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# AN ANALYSIS OF PERSONAL PROTECTIVE EQUIPMENT (PPE) COSTS INCURRED BY THE CONTRACTORS OF MRT PROJECTS

Izatul Farrita Mohd Kamar<sup>1</sup>, Mohd Hadi Putra Umari<sup>2</sup>, Nor Suzila Lop<sup>3</sup> and Asmalia Che Ahmad<sup>4</sup>

<sup>1234</sup>*Department of Quantity Surveying, Faculty of Architecture, Planning and Surveying, Universiti Teknologi MARA, Perak Branch, Seri Iskandar Campus, Seri Iskandar, 32610 Perak, Malaysia*

## Abstract

The construction of rail infrastructure projects such as Mass Rapid Transit (MRT) is expanding in Malaysia to enhance and integrate the urban public transportation services. However, fatalities, serious injuries, and damage to properties occur every year due to the rapid construction of this project. The costs of these injuries to an organisation are very crucial in establishing how much it should spend on safety control. Most of the contractors had some problems with the safety budget. The budget is always overrun due to the lack of systematic calculation during the construction stage. Thus, the safety budget required is not clearly defined and specified in the existing contract document. Most of them are not able to identify the safety items clearly and do not know the requirements required for the project, causing them to estimate the safety budget by using their experience. The effect causes the defective budget system for the construction project. This research aims to analyse the Personal Protective Equipment (PPE) costs that are most incurred by the contractor of MRT projects. A quantitative method was used in this research. The questionnaires were distributed to the Work Packages Contractor (WPC) who were involved for guideway (viaduct) package works in MRT projects. The finding shows that the types of PPE like steel toe safety shoes, traffic vest and earplugs (>85 dBA) are the most cost incurred in MRT projects. These findings could assist the contractor to allow a reliable safety budget during the pre-contract stages.

**Keywords:** *personal protective equipment; cost incurred; contractor; mass rapid transit (MRT) projects.*

## 1.0 INTRODUCTION

Workplace accident rates are very high in the construction sector compared to other sectors (Hola & Szostak, 2017; Martinez Aires et al., Loosemore & Andonakis, 2007; Mitropoulos et al., 2005; Abdelhamid & Everett, 2000). Construction is a complex activity where various stakeholders are present working under constant challenges from the demands of the job. It stands unique compared to other industries because most of its activities take place outdoors and under conditions that are not conducive to safety and health (Misnan & Mohammed, 2007). Each job entails several safety and risk factors, requiring quality and safety management systems to be established, as indicated by Mehta and Agnew (2010). This view is supported by Imriyas et al. (2007) who argued that construction site conditions are hazardous due to the scope of works and location of the project. Higher project hazard levels tend to be associated with higher risk levels on site.

Recently, Malaysia has reached another milestone in the urban rail infrastructure with the completion of the MRT 1 (SBK Line) Project in July 2017. Other rail infrastructure projects that are currently under construction are the MRT 2 (SSP Line) Project and the Light Rail Transit (LRT) 3 (Bandar Utama to Klang Line) Project. These developments indicate that Malaysia is in line with other developed countries that have high-speed and modern public transportation. The projects are generally having a large investment, long development cycle, high technical requirements and the construction environment are complex. Many risk factors are involved

such as economic, political, law, physical site, the scope of work, construction contract, designing, materials, financial and human resource risks during the construction project (Sangsomboon & Yan, 2014).

Personal Protective Equipment (PPE) is the first choice of safety protection before other safety protection is given consideration. In addition, PPE is designed to protect employees from serious workplace injuries or illness resulting from contact with chemical, radiological, physical, electrical, mechanical, or other workplace hazards. The PPE equipment include face shields, safety glasses, safety helmets, safety shoes, gloves, eye protection, ear protection, safety harness, vests, high-visibility clothing, and respirators (OSHA, 2014).

Moreover, the main function of PPE is to protect the workers against health or safety risks at work and also designed to protect the body from injury by electrical hazards, heat, chemicals and infection for job-related occupational safety and health purposes (Ahmed & Azhar, 2015). There are different types of PPE used for each type of construction, but the most common being used are head, hand, face, eye, foot, and body protection.

Occupational Safety and Health Act (OSHA) requires employers to allocate PPE to comply with the OSHA standards (OSHA, 2014). Chuong & Abdul (2011) revealed that the implementation of safety measures during the conceptual design phases is substantially lower cost than implementation systems during or after construction. However, many clients and contractors did not allocate the cost of PPE and safety has become more ineffective due to insufficient safety budget (Ahmed & Azhar, 2015). Most of them estimate the safety budget by using their experience and lack of systematic calculation (Barlow, 2009).

They were not able to identify the safety items clearly in the safety budget which includes the cost of PPE. As a result, it will cause a defective budget system, especially for the safety equipment. Therefore, a project's safety budget may exceed the actual cost. There is no competency and reliable systems for estimating the safety budget. This significant gap that is highlighted in this research is towards the empirical study on the types of PPE which are considered important in terms of costs incurred by the contractors for MRT projects.

