Hz & 125 Hz among vehicle service technician in difference service centers.

3. There is no significant different of VPT level among exposed and non-exposed workers.

4. There is no significant relationship between chemical exposures to VPT Level at 31.5 Hz and 125 Hz.

5. There is no significant relationship between others factors which are age, use of respirator, score use of PPE, BMI, years of employment, working duration, average overtime per week and exposure to hand arm vibration to the VPT Level at 31.5 Hz and 125 Hz

6. There is no significant relationship between overall VPT level & chemical exposure.

7. There is no significant relationship between overall VPT level with others factors which are age, use of respirator, score use of PPE, BMI, years of employment, working duration, average overtime per week and exposure to hand arm vibration

1.6 Definition

1.6.1 Conceptual Definition

a) Organic solvents
Carbon-based solvents are capable of dissolving or dispersing one or more other substances (National Institute of Occupational Safety and Health (NIOSH), 2009).

b) Chemical Exposure
The common types of solvent used at the vehicle servicing company are gasoline, diesel and also mixture of gasoline and benzene. The exposure to the gasoline, diesel and benzene could bring harm to human especially to workers that been using solvent in their work tasks.

c) Vibrotactile Perception Threshold (VPT)
The evaluation of Vibrotactile Perception Threshold (VPT) at fingers is one of the basic methods for early detection of peripheral neuropathies in the upper extremities in workers who were exposed to chemical neurotoxic agents (Bovenzi et al., 1997). VPT method are known to be suitable for screening the neurotoxic effects on peripheral nerves (Anne et al., 1994).

1.6.2 Operational Definition

a) Organic solvents
The common types of solvent that had been used at the vehicle servicing industries are gasoline, diesel and also mixture of gasoline and benzene. The exposure to the gasoline, diesel and benzene could bring harm to human especially to workers that been using those solvents in their work tasks.

b) Vibrotactile Perception Threshold (VPT)
Measures the tactile perception threshold at the end of the workers' fingertips for two different frequencies (31.5hz and 125 hz) of vibration level using Havlab Tactile Vibrometer. The measurement was conducted based on the ISO 13091-1:2001 method.

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