Assessment of Knowledge, Attitude and Usage on Personal Protective Equipment among Mechanical Maintenance Workers of A Power Generation Unit in Thailand

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การประเมินความรู้ ทัศนคติ และการใช้อุปกรณ์ป้องกันอันตรายส่วนบุคคลของพนักงานบำรุงรักษาเครื่องกลของหน่วยงานผลิตไฟฟ้าแห่งหนึ่งในประเทศไทย

น.ส.ฐิติพร ตั้นเคี้ยน

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาสาธารณสุขศาสตรมหาบัณฑิต
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ฐิติพร ตั้นเคี้ยน : การประเมินความรู้ ทัศนคติ และการใช้อุปกรณ์ป้องกันอันตรายส่วนบุคคลของพนักงานบำรุงรักษาเครื่องกลของหน่วยงานผลิตไฟฟ้าแห่งหนึ่งในประเทศไทย. (Assessment of Knowledge, Attitude and Usage on Personal Protective Equipment among Mechanical Maintenance Workers of A Power Generation Unit in Thailand) อ.ที่ปรึกษาหลัก : อ. ดร.เทพนาฏ พุ่มไพบูลย์

หน่วยงานผลิตไฟฟ้าในประเทศไทยมีหน้าที่รับผิดชอบในการจ่ายพลังงานไฟฟ้าให้กับประชาชนโดยผ่านทั้งการผลิตและการจำหน่ายพลังงานไฟฟ้าซึ่งแผนกซ่อมบำรุงรักษาเครื่องกลเป็นส่วนหนึ่งของความรับผิดชอบในการบรรลุเป้าหมายดังกล่าว อย่างไรก็ตามในช่วงปี พ.ศ. 2555 ถึง ปี พ.ศ 2562 มีรายงานกรณีการเกิดอุบัติเหตุจำนวน 207 ราย โดยผลจากการสอบสวนอุบัติเหตุพบว่าสาเหตุหลักคือการกระทำที่ไม่ปลอดภัยและสภาพการณ์ที่ไม่ปลอดภัย ซึ่งได้รวมถึงการใช้งานที่ไม่เหมาะสมและการขาดอุปกรณ์ป้องกันอันตรายส่วนบุคคล ดังนั้น การศึกษานี้มุ่งเน้นในการประเมินความรู้ ทัศนคติเกี่ยวกับการใช้อุปกรณ์ป้องกันอันตรายส่วนบุคคล การใช้อุปกรณ์ป้องกัน และปัจจัยที่เกี่ยวข้องกับการใช้อุปกรณ์ป้องกันอันตรายส่วนบุคคล ของพนักงานบำรุงรักษาเครื่องกล ซึ่งการศึกษาได้ศึกษาผ่านการสำรวจรวบรวมข้อมูลโดยใช้แบบสอบถามชนิดตอบด้วยตนเองจากพนักงานบำรุงรักษาเครื่องกลจำนวน 379 คนของหน่วยผลิตไฟฟ้าในประเทศไทย โดยอายุเฉลี่ยของพนักงานคือ 42 ปี ซึ่งส่วนใหญ่เป็นเพศชาย และร้อยละ 80.7 ปฏิบัติงานในตำแหน่งช่าง พนักงานส่วนใหญ่เคยผ่านการอบรมด้านความปลอดภัยก่อนเริ่มทำงาน ซึ่งการสวมใส่อุปกรณ์ป้องกันอันตรายส่วนบุคคลเป็นส่วนหนึ่งของการอบรมด้านความปลอดภัย และพนักงานจำนวนครึ่งหนึ่งมีประวัติเคยได้รับบาดเจ็บจากอุบัติเหตุขณะทำงาน ผลการศึกษาวิจัยพบว่า ร้อยละ 43.3 54.6 และ 2.1 ของพนักงานมีความรู้ระดับสูง ปานกลาง และต่ำตามลำดับ และมีเพียงร้อยละ 20.8 ที่แสดงทัศนคติต่อการใช้อุปกรณ์ป้องกันอันตรายส่วนบุคคลในระดับสูง นอกจากนี้ร้อยละ77 ของผู้ปฏิบัติงานไม่ได้ใช้อุปกรณ์ป้องกันอันตรายส่วนบุคคลที่แนะนำเป็นประจำในขณะที่ปฏิบัติงาน โดยในจำนวนดังกล่าวแบ่งออกเป็นร้อยละ 60 ที่ไม่ได้ใช้อุปกรณ์ป้องกันอันตรายส่วนบุคคลพื้นฐานทั่วไป และมีผู้ปฏิบัติงานจำนวนน้อยที่ใช้อุปกรณ์ป้องกันอันตรายประเภทเฉพาะ จากผลการทดสอบความสัมพันธ์ระหว่างทัศนคติและการปฏิบัติเกี่ยวกับการใช้อุปกรณ์ป้องกันอันตรายส่วนบุคคลพบว่ามีความสัมพันธ์เชิงบวกอย่างมีนัยสำคัญ นอกจากนั้นยังพบความสัมพันธ์ระหว่างทัศนคติและความรู้ ไม่พบความสัมพันธ์ระหว่างระดับความรู้และการปฏิบัติเกี่ยวกับการใช้อุปกรณ์ป้องกันอันตรายส่วนบุคคล ปัจจัยที่เกี่ยวข้องที่อาจส่งผลต่อการใช้อุปกรณ์ป้องกันส่วนบุคคล (p-$value$<0.05) ได้แก่ ตำแหน่งงาน แผนก ระดับการศึกษา จำนวนครั้งเฉลี่ยที่ได้รับการฝึกอบรมด้านความปลอดภัย และประวัติการได้รับการบาดเจ็บในระหว่างการปฏิบัติงาน จากการศึกษาการประเมินความรู้ ทัศนคติและการใช้อุปกรณ์ป้องกันอันตรายส่วนบุคคลของพนักงานบำรุงรักษาเครื่องกลของหน่วยงานผลิตไฟฟ้าแห่งหนึ่งในประเทศไทยชี้ให้เห็นว่านโยบายและแผนงานเป็นสิ่งจำเป็นในการเสริมสร้างความตระหนักรู้ถึงประโยชน์ของการสวมใส่อุปกรณ์ป้องกันส่วนบุคคลและควรมีการแนะนำการฝึกอบรมสำหรับผู้ปฏิบัติงานบำรุงรักษาเครื่องกลในประเทศไทยทั้งนี้ในอนาคตควรจะมีการศึกษาเพิ่มเติมเพื่อตรวจสอบสาเหตุที่แท้จริงของการที่ผู้ปฏิบัติงานไม่สวมใส่อุปกรณ์ป้องกันอันตรายส่วนบุคคลในระหว่างการปฏิบัติงานต่อไป

สาขาวิชา	สาธารณสุขศาสตร์	ลายมือชื่อนิสิต .....
ปีการศึกษา	2564	ลายมือชื่อ อ.ที่ปรึกษาหลัก .....

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Titiphorn Tankian : Assessment of Knowledge, Attitude and Usage on Personal Protective Equipment among Mechanical Maintenance Workers of A Power Generation Unit in Thailand. Advisor: TEPANATA PUMPAIBOOL, Ph.D.

A Power Generation Unit has duty of electric power supply to the people by producing and distributing electric power. The mechanical maintenance department is one part of their responsibility to achieve the target. However, 207 accident cases were reported during 2012 to 2019. The main causes were found to be unsafe act and unsafe condition including improper usage and lack of personal protective equipment (PPEs). Thus, knowledge, attitude regarding to PPEs, its usage, and factors related to PPEs usage of mechanical maintenance workers need to be assessed. This survey study collected data through self-response questionnaire from 379 mechanical maintenance workers of a power generation unit in Thailand. The average age of the workers is 42 years. Most of workers are man and 80.7% have a position as technician. Most of them have ever passed safety training before starting working which wearing PPEs was a part of safety training. Half of workers got injury from accident while working. The results reveal that 43.3%, 54.6%, and 2.1% of the workers possess level of knowledge at high, moderate, and low respectively. Only 20.8% showed high level of attitude on PPE usage. Moreover, 77% of them did not regularly use recommended PPEs while working, among these, 60% of them did not use regular PPEs and a few used particular PPEs. The association between attitude and practice was significantly low positive correlation. Besides, attitude also associated with knowledge. No association between knowledge and practice was found. Related factors can affect to usage PPEs (p-*value*<0.05); i.e., job position, department, education, times of safety training), injury's history, and attitude. The results of the study suggested that policy and program is necessary enhance the awareness of the benefit of wearing PPEs and training should be introduced for workers in Thailand. The further study should be conducted to investigate the reason behind cause of non-use PPEs during working.

Field of Study:	Public Health	Student's Signature .....
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I'm extremely grateful to all mechanical maintenance workers of A Power Generation Unit in Thailand and would like to express my sincere gratitude for their kindness and their friendliness.

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CHAPTER I

INTRODUCTION

1.1 Background

Hazards exist in every workplace in many different forms such as sharp edges, falling objects, sparking up, chemicals, noise, and a lot of other possible dangerous situations. The Occupational Safety and Health Administration (OSHA) requires that employers protect their employees from workplace hazards that can cause injury. The best way to control hazards should be to control its source to protect employees. It depends on working's hazard or workplace conditions; OSHA recommends the use of engineering or work practice controls to manage or eliminate hazards to the greatest extent possible. For example, an engineering control is building a barrier between the employees and the hazard, a work practice control is changing the way in which employees perform their work. When engineering, work practice, and administrative controls are not practicable or do not provide sufficient prevention, employers must provide appropriate personal protective equipment (PPE) to their employees and ensure its use. Personal protective equipment, commonly referred to as "PPE", is equipment worn to minimize exposure to a variety of hazards. Examples of PPE include items such as gloves, foot, and eye protection, protective hearing devices (earplugs, muffs) hard hats, respirators, and full body suits (OSHA, 2007).

According to Thailand's law: Chapter 2 Administration, Management and Operation on Occupational Safety, Health and Environment, section 22 stated an employer shall provide for and control an employee to wear standard personal protective equipment as stipulated by the Director-General. The employee is obligated to wear personal protective equipment and to maintain the equipment(as stated under paragraph one), in good and working condition depending on the nature of the work throughout the working period. Whereas if the employee does not wear such equipment, the employer shall order the employee to cease working until the employee wears such equipment (OSHA ACT B.E. 2554 (A.D. 2011).

A Power Generation Unit has a duty of electric power supply to the people by producing and distributing electric power. The mechanical maintenance department has one part of their responsibility which is to achieve the target of electricity generating. There are 624 mechanical maintenance workers. They have to work in hazardous environments that could lead to incidents that are divided into accident and near-miss following the Occupational Safety and Health Administration (OSHA, 2017).

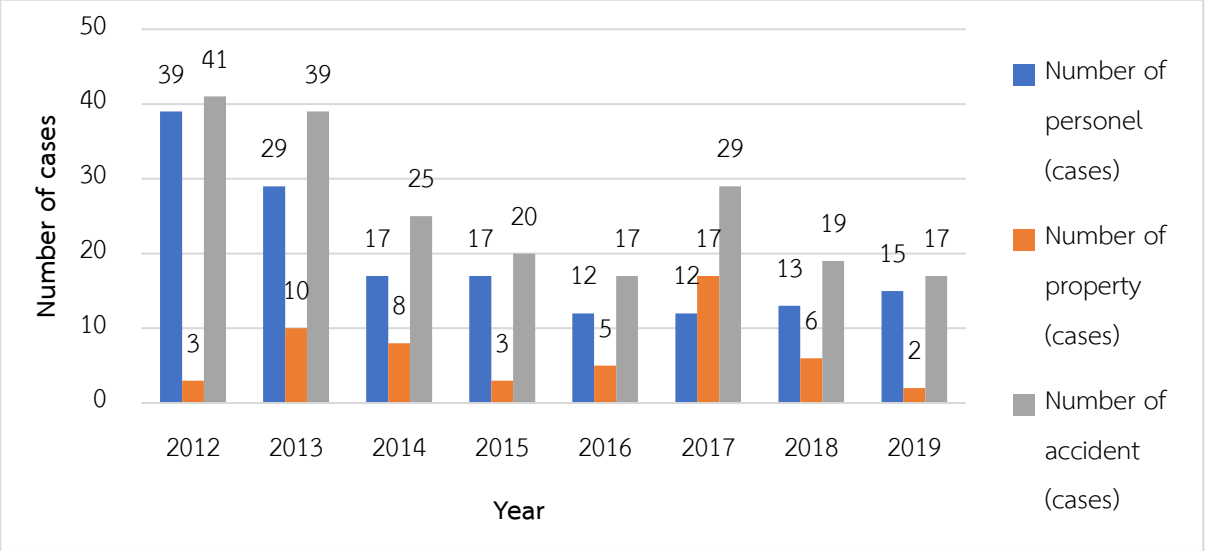

Figure 1: Number of accident cases in the mechanical maintenance division from 2012 to 2019

Statistics showed a total cumulative accident from 2012 to 2019 were 207 cases, that data was presented as accidents into loss of personnel and loss of property. Although there were over half lesser accident cases from 2012 to 2014, the number of accidents was stable from 2015 to 2019 (Figure 1).

Although there are many regulations to control accident such as local safety rules, safety policy including providing appropriate personal protective equipment to fit their work, accidents while working still occur that leads to a direct loss (medical

fee, life insurance, or compensation) and indirect loss (wasting time for working, repairing expenses for machinery, tools, and equipment that have been damaged, loss of reputation and image of the organization or any welfare of the injured workers) (Neo, Edward, & Mills, 2012)

All reported incidents were investigated by the investigation team to find a corrective and preventive action for working and preventing the occurring of the same cases of accident. The incident report will be an accident analysis process and the main causes of the accident were found to be unsafe acts and unsafe conditions including working on the wrong procedure, improper usage of PPE, lack of personal protective equipment, and lack of attention during work. Many studies showed that decision of PPE usage depend on individual determinants such as hazard perception (Nichol et al., 2008), attitude about using PPEs while working (IOM, 2008), and perception on the benefit of using PPEs (Nichol et al., 2008; Lu et al., 2015).

Although there are few studies about PPEs usage and the relationship of knowledge, attitude including individual determinants that are affecting on PPEs usage in Thailand, especially in an industry with a power plant. Thus, this research aims to study the knowledge regarding PPEs, attitude, and usage of PPEs among mechanical maintenance of a power generation unit in Thailand. The results will be used to develop safe working awareness for workers and to improve mechanical maintenance to become effective workers without accidents or lesser accidents in the future.

1.2 Research Question

1. What are the levels of knowledge, attitude and usage of PPEs among mechanical maintenance workers?
2. Are there any associations between socio-demographic characteristics, work experience, social support, knowledge, attitude and usage of personal protective equipment among mechanical maintenance workers?

1.3 Research Objective

1. To assess the levels of knowledge, attitude on PPEs and its usage among Mechanical Maintenance Workers.
2. To find an association between socio-demographic and knowledge, attitude on PPEs, and its usage among mechanical maintenance workers.
3. To find an association between work experience and knowledge, attitude on PPEs, and its usage among mechanical maintenance workers.
4. To find an association between social support and knowledge, attitude on PPEs, and its usage among mechanical maintenance workers.
5. To determine the correlations between knowledge, attitude, and PPEs usage among mechanical maintenance workers.

1.4 Research Hypothesis

1. There are associations between mechanical maintenance workers' socio-demographic characteristics including work experience and social support and their knowledge, attitude and PPEs usage.
2. There are correlations between knowledge, attitude and PPEs usage.

1.5 Conceptual Framework

In this study, a conceptual framework is defined under the relationship between the independent and dependent variables (Ravitch & Riggan,2012). The independent variables are defined and those affecting the usage of PPEs are presented as dependent variables.

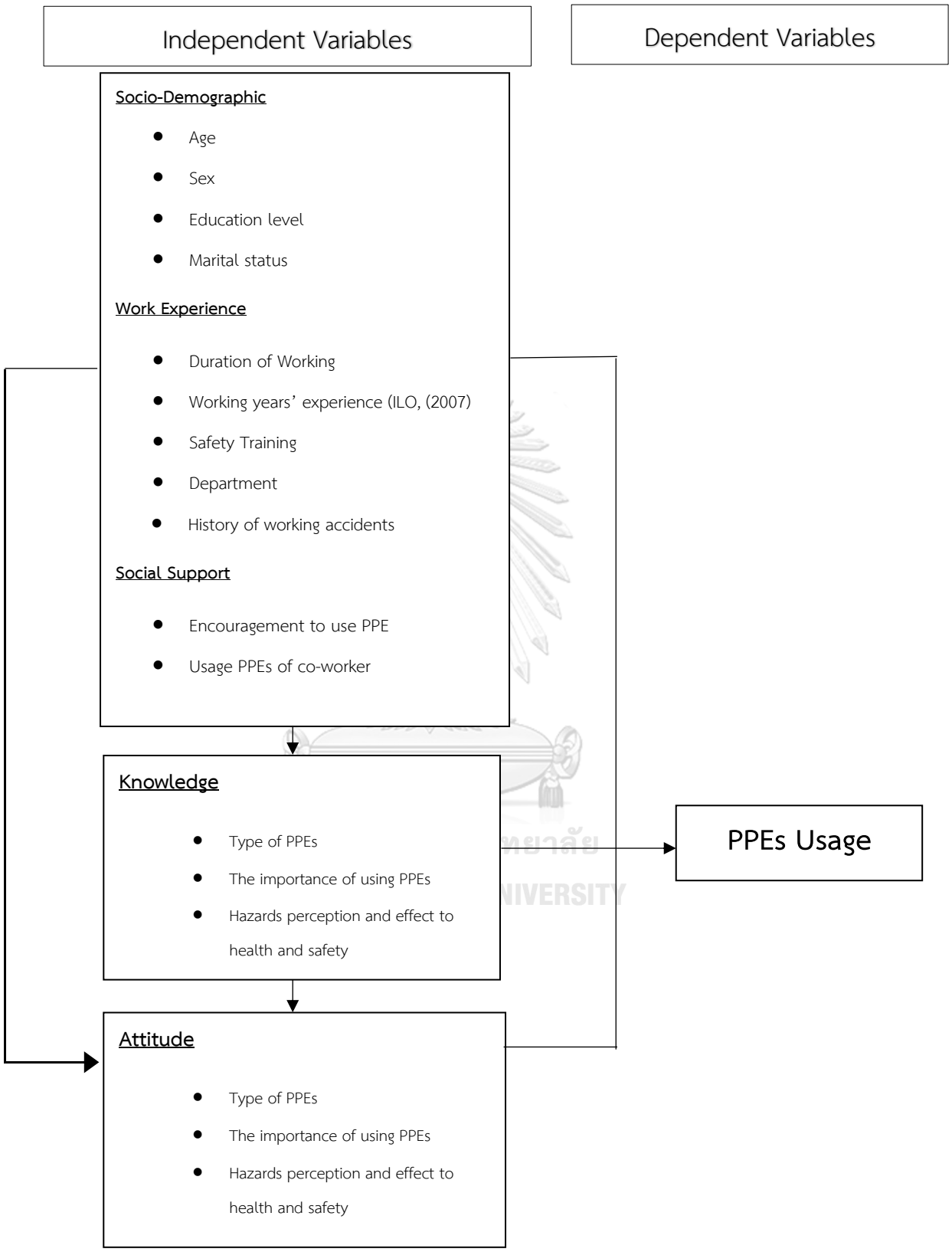

Figure 2: Conceptual Framework

1.6 Operational Definition

Mechanical maintenance workers refer to individuals who work in Boiler Maintenance, Gas Turbine and Diesel, Steam Turbine, Hydro Power Plant or Planning Department of this organization

Types of PPEs refer to head protection devices, eye and face protection, ear protection, respiratory protection, body protection, arm and hand protection, foot and leg protection, fall protection, and special protective equipment used for mechanical maintenance work according to the local policy of the agency.