## **2.0 TYPES OF PERSONAL PROTECTIVE EQUIPMENT (PPE)**

Personal Protective Equipment (PPE) is anything used or worn by a person to minimise risk to the person's health or safety and includes a wide range of clothing and safety equipment (OSHA, 2014). PPE considered the first line of defence against hazards and preventing work injuries (Ahmed & Azhar, 2015). The PPE is also designed to protect employees from serious workplace injuries or illness resulting from contact with chemical, radiological, physical, electrical, mechanical, or other workplace hazards (Tanko & Anigbogu, 2012).

PPE should be chosen carefully according to what the hazard is, the extent of its use, and the suitability of the PPE to the task intended. A lot of PPE types are used by individual workers to protect them from hazards. These types vary depending on the worksite at the construction industries and the level of hazards at the workplace (Romulo, 2015). Figure 1 shows the allocation of PPE for an employee at the workplace and Table 1 shows the categories of PPE.

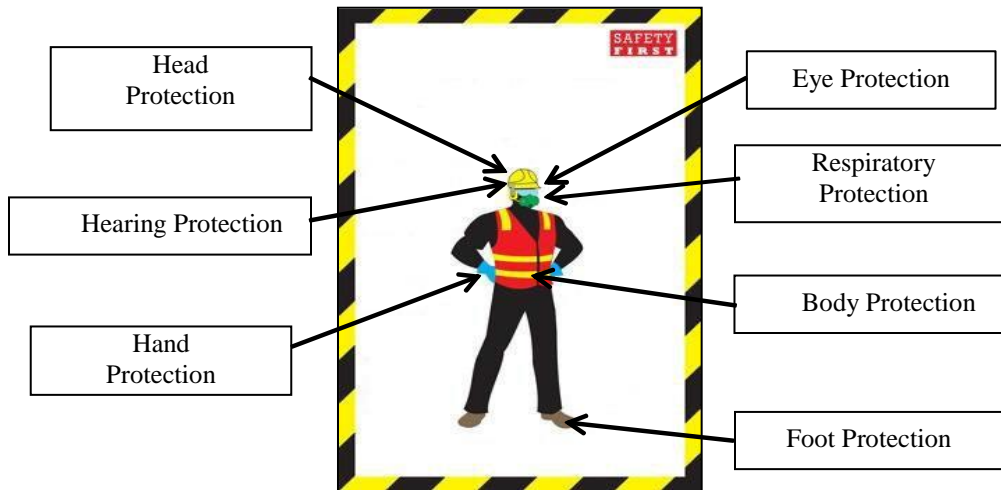




Figure 1: Allocation of personal protective equipment (PPE) for employee at the workplace

(Source: Romula, 2015)





Table 1: Categories of personal protective equipment (PPE)

Categories	Descriptions	Types of tools	Sign of protection
Head Protection	<ul style="list-style-type: none"> <li>A head injury can impair a worker for life, or it can be fatal.</li> <li>Wearing a safety helmet or hard hat is one of the easiest ways to protect a worker's head from injury.</li> </ul>		
Eye Protection	<ul style="list-style-type: none"> <li>Workers can be exposed to a large number of hazards that pose danger to their eyes and face.</li> <li>Example of tools: safety glasses with side shields, goggles with face shields, goggles, eyecup and cover types, welding goggles, welding helmet or shields with safety glasses &amp; side shields, chemical goggles or face shield and unvented chemical goggles.</li> </ul>		
Hand Protection	<ul style="list-style-type: none"> <li>Potential hazards to hands and arms include skin absorption of harmful substances, chemical or thermal burns, electrical dangers, bruises, abrasions, cuts, punctures, fractures, and amputations.</li> <li>Example of tools: gloves, finger guards and arm coverings or elbow-length gloves.</li> </ul>		
Hearing Protection	<ul style="list-style-type: none"> <li>All workplaces generate noise and sometimes the level of noise may lead to temporary or permanent loss of hearing.</li> <li>Example of tools: earplugs and earmuffs.</li> </ul>		



Respiratory Protection	<ul style="list-style-type: none"> <li>Respiratory protection is designed to give protection for an employee against inhalation hazards such as lack of oxygen, particulate contaminants (dust, fibres, mists, fumes, or dirt), hazardous gases, vapors and contaminants - solvents.</li> </ul>		
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**Table: Categories of Personal Protective Equipment (PPE) (cont'd)**

