TRAINING DESIGN, DEVELOPMENT AND EVALUATION FOR OCCUPATIONAL SAFETY AND HEALTH HAZARD IDENTIFICATION USING VIRTUAL REALITY

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DEDICATION

This dissertation is dedicated:

To beloved myself

Dr. Nurshamshida Md Shamsudin

You made it dear!

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"Faith is taking the first step even when you don't see the whole staircase"

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ABSTRACT

Occupational Safety and Health (OSH) hazard identification training for Site Safety Supervisor (SSS) is challenging in meeting the demands of construction industry since accident rates are still alarming despite robust OSH enforcement and practices implemented. The major reason is an incompetent hazard identification by safety personnel due to ineffective training of hazard identification. Hence, this study aimed at identifying the perception of current practices in OSH hazard training, designing and developing a new proposed hazard identification training approach for SSS utilizing mobile Hazard Identification - Virtual Reality Simulation (HI-VRS) and evaluating its effectiveness. This study employed a mixed method approach through incorporation of quantitative and qualitative approaches. This study was carried out in three major phases. The first phase was the analysis phase involving quantitative data analysed using SPSS to derive the guideline for the design and development stage. The second phase involved a qualitative approach that employed a design and development research (DDR) design for creating the HI-VRS that involved a qualitative approach. Finally, the third stage utilized a quantitative approach through an experimental study for empirical testing on HI-VRS implementation in hazard identification training. A total of 208 SSS trainees participated in the study and were assessed for their reaction, learning and safety performance. A Structural Equation Modeling was utilized for hypothesis testing and model of prediction and confirmation using PLS-SEM. Training for OSH hazard identification conducted through the use of mobile HI-VRS showed that trainee satisfaction on proposed training design utilizing HI-VRS, platform, content, virtual function learning satisfaction and safety performance were rated at high and moderate whereby learning and safety performance showed significant changes of hazard recognition score and hazard identification accuracy grade. The results obtained also validates the coefficient of determination (R2) for the overall model to be considerable in which all exogenous constructs in the model had a good predictive relevance for endogenous constructs. Findings of the study showed that Virtual Reality Interaction and Virtual Reality Features influence learning while Virtual Reality Immersion and Virtual Reality Features improve OSH performance. Hence, it can be observed that the Transfer of Training (TOT) model adapted to the training design influences the performance of trainee at construction site. This research contributes to the values on current practices of construction hazard identification training and enriches literature on empirical findings for the effectiveness of training practices particularly for OSH training implementation.

ABSTRAK

Latihan pengenalpastian hazad Keselamatan dan Kesihatan Pekerjaan (KKP) bagi Penyelia Keselamatan Tapak (SSS) adalah mencabar dalam memenuhi permintaan industri pembinaan memandangkan kadar kemalangan masih membimbangkan walaupun penguatkuasaan dan amalan KKP sudah pun dilaksanakan. Alasan utama adalah pengenalpastian hazad yang tidak cekap oleh kakitangan keselamatan akibat latihan pengenalpastian hazad yang tidak berkesan. Oleh itu, kajian ini bertujuan untuk mengenal pasti persepsi amalan semasa dalam latihan kursus pengenalpastian hazad KKP, merekabentuk dan membangunkan pendekatan latihan pengenalpastian hazad yang dicadangkan untuk SSS menggunakan Pengenalpastian Hazad Mudah Alih - Simulasi Realiti Maya (HI-VRS) dan menilai keberkesanannya. Kajian ini menggunakan pendekatan kaedah campuran melalui penggabungan pendekatan kuantitatif dan kualitatif. Kajian ini dijalankan dalam tiga fasa utama. Fasa pertama adalah fasa analisis yang melibatkan data kuantitatif yang dianalisis dengan menggunakan SPSS untuk memperoleh garis panduan bagi peringkat reka bentuk dan pembangunan. Fasa kedua melibatkan pendekatan kualitatif yang menggunakan kaedah penyelidikan reka bentuk pembangunan (DDR) untuk mewujudkan HI-VRS yang melibatkan pendekatan kualitatif. Akhirnya, tahap ketiga menggunakan pendekatan kuantitatif melalui kajian eksperimen untuk ujian empirik terhadap pelaksanaan HI-VRS dalam latihan pengenalpastian hazad. 208 pelatih SSS mengambil bahagian dalam kajian ini dan dinilai untuk reaksi, pembelajaran dan tahap keselamatan mereka. Pemodelan Persamaan Struktur digunakan untuk ujian hipotesis dan model ramalan dan pengesahan model menggunakan PLS-SEM. Latihan untuk pengenalan hazad KKP yang dijalankan melalui penggunaan HI-VRS mudah alih menunjukkan bahawa kepuasan pelatih terhadap reka bentuk latihan yang dicadangkan menggunakan HI-VRS, platform, kandungan, prestasi pembelajaran maya dan prestasi keselamatan dinilai pada kadar yang sederhana dan tinggi di mana prestasi pembelajaran dan keselamatan menunjukkan perubahan ketara pada skor pengiktiraf hazad dan gred ketepatan pengenalpastian hazad. Dapatan ini juga mengesahkan pekali penentuan (R2) untuk keseluruhan model di mana semua eksogen dalam model mempunyai perkaitan ramalan yang baik untuk konstruk endogen. Dapatan kajian menunjukkan bahawa Realiti Maya Peralatan dan Realiti Maya Interaksi membantu pembelajaran manakala Realiti Maya Peralatan dan Realiti Maya Rendaman mempengaruhi pengalaman dan meningkatkan prestasi KKP. Oleh itu, dapat dinyatakan bahawa Model Pemindahan Latihan (TOT) yang disesuaikan dengan reka bentuk latihan mempengaruhi prestasi pelatih di tapak pembinaan. Kajian ini menyumbang kepada nilai-nilai mengenai amalan semasa latihan pengenalpastian hazad dan menambah penemuan empirikal untuk keberkesanan amalan latihan, khususnya untuk pelaksanaan latihan hazad KKP.