Socio-demographic

- **Age** refers to the current age. For this study, mechanical maintenance workers must be of age equal to or more than 18 years old.
- **Sex** refers to the gender of the mechanical maintenance workers classified into (1) Male (2) Female.
- **Education level** refers to formal education that mechanical maintenance workers obtained and be categorizing people into the following groups: (1) Vocational Certificate (2) Higher Vocational Certificate (3) Bachelor's degree (4) Master's degree and higher.
- **Marital status** will be categorized into the following groups: (1) Single (2) Married (3) Divorced (4) Widowed

Working experience

- **Department** refers to five departments under Mechanical Maintenance Division which are Boiler Department, Steam Turbine Department, Gas Turbine and Diesel Department, Hydro Power Plant Department, and Planning Department.
- **Duration of work** refers to the length of working hours of the worker in each mechanical maintenance job per day.

- **Working year experience** refers to the years of working in the mechanical maintenance department.
- **Safety training** refers to the number of times the mechanical maintenance workers pass the safety training before starting work per year.
- **History of working accidents** refers to the times of accidents in which individuals have been involved before.

Social Support refers to an important work environment factor associated with PPE by asking the participant to indicate whether mechanical maintenance workers are encouraged to use PPE from their co-workers and their co-worker's PPE usage.

- **Encouragement to use PPE** refer to their co-worker's encouragement, it may affect individuals' decision to wear PPEs.

- Usage PPEs of co-worker refers to individuals seeing their co-worker using PPEs while working, it may affect individuals' decision to wear PPEs.

- History of co-worker accidents refer to workers experiencing their friends at work getting injured while doing maintenance work.

Knowledge refers to an understanding of mechanical maintenance workers on the hazard in mechanical maintenance work and their health effects, types of personal protective equipment used in different conditions of maintenance work, and the importance of using PPEs.

Attitude refers to personnel opinions of mechanical maintenance workers based on hazards from working which affects their health, hazard perception including susceptibility and benefits of using personal protective equipment.

PPEs usage refers to equipment that is worn to minimize exposure to hazards that cause serious workplace injuries and illnesses linked with their mechanical maintenance work. These injuries and illnesses may result from contact with their work. Personal protective equipment may include items such as

Regular PPE refers to equipment that mechanical maintenance workers should wear when they enter the power plant

- **Head protection**; the workers should wear safety hats.
- **Ear protection**; the workers should wear earplugs or earmuffs.
- **Eye and face protection**; the workers should wear impact goggles or safety glasses.
- **Respiratory protection**; the workers should wear dust masks or chemical protective masks
- **Foot and leg protection**; the workers should wear ankle safety shoes or heeled safety shoes

Particular PPE refers to equipment that mechanical maintenance workers should wear when they do a specific job

Working with tools, equipment, and machinery using tools or working manual material handling

- **Arm and hand protection**; the workers should wear knitting thread gloves

Working at high altitude and scaffolding

- **Fall protection**; the workers should wear full body safety harness or safety belt

Working in confined spaces

- **Respiratory protection**; the workers should wear Self-Contained Breathing Apparatus (SCBA)

Working with activities that produce sparks or hot work

- **Eye and face protection**; the workers should wear a face shield

- Arm and hand protection; the workers should wear heat resistant gloves when working with mobile cranes and cranes

- **Special protective equipment**; the workers should wear high-visibility warning clothing

CHAPTER II

LITERATURE REVIEW

2.1 KAP concept

"KAP" study measures the Knowledge, Attitude, and Practices of a community to properly carry out this type of survey. It is important to establish a basic premise and provide definitions for each word (Kaliyaperumal,2004).

KAP Study

A Knowledge, Attitude, and Practices (KAP) survey is a quantitative method (predefined questions formatted in standardized questionnaires) that provides access to quantitative and qualitative information. KAP surveys reveal misconceptions or misunderstandings that may represent obstacles to the activities that we would like to implement and potential barriers to behavior change. In other words, the KAP survey reveals what was said, but there may be considerable gaps between what is said and what is done (Médecins du Monde 2001).

A KAP survey is a representative study of a specific population to collect information on what is known, believed, and done in relation to a particular topic (Who, 2008).

The KAP survey step following as (Who, 2008) ;

I. **Define the survey** objectives contain information about how to access existing information, determine the purpose of the survey and main areas of inquiry, and identify the survey population and sampling plan.

II. **Develop the survey protocol** outlines elements to include in the survey protocol and suggestions to help identify the key research questions. Determining whether the survey needs ethical review is critical to this step, as well as creating a work plan and budget.

III. **Design the survey questionnaire** proposes important steps for developing, pre-testing, and finalizing the questionnaire, and for making a data analysis plan.

IV. **Implement the KAP survey** includes considerations for choosing survey dates, recruiting and training survey supervisors and interviewers, and managing survey implementation.

V. **Analyses of the data** consist of entering and checking the quality of the survey data and implementing the data analysis plan created in Step III.

VI. **Use the data** to highlight ideas on how to translate the survey findings into action, elements to include in the study report, and how to disseminate the survey findings.

2.2 Definition of accident and relevant theory

Definition of accident

There are the meaning of incidents, accidents, and near-miss proposed by organizations and researchers such as definition from health and safety executive, 2004, they defined accidents as an event that results in injury or ill health. They divided incidents into 2 types which were near-miss and undesired circumstances. They defined the meaning of near-miss as an event that does not cause harm but has the potential to cause injury or ill health, and undesired circumstances are defined as a set of conditions or circumstances that has the potential to cause injury or ill-health. Heinrich, H. defined an accident's meaning as an unplanned and uncontrolled event in which the action or reaction of an object, substance, person, or radiation results in personal injury or the probability thereof (Heinrich, H., Industrial Accident Prevention, 1931). Bird and Germain defined an accident as an unintended or unplanned happening that may or may not result in property damage, personal injury, work process stoppage or interference, or any combination of these conditions under such circumstances that might have resulted in personal injury (Bird, F., Germain, G, 1966). Occupational Safety and Health Administration (OSHA) defines the meaning of incidents as a work-related event(s) in which an injury or ill health (regardless of severity) or fatality occurred or could have occurred. They have divided incidents into 2 types, accident and near-miss. Accidents can be injury or illness work-related event(s) occurs. On the other hand, near miss's definition is as a work-related event(s) that

results in no injury or illness. All of the definitions can be concluded that an incident's severity level can be near misses to fatal accidents (OHSAS 18001,2007

The incidents that occurred in the mechanical maintenance division can be both accidents and near-miss. Accidents and near-miss can be divided into two types that are personal and property. A power generation unit defined the meaning of a personal accident as a work-related event(s) that causes an injury (regardless of severity) or fatality to the worker and the contractor under the supervision of the department. The meaning of property accident is a work-related event(s) that affect the loss to buildings, equipment or tools, machinery, and hazardous vehicles under the supervision of the department. The meaning of personal near-miss is unwanted events that occurred that are likely to cause personal accidents. The meaning of property near miss is the occurrence of unwanted events that are likely to cause property accidents. A situation of accident and near-miss in this division can occur to both personal and property at the same time or either one. Statistical data of this division will be collected only on accident cases. The near-miss cases will be only reported to their supervisors.

The domino theory

According to W.H. Heinrich (1931), who developed the so-called domino theory, 88% of all accidents are caused by unsafe acts of people, 10% by unsafe actions and 2% by "acts of God".

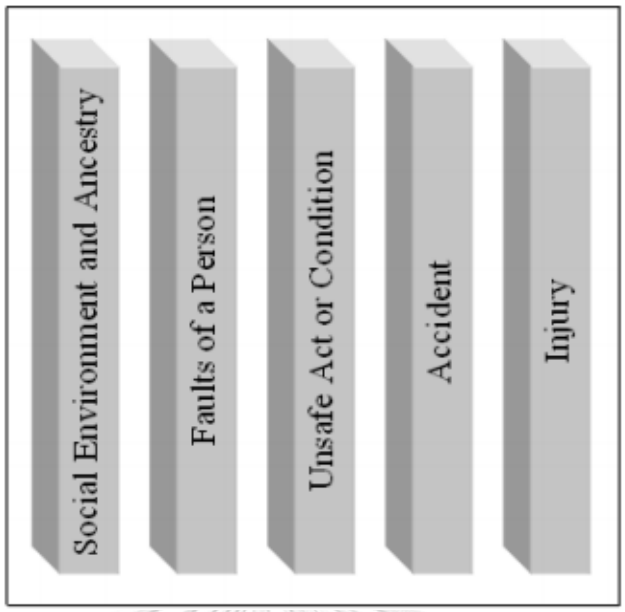

Figure 3: Heinrich's Domino Theory

W.H. Heinrich (1931) proposed a "five-factor accident sequence" in which each factor would actuate the next step in the manner of toppling dominoes lined up in a row. The sequence of accident factors is as figure 3.

1. Social Environment and Ancestry refers to anything that may lead to producing undesirable traits in people. A modernized version of this theory would likely use the term "inherited behavior". This stage of accident causation is quite similar to the social learning theories discussed in criminology**.**

2. Faults of a Person refers to personal characteristics that are conducive to accidents. For example, having a bad temper may lead to spontaneous outbursts and disregard for safety. Similarly, general recklessness can also be one of the manifestations of poor character. Ignorance, such as not knowing safety regulations or standard operating procedures, is also an example of this stage.

3. Unsafe Act or Condition is often the identifiable beginning of a specific incident. Unlike the first two stages, which affect the probability of accidents occurring, this stage is closer to the accident in terms of temporal proximity.

4. Accident refers to an event that leads to injury.

5. Injury refers to the unfortunate outcome of some accidents. In the same way that the removal of a single domino in the row would interrupt the sequence of toppling, Heinrich suggested that removal of one of the factors would prevent the accident and resultant injury; with the key domino to be removed from the sequence being number 3, unsafe act together with mechanical and physical hazard.

2.3 Job description and hazardous in Mechanical Maintenance Works

Mechanical maintenance division's job descriptions have many main duties in the agency to approach effective work and give suggestions to maintenance engineering's work such as root cause analysis, problem-solving analysis, condition assessment, and modification, do or adjust equipment maintenance, fixing of electricity supply in the maintenance work as scheduled and emergency work and mend, modify, demolish, and install mechanical equipment. The mechanical maintenance, division consists of five departments and a central agency to manage administrative work (Figure 4).

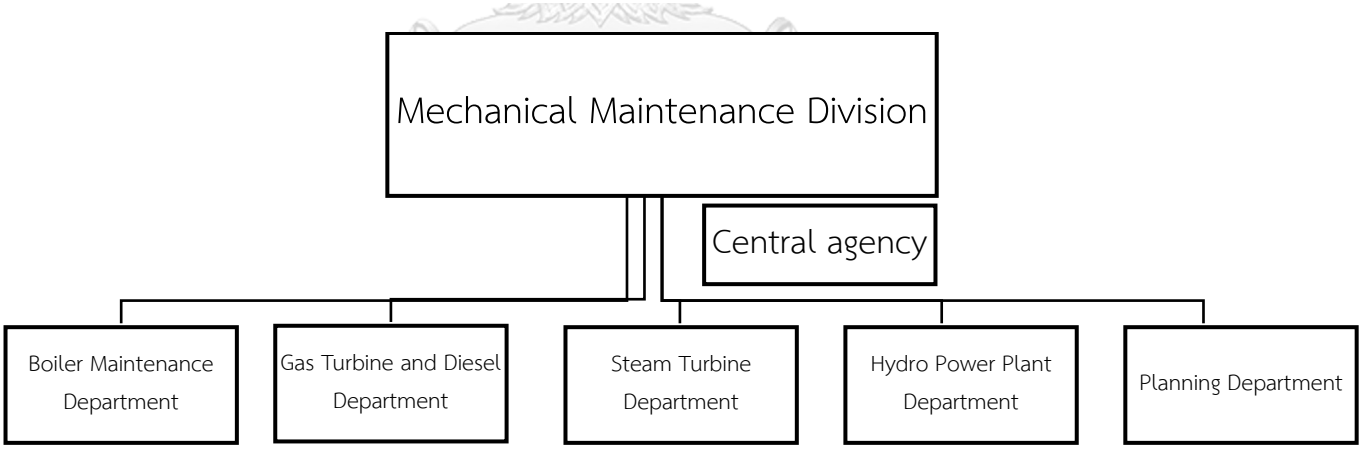

Figure 4: Organizational chart

There are four departments for operation work (Boiler maintenance, Gas turbine, and Diesel, Steam Turbine and Hydro Power plant department) and a department for

doing job in the office (Planning department). Each department has different responsibilities in the division.

Before starting their job for each department, supervisors must do hazard identification and risk assessment to find the root cause of workplace incidents or to recognize hazards that are present or that could have been anticipated. The process of hazard identification of each department is first, conduct information about workplace hazards and identify the workplace for safety hazards from job descriptions. Second, identify any effects from that hazard. Third, identify the likelihood and severity of incidents that could result from each hazard. Lastly, after getting that information to specify the risk level (high, medium, and low level). hazard supervisor will prioritize corrective actions including wearing personal protective equipment to prevent their workers from any incident.

1. Boiler Maintenance Department

Job description

The boiler maintenance department has main duties such as repairing or recovering damaged parts by welding, especially for Low Alloy Material grade 91, doing special techniques for welds may be performed without the specified -post-weld heat treatments, according to ASME/NBIC Standard such as half bead techniques, temper bead techniques, weld pad, and window weld, boiler inspection and testing in the power plant or a power generation unit, doing multi-stage pump partial or complete overhaul, repair and recondition, doing main fan inspection, partial or complete overhaul and repairing, saving boiler energy and this department has valve maintenance service, valve inspection, and nondestructive test, valve repairing for overhaul, lapping, re-seat machining, and valve bench testing.

Hazard identification

After the assessment, there are many hazardous works specified as medium to high level as maintenance safety or relief valve, maintenance gate globe check, and ball /butterfly valve/ stop check valve. Welding, hazard from maintenance welding crack high-pressure steam turbine casing, post-weld, Heat Treatment (PWT), pipe welding pressure part, maintenance welding duct, and expansion joint, bending pipe and valve, inspection air angle grinder and air straight grinder, inspection high-pressure water jet pump, inspection welding, and plasma cutting machine, inspection electric tool, equipment moving such as moving high-pressure water jet pump and air compressor, inspection maintenance stack boiler and boiler structure, maintenance burner, wind box, and soot blower, inspection and clean tube shied, maintenance inspection air heater & gas heater, inspection absorber tank, maintenance inspection boiler circulating water pump and inspection steam air preheater. They specify risk control measures to reduce that hazard by following instruction manuals, inspection equipment, and machine before starting work, measuring oxygen before entering confined space area, wearing any PPE such as chemical mask, safety glass, SCBA while doing confined space, full body harness while working at heights, face shield while welding etc.

2. Gas Turbine and Diesel Department

Job description

This department's duties consist of two main sections. The first section is the engineering section. They will provide technical advice and suggest maintenance methods, assess the machinery and maintenance then analyze and assess the damaged condition. The second section is technical and maintenance. They will perform maintenance and maintenance of mechanical equipment for gas turbines and diesel or provide support for other related repair work.

Hazard identification

After the assessment, there are many hazardous works to be specified as medium to high level such as removing and assembling instrument such as ceramic shield, insert burner, coupling shaft with pump shaft, seal ring generator, mechanical jack, bearing generator, rotor generator, and rotor torque convertor, inspection inlet guide vane in inlet plenum, field balance in turbine bearing room, working with air grinder, cleaning ventilation and lube oil tank, heat bearing to assemble pump shaft and checking backlash of drive gear pump shaft. They specify risk control measures to reduce hazards by following instruction manuals and safety local rules, safety meetings before starting work, wearing PPEs such as ear protection, heat resistant gloves, goggles, and safety shoes.

3. Steam Turbine Department

Job description

This department's responsibilities are divided into five stages (Figure 5). The first stage of their duties is "plan" to optimize the work list and recommend spare parts and special tools to customers. The second stage is "performed" for doing warranty inspection, yearly inspection, minor or medium inspection, major overhaul, and emergency shutdown in the power plant. The third stage is "fact find" to find the root cause and its analysis, damage inspection then making an engineering report. The fourth stage is "correct" to correct the problems and repair the damages within the machinery. The last stage is "evaluated", this stage is analyzed vibration, estimated life, and then analyzed performance.