CATEGORIES	DESCRIPTIONS	TYPES OF TOOLS	SIGN OF PROTECTION
Body Protection	<ul style="list-style-type: none"> <li>The workplace hazards that could cause bodily injury are temperature extremes, hot splashes from molten metals and other hot liquids, potential impacts from tools, machinery and materials and hazardous chemicals.</li> <li>Examples of tools: laboratory coats, coveralls, traffic vests, jacket and full-body suits, cut resistant sleeves, static control coats or overalls, flame-resistant jacket or aluminium fire suits, chemical apron or suits, body harness and lanyard.</li> </ul>		
Foot Protection	<ul style="list-style-type: none"> <li>Employees who face possible foot or leg injuries from falling or rolling objects or from crushing or penetrating materials and whose work involves exposure to hot substances or corrosive or poisonous materials must have protective gear to cover exposed body parts, including legs and feet.</li> <li>Example of tools: steel toe safety shoes, leather boots or safety shoes with metatarsal, slip resistance soles, puncture resistance soles and electrical shoes.</li> <li>Types of hazards: water (slip), chemical, hot splashes, penetration to the underside of the foot and ankle twist injuries from rough terrain.</li> </ul>		

### 3.0 METHOD

This research was conducted on the work packages contractors (WPC) from viaduct (guideway) package of MRT 1 (SBK Line) Project and MRT 2 (SSP Line) Project. The respondents, who are the safety personnel for both projects were required to answer the questionnaire survey based on the experience involved in those projects. The questionnaire was adopted and modified to suit the Malaysian context. A cover letter was attached to inform the importance of the survey. The letter also informed on the confidential nature of the study by ensuring anonymity.

Respondents were asked about their knowledge based on the experience regarding the types of PPE costs which are the most cost incurred by the contractor for MRT projects. The survey was divided into three (3) parts: 1) Organisation background; 2) Respondents' particulars; and 3) Types of PPE that are most cost incurred by the contractor of MRT projects. There are seven (7) categories of PPE in this section using a five-point Likert scale.

### 4.0 RESULTS AND DISCUSSION

Table 2 presents the respondents' profile of the research. The majority (46.3%) assigned as a Site Safety Supervisor position followed by the Safety & Health Officer (26.8%) and Safety Manager (24.4%) positions. The designation that someone holds in an organisation



portrays their working experience. Thus, it shows most of the respondents (36.6%) had working experience which ranges from 10-20 years and only 12.2% had experience in construction safety for more than twenty (20) years.

**Table 2: Respondent's profile**

Items	Sub-Items	Frequency (N)	Percentage (%)
Job Position	Safety Manager	10	24.4
	Safety & Health Officer	11	26.8
	Site Safety Supervisor	19	46.3
Working Experience	< 5 years	11	26.8
	5-10 years	10	24.4
	10-20 years	15	36.6
	> 20 years	5	12.2

Table 3 shows the mean rank score for the types of PPE that incurred costs to the contractor of MRT projects. Based on the table, the highest cost incurred was foot protection, which is steel toe safety shoes (mean=4.63). The second highest was the cost of traffic vest (mean=4.56) for the body protection, followed by the cost of earplugs or earmuffs (>85 dBA) (mean=4.49) for the ear protection and disposable dust or mist mask (mean=4.48) for respiratory protection. While the lowest PPE cost incurred was the safety glasses with side shields for eye protection (mean=1.80).

**Table 3: Mean rank score for the types of PPE that incurred costs to the contractor**

Categories of PPE	Types of PPE Costs	N	Mean	Rank
Foot Protection	Steel toe safety shoes	41	4.63	1
Body Protection	Traffic vest	41	4.56	2
Ear Protection	Earplugs or earmuffs (>85 dBA)	41	4.49	3
Respiratory Protection	Disposable dust or mist mask	41	4.48	4
Head Protection	Type 1 ANSI Z89.1-1997	41	4.39	5
Hand Protection	Insulated gloves	41	2.27	6
Eye Protection	Safety glasses with side shields	41	1.80	7

The results obtained agreed with previous work carried out by OSHA (2007), where OSHA highlighted several items of PPE that employers are required to provide for their employees such as safety-toe protective footwear. Moreover, according to the Health & Safety Policy (2014), steel toe shoes or boots have a protective covering to the wearer from an injury that results from impact and or compression by heavy objects. It is generally accepted as best practices and most significant for the protection to be fully integrated into the construction.

However, the lowest mean rank (mean=1.80) was the eye protection category, which is safety glasses with side shields. This PPE used for the hazard impact likes flying objects, chips, sand, or dirt. The less cost is incurred due to the hazards being beyond expectations. It could happen outside of the project site. While the second-lowest mean rank was the insulated gloves of hand protection (mean=2.27). It provides the protection and warmth for the employees on cold winter days. This type of PPE is not used and inappropriate for MRT projects due to the weather in Malaysia being hot and humid year-round.

## 5.0 CONCLUSIONS

In conclusion, the study found that the steel toe safety shoes for foot protection are the highest cost incurred by the contractors of MRT projects. The eye protection category, which is safety glasses with side shields, is the lowest costs incurred. Overall, the presented results could enrich awareness and help among the contractors to plan their investment in safety measures appropriately according to the related PPE categories. Proactive actions on the

allocation of safety and health cost are required to overcome the safety issue in the construction sector.

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