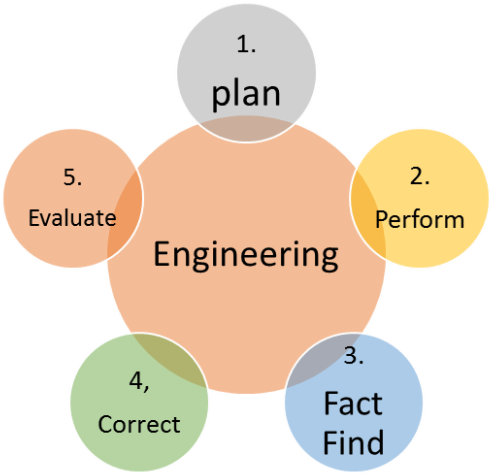

Figure 5: Five stages of steam turbine working

Hazard identification

After the assessment, there are many hazardous work to be specify as medium to high level as driving overhead crane, install and assemble lagging, insulation inspection bearing, inspection at thrust bearing, main oil pump, HP stop load, HP governing valve, LP stop load, LP governing valve, an actuator of the mainstream valve, clean and inspect low pressure and last stage blade, repair work in the auxiliary system and condensing system, install/assemble/clean at condensate pump, close cycle cooling water pump and circulating water pump. They provide risk control measures to reduce any hazard from their job and inspect all equipment to be in good condition before starting work, inspecting cranes before usage, wearing PPEs such as safety glasses, safety hats, high-visibility warning clothing, etc., Workers who work at confined space area must pass confined space's training and annual medical checkup and usage of the right tool to fit their job.

4. Hydro Power Plant Department

Job description

This department's duties consist of two main sections, the first section is Hydro power plant's engineering. Their main duties are engineering consultant, root cause

analysis, condition site survey and work optimization, condition assessment, governor performance test, engineering network and crane inspection including crane maintenance. The second section is underwater working for inspection and repairing underwater equipment, removing mud and obstacle, recording exploration, video, and picture, laying exploration and buoy, and welding underwater.

Hazard identification

After the assessment, there are many hazardous work to specify as a medium to high level such as operation test in air compressor and distributing valve, Auxiliary servomotor, and actuator, drain pressure at compressed air supply tank, open manhole compressed air supply tank, build up pressure at compressed air supply tank, dismantle, set up & install distributing valve, auxiliary servomotor, and Actuator, Open Man Hole Governor/Inlet Valve Pressure Tank, inspection brake, test load working and moving dummy load. They provide risk control measures to reduce hazards by providing PPEs for workers such as full body harness, chemical gloves, and safety glasses etc., install safety cut and inspection electricity equipment before starting work, put up safety signs and promote workers to follow it, body condition checkup before starting work and following safety local rules.

5. Planning Department

Job description

The main responsibilities of the planning department mostly occurs in the office. The duties are doing a maintenance plan for the mechanical equipment of the power plant, strategic framework for management and presentation of management information, managing both technical resources and work costs, analyzing and evaluating of services and creating and developing work systems and databases. Also, they created data systems for engineering management and maintenance operations.

Hazard identification

After the assessment, there is no medium or high level but there are a few hazardous work to be specified as low level such as planning and service and administration work. The hazard in this department can be eye pain or blurred vision, the wrist nerve is pressed then affected to trigger the finger, neck pain, or office syndrome symptoms because workers are staring or using the computer for a long time. They provide risk control measures to reduce those hazards by providing light measurement, promoting workers to change their sitting position periodically, and promoting ergonomic keyboard use.

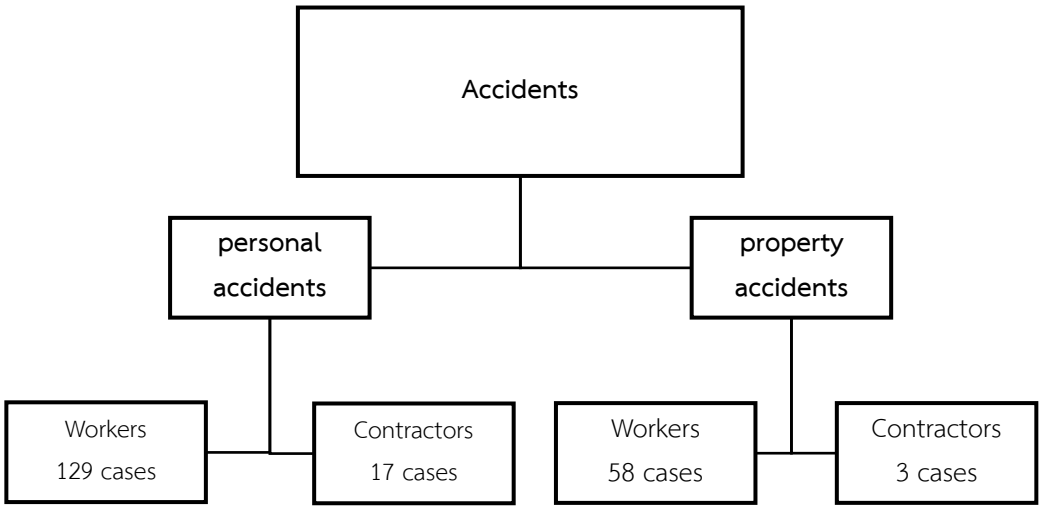

Figure 6: The number of personal and property accidents from 2012 to 2019

The accidents at the worksite that occurred in the mechanical maintenance division are both personal and property accidents. These occurred from both individual workers and contractors that are hired by each department as shown in Figure 6.

For each department in the mechanical maintenance division, all workers must work at a power plant including boiler maintenance, gas turbine and diesel, steam

turbine, and hydro power plant department except the planning department. For this reason, the workers of the planning department usually completed their responsibilities in the office, thus, their work didn't require them to wear personal protective equipment. All operating units (boiler maintenance, gas turbine, and diesel, steam turbine and hydro power plant department), their responsibilities involved hand tools, machinery, confined space, working at height and scaffolding, manual material handling, the use of mobile cranes and cranes, activities that produce sparks or hot work such as safety when welding gas, cutting gas, burning and gas cylinders and working with welding equipment or working in the workshop so their work hazards may lead to injury, being disabled or passing away that is why they need protection to prevent from accident or incident.

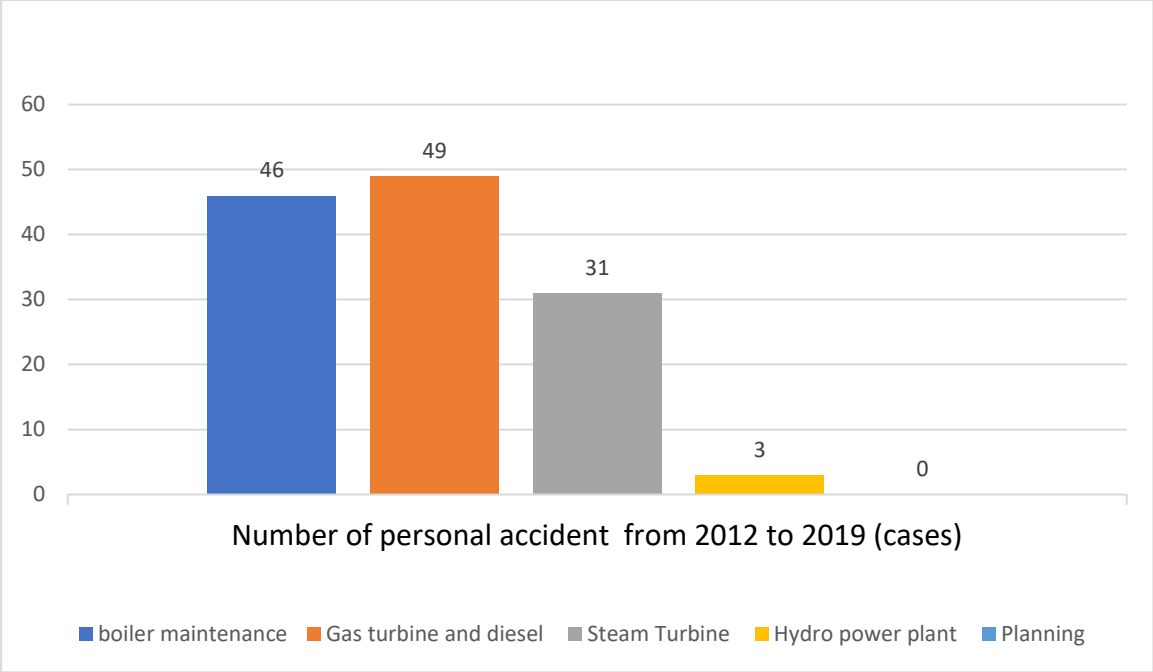

Figure 7: Accumulative number of accidents in each depart during 2012-2019

As shown in figure 7, statistical data showed that the highest accidents around 38% occurred in the gas turbine and diesel department followed by 36% of the cases in the boiler maintenance and 24% in the steam turbine department. A few accident cases were reported in the hydro power plant department. Furthermore, no accident was reported in the planning department.

2.4 Safety local rules in Mechanical Maintenance Works

In maintenance work, there are 8 major hazards that lead to the setting up of safety rules for each type specifically. So, the purpose of such rules is to prevent workers from danger and provide them an accident-free environment.

2.4.1 Safety rules for tools, equipment and machinery using tools (Hand tools)

Workers choose the right tool for the job, both type and size and they must wear appropriate personal protective equipment while working including not throwing tools to coworkers.

2.4.2 Safety rules for tools, equipment and machinery using machinery (Machine)

mainly if the machine is not normal, turn off the machine to check for it. If the machine is working, be careful do not get to too close to it, it is dangerous don't touch machines with rotating parts while it is working and hold the rotating parts of the machine to experiment with manual rotation such as pulley and belt drives. Be careful not to allow the hand to hold in a position that may be crushed, clamped while being rotated.

2.4.3 Safety rules regarding confined spaces

Confined space means a place with limited entrances and insufficient ventilation to allow internal air to be hygienic and safe such as tunnels, caves, potholes, basements, vaults, silos, hoses, stoves, containers, or anything else which has similar characteristics (as specified by the power plant owner in the area). Working in a confined space they must ask for permission through the work permit system for entry into confined spaces and always have work permit before entering a confined space. Workers must be inspected before operating in a controlled area in a confined area by the supervisor for inspection safety measures and advice on operations.

Workers must wear or use appropriate personal protective equipment to prevent from danger while working. Another important equipment that must be considered is protective equipment respiratory system, for example, SCBA, Air Line, life support equipment which must be considered appropriate with the atmosphere in a confined location in case of poisonous gas or dust or vapors or inert gas throughout the operation.

Confined locations must eliminate the dangers that are expected to be removed from the system (System Isolate). The air in the confined space area must be measured before each work and needs to be repeated periodically while operating and checking before entering after a break, may use measuring equipment to measure. Those with the duty of measurement must be trained and have the knowledge in using measuring tools and modifying the data obtained. In the event of an absence of more than 1 hour, the responsible person must be informed of gas measurements and inspections.

Oxygen gas in confined spaces should not be less than 19.5% and not more than 23.5% so workers that must go to work in a confined space must be healthy both physically and mentally with medical check-ups and certification that shows that they can work in confined spaces. Workers must be trained as "Safety at work in confined spaces for workers course" and can work, use tools or equipment as well. Lighting and electrical lighting equipment and electrical equipment must be appropriate, there must be special safety measures in the event of operations that generate heat and sparks. The use of volatile, flammable, combustible substances in confined spaces. In case of confined work that is considered dangerous to the worker, stop work, and fix working conditions that are not harmful to health and safety.

2.4.4 Safety rules for working at high altitude and scaffolding

Before working on the scaffolding, it must be inspected and approved by the staff at the factory. The owner of the specified area must pass the inspection according

to the period specified by the owner of the power plant. Operating at a height of 2 meters above the ground without a structure strong enough to support must install scaffolding.

In the case of working on multiple scaffolding at the same time or on a walkway, they must have a side guard and fall protection net to prevent danger to those below. Installation and fixing of the scaffolding must be prepared and always use a safety harness while working. Scaffolding higher than 2 meters must be prepared and wearing a safety belt or safety harness to prevent falling from a height every time. Scaffolding that is more than 2 meters above the ground must have a railing falling 90-110 centimeters higher than the scaffold and scaffolding higher than 6 meters must be supported.

2.4.5 Safety rules regarding manual material handling

Workers must wear personal protective equipment such as gloves before lifting or moving items to prevent abrasions, scratch and cut with sharp objects, wear safety shoes to prevent slipping, wear a helmet to prevent Injury from material falling, and assess the weight and size of items before lifting or moving.

2.4.6 Safety rules regarding the use of mobile cranes and cranes

The crane of the power plant must be inspected in accordance with the law by the project manager or area manager before starting work. If it is not checked, it is not allowed to be used. Crane operators must be responsible for safely lifting items every time and must have a crane signal provider and they must wear shirts with reflective stripes showing the status clearly. Those that are involved in working with a crane, such as signal provider, material binder and crane operators must be trained. Reflective cloth must be provided to crane operators to show the status while operating the crane signal provider must wear a reflective vest with a whistle to indicate the status

during operation. Hand signals to communicate during work should be used between operators of cranes and mobile cranes.

2.4.7 Safety rules regarding sparking operations (Hot work)

Working with activities causing sparks must obtain permission through the work permit system for work that causes sparks to power plants. Workers must wear clothes and personal protective equipment that must be dry. Additional personal safety equipment according to the type of work, must be provided correctly, appropriately, and have enough to the amount of worker's use according to the type of work which has the following.

(a) Grinding work: workers must wear leather gloves, face shields, safety glasses, and silencers.

(b) Cutting work: workers must wear leather gloves, clear safety glasses (Goggle), and silencer.

(c) Welding work: workers must wear leather gloves, welding glasses, or welding masks.

(d) Sounding work: workers must wear ear protection devices such as earplugs or earmuffs.

(e) Smashing, smacking, and chiseling workers must wear leather gloves, safety glasses, ear protection devices.

(f) Work that must be operated at a height of 2 meters: workers must wear a safety harness and a lifeline attached to the worker all the time while working.

(g) Punching work: workers must wear leather gloves, clear safety glasses (Goggle), ear protection devices.

(h) Impact work: workers must wear cloth gloves, clear safety glasses (Goggle), ear protection devices.

(i) Insulated work: Cloth gloves, safety glasses, and safety belts.

Working with welding gas, cutting gas, burning and gas cylinders, especially tools related to oxygen, propane, and acetylene should not store gas cylinders near hot equipment or in high temperature or contact with electrical circuits or near other people that may fall over it must be placed in a stable place. Safety cap must be covered when the line is not connected. Workers should always check the cable, it should not leak or break and check the joints it shouldn't be loose before using it.

A barrier is a stall using a fireproof barrier to prevent flakes from welding, grinding, and cutting gas by using fireproof fabric. The purpose is to use a fireproof cloth dampened with water to prevent splashes from spreading by limiting the area to be in one area to control extinguishing easily. Most will have to use a barrier as a stall and the worker is in the stall. The flake cannot bounce off but will fall below. Therefore, the area of sparks falling must use fire protection cloth. If it is a scaffolding in which the planks are laid, use metal sheets, zinc, and overlays. Prevention by using water injection.

Safety rules for arc welding equipment

Welders must inspect welding wires that are grounded from the welding machine, it must be connected tightly to the welded workpiece. Do not use steel structures, electrical wiring, electrical system cables and motors are parts of electrical pathways. Electric wires are welded from the welding machine. If extending over the road, wood must be laid on either side of the car or machine or raising the line higher than what ran through. When workers are connecting and cutting the cabinet to the power supply they must cut the electricity first. When workers stop welding or cutting or when taking a break they must cut the electricity or turn off the machine first and move out in a safe area. Cables and

welding machines must be inspected every time before use. If the cable is damaged, it must be repaired immediately or changed to a new one.

2.4.8 Safety rules for working in a workshop

Rules of working in a workshop, usage machinery, tools, or devices must obtain permission from the responsible person of the machine. . Equipment inspection or danger prevention system must be done before operating the machine. All workers must follow the precautions and warning signs. They have to strictly wear proper clothing and protective equipment according to the nature of the work.

2.5 Personal Protective Equipment

There are nine types of personal protective equipment to be provided for usage among workers in a power generation plant in Thailand.

2.5.1 Head protection devices

Characteristics of helmets or hard hats should be able to resist penetration by objects, absorb the shock of a blow, be water-resistant and slow-burning, have clear instructions explaining proper adjustment and replacement of the suspension and headband (Figure 8). A hard hat or helmet is required to be worn while working or entering the operational areas to prevent personnel from potential hazards such as falling or flying objects, fixed objects, and contact with electrical. Protective headgear must meet ANSI Standard Z89.1-1986/1969 (Protective Headgear for Industrial Workers) or provide an equivalent level of protection.

(a) (b)

Figure 8: Head protection devices. Borderless safety hat with a visor (a), and full border safety hat (b).

2.5.2 Ear protection devices

Hearing protection shall be issued to all individuals when sound levels are greater than 85dBA. The following elements should take into consideration to select the most suitable and sufficient hearing protection for employees. There are different types of hearing protection that are used such as earplugs, earmuffs, and banded hearing protection (Figure 9). Hearing protection should muffle sound, but not completely mask all sound. Be aware that re-inserting the same earplugs with dirty fingers could introduce dirt and bacteria possibly leading to an ear infection.

(a) (b) (c)

Figure 9: Ear protection devices. Ear plug (a), Banded hearing protection (b) and Earmuff (c).

2.5.3 Eye and Face protective devices

All individuals who perform any tasks where the eyes or face might contact flying particles, molten metal, liquid chemical, biological hazards, acids or caustic liquids, chemical gases or vapors, potentially infected material, and potentially harmful light radiation, should take into consideration to select the most suitable eye and face protection (Figure 10). Protection equipment must fit properly, be reasonably comfortable to wear, and be compatible with other PPE provided, to provide unrestricted vision and movement to be durable and cleanable.

Eye and face protective devices must comply with ANSI Z87.1-1989/1986 or be at least as effective as this standard requires such as impact goggles, safety glasses and face shields.

Figure 10: Eye and face protective devices. Safety Glass (a), Goggle (b), Face shield (c) and Face shield used with helmet (d).

2.5.4 Respiratory Protection devices

The Respiratory Protection device (Figure 11) was used to prevent breathing atmosphere contamination and air supply such as air contaminated with harmful dust, fog, fumes, mists, gases, smoke, spray, or vapors. The characteristics of the device should be appropriate with the nature of the hazards. The main kind of equipment, type of chemical hazards including concentration of substance and location of work or activities must be selected depending on the level of impact to your workers' respiratory issues.

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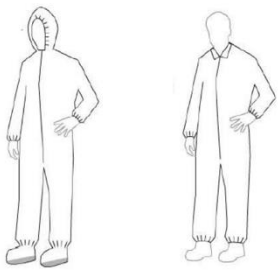
(a) **(b)**

Figure 11: Respiratory protection devices. Particle filter mask (a), and Particle filter mask with exhalation valve (b).

2.5.5 Body Protection

A reflective vest/cloth with a reflective strip (Figure 12) is required to be worn while working or entering the operational areas. The reflective vest ensures that all individuals are visible in any circumstances. The best way to improve individuals' visibility in a night work zone is to have individuals use the reflective vest or other visual appeals. The reflective part should be seen at great lengths and in all directions.



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(a) **(b)**

Figure 12: Body protection. Reflective vest (a), and Chemical Protective Clothing (b).

2.5.6 Arm and Hand Protection

Hand protection equipment (Figure 13) is used to protect all individuals who perform works that might be harmful to skin, such as chemical or thermal burn, electrical danger, bruises, abrasions, cuts, punctures, fractures, and amputations. Selecting the most suitable gloves for each performance should consider the nature of the hazard and the operation.

Figure 13: Arm and hand protection. Gloves (a) and Armband (b).

2.5.7 Foot and Leg Protection

Safety shoes or boots (Figure 14) are required to be worn while working or entering the operational areas. It is recommended that the safety shoes or boots provided to employees should be designed to protect the workers from any hazards such as when heavy objects e.g., barrels or tools might roll onto or fall on one's feet while working with sharp objects such as nails or spikes that could pierce the soles or uppers of an ordinary shoe, avoid exposure to molten metal that might splash on feet or legs while working on or around hot, wet or slippery surfaces and while working with electrical hazards.

(a) (b) (c)

Figure 14: Foot and leg protection. Safety Shoes (a), Safety boots (b), and Welding Gaiter (c).

2.5.8 Fall Protection devices

Fall protection devices are used for protecting employees from falls e.g., guardrail, cover, safety net, body harness (Figure 15), lifeline, safety belt, lanyard, connectors, and anchorages or a suitable combination of these.

Figure 15: **Full Body Harness**

2.5.9 Special Protective Equipment

Special protective devices are used for protecting workers who do specific jobs onsite such as, high-visibility warning clothing (used in maintenance workers who must work in the low light area) (Figure 16), and life jacket (used by workers who have to work on the surface of water e.g., survey working in the dam).

Figure 16: High-visibility warning clothing

2.6 Relevant research

Filn and team (1996) explored the hazardous perception of the workers in the offshore industry and identified important determinants related to safe practices. More than 30% of workers have been involved in accidents at least once during work. The determinants that affected the safety practice of workers the most were workers' attitude, stress, and safety contentment.

Rongo and team (2004) conducted a focused group discussion among four occupations (welders, spray painters, wood workers, and metal workers) of small-scale industry in Tanzania to assess hazardous exposure from their occupation. Over 90% of workers are exposed to hazard at high level especially among welders and metal workers who are exposed to dust, fume, and noise, etc. This hazardous exposure affected their health such as skin burn found in welders (86.1 percent), eye problems and skin irritations found in metal workers (75.4 percent), etc. Even hazardous exposure of these workers was high, the usage of personal protective equipment among these workers was poor.

Lind and colleagues (2009) assessed and analyzed accidents in the maintenance industry in Finland. They collected data from accident reports that explained both fatal and severe non-fatal accidents in the Finnish industry. The research studied only full-time maintenance workers while working in industrial maintenance operations. The

fatal accident cases were collected from 1985 to 2004. The severe non-fatal accidents cases were collected from 1994 to 2004. Among 33 accident cases, 37 maintenance workers died. Among severe non-fatal accident cases, there were 90 victims. The most typical accident type in both fatal and severe non-fatal accidents is crushing (27 percent in fatal accidents and 39 percent in non-fatal accidents). The most frequently identified unsafe act led to fatal accidents, while the severe non-fatal accidents mostly occurred while working at a running process (30 percent). In both types of accidents, the most typical causes are defects in work instructions and machinery safety equipment. The most important of accident prevention was the role of organizational factors, such as safety management and operations planning.

Hon and colleagues (2010) did a mixed approach of qualitative and quantitative methods by semi-structured interview and questionnaire to find causes of accidents in Repair, Maintenance, Alteration and Addition (RMAA) work and to identify underlying causes of RMAA work accidents. The result of research revealed that one of the root causes of accidents in RMAA work is low safety awareness of RMAA workers. The three most important causes leading to accidents were poor safety conscientiousness of RMAA workers, RMAA workers underestimated potential risks when performing small tasks for a short period of time, and personal protective equipment not used, incorrectly used, or not provided.

Nantasang and team (2012) performed descriptive research to study the health problems and work environment of ARC Welding Workers. The research showed that most of the workers have problems with muscle especially leg muscle pain, shoulder pain, and backache. Illness caused by chemicals and heat were found in the skin, eye, and nose irritation. Skin, eye, and nose irritation were found to be as high as 50.1 percent for the worker following rash (38.1 percent), dizziness (31.4 percent). Eye and visual problems including eye irritation affected 67.3 percent of the workers, eye pain and bleary eye 67.1 percent, and eye injury 68.6 percent. Photophobia and red eyes were the most common problems found for 84.0 percent of the workers. Respiratory problems include nose and throat irritation and breathlessness. Workplaces were

lacking fire extinguishers for 94.3 percent, and 95.8 percent of the places had highly unsafe-work stations. The research showed that all welders did not use personal protective equipment such as earplugs, and protective respirators.

Dhillon (2014) analyzed human error in maintenance. Human error in maintenance can affect the safety processing and capacity of the equipment. The research showed the causes of maintenance error were complex maintenance tasks, outdated maintenance manuals, poor equipment design, improper work tools, poor work environment, poorly written maintenance, fatigued maintenance personnel, inadequate training and experience, and poor work layout. They also mentioned that in poor maintenance environments such as noisy environments, each personnel should wear personal protective equipment to prevent hazards from that noise.

Lu and team (2015) performed a cross-sectional study of migrant workers in China. The results revealed that individual determinants influenced the usage of PPEs especially when they were in the supporting work environment such as social emulation, they preferred practicing of PPEs usage during work.

Alves and colleagues (2015) performed a cross-sectional study aimed to explain the history of serious accidents at the workplace in Brazil from 2007 to 2014. The result showed an increased incident of occupational accidents every year from 2007 to 2014. Most of the incidents occurred in male workers (for more than 90 percent) who were 22 to 44 years. Most accident types were typical accidents, and the most common outcome was temporary disability (over 50 percent). These accidents mostly affected the hands followed by an upper-lower limb of the workers. The top four worker groups that were involved in the incidents were mining and quarrying and construction (25.1 percent), agricultural exploitation (12.5 percent), service workers (11.1 percent), and conservative/maintenance/repair workers (9 percent). The researcher hoped that serious work accidents will be realized by the public agency to create policy for preventing workers from any hazard.

Unsar and Sut (2015) analyzed work accidents in thermal and hydroelectric plants between 2002 and 2010 in Turkey. They showed that many accidents that occurred from working can lead to deaths and disabled workers. Among these accidents, using unsafe materials, personal faults, and insufficiencies in the plants were found to be the three main causes of accidents. Most injuries in the body occurred at back and dorsa, chest and stomach. Most work accidents in thermal plants occurred in boiler turbine change and maintenance, ash-coal system and machine-mechanic workshop units. In hydroelectric plants, work accidents mostly occurred in electrical maintenance and machine-mechanic workshop units. The researcher suggested that causes of accidents should be defined to create an accident preventive protocol for safety work to reduce the number of accident cases in both plants.

Z'gambo (2015) conducted a cross-sectional study on 430 welders to assess occupational hazards and usage of personal protective equipment through many factors including gender, age, marital status, level of education, welding work experience, etc. The results showed that welders exposed many hazards during work under hazardous situations led them to several safety and health hazards. Furthermore, the preventive measures provided to workers including personal protective equipment were not enough for their safety, therefore, acute health effects were still found in many workers. Further studies should be conducted to discover strategies to reduce hazardous exposure among welders.

Muema (2016) did a cross-sectional study to assess the utilization of personal protective equipment (PPEs) among construction workers in Kenya. Over 80 percent of workers suffered injuries and illness because of their work. Over 50 percent of workers did not have PPEs. For 76 percent of those workers had never been trained on PPE's training and any safety training. From the findings, the researcher suggested that workers should use appropriate PPEs such as helmets, safety boots, ear masks, goggles etc, while working and suggested that any agency such as the Ministry of Labour Officials should implement Occupational Safety and Health Administration (OSHA), 2007 to provide free PPEs to all workers.

Lombordi (2019) collected data in manufacturing, construction, service/retail, or related industries in Massachusetts, the USA to analyze determinants that affect the decision of wearing eyewear protection. The total number of participants in this research was 51 persons. They divided participants into seven groups (six groups for workers and a group for supervisors) which are construction, production, Installation/repair/maintenance, healthcare, management, building and grounds (both cleaning and maintenance), and life/physical/social service. More than half of them (59 percent) worked over twenty years in their occupation and 42 percent received safety training. The research showed the main barrier to decision on wearing eyewear protection was their perception of risk of an eye injury which was affected by age, safety training and environment at workplace. Other factors were the style and comfort of eyewear protection.

Rolex (2015) did a cross-sectional study in a small-scale industry to assess knowledge, attitude and usage of personal protective equipment among their workers. Their workers had a positive attitude (93.2 percent) and well practice (92.5 percent) on PPEs, but insufficient knowledge. The researcher concluded that training and administration to educate about workers' safety were not enough. It seems that investment in knowledge of workers will be affected in the long term in practice and attitude part. If workers have poor knowledge, they cannot use PPEs effectively during work.

CHAPTER III

RESEARCH METHODOLOGY

3.1 Research Design

This research was a cross-sectional design which aimed to explore levels of mechanical maintenance workers' knowledge, attitude and their usage of PPEs and find out associations between them. The factors related to knowledge, attitude , and usage level of PPEs among the mechanical maintenance workers were also examined.

3.2 Study Area

This study was carried on among the mechanical maintenance workers of a power generation unit in Thailand. The workers' duty is analysis, planning of problems, maintenance, improvement, demolition and mechanical equipment installation of all types of power plants such as thermal, combined thermal, renewable energy (hydro power and wind) and diesel power plant.

3.3 Study Period

Data collection was conducted during January to March 2021.

3.4 Study Population

The study population was mechanical maintenance workers in a power generation unit in Thailand. There are 624 mechanical maintenance workers working in this unit. This power generation unit is divided into five departments and one central agency performing administrative work. Manpower of the mechanical maintenance division is 12 workers in central agency, 198 workers in boiler maintenance, 165 workers in gas turbine and diesel, 149 workers in steam turbine, 68 workers in hydro power plant and 32 workers in planning department (as shown in figure 17).

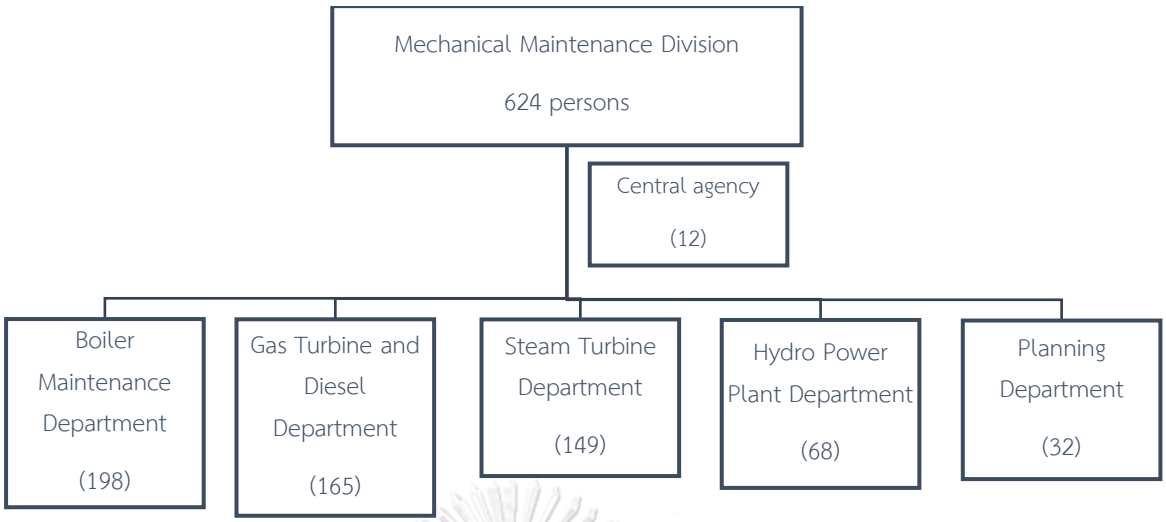

Figure 17: Human resource of each department in mechanical maintenance division

Inclusion criteria:

- Workers who worked in boiler maintenance or gas turbine and diesel or steam turbine department
- Workers who had been working at maintenance plant
- Workers who were willing to participate the study

Exclusion criteria:

- Workers who were on vacation leave, sick leave or personal leave during data collection
- Workers who worked in office department

3.5 Sample & Sample size

The sample size was calculated from finite population along Wayne's formula (1995) shown as followed ;

$$n = \frac{N\sigma^2 z^2_{1-\frac{\propto}{2}}}{d^2(N-1) + \sigma^2 z^2_{1-\frac{\propto}{2}}}$$

n = Sample Size

N = Population size (Total of mechanical maintenance workers = 624 persons)

σ = Standard deviation (referred from previous KAP study among workers in small scale industries, σ = 0.76 (Robson Rolex, 2019))

d (error) = Absolute precision required (d=0.05)

$\propto$ (alpha) = Confidence interval 95% ($\propto$=0.05)

$$n = 367$$

From above formulation, the result of 367 was added for a predicted number of workers who may refuse to join this research or incomplete data. Therefore, after adding 10% refusing or dropping out, the sample was 398.

3.6 Sampling Technique

Among five departments, three hundred and seventy-ninth workers were selected by simple random sampling from three units, i.e., boiler maintenance, gas turbine and diesel, and steam turbine, where most accident cases have been reported since 2012. The proportionate to size was applied as presented in Table 1. The 154 workers from boiler maintenance, 128 workers from gas turbine and diesel and 116 workers from steam turbine were recruited.

Table 1: Sample size of three departments

Department	Number of populations	Sample Size (persons)
Boiler Maintenance	198	154
Gas Turbine and diesel	165	128
Steam Turbine	149	116
Total	**512**	**398**

3.7 Measurement Tools

In this study, the questionnaire was used to assess the socio-demographic characteristics, work-experiences and social support, knowledge, attitude, and usage on personal protective equipment of mechanical maintenance workers.The questionnaire was developed from previous study (Kralam,2011). There were five parts of questionnaire.

Part 1 Socio-demographic

In this section consisted of six questions, in aspects of socio demographic factors including age, gender, education level, marital status, department and working's years.

Part 2 Work-experience

In this section consists of ten questions asked about safety training, time average of safety training, type of work, length of working, incident and accident's history, and social support on PPE use.

Part 3 Knowledge

In this section, there were 15 questions that asked about the understanding of PPEs usage and understanding in accidents terminology, proper PPEs use in different hazardous works, and concerning effect from hazard on safety and health.

A correct answer was given 1 score and 0 score for wrong and don't know answer. The scores varied from 0-15 points. Bloom's cut off point (Bloom, 1956) was used to determine knowledge level which was classified into 3 levels. The score between 12-15 or 80-100% was classified into high knowledge level, score between 9-11 or 60-79% was classified into moderate knowledge level, and score between 0-8 or less than 60% was classified into low knowledge level as shown in Table 2.

Table 2: Classification of knowledge levels

Level of Knowledge	Score (points)	Percentage
High	12-15	80-100%
Moderate	9-11	60-79%
Low	0-8	Less than 60%

Part 4 Attitude

There were 15 questions in this part including attitude of usage personal protective equipment and hazardous in work condition, which included both positive and negative statements. The statements were assessed by using Likert's scale (Likert, 1932). The rating scale was measured as followed:

Positive statement		Negative statement	
Choice	Scores	Choice	Scores
Strongly agree	4	Strongly agree	0
Agree	3	Agree	1
Neural	2	Neural	2
Disagree	1	Disagree	3
Strongly disagree	0	Strongly disagree	4

A score from each question was summed up for total scores. The score varied from 0 to 60. Then mean of scores and its standard deviation were calculated. The score was classified into 3 levels, high, moderate, and poor attitude according to mean (51.4) plus and minus standard deviation (6.5) (Table 3).

Table 3: Classification of attitude levels

Level of attitude	Score (points)
High	≥58
Moderate	45-57
Low	≤44

Part 5 Usage questionnaire.

In this section, the 11 questions related to the usage of personal protective equipment among mechanical maintenance workers were asked. The respondents responded how often they used each personal protective equipment while working. The personal protective equipments were divided into "general personal protective equipments" and "special personal protective equipments". The maintenance workers must wear general protective equipments when they enter in the power plant while special protective equipments, the workers must use the equipment specified for their tasks for example, if the workers were working at high altitude and scaffolding ,they should wear body safety harness or safety belt. The score was "3" if their answer was "always" used, and score was "2", and "1" if their answer was "sometime", and "never" used, respectively. A score from each question was summed up for total scores. The total scores for each participant varied from 3 to 33. Then mean of scores and its standard deviation were calculated. The score was classified to 3 levels as high,

moderate, and low usage according to mean (27.7) plus and minus standard deviation (3.3) (Table 4).

Table 4: Classification of PPEs usage levels

Level of usage	Score (points)
High	≥31
Moderate	25-30
Low	≤24

3.8 Validity and reliability of questionnaire

Validity

The content validity was evaluated by three experts on occupational health and related field of the College of Public Health Sciences, Chulalongkorn University. The experts checked the validity according to theory and checked for accuracy and suitability of the content and language by giving score "+1" if the expert was sure that this item really measured the attribute, "0" if the expert was not sure that the item did measure or did not measure the expected attribute, or "-1" if the expert was sure that this item did not measure the attribute for each question. The Index of Item-Objective Congruence (IOC) was calculated for each item. The IOC score of the question that was less than 0.5 was revised. After questions were revised then it was reviewed by experts again (IOC = 0.67).

Reliability

The reliability testing of questionnaire was carried out with forty workers who worked closely with mechanical maintenance work as 20 workers from civil maintenance division and 20 workers from electrical maintenance division of a power

generation unit in Thailand. After that KR-20 (Kuder–Richardson formula 20) was used to test the internal consistency reliability of knowledge part, Cronbach's alpha was used to test attitude part. The coefficient score was from 0 to 1. It should be over 0.70 that mean the questionnaire was considered acceptable reliability (Bolarinwa, 2015). The reliability testing of questionnaire was 0.682.

3.9 Data Collection:

The data collection was performed after getting approval from the Research Ethics Review Committee for Research Involving Human Research Participants, Health Sciences Group, Chulalongkorn University. The process was shown as followed.

3.8.1 The document asking for allowance on the data collection issued by the college of Public Health Sciences, Chulalongkorn University was sent to mechanical maintenance division's chief to ask for the permission on the data collection.

3.8.2 After getting the approval from mechanical maintenance division's chief, the researcher used simple random sampling to randomly select the target samples. The researcher approached to department head for asking permission to meet their workers then the researcher contacted target workers to submit self-response questionnaire to them

Before the workers answered the self-response questionnaire, the researcher explained the objectives and benefits of this study and let them make clear understanding for all step that they involved and asked them to sign in the consent form and assured them of voluntary participation and if someone was not available to be respondent, they could deny the study.

The respondents were allowed to answer the questionnaire at their home after finishing work, that could make them feel relax in their private environment to answer questionnaire.

3.8.3 After complete answering the questionnaire, the workers put it in an envelope and gave it back to their department head then the questionnaires returned to the researcher. The researcher checked on the completeness and correctness of the questionnaires later.

The process of data collection was conducted from January to March 2021.

3.9 Data analysis

The data entry was done by double entry process and data cleaning was performed before the analysis. The collected data was checked for completeness, then the researcher used SPSS program version 28 to analyze all data.

Test of normality was performed using Kolmogorov-Smirnov test for quantitative data. The result showed a normal distribution of the data only knowledge score while attitude and PPE usage scores were not normally distributed.

The descriptive statistic was used to describe the frequency and the percentage for the categorical data, mean and standard deviation or median and inter quartile range for the numerical data of independent variables when the data was normally or non-normally distributed, respectively. This was used primarily to summarize data to make it more apprehensive.

The analytic statistic:

To find association of categorical data to describe association between socio-demographic, work-experiences and social support with level of knowledge, attitude, and usage personal protective equipment, each outcome variable (knowledge , attitude and usage) was recoded into two categories in which first group included “low and medium level” and “high level” was included in the second group.

To explore the association between each independent variable and dependent variable, simple logistic regression was used and *p-value* less than 0.05 was considered as significant.

Spearman's Rank Correlation Coefficient was used to analyze the relationships between knowledge, attitude, and usage score. The interpretation of correlation coefficient was shown as followed (Hinkle et al, 2003).

Absolute value of r_s	Interpretation
0.90 to 1.00	Very high correlation
0.70 to 0.90	High correlation
0.50 to 0.70	Moderate correlation
0.30 to 0.50	Low correlation
0.00 to 0.30	Little if any correlation

3.10 Ethical Consideration

This study was approved by the Research Ethics Review Committee for Research Involving Human Research Participants, Health Sciences Group, Chulalongkorn University. The certificate of ethical approval number was 008/2564.

The main ethical issue was confidentiality. All the participants were gathered by inclusion criteria and exclusion criteria without selection bias and participants were informed about the process of studying and voluntarily signed the consent form before participating in this study. They could refuse to join this study without any effects. However, following all steps were taken into consideration to ensure that the participant confidentiality was not breached. Their information was kept confidentiality.

Data was used for research's purpose only. Data was generalizable knowledge to increase their understanding of reason behind usage or non-usage of PPEs among mechanical maintenance workers.

CHAPTER IV
RESULTS

This chapter provides a detailed description of the results obtained from the analysis of the survey. This showed the socio-demographic characteristics, work experience, social support, level of knowledge, attitude towards usage on personal protective equipment of mechanical maintenance workers followed by the responses for each section of the questionnaire. This chapter also presents the relationship between socio-demographic factors, work experience, social support knowledge and attitude that affected the usage of personal protective equipment among workers.

4.1 Socio-demographic of the maintenance workers

This study was conducted in a power of generation unit, Thailand. The questionnaires were contributed to 398 workers. The complete questionnaires were responded by only 379 workers (95.23%), however, the complete questionnaires were more than the sample size (367 workers). The respondents 40.4% (153 workers) were from the boiler department, 30.6% (116 workers) were from the gas turbine and diesel department, and 29.0% (110 workers) were from the steam turbine department

Table 5: Number and percentage of the mechanical maintenance workers' response from each department

Department	N (Workers)	n (Workers)	Percentage (%)
Boiler	154	153	40.4
Steam Turbine	128	110	29.0
Gas Turbine and Diesel	116	116	30.6
Total	**398**	**379**	**100**

4.1.1 General socio-demographic characteristics

Almost all respondents were male (95.8%). The participant's age was ranged between 23 and 60 years. The average age was 42.5 years with a standard deviation 10.6. The majority range of age was 51-60 years (32.5%) and 31-40 years (31.9%), while 20-30 years and 41-50 years ranges showed 18.2 and 17.4 percent, respectively.

In term of the respondent's position, 80.7% of them was technician, 11.1% was expert technician and only 8.2% was engineer. For the working duration of the respondent the average was 14.9 years with a standard deviation of 11. Their range of working duration was from 1 to 40 years. Nearly half of them have been working at this power plant for up to 10 years (49.3%), 24.3% of them work for 21-30 years, 18.2% work for 11-20 years, and 8.2% work for 31-40 years.

The majority of respondents had graduated from higher vocational certificate (63.6%), followed by bachelor's degree (19.5%), vocational certificate (15.8%) and only 1.1% graduated from master's degree and higher. For marital status, 66.5% of them are married, 28.5% are single and only a few percent are divorced and widowed.

Table 6: Socio-demographic characteristics of the maintenance workers (n = 379)

Characteristics	Number	Percentage (%)
Gender		
Male	363	95.8
Female	16	4.2
Age (years)		
20-30	69	18.2
31-40	121	31.9
41-50	66	17.4
51-60	123	32.5
Mean ± SD = 42.5±10.6	Range = 23-60	
Position		
Technician	306	80.7
Expert Technician	42	11.1
Engineer	31	8.2
Duration of working (years)		
≤10	187	49.3
11-20	69	18.2
21-30	92	24.3
31-40	31	8.2
Mean ± SD = 14.9 ± 11	Range = 1-40	
Education level		
Vocational Certificate	60	15.8
Higher Vocational Certificate	241	63.6
Bachelor's degree	74	19.5
Master's degree and higher	4	1.1
Marital status		
Single	108	28.5
Married	252	66.5
Divorced	16	4.2
Widowed	3	0.8

4.2 Work experience information

Almost all respondents in this study passed the safety training (99.5%) before starting work. They attended safety training on an average of 6 times per year (SD=3.2). The maximum of passing safety training was 20 times per year. Ninety-seven percent of the safety training topic consisted of wearing personal protective equipment. Most of the respondents (95.8%) had worked under their own responsibility up to 10 hours per day and the average working hour was 8.62 hours per day.

For the type of jobs that the respondents worked 6 months ago, most of them worked with tools, equipment, and machinery (83.4%), high altitude and scaffolding (79.4%), in a workshop (76.3%), manual material handling (74.7%), confined spaces (74.7%), sparking operations or hot work (73.6%), mobile cranes and cranes (55.4%) and others (3.4%), respectively. Over half of the respondents had been injured because of the accident but were not in serious condition. After they got injured in the accident first aid was provided to them (34%). Only 11.9% of respondents were referred to the hospital. Data shown in Table 7.

Table 7: Work experiences of the maintenance workers (n = 379)

Characteristics	Number	Percentage (%)
You have ever passed safety training		
Yes	377	99.5
No	2	0.5
Time averages of safety training that you pass per year (times)		
≤5	183	48.3
6-10	177	46.7
≥11	19	5.0
Mean ± SD = 6 ± 3.2	Range = 0-20	
There was part of wearing personal protective equipment in safety training		
Yes	368	97.1
No	11	2.9
Type of works you have done for 6 months ago (multiple response)		
Working with tools, equipment and machinery using tools or machinery using machinery	316	83.4
Working in confined spaces	283	74.7
Working at high altitude and scaffolding	301	79.4
Working manual material handling	283	74.7
Working with mobile cranes and cranes	210	55.4
Working sparking operations or hot work	279	73.6
Working in workshop	289	76.3
Others	13	3.4
Length of working hour(s) per day (hours)		
≤10	363	95.8
11-20	16	4.2
Mean ± SD = 8.62 ± 1.76	Range = 1-18	

Table 7: Work experiences of the maintenance workers (n = 379) (continue)

Characteristics	Number	Percentage (%)
You have ever injured from accidents		
Yes	196	51.7
No	183	48.3
You have ever been involved incidents during working (including near-miss case)		
Yes	192	50.7
No	187	49.3
What's happened after you get injured		
Got first aid at the workplace	129	34.0
Went to the hospital	45	11.9
Got first aid then went to the hospital	23	6.1
None	182	48.0

Others = Work in laboratory and Work with chemical hazards

4.3 Social support by co-workers on personal protective equipment use

The respondents were encouraged by their co-workers on the usage of PPEs (77.6%), while 22.4% of them was not get encouraged to use PPEs. Most of the respondents (97.1%) had seen their co-workers use PPEs while working as shown in Table 8.

Table 8: Social support by co-workers on PPEs usage (n = 379)

Characteristics	Number	Percentage (%)
You got encourage to use personal protective equipment from co-worker for six months ago		
Yes	294	77.6
No	85	22.4
You have ever seen your co-worker wear PPEs while working for six months ago		
Yes	368	97.1
No	11	2.9

4.4 Knowledge on usage personal protective equipment among mechanical maintenance workers

Respondents answered a total of 15 knowledge questions. Each correct answer was given one point, thus a total score was 15 points. The average knowledge score from all respondents was 11.23 (SD=1.24). The range of knowledge score was from 6 to 15.

Distribution of knowledge on usage of PPEs regarding type, importance, hazard and perception effect to health and safety showed that 54.6% of respondents had "moderate knowledge", 43.3% of respondents had "high knowledge", and only 2.1% had "low knowledge" as shown in Table 9.

Table 9: Knowledge level of the maintenance workers regarding usage of personal protective equipment (n = 379)

Knowledge level	Number	Percentage (%)
High (12-15 scores)	164	43.3
Moderate (9-11 scores)	207	54.6
Low (0-8 scores)	8	2.1

Minimum = 6 Maximum = 15 Median = 11 Mean ± SD = 11.23 ± 1.24

As shown in table 10, The questionnaire which most respondents can answer correctly was item 1 as there were many hazardous works in maintenance (99.2%), respondents knew that confined space, working at height, welding was one of the hazardous works in this subject. Many respondents knew that besides wearing PPEs, following safety rules and safety signs can be accident's prevention and accident can

be cause many points of loss (98.2%). Around 98% of respondents realized the importance of PPEs was a prevention tool from accidents. Less than 25% of them knew that when they weld, wearing a face shield can prevent from respiratory system from the hazard. Approximately, 13% of them knew the number and types of PPEs that the agency provided for workers. The lowest score that respondents can answered correctly was question number 6 “there are unsafe act and unsafe conditions, lack of wearing PPEs is one of the unsafe conditions”, only 9.8% of respondents knew it.

Table 10: Distribution of number and percentage of correct response on knowledge items of usage on personal protective equipment by the maintenance workers (n = 379)

Knowledge question	Correct answer	
	Number	Percentage (%)
1. I think, there are many hazardous works in maintenance such as confined space, working at height, welding etc.	376	99.2
2. I think, wearing PPEs are one of accidents prevention from hazardous	371	97.9
3. I think, besides wearing PPEs, following safety rule, safety sign can be accidents prevention	372	98.2
4. In my agency there are only four types of PPEs as head protection, ear protection, face and eye protection and respiratory protection type	51	13.5
5. I think, there isn't legal in Thailand to force that employer have to provides PPEs to their workers	291	76.8
6. I think, there are unsafe act and unsafe condition, lack of wearing PPEs is one of unsafe condition	37	9.8
7. I think, wearing full body safety harness is safer than lifeline certainly	322	85.0
8. I think, there are 2 types of ear protection as ear plug and earmuff	352	92.9

Table 10: Distribution of number and percentage of correct response on knowledge items of usage on personal protective equipment by the maintenance workers (n = 379) (continue)

Knowledge question	Correct answer	
	Number	Percentage (%)
9. I think, railing's height for scaffolding installation should have railing's height at least 90 to 110 cm	325	85.8
10. I think, I have to wear face shield to prevent respiratory system when welding	83	21.9
11. I think, A Self-contained breathing apparatus is the only enough device when I'm working in confined space area	289	76.3
12. I think, safety hat, ear plug or earmuff, dust mask, safety shoe and safety glasses are basically personal protective equipment when I entered in power plant	353	93.1
13. I think, wearing personal protective equipment as gloves should be chosen to depend on type of works	372	98.2
14. I think, wearing respiratory protection equipment can prevent Fume and gases can be cause of respiratory disorder	291	76.8
15. I think, accidents can be cause of many points of loss such as physical loss, wasting time, property loss etc.	372	98.7

4.5 Attitude on usage of personal protective equipment among mechanical maintenance workers

According to table 11, respondents answered 15 questions both positive and negative questions with a total score of 60 points. There were 61.8 % of them who had “moderate attitude”, 20.8% of them had “high attitude” and only 17.4 of them had “low attitude”. The score of attitudes ranged from 30 to 60 points. The average of attitude score was 51.4 with a standard deviation of 6.5.

Table 11: Distribution of number and percentage on attitude level on usage of personal protective equipment of maintenance workers (n = 379)

Attitude level	Number	Percentage (%)
High (≥58 scores)	79	20.8
Moderate (45-57 scores)	234	61.8
Low (≤44 scores)	66	17.4

Minimum =30 Maximum = 60 Median = 53 Mean ± SD = 51.4 ± 6.5

According to table 12, over 70% of the respondent ‘s attitude strongly agreed with the thought that the more hazards in maintenance working at power plant, the more awareness on wearing personal protective equipment (76.3%), wearing PPEs can reduce the cause of injury or illness that can lead to disability or death case while working (74.1%) and it was one of the necessary tools for working (78.1%). Nearly 55% of respondents believed that wearing PPEs can reduce incidents rate because of working. Fifty-seven percent of respondents need to be trained for usage each PPEs. Around 56% of respondents will consent safety officer stop their work if they do not wear PPEs. Less than 67% of them knew hazardous of work, then they choose

appropriate PPEs to fit work. Moreover, more than 60% of respondents knew about correctly choosing the type of PPEs to fit with work such as welding job which they must wear eye and face protection, working with splashy fire which they have to wear safety glass and leather gloves to reduce any injury and also working in confined space, respiratory protection was needed to prevent a harmful accident. Approximately 40% of respondents thought that the organization has provided enough PPEs to them. In a negative statement, 44.9% of respondents disagreed that the scaffold had already been installed, there is no need to wear any personal protective equipment and 57% of them disagreed that a full body safety harness is not necessary equipment for working at height. Approximately 40% of respondents did not think that wearing PPEs are barriers of working, about 58% of them did not think that having PPEs is a useless investment.

Table 12: Distribution of number and percentage on attitude items of usage on personal protective equipment

Attitude question	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
	%	%	%	%	%
1. In my view, the more hazardous in maintenance working at power plant, the more awareness on wearing personal protective equipment.	76.3	21.1	2.1	0.3	0.3
2. I think that wearing personal protective equipment can reduce cause of injury or illness into disable or death case during maintenance working.	74.1	24.0	1.8	0	0
3. In my view, PPEs are the one of necessary devices for working.	78.1	15.6	5.3	1.1	0
4. In my opinion, working at heights If the scaffold has already been installed, there is no need to wear any personal protective equipment. *	7.4	9.2	6.1	32.5	44.9
5. In my view, wearing PPEs can reduce incidents rate because of working.	54.9	35.4	6.6	2.9	0.3

Negative Statement *

Table 12: Distribution of number and percentage on attitude items on usage of personal protective equipment (continue)

Attitude question	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
	%	%	%	%	%
6. In my opinion, Full body safety harness's not necessary equipment while working at height. *	5.0	5.0	1.8	30.9	57.3
7. In my view, workers need to be trained for usage each PPEs.	57.0	36.7	4.5	0.3	1.6
8. In my view, wearing PPEs are barrier of working. *	4.5	5.0	16.6	33.5	40.4
9. If I didn't wear of PPEs, safety officers could stop my work	55.9	37.7	4.2	1.3	0.8
10. In my view, it's important to know hazardous of work, then I can choose appropriate PPEs to fit work.	66.8	30.1	2.4	0.5	0.3
11. If I work welding job, only eye and face protection need to be worn	61.2	31.1	4.5	2.1	1.1
12. In my opinion, wearing personal protective equipment such as safety glass and leather gloves can reduce any injury from splashy fire while working.	65.2	28.5	5.0	0.8	0.5

Negative Statement *

Table 12: Distribution of number and percentage on attitude items on usage of personal protective equipment (continue)

Attitude question	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
	%	%	%	%	%
13. I think that having PPEs is useless investment*	2.4	3.2	3.4	32.2	58.8
14. From my perspective, my organization has provided PPEs enough to their workers	34.3	39.8	18.5	5.8	1.6
15. It seems to me, working in confined space without respiratory protection device can be harmful to death	66.2	25.6	3.4	3.7	1.1

Negative Statement *

4.6 Usage of personal protective equipment among mechanical maintenance workers

Personal protective equipment for mechanical maintenance workers were divided into two types. They were regular and particular personal protective equipment. The workers should wear regular personal protective equipment before entering the power plant and the particular one was worn for specific hazardous works. The number of workers who wore these two kinds of personal protective equipment at different frequencies of use was separately presented in Table 13 and Table 14, respectively. Table 15 presented the number of workers that used both kinds of personal protective equipment when they do maintenance work in the power plant and then the number and percentage of the two groups of workers; high usage and low to moderate usage of both kinds of equipment were shown in Table 16.

The respondents answered a total of 11 questions with a total score of 33. The distribution of usage of regular PPEs level showed that 40.6% had “High usage”, 36.2 % of them had “Moderate usage” and only 23.2% had “Low usage”. The range of usage of regular PPEs score was from 5 to 15 points. The average of usage regular PPEs was 13.6 out of possible 15 points, with the standard deviation of 1.5 as shown in Table 13.

Table 13: Distribution of number and percentage on usage regular personal protective equipment (n = 379)

Level of usage regular PPEs	Number	Percentage (%)
High usage (≥15 score)	154	40.6
Moderate usage (13-14 score)	137	36.2
Low usage (≤12 score)	88	23.2

Minimum = 5 Maximum = 15 Median = 13 Mean ± SD = 13.6 ± 1.5

According to table 14, the distribution of usage particular PPEs level showed that 47.8% had “Moderate usage”, 29.6 % of them had “High usage” and only 22.7% had “Low usage”. The range of usage particular PPEs score was from 6 to 18 points. The average of usage regular PPEs was 14.1 out of possible 18 points, with a standard deviation of 2.2.

Table 14: Distribution of number and percentage on usage particular personal protective equipment (n= 379)

Level of usage particular PPEs	Number	Percentage (%)
High usage (≥16 score)	112	29.6
Moderate usage (13-15 score)	181	47.8
Low usage (≤12 score)	86	22.7

Minimum = 6 Maximum = 18 Median = 14 Mean ± SD = 14.1 ± 2.2

According to table 15, The distribution of usage totally PPEs level showed that 64.1% had “Moderate usage”, 22.7 % of them had “High usage” and only 13.2% had “Low usage”. Range of usage totally PPEs score was from 12 to 33 point. The average of usage totally PPEs was 27.7 out of possible 33 points, with the standard deviation 3.3.

Table 15: Distribution of number and percentage on level of usage totally personal protective equipment (n= 379)

Level of totally usage PPEs	Number	Percentage (%)
High usage (≥31 score)	86	22.7
Moderate usage (25-30 score)	243	64.1
Low usage (≤24 score)	50	13.2

Minimum = 12 Maximum = 33 Median = 28 Mean ± SD = 27.7 ± 3.3

According to table 16, The distribution of grouping usage totally PPEs level from table 15 was categorized to two groups as high usage (22.7%) and low and moderate usage (77.3%).

Table 16: Distribution of number and percentage on usage totally personal protective equipment (n = 379)

Usage PPEs	Number	Percentage (%)
High usage (≥31 score)	86	22.7
Low and Moderate usage (<30 score)	293	77.3

Regarding the usage of regular PPEs, table 17 showed that 95% of respondents wore safety hats for head protection, 72.8% of them wore dust masks or chemical protective masks for respiratory protection and 95% of them used safety shoes for foot protection. For the usage of particular PPEs, 78.1% of respondents used knitting thread gloves, 64.1% used heat resistant gloves for hand and arm protection, 52.5% of them used body safety harness or safety belt for body protection, 67.8% of them used face shield for eye and face protection. A few of them (8.7%) used self-contained breathing apparatus (SCBA) for respiratory system protection.

Table 17: Number and percentage of respondents on usage each individual PPEs

Type of Personal protective equipment (PPEs)	Usage		
	Always	Sometime	Never
	Number (%)	Number (%)	Number (%)
Regular PPEs			
1. Safety hat	360 (95.0)	13(3.4)	6(1.6)
2. Ear plug or Earmuff	182 (48.0)	194 (51.2)	3 (0.8)
3. Safety glass or Impact goggle	188 (49.6)	188 (49.6)	3 (0.8)
4. Dust mask or Chemical protective mask	276 (72.8)	100 (26.4)	3 (0.8)
5. Safety Shoes	360 (95.0)	13 (3.4)	6 (1.6)
Particular PPEs			
1. Knitting thread gloves	296 (78.1)	80 (21.1)	3 (0.8)
2. Body safety harness or safety belt	199 (52.5)	170 (44.9)	10 (2.6)
3. Self-contained breathing apparatus (SCBA)	33 (8.7)	72 (19.0)	274 (72.3)
4. Face shield	257 (67.8)	110 (29.0)	12 (3.2)
5. Heat resistant gloves	243 (64.1)	123 (32.5)	13 (3.4)
6. High-visibility warning clothing	151 (39.9)	187 (49.3)	41 (10.8)

4.7 Association among worker's socio-demographic characteristics, work experience and social support with the level of KAP

To find out the associations of the knowledge level and workers' socio-demographic characteristics (gender, age, position, duration of working, department, education level, marital status), work experiences (safety training, length of working, history of accident) and social support (co-worker's behaviors on usage PPEs), binary analysis by using simple logistic regression was used. In the result of the analysis, the factors with a *p-value* less than 0.05 were considered statistically significant.

The predictor' variables were sociodemographic characteristics, work experience and social support factors. The outcome variables were level of knowledge, in which the range in high level of each dependent variable was determined as presenting of knowledge on usage PPEs as shown in Table 18.

Table 18 showed that among those characteristics (gender, age, position, duration of working, department, education level, marital status, safety training, length of working, history of accident and co-worker's behaviors on usage PPEs), only education level (vocational certificate), treatment after worker gets injured (got first aid at the workplace) and social support (encouragement to use PPEs from their co-workers for 6 months ago) possessed *p-value* less than 0.05. The remaining factors were not found an association with knowledge on usage PPEs. All significant variables were at a 95% confidence interval. The treatment after worker got injured who got "first aid at the workplace" was found that 53.0% less likely to have high knowledge level compared to works who went to the hospital and got first aid then went to the hospital with *p-value* = 0.013 which is statistically significant (Crude OR = 0.47 , 95% CI : 0.26,0.85).

Workers who got encouragement to use PPEs from their co-workers for 6 months ago was 1.99 times more likely to have high knowledge level compared to workers who never got encouragement to use PPEs from their co-workers with *p-value*=0.006 which is statistically significant (Crude OR = 1.99 , 95% CI : (1.22,3.24).

Table 18: Association among worker's socio-demographic characteristics, work experience and social support with knowledge on usage PPEs

Factors	Knowledge level		High level of knowledge			
	Low and medium Number (%)	High Number (%)	β	*p-value*	Crude OR	95% CI
Socio-demographic						
Gender						
Female (ref)	8 (50.0)	8 (50.0)			1.00	
Male	207 (57.0)	156 (43.0)	-0.283	0.580	0.75	(0.28,2.05)
Age						
51-60 years (ref)	62 (50.4)	61 (49.6)			1.00	
20-30 years	41 (59.4)	46 (38.0)	-0.365	0.230	0.69	(0.38,1.26)
31-40 years	37 (56.1)	29 (43.9)	-0.473	0.069	0.62	(0.38,1.04)
41-50 years	37 (56.1)	29 (43.9)	-0.227	0.458	0.80	(0.44,1.45)
Position						
Expert Technician & Engineer (ref)	43 (58.9)	30 (41.1)			1.00	
Technician	172 (56.2)	134 (43.8)	0.110	0.676	1.12	(0.67,1.88)
Duration of working (years)						
≤10 (ref)	106 (56.7)	81 (43.3)			1.00	
11-20	40 (58.0)	29 (42.0)	-0.053	0.854	0.95	(0.54,1.66)
21-30	55 (59.8)	37 (40.2)	-0.127	0.622	0.88	(0.53,1.46)
31-40	14 (45.2)	17 (54.8)	0.463	0.235	1.59	(0.74,3.41)

Table 18: Association among worker's socio-demographic characteristics, work experience and social support with knowledge on usage PPEs (continue)

Factors	Knowledge level		High level of knowledge			
	Low and medium Number (%)	High Number (%)	β	*p-value*	Crude OR	95% CI
Department						
Gas Turbine and Diesel (ref)	67 (57.8)	49 (42.2)			1.00	
Boiler	87 (56.9)	66 (43.1)	0.037	0.883	1.04	(0.64,1.69)
Steam Turbine	61 (55.5)	49 (44.5)	0.094	0.727	1.10	(0.65,1.86)
Education level						
Bachelor's degree and Master's degree and higher (ref)	38 (48.7)	40 (51.3)			1.00	
Vocational Certificate	30 (50.0)	30 (50.0)	-0.051	0.881	0.95	(0.49,1.86)
Higher Vocational Certificate	147 (61.0)	94 (39.0)	-0.498	0.057	0.61	(0.36,1.02)
Marital status						
Married	153 (56.5)	118 (43.5)				
Divorced& Widowed (ref)					1.00	
Single	62 (57.4)	46 (42.6)	-0.039	0.866	0.96	(0.61,1.51)

Table 18: Association among worker's socio-demographic characteristics, work experience and social support with knowledge on usage PPEs (continue)

Factors	Knowledge level		High level of knowledge			
	Low and medium Number (%)	High Number (%)	β	*p-value*	Crude OR	95% CI
Work Experience						
You have ever passed safety training						
No (ref)	2 (100)	0 (0)				
Yes	213 (56.5)	164 (43.5)				
Time averages of safety training that you pass per year (times)						
≥11 (ref)	9 (47.4)	10 (52.6)			1.00	
≤5	91 (49.7)	92 (50.3)	-0.094	0.845	0.91	(0.35,2.34)
6-10	115 (65.0)	62 (35.0)	-0.723	0.137	0.49	(0.19,1.26)
There was part of wearing personal protective equipment in safety training						
No (ref)	8 (72.7)	3 (27.3)			1.00	
Yes	207 (56.3)	161 (43.8)	0.730	0.287	2.07	(0.54,7.94)
length of working hour(s) per day (hours)						
11-20 (ref)	10 (62.5)	6 (37.5)			1.00	
≤10	205 (56.5)	158 (43.5)	0.250	0.635	1.29	(0.46,3.61)
You have ever injured from accidents						
No(ref)	104 (56.8)	79 (43.2)			1.00	
Yes	111 (56.6)	85 (43.4)	0.008	0.969	1.01	(0.67,1.51)
You have ever been involved incidents during working (including near-miss case)						
No(ref)	108 (57.8)	79 (42.2)			1.00	
Yes	107 (55.7)	85 (44.3)	0.083	0.691	1.09	(0.72,1.63)
What's happened after you get injured						
Went to the hospital / Got first aid then went to the hospital (ref)	30 (44.1)	38 (55.9)			1.00	
Do nothing	104 (57.1)	78 (42.9)	-0.524	0.067	0.59	(0.34,1.04)

Table 18: Association among worker's socio-demographic characteristics, work experience and social support with knowledge on usage PPEs (continue)

Factors	Knowledge level		High level of knowledge			
	Low and medium Number (%)	High Number (%)	β	*p-value*	Crude OR	95% CI
Work Experience						
What's happened after you get injured						
Got first aid at the workplace	81 (62.8)	48 (55.9)	-0.760	*0.013**	0.47	(0.26,0.85)
Social support						
You got encourage to use personal protective equipment from co-worker for six months ago						
No (ref)	37 (43.5)	48 (56.5)			1.00	
Yes	178 (60.5)	116 (39.5)	0.688	*0.006**	1.99	(1.22,3.24)
You have ever seen your co-worker wear PPEs while working for six months ago						
No (ref)	5 (45.5)	6 (54.5)			1.00	
Yes	210 (57.1)	158 (42.9)	-0.467	0.448	0.63	(0.19,2.09)

**p-value* < 0.05

To find out the associations of the attitude level and workers' socio-demographic characteristics (gender, age, position, duration of working, department, education level, marital status), work experiences (safety training, length of working, history of accident) and social support (co-worker's behaviors on usage PPEs), binary analysis by using simple logistic regression was used. In the result of the analysis, the factors with a *p-value* less than 0.05 were considered statistically significant.

The predictors' variables were sociodemographic characteristics, work experience and social support factors. The outcome variables were level of attitude, in which the

range in high level of each dependent variable was determined as presenting of attitude on usage PPEs as shown in Table 19.

Table 19 showed that among those characteristics (gender, age, position, duration of working, department, education level, marital status, safety training, length of working, history of accident and co-worker's behaviors on usage PPEs), only duration of working (11-20 years), department (boiler department), history in getting injured from accident, experience in involved incidents during working and treatment after getting injured possessed *p-value* less than 0.05. The remaining factors were not found an association with attitude on usage PPEs. All of the significant variables were at a 95% confidence interval. The duration of working worker who had duration from 11 to 20 years was 1.9 times more likely to have a high attitude on usage PPEs compared to workers who had a duration of working less than 10 years with *p-value*=0.046 which is statistically significant (Crude OR = 1.90, 95% CI: 1.01,3.57). Department, workers who worked in the boiler department were 1.89 times more likely to have high attitude level compared to workers who worked in gas turbine and diesel with *p-value*=0.034 which is statistically significant (Crude OR = 1.89, 95% CI : (1.05,3.39). History of injuries from accident, workers who have been injured from accidents was found that 62.0% were less likely to have high attitude level compared to workers who have never had injuries from accident with *p-value* = <0.001 which is statistically significant (Crude OR = 0.38, 95% CI: 0.22,0.63). Workers that have never been involved in incidents during working were found to be 60.4% less likely to have an attitude level compared to workers who have never been involved in incidents with *p-value* <0.001 which is statistically significant (Crude OR = 0.40, 95% CI: 0.24.0.67). Workers who do nothing when they got injured were 2.38 times more likely to have high attitude level compared to workers who went to the hospital and got first aid then went to the hospital with *p-value* 0.022 which is statistically significant (Crude OR = 2.38, 95% CI: 1.13,5.01).

Table 19: Association among worker's socio-demographic characteristics, work experience and social support with attitude on usage PPEs

Factors	Attitude level		High level of Attitude			
	Low and medium Number (%)	High Number (%)	β	*p-value*	Crude OR	95% CI
Socio-demographic						
Gender						
Female (ref)	14 (87.5)	2 (12.5)			1.00	
Male	286 (78.8)	77 (21.2)	0.634	0.409	1.89	(0.42,8.47)
Age						
51-60 years (ref)	99 (80.5)	24 (19.5)			1.00	
20-30 years	54 (78.3)	15 (21.7)	0.136	0.713	1.15	(0.56,2.37)
31-40 years	95 (78.5)	26 (21.5)	0.121	0.702	1.13	(0.61,2.10)
41-50 years	52 (78.8)	14 (21.2)	0.105	0.781	1.11	(0.53,2.33)
Position						
Expert Technician & Engineer (ref)	58 (79.5)	15 (20.5)			1.00	
Technician	242 (79.1)	64 (20.9)	0.022	0.945	1.02	(0.54,1.92)
Duration of working (years)						
≤10 (ref)	152 (81.3)	35 (18.7)			1.00	
11-20	48 (69.6)	21 (30.4)	0.642	*0.046**	1.90	(1.01,3.57)
21-30	76 (82.6)	16 (17.4)	0.090	0.788	0.91	(0.48,1.76)
31-40	24 (77.4)	7 (22.6)	0.236	0.614	1.27	(0.56,3.17)
Department						
Gas Turbine and Diesel (ref)	95 (81.9)	21 (18.1)			1.00	
Boiler	108 (70.6)	45 (29.4)	0.634	*0.034**	1.89	(1.05,3.39)

Table 19: Association among worker's socio-demographic characteristics, work experience and social support with attitude on usage PPEs (continue)

Factors	Attitude level		High level of Attitude			
	Low and medium Number (%)	High Number (%)	β	*p-value*	Crude OR	95% CI
Steam Turbine	97 (88.2)	13 (11.8)	-0.500	0.189	0.61	(0.29,1.28)
Education level						
Bachelor's degree and Master's degree and higher (ref)	64 (82.1)	14 (17.9)			1.00	
Vocational Certificate	42 (70.0)	18 (30%)	0.673	0.099	1.96	(0.88,4.36)
Higher Vocational Certificate	194 (80.5)	47 (19.5)	0.102	0.762	1.11	(0.57,2.14)
Marital status						
Married	213 (78.6)	58 (21.4)				
Divorced& Widowed (ref)					1.00	
Single	87 (80.6)	21 (19.4)	-0.121	0.672	0.89	(0.51,1.55)
Work Experience						
You have ever passed safety training						
No (ref)	1 (50.0)	1 (50.0)			1.00	
Yes	299 (79.3)	78 (20.7)	-1.344	0.344	0.26	(0.02,4.22)
Time averages of safety training that you pass per year (times)						
≥11 (ref)	14 (73.7)	5 (26.3)			1.00	
≤5	143 (78.1)	40 (21.9)	-0.244	0.657	0.79	(0.27,2.31)
6-10	143 (80.8)	34 (19.2)	-0.407	0.463	0.67	(0.22,1.98)

Table 19: Association among worker's socio-demographic characteristics, work experience and social support with attitude on usage PPEs (continue)

Factors	Attitude level		High level of Attitude			
	Low and medium Number (%)	High Number (%)	β	*p-value*	Crude OR	95% CI
There was part of wearing personal protective equipment in safety training						
No (ref)	9 (81.8)	2 (18.2)			1.00	
Yes	291 (79.1)	77 (20.9)	0.175	0.826	1.19	(0.25,5.63)
length of working hour(s) per day (hours)						
11-20 (ref)	13 (81.3)	3 (18.8)				
≤10	287 (79.1)	76 (20.9)				
You have ever injured from accidents						
No(ref)	130 (71.0)	53 (29.0)			1.00	
Yes	170 (86.7)	26 (13.3)	-0.980	*<0.001**	0.38	(0.22,0.63)
You have ever been involved incidents during working (including near-miss case)						
No(ref)	134 (71.7)	53 (28.3)			1.00	
Yes	166 (86.5)	26 (13.5)	-0.926	*<0.001**	0.40	(0.24.0.67)
What's happened after you get injured						
Went to the hospital / Got first aid then went to the hospital (ref)	58 (85.3)	10 (14.7)			1.00	
Do nothing	129 (70.9)	53 (29.1)	0.868	*0.022**	2.38	(1.13,5.01)
Got first aid at the workplace	113 (87.6)	16 (12.4)	-0.197	0.650	0.82	(0.35,1.92)

Table 19: Association among worker's socio-demographic characteristics, work experience and social support with attitude on usage PPEs (continue)

Factors	Attitude level		High level of Attitude			
	Low and medium Number (%)	High Number (%)	β	*p-value*	Crude OR	95% CI
Social support						
You got encourage to use personal protective equipment from co-worker for six months ago						
No (ref)	70 (82.4)	15 (17.6)			1.00	
Yes	230 (78.2)	64 (21.8)	0.261	0.411	1.30	(0.70,2.42)
You have ever seen your co-worker wear PPEs while working for six months ago						
No (ref)	9 (81.8)	2 (18.2)			1.00	
Yes	291 (79.1)	77 (20.9)	0.175	0.826	1.19	(0.25,5.63)

**p-value* < 0.05

To find out the associations between the usage level on PPEs and different groups (gender, age, position, duration of working, department, education level, marital status), work experiences (safety training, length of working, history of accident) and social support (co-worker's behaviors on usage PPEs), binary analysis by using simple logistic regression was used. In the result of the analysis, the factors with *p-value* less than 0.05 were considered statistically significant.

The predictors' variables were sociodemographic characteristics, work experience and social support factors. The outcome variables were level of usage, in which the range in high level of each dependent variable was determined as presenting the usage of PPEs as shown in Table 20.

Table 20 showed that among those characteristics (gender, age, position, duration of working, department, education level, marital status, safety training, length of working, history of accident and co-worker's behaviors on usage PPEs), only position

(technician), department (boiler and steam turbine), education level (vocational certificate), time on average of safety training ($\leq$ 5 times/year) and history of accident (workers who have ever injured from accidents) possessed *p-value* less than 0.05. The remaining factors were not found an association with usage of PPEs. All of the significant variables were at a 95% confidence interval. The workers who worked in technician positions was found 55.9% less likely to have high usage level compared to other positions with *p-value* = 0.004 which is statistically significant (Crude OR = 0.44, 95% CI : 0.25,0.77). Department, workers who worked in the boiler department were 3.33 times more likely to have high usage PPEs compared to workers who worked in gas turbine and diesel with *p-value*= <0.001 which is statistically significant (Crude OR = 3.33, 95% CI: 1.73,6.41). The education level, workers who graduated from vocational certificate was 2.462 times more likely to have high level of usage on PPEs compared to workers who graduated from Bachelor's degree and higher with *p-value*=0.024 which is statistically significant (Crude OR = 2.46, 95% CI: 1.12,5.40). Workers who have passed safety training less than or equal to 5 times per year were found 68.6% less likely to have high level of usage on PPEs compared to workers who has passed safety training more than or equal 11 times per year with *p-value* = 0.021 which is statistically significant (Crude OR = 0.314, 95% CI: 0.12,0.84). Workers who have been injured from accidents was found to be 40.1% less likely to have high level of usage on PPEs compared to workers who have never been injured from accident with *p-value* = 0.039 which is statistically significant (Crude OR = 0.60 , 95% CI : (0.37,0.97).

Table 20: Summary of association among worker's socio-demographic characteristics, work experience and social support with usage PPEs

Factors	Usage level		High level of Usage			
	Low and medium Number (%)	High Number (%)	β	*p-value*	Crude OR	95% CI
Socio-demographic						
Gender						
Female (ref)	13 (81.3)	3 (18.8.)			1.00	
Male	280 (77.1)	83 (22.9)	0.250	0.701	1.29	(0.36,4.62)
Age						
51-60 years (ref)	101 (82.1)	22 (17.9)			1.00	
20-30 years	54 (78.3)	15 (21.7)	0.243	0.517	1.28	(0.61,2.66)
31-40 years	90 (74.4)	31 (25.6)	0.458	0.145	1.58	(0.85,2.93)
41-50 years	48 (72.7)	18 (27.3)	0.543	1.134	1.72	(0.85,3.51)
Position						
Expert Technician & Engineer (ref)	47 (64.4)	26 (35.6)			1.00	
Technician	246 (80.4)	60 (19.6)	0.819	*0.004**	0.44	(0.25,0.77)
Duration of working (years)						
≤10 (ref)	151 (80.7)	36 (19.3)			1.00	
11-20	49 (71.0)	20 (29.0)	0.538	0.097	1.71	(0.99,3.23)
21-30	68 (73.9)	24 (26.1)	0.392	0.193	1.48	(0.82,2.67)
31-40	25 (80.6)	6 (19.4)	0.007	0.989	1.01	(0.39,2.64)
Department						
Gas Turbine and Diesel (ref)	102 (87.9)	14 (12.1)			1.00	
Boiler	105 (68.6)	48 (31.4)	1.203	*<0.001**	3.33	(1.73,6.41)

Table 20: Summary of association among worker's socio-demographic characteristics, work experience and social support with usage PPEs (continue)

Factors	Usage level		High level of Usage			
	Low and medium Number (%)	High Number (%)	β	*p-value*	Crude OR	95% CI
Socio-demographic						
Department						
Steam	86 (78.2)	24 (21.8)	0.710	0.053	2.03	(0.99,4.17)
Turbine						
Education level						
Bachelor's degree and Master's degree and higher (ref)	64 (82.1)	14 (17.9)			1.00	
Vocational Certificate	39 (65.0)	21 (35.0)	0.901	*0.024**	2.46	(1.12,5.40)
Higher Vocational Certificate	190 (78.8)	51 (21.2)	0.205	0.541	1.23	(0.64,2.36)
Marital status						
Married Divorced& Widowed (ref)	205 (75.6)	66 (24.4)			1.00	
Single	88 (81.5)	20 (28.5)	-0.348	0.222	0.71	(0.40,1.24)
Work Experience						
You have ever passed safety training						
No (ref)	2 (100.0)	0 (0)				
Yes	291 (77.2)	86 (22.8)				

Table 20 : Summary of association among worker's socio-demographic characteristics, work experience and social support with usage PPEs (continue)

Factors	Usage level		High level of Usage			
	Low and medium Number (%)	High Number (%)	β	*p-value*	Crude OR	95% CI
Work Experience						
Time averages of safety training that you pass per year (times)						
≥11 (ref)	11 (57.9)	8 (42.1)			1.00	
≤5	149 (81.4)	34 (18.6)	-1.159	*0.021**	0.31	(0.12,0.84)
6-10	133 (75.1)	44 (24.9)	-0.788	0.112	0.46	(0.17,1.20)
There was part of wearing personal protective equipment in safety training						
No (ref)	11 (100.0)	0 (0)				
Yes	282 (76.6)	86 (23.4)				
length of working hour(s) per day (hours)						
11-20 (ref)	12 (75.0)	4 (25.0)			1.00	
≤10	281 (77.4)	82 (22.6)	-0.133	0.822	0.88	(0.28,2.79)
You have ever injured from accidents						
No(ref)	133 (72.7)	50 (27.3)			1.00	
Yes	160 (81.6)	36 (18.4)	0.513	*0.039**	0.60	(0.37,0.97)
You have ever been involved incidents during working (including near-miss case)						
No(ref)	138 (73.8)	49 (26.2)			1.00	
Yes	155 (80.7)	37 (19.3)	-0.397	0.108	0.67	(0.41,1.09)
What's happened after you get injured						
Went to the hospital / Got first aid then went to the hospital (ref)	52 (76.5)	16 (23.5)			1.00	

Table 20 : Summary of association among worker's socio-demographic characteristics, work experience and social support with usage PPEs (continue)

Factors	Usage level		High level of Usage			
	Low and medium Number (%)	High Number (%)	β	*p-value*	Crude OR	95% CI
Social support						
What's happened after you get injured						
Do nothing	133 (73.1)	49 (26.9)	0.180	0.586	1.20	(0.63,2.29)
Got first aid at the workplace	108 (83.7)	21 (16.3)	-0.459	0.218	0.63	(0.31,1.31)
You got encourage to use personal protective equipment from co-worker for six months ago						
No (ref)	69 (81.2)	16 (18.8)			1.00	
Yes	224 (76.2)	70 (23.8)	0.298	0.335	1.35	(0.74,2.47)
You have ever seen your co-worker wear PPEs while working for six months ago						
No (ref)	8 (72.7)	3 (27.3)				
Yes	285 (77.4)	83 (22.6)	-0.253	0.713	0.78	(0.20,2.99)

**P-value* < 0.05

Knowledge, attitude, and usage regarding the use of personal protective equipment were also treated as a continuous variable, and correlation coefficients were computed. As shown in table 21, knowledge on PPEs was not regarded as a significant correlation with the usage of personal protective equipment (Spearman's rho= 0.089, *p*-value= 0.083). In contrast, attitude on PPEs was regarded as having little significant correlation with the usage of personal protective equipment (Spearman's rho= 0.184, *p-value* < 0.01). Attitude also had a little statistically significant correlation with knowledge on usage of PPEs (Spearman's rho= 0.185, *p-value* < 0.01).

Table 21: Correlation between knowledge scores, attitude scores and usage PPEs

Variable	Usage PPEs		Knowledge	
	Spearman's rho	*p-value*	Spearman's rho	*p-value*
Knowledge	0.089	0.083	-	-
Attitude	0.184	*<0.001**	0.185	*<0.001**

*Correlation was significant at the 0.01 level

CHAPTER V

DISCUSSION

The purpose of this study was to evaluate the knowledge, attitude, and practice on the usage of personal protective equipment among mechanical maintenance workers and the factors associated with them. Furthermore, the correlations between knowledge, attitude, and practice were also examined. In this chapter, a brief description of the major finding and their significance to practice were discussed with its limitations.

5.1 Socio-demographic characteristics

The socio-demographic characteristics in this study included gender, age, position, duration of working, education level, marital status, work experience and social support of 379 respondents. The study showed 95.8% of workers were male, in general, the organization recruited requirements gender (male) to suit the job. The age range was 23 to 60 years old and the majority of workers (32.5%) were aged between 51 and 60 years old. Nearly half of them (49.5%) worked in mechanical jobs, for less than or equal to 10 years. Over half of the workers (63.6%) had education level as higher vocational certificate. Nearly 70 percent of them were married. These findings are like Gambo's study in Lusaka, Zambia (Z'gambo,2015) which found that the age of welders ranged from 16 to 74 years, almost 70 percent of welders have married status, more than 50% of them had education as secondary and higher and their work experience showed 40% had their own career in less than 4 years Another similar study on construction workers in Mombasa County, Kenya (Muema,2016) showed that the number of male workers in the factories were as high as (75.0%) compared to their female counterparts (25.0%). Their marital status was married in the construction

industry for 54.4% and 78.9 percent had working years' experience from 0 to 10 years on own job.

This study showed that almost all of the respondents (99.5%) have ever passed safety training before starting work which the personal protective equipment was included in the training, this result was quite a high number because the organization's regulation forces all workers to pass safety training before starting work. Half of the workers had been trained more than 6 times per year and the average training time of workers received was 6 times. According to the findings, these trainings could not promote the proper use of PPEs among the mechanical maintenance workers and raise their awareness of protecting hazardous events from work by using PPEs. Moreover, the training cannot persuade workers to wear PPEs even if they attended more than 11 times (5%). Thus, the training course should be evaluated or revised by the authority to make it effective. It may involve a training process or presentation forms. Training sessions regarding the use of PPE should be arranged on a regular basis and add examples of serious accident cases to point out various losses and consequences of the accidents. Besides, many barriers that important in terms of whether the PPEs would stay on properly and provide the appropriate protection such as style of PPEs including proper and fit style, availability and accessibility should be explored (Rolex,2015). More than 50% of workers have ever get injured from accident while working that got treatment as went to the hospital and got first aid then went to the hospital (18%) . This study was consistent with the findings of another study (Muema, 2016). showed that 88.5 % have ever suffered from injured or ailments in their site. For safety training findings, this study was inconsistent with findings in construction, installation/repair/maintenance or related industries (Lombardi, 2009), only 42% of workers had ever received safety training and Lilian's study showed that 76% of

participants had never undertaken any safety training especially on the use of PPE on construction sites (Muema, 2016).

5.2 Knowledge on Personal Protective Equipment

The result of this study showed that there was nearly 60% of workers that had the knowledge level lower than high level (54.6% in moderate and 2.1% in low level). This result may be suggestive of insufficient understanding of mechanical maintenance workers on the hazard in working and their health effects, types of PPEs used in different conditions of maintenance work and the importance of using personal protective equipment. Considering in the specific knowledge questions, few mechanical maintenance workers know that wearing face shield can prevent the respiratory system from fume and gas when welding (21.9%), and working without wearing PPEs was one of the unsafe conditions that can lead to accident (9.8%). This situation led to an increase in program to inform workers about safety prevention to fill knowledge.

Similar low knowledge level found in the 206 workers randomly selected from 20 small-scale industries in Lira municipality, majority of the workers lack knowledge on PPE use, only 39.32% of them indicated good knowledge on PPEs (Rolex,2015). The study of Cong Dat Troung also indicated that there was a low level of knowledge (78.16%) about usage of PPEs to prevent the health effect from sulfur dioxide, type of PPEs among rattan craftsmen in Vietnam (Truong,2008). However, in the Thai steel industry, 62.2% of the workers had good knowledge on personal protective equipments (Kralam,2011). Knowledge of the importance and proper usage on personal protective equipment is essential and imperative for organizations that organization should pay attention and train their staff to have a good knowledge.

5.3 Attitude on Personal Protective Equipment

The finding of this study, show majority of the workers (61.8%) had a moderate attitude towards the usage of personal protective equipment. This result was consistent with the study on usage of PPEs among rattan craftsmen in trade village, which revealed that the majority of the workers had neutral attitude (68.98%) while few of workers (4.22%) had a positive attitude (Truong,2008). Another study conducted in Thailand among steel industry workers about attitude towards usage, importance, and type of PPEs and hazard and effect to their health and safety while working in steel industry also indicated that most of the workers had moderate attitude and only 23.2% had a good attitude towards usage PPEs (Kralam, 2011).

More than 95% of workers have a positive attitude though that agree and strongly agree with statement "it's important to know hazardous of work, then I can choose appropriate PPEs to fit work", 76.3% of workers strongly agree with the statement "the more hazardous in maintenance working at power plant, the more awareness on wearing personal protective equipment" and 78.1% of workers agree that PPEs are the one of necessary devices for working. This finding may imply that the majority of mechanical maintenance workers may be willing to wear personal protective equipment to prevent themselves form the hazard that can be occurred anytime in the workplace.

Interestingly, only 3.2% had disagree and strongly disagree towards statement "If I work welding job, only eye and face protection need to be worn" and 16.6% of workers had neutral attitude with statement "Wearing PPEs are barrier of working". This finding is very important to change their attitude from negative or neutral to positive attitude because this can be implied that wearing personal protective equipment should be fit style, more proper, availability, accessibility and completely

wearing to effective prevention. Communication between workers and organization should be increased to declare requirement and any own barrier from wearing PPEs .

5.4 Usage on Personal Protective Equipment

The finding of this study, majority of workers (64.1%) had moderate usage towards totally personal protective equipment while a quarter of them (22.7%) had high usage. This finding was consistent with study conducted by workers in steel industry (Kralam, 2011), the study found that the few of the workers (21.4%) had good practices level on personal protective equipment and majority of the workers (47.3%) had moderate practice level. Another previous study in welder found that even welders were exposed many hazards from working and environment, none of welders used all the suggested PPEs anytime while welding (Z'gambo,2015).

Most of workers (77.3%) had never been wearing personal protective equipment while working. This was consistent with the finding of previous study (Truong,2008) which conducted in rattan crafts men found that the craft men had never been using any PPEs (71%) and among the respondents had only 29% had ever been using at least one type of personal protective equipment. Similarly, another study among workers in 13 construction sites, the finding revealed that half of them did not use PPEs despite having them while working in the site and more than half of them had PPEs that did not proper with the hazards (Muema,2016). In Contrast, another study of small-scale industry in Lira Municipality found that most of them (92.5%) had PPEs and they decided to use PPEs (64.8%) among dangerous works that seem that they were good practices on it (Rolex,2015).

5.5 Association between worker's socio-demographic characteristics, work experience, social support, knowledge, attitude and usage personal protective equipment

5.5.1 Association between worker's socio-demographic characteristics, work experience and social support and usage of personal protective equipment

Regarding the related factor with decision on usage personal protective equipment such as position of working (technician) , department (boiler department), an education level (vocational certificate), time average of safety training (≤5 times/year) and experience of injured from accident during working have been found to have significantly associated with usage personal protective equipment. Position of working (*p-value*=0.004) was statistically significant associated with usage personal protective equipment. Among three positions; technician, expert technician, and engineer, the technician had lowest rate of PPEs usage when it was compared with expert technician and engineer. This may be caused by improvidence because technician was group who work most in the power plant so they have deftness on own job then they may work without own hazard prevention. Among department, the workers in boiler department were 3 times more likely to use PPEs than those of gas turbine and diesel with statistically significant (*p-value* <0.001) and the workers in steam turbine department was also 2 times more likely to use PPEs than those of gas turbine and diesel. This can imply that workers who were working maintenance for the gas turbine and diesel use PPEs in the lowest rate when comparing with other departments. It may result from difference of job description, administration of each department and personal safety mind. The finding was consistent with previous study (Kralam., 2011), that showed that workers in different departments had different rate of PPEs use. Workers who graduated from vocational certificated was more likely to use PPEs than other workers who had higher education level (*p-value*=0.024). The finding was consistent with Kralam's study (Kralam, 2011), education level was related

to level of practice among steel industrial workers. The study of Gambo also showed that there was an increase in mean awareness levels regarding PPE with increase in level of education (Z'gambo, 2015). The finding was also inconsistent with Truong's study (Truong, 2008) who studied about socio-demographic characteristics factor between education level on using PPEs among rattan craft men. The result of this study was shown that workers who had vocational certificated were 2.46 times to have higher level of usage PPEs than workers who graduated from bachelor and master's degree. This may imply that workers who had higher certificate that might not increase usage level of PPEs. Time average of safety training less than 5 times per year (*p-value*=0.314) was statistically significant associated with usage personal protective equipment. They used PPEs less than workers who have trained more than 5 times. This finding is useful for administration and can create program or policy to promote attending in safety training in the agency. The finding was consistent with Tanko's study (Tanko, 2012) that they conducted PPEs usage among construction workers revealed that most of workers truly understand wearing PPEs because they got instruction of usage toward training. Similarly, study of Lombardi (Lombardi,2009) they indicated that working without safety training can be factored affecting usage PPEs. In contrast another Lilian 's study (Muema,2016), it was no association between safety training issue and PPEs usage (p=0.72) among workers in construction site. Opio 's study (Rolex,2015) also showed that training on usage PPEs had no significant association with worker's practice. History of injured from accident while working (p=0.039) was statistically significant associated with usage personal protective equipment. More than 80% who had injured experiences that categorized to have low and moderate level of usage PPEs , only 18% of workers who had injured experience had high level of usage PPEs that imply even they have injured during working that might not increase decision to wear PPEs, the workers overlook the necessity of using PPEs. The finding was consistent with Kulitsara 's study (Kralam, 2011), that showed getting accident or any disorder from working, was associated with practice personal protective equipment.

5.5.2 Association between worker's socio-demographic characteristics, work experience and social support and knowledge on usage personal protective equipment

Regarding the related factor with knowledge on usage personal protective equipment such as treatment after workers got injured (got first aid at the workplace) and social support (encourage to use PPEs from co-worker) was statistically significant associated with knowledge on usage personal protective equipment. Treatment after workers got injured, only workers who received first aid at the workplace were associated (*p-value*=0.013) that less likely (53%) have high knowledge on usage PPEs when they were compared with workers who were referred to hospital and who received first aid then were referred to the hospital. This result may imply that severe of accident in the mechanical maintenance job can affect on decision to pay attention on importance or perception risk involved knowledge on usage personal protective equipments. Organization should concern about this issue, It's important to enhance all workers about hazardous in mechanical maintenance job can occur severe case to everyone and it can led them to disability or death. This situation should increase program about correctly safety prevention. Workers who got encouragement to use PPEs from co-workers for 6 months ago were 1.99 time more likely to have high knowledge level when they compared with workers who have never got encouragement to use PPEs from their co-workers (*p-value*=0.006). These results can imply that mechanical maintenance workers did team working in the power plant, they trust and follow their co-workers so organization can create program to increase participation activities among workers for motivation knowledge on usage PPEs among them.

5.5.3 Association between worker's socio-demographic characteristics, work experience and social support and attitude on usage personal protective equipment

Regarding the related factor with attitude on usage personal protective equipment such as duration of working (11-20 years) ,department (boiler department), experience in accident, experience in incident, and treatment after workers got injured (they do nothing) was statistically significant associated with attitude on usage personal protective equipment. The duration of working, worker who have been working from 11 to 20 years was 1.9 times more likely to have high attitude on usage PPEs compared to workers who had duration of working less than 10 years (*p-value*=0.046). Although worker who had duration 11-20 years was 1.9 times to have high attitude, only 30.4% of them had high attitude. Majority of them (69.9%) still had low and medium attitude level. Consideration on department, workers who worked in boiler department was 1.89 times more likely to have high attitude level compared to worker who worked in gas turbine and diesel (*p-value*=0.034). These results can imply that boiler department have safety mindset to aware their workers about usage PPEs to prevent themselves from hazard in the power plant, other department should learn this issue to increase attitude in own department. This may reflect to the highest rate of PPEs use in the boiler department. History in injured from accident, workers who have ever injured from accidents was found 62.0% less likely to have high attitude level compared to workers who have never injured from accident (*p-value* = <0.001). Although some workers got experience injured, they have less attitude on usage PPEs. Regarding this result, those workers may wear completely PPEs, but not proper and fit to their work. Organization and foreman should concern it and recheck about usage PPEs . Communication between workers and organization should be increased to declare requirement and any own barrier from wearing PPEs. Workers who have ever been involved incidents during working was found to be 60.4% less likely to have attitude level compared to workers who have never been involved incidents (*p-value* <0.001). Workers who do nothing when they got injured were 2.38 times more likely to have

high attitude level compared to workers who were referred to the hospital or received first aid then were referred to the hospital (*p-value*=0.022).

5.5.4 Association between worker's knowledge and usage personal protective equipment

The mean and median knowledge score of this study was 11.23 and 11 from maximum 15 point with standard variation was 1.24. Distribution of knowledge towards personal protective equipment usage had moderate level (54.6%).

There is no correlation between knowledge about understanding of mechanical maintenance workers on the hazard in mechanical maintenance work and their health effects, types of personal protective equipment used in different conditions of maintenance work and the importance of usage PPEs and usage PPEs (*p-value*=0.083) at 0.01 level and Spearman's rank correlation coefficient was 0.089. This contrast with another study in Thailand (Kralam, 2011),a little positive correlation with practice PPEs was reported they showed knowledge about hazard in steel industry and their effect to health and safety and usage personal protective equipment was significance association at 0.05 level. Other previous studies found that respondents who had poor knowledge, there were not regarded significance correlation with usage personal protective equipment (Rolex,2015 and Truong,2008).

Even no correlation has been found between knowledge and usage of personal protective equipment, but it has a little positive correlation with attitude and the attitude then links to the practice of using PPEs among the workers (*p-value* <0.001) at 0.01 level and Spearman's rank correlation coefficient was 0.185.

5.5.5 Association between worker's attitude and usage personal protective equipment

The mean and median attitude score of this study was found 51.4 and 53 from maximum 60 point with standard variation was 6.5. Distribution of attitude towards personal protective equipment usage had moderate level (61.8%).

There was little correlation between attitude of mechanical maintenance workers based on hazardous from working that effect their health, hazard perception including susceptibility and benefits of using of personal protective equipment and usage personal protective equipment ($p\text{-}value < 0.001$) at 0.01 level and Spearman's rank correlation coefficient was 0.184. Consistent with previous studies (Rolex,2015 and Truong,2008) revealed that appropriate attitude was related to prevalence of usage personal protective equipment.

This study showed that around one-fifth (20.8%) of the workers had high attitude on using PPEs. It seems that worker did not recognize proper of PPEs as expected. Attitude of the workers on using PPEs needs to be improved. Although decision of an individual is one of the main determinants of PPEs usage, many others can still affect usage as well such as unclear hazard identification and risk assessment, insufficient communication between workers, incomplete work instruction following job description or poor risk control measure. To build a good safety conscience, strong monitoring and evaluation need to be introduced to ensure the proper practice of PPE. Appropriate measures should be taken at the policy level to ensure adequate prevention and increased control measures.

CHAPTER VI

CONCLUSION AND RECOMMENDATION

Assessment of knowledge, attitude and usage on personal protective equipment among mechanical maintenance workers of A Power Generation Unit in Thailand to prevent them from hazard, health effect or accident from working at site could be concluded by answering a self-administrative questionnaire comprising of 5 sections with 57 questions from 379 workers that were selected to join this study by simple random sampling. The result showed that approximately 95.8% of the respondents were male and 32.5% of their age were in the range 52 to 60 years old. Most of them were technician position in this agency. 49.3% worked in their own department for less than 10 years. The majority of them were from the boiler department. 63.6% had educated higher vocational certificate. They had been married family for 66.5%. Many respondents had ever passed safety training (99.5%) and they knew that safety training had instruction on personal protective equipment (97.1%).

The finding of this study indicated that 54.6% of worker had moderate knowledge level about usage personal protective equipment. While 43.3% of workers had high level that mean 164 of them can answer question correctly. This may be implied that workers have sufficient knowledge towards understanding of mechanical maintenance workers on the hazard in mechanical maintenance work and their health effects, types of personal protective equipment used in different conditions of maintenance work and the importance of usage PPEs.

The finding of this study indicated that 61.8% of worker had moderate attitude level about hazardous from working that effect their health, hazard perception including susceptibility and benefits of using of personal protective equipment. While only 79 workers among 379 workers had high level.

Knowledge, attitude, and usage towards using of personal protective equipment were tested the association with Spearman's rank correlation coefficient. Most of respondent had "Moderate knowledge, "Moderate Attitude" and categorized as "Low and moderate on usage PPEs". There were no association between knowledge and usage personal protective equipment. There was a little positive correlation between attitude and usage personal protective equipment, also between knowledge and attitude among workers (Spearman's rank correlation coefficient =0.184, 0.185, respectively, *p-value* < 0.01).

Usage of PPEs is helpful to improve occupational health and safety among of workers. Even the workers knew about type, importance and hazard perception and effect to health and safety from usage PPEs well, but they decide to not use it. In addition, based on opinion, they do not realize the hazard then they work without wearing PPEs. Workers perform on PPEs use only gathered from the self-administrative questionnaire, but they were not observed their performing at the workplace, it might not be true practice. The bias of answered should also be recognized because the workers may not answer the truth.

This study is only considered as the first step to explore the knowledge, attitudes, and practices of workers on occupational safety in an electricity supply unit. From there, further studies are needed to find out the actual causes of omission PPEs use, so that appropriate adjustments and policies will be made to reduce occupational accidents of workers.

Policy and program are necessary to enhance the awareness of the benefit of wearing PPEs and promote positive attitude of the workers especially targeted on workers who have to work on site. Organization should revise hazard identification, risk assessment and preventive control measures, increase communication toolbox meeting activity between foreman for recognize risk or hazardous before starting work, adjust work instruction to cover each step of working and clearly increase safety quality

checklist in work instruction and provide proper tool and PPEs to fit work condition and nature of work.

Limitation

The result of study focuses on only knowledge, attitude and PPEs usage among mechanical maintenance workers who work in the power plant so it cannot be applied in other workers. The self-response questionnaire was used to collect the data, thus bias self-report, and recall bias can be occurred. The study design of this research is cross-sectional study so it can use only a specific moment/period, not in the long period.

Expected Benefit & Application:

From the result of this study will know the levels of knowledge, attitude and usage of PPEs among of mechanical maintenance workers in a power generation unit in Thailand. It also shows an association between knowledge, attitude and usage of PPEs among of mechanical maintenance workers and as well as the factors related to PPEs usage of mechanical workers. This research will create ideas for further research in this field also. It will be increased our understanding of reason behind usage or non-usage of PPEs among mechanical maintenance workers in Thailand.

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Appendix A

Questionnaire (English Version) No _____

Mechanical Maintenance Workers Questionnaire

In a Power Generation Unit, Thailand

Note: questionnaire will be responded by only mechanical maintenance workers,

there are six parts, as following

1. Socio-Demographics (6 items)

2. Work-experience (8 items)

3. Social support (2 items)

4. Knowledge Part (15 items)

5. Attitude Part (15 items)

6. Practicing on personal protective equipment to prevent themselves from the hazard (11 items)

Respondents please make √ in the ☐

1. Personal information part

1.1 Gender ☐ Male ☐ Female

1.2 Age (years) _____ years _____ months

1.3 Department ☐ Boiler ☐ Steam Turbine ☐ Gas Turbine and Diesel

Position _____

1.4 How long have you been in your department?

_____years _____months

1.5 What is your formal Education level?

☐ Vocational Certificate ☐ Higher Vocational Certificate

☐ Bachelor Degree ☐ Master Degree and higher

1.6 What is your marital status?

☐ Single ☐ Married

☐ Divorced ☐ Widowed

2. Work-experience part

2.1 Have you ever passed safety training?

☐ Yes ☐ No (Please skip to 2.4)

2.2 How many time averages of safety training in power plant both in the country and in another country do you pass _____ Time(s) per year since starting work in this department?

2.3 Is there part of wearing personal protective equipment in safety training?

☐ Yes ☐ No

2.4 Which type of works have you done for 6 months ago? (you can make √ more than one)

☐ Working with tools, equipment and machinery using tools or machinery using machinery

☐ Working in confined spaces

☐ Working at high altitude and scaffolding

☐ Working manual material handling

☐ Working with mobile cranes and cranes

☐ Working sparking operations or hot work

☐ Working in workshop

☐ Others_____ (Please specific kind of work)

2.5 What is the average length of working hour(s) per day? _____ hour(s)

2.6 Did you get injured from accidents?

☐ Yes ☐ No (Please skip to 3.1)

2.7 Have you ever been involved incidents during working?

☐ Yes ☐ No (Please skip to 3.1)

2.8 What's happened after you get injured?

☐ Got first aid at the workplace ☐ Went to the hospital

☐ Got first aid then went to the hospital

☐ Others (Please specific) _____

3. Social Support

3.1 Do your co-workers encourage you to use personal protective equipment for six months ago?

☐ Yes ☐ No

3.2 Have you seen your co-worker wear PPEs while working for six months ago?

☐ Yes ☐ No

4. Knowledge Parts

Q1. In your perspective, please considered which statement is true or false then make ☑ in your choice.

No	Statement	True	False	Don't know
1	I think, there are many hazardous works in maintenance such as confined space, working at height, welding etc.			
2	I think, wearing PPEs are one of accidents prevention from hazardous			
3	I think, besides wearing PPEs, following safety rule, safety sign can be accidents prevention.			
4	I think, in my agency there are only four types of PPEs as head protection, ear protection, face and eye protection and respiratory protection type.			
5	I think, there isn't legal in Thailand to force that employer have to provides PPEs to their workers.			
6	I think, there are unsafe act and unsafe condition, lack of wearing PPEs is one of unsafe condition.			
7	I think, wearing full body safety harness is safer than life line certainly.			
8	I think, there are 2 types of ear protection as ear plug and ear muff.			
9	I think, railing's height for scaffolding installation should have railing's height at least 90 to 110 cm.			

No	Statement	True	False	Don't know
10	I think, I have to wear face shield to prevent respiratory system when welding.			
11	I think, A Self-contained breathing apparatus is the only enough device when I'm working in confined space area.			
12	I think, safety hat, ear plug or earmuff, dust mask, safety shoe and safety glasses are basically personal protective equipment when I entered in power plant.			
13	I think, Wearing personal protective equipment as gloves should be chosen depend on type of works.			
14	I think, wearing respiratory protection equipment can prevent Fume and gases can be cause of respiratory disorder.			
15	I think, accidents can be cause of many point of loss such as physical loss, wasting time, property loss etc.			

5. Attitude Part

Q1 : What is your perspective with this statement :

No.	Questions	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1	In my view, The more hazardous in maintenance working at power plant, the more awareness on wearing personal protective equipment.					
2	I think that wearing personal protective equipment can reduce cause of injury or illness into disable or death case during maintenance working.					
3	In my view, PPEs are the one of necessary devices for working.					
4	In my opinion, Working at heights If the scaffold has already been installed, There is no need to wear any personal protective equipment.					
5	In my view, wearing PPEs can reduce incidents rate because of working.					
6	In my opinion, Full body safety harness's not necessary equipment while working at height.					
7	In my view, workers need to be trained for usage each PPEs.					

No.	Questions	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
8	In my view, wearing PPEs are barrier of working.					
9	If I didn't wear of PPEs, safety officers could stop my work.					
10	In my view, it's important to know hazardous of work, then I can choose appropriate PPEs to fit work.					
11	If I work welding job, only eye and face protection need to be worn.					
12	In my opinion, wearing personal protective equipment such as safety glass and leather gloves can reduce any injury from splashy fire while working.					
13	I think that having PPEs is useless investment.					
14	From my perspective, my organization has provided PPEs enough to their workers.					
15	It seems to me, working in confined space without respiratory protection device can be harmful to death					

6. Usage on personal protective equipment to prevent themselves from the hazard

Introduction : Please make √ in the box that you did for 6 months ago

Q1. Have you ever used the personal protective equipment as below while working in mechanical maintenance works for 6 months ago?

Type of PPE	PPEs	Figure	Always	Sometimes	Never
Regular PPE					
Head protection	Safety hat				
Ear protection	Ear plug or Ear muff				

Type of PPE	PPEs	Figure	Always	Sometimes	Never
Face and eye protection	Safety glass or Impact goggle	 			
Respiratory protection	Dust mask or Chemical protective mask				
Foot and leg protection	Safety Shoe				

Type of PPE	PPEs	Figure	Always	Sometimes	Never
Particular PPE					
Working with tools, equipment and machinery using tools or machinery using machinery or Working manual material handling					
Arm and hand protection	Knitting thread gloves				

Type of PPE	PPEs	Figure	Always	Sometimes	Never
Working at high altitude and scaffolding					
Fall protection	Body safety harness or safety belt	 			

Type of PPE	PPEs	Figure	Always	Sometimes	Never
Working in confined spaces					
Respiratory protection	Self-contained breathing apparatus (SCBA)				
Working sparking operations or hot work					
Face and eye protection	Face shield				
Arm and hand protection	Heat resistant gloves				

Type of PPE	PPEs	Figure	Always	Sometimes	Never
Working with mobile cranes and cranes					
Special protective equipment	high-visibility warning clothing				

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