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LIST OF ABBREVIATIONS

DOSH	-	Department of Occupational Safety and Health
HI-VRS	-	Hazard Identification Virtual Reality Simulation
IP	-	Intellectual Property
KLIA	-	Kuala Lumpur International Airport
NDA	-	Non Disclosure Agreement
NIOSH	-	National Institute of Occupational Safety and Health
OSH	-	Occupational Safety and Health
SSS	-	Site Safety Supervisor
VR	-	Virtual Reality

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Due to the nature of hazardous work at major industry such as construction site which involve continual changes, poor working conditions and hazardous nature of work, safety is uncompromised (Cameron & Hare, 2008; Choudhry, 2014). According to accidents statistics by Department of Occupational Safety and Health (DOSH; 2013, 2017) high numbers of injuries and fatalities were caused by the unsafe actions and operations due to failure of following Occupational Safety and Health (OSH) requirements (Amezcua, Boverie & Warner, 2013).

1.2 Background of Study

To address poor OSH performance, researchers and OSH professionals have devoted much effort to understanding and identifying precursors to injury incidents. Among others, human factors have received much recent attention. For example, (Hinze, 2006; Haslam *et al*., 2005) found that more than 70% of injuries involve unsafe worker actions. (Tixier *et al*., 2014) explain that such unsafe worker actions are not deliberate safety violations; but are rather outcomes resulting from poor hazard identification. When hazards are not recognized, or when the safety risk is not accurately perceived, workers may not be able to adopt effective OSH measures to prevent injury (Albert *et al*., 2014a; Bahn, 2013; Carter & Smith, 2006). Many accidents could be prevented and minimized if workers were able to take proper actions by rapidly identifying hazard types and their severity levels. (Dunston & Chen, 2010; Evia & Ph, 2011) emphasized the importance of training program in reducing the injuries number. (Chen & Kleiner, 2014)

To overcome issues of accidents at workplace and construction sites, National Institute of Occupational Safety and Health (NIOSH) and Construction Industry Development Board (CIDB) has urge the requirements of OSH training for constructions. There were many efforts has been taken by NIOSH and CIDB to adapt a wide variety of training programs to improve hazard identification. However, the prevalent use of ineffective, unengaging, and poorly designed training programs significantly impedes training efforts (Wilkins, 2011). In fact, (Li *et al*., 2012) argue that a positive correlation does not exist between traditional safety training and safety performance. Not surprisingly, workers lack essential safety knowledge despite having received substantial safety training (Haslam *et al*., 2005). For effective training, employers and organisation must adopt training practices that will yield maximum benefits.

OSH training emphasis towards safety knowledge and hazard recognition which considered as the keys to approach the goal of reducing unsafe practices(Belle, 2000;Chen *et al*., 2010; Vivian W Y Tam & Fung, 2012). Research has approved that effective safety training is vital to be considered, as this is the mechanism in reducing number of injuries and accident at workplace especially when dealing with unsafe act and unsafe behavior. (Seppala, 1995; Fakhru'l-Razi, Iyuke, Hassan, & Aini, 2003;Wallen & Mulloy, 2006; Burke *et al*., 2006; Burke *et al*., 2011;Bahn, 2012; Brahm & Singer, 2013). Among the most dangerous workplaces, with fatalities and recurring accidents still plaguing the industry (Le *et al*., 2014a). These occur for various reasons; however, one underlying cause relates to deficiencies in the education and training (Guo *et al*., 2012). An efficient and effective OSH training program have the potential to improve safety performance by preventing accident occurrences, improves behavioral attitudes and makes accidents more predictable. Since Malaysian government has announced, through the RMK-11 OSHMP 202 0 were launched with the aim of preventive culture through training, research and education. This is because looking back at industries injuries that the a lot of money has been simply wasted for the accidents cost involving foreigner workers fatal accident for RM14.16 million while RM16.77 on local accident in 2015, under the RMK-11, has for the OSH preventive culture, the OSHMP 2020 transformation programme towards 2020 strategy 2 through OSH training conducted by NIOSH, developing, and delivering hazard identification and OSH training programs. The goal of these training programs is to equip workers with the skills necessary to identify and manage hazards in complex environments (Hinze & Gambatese 2003). (Albert *et al*., 2013; Carter& Smith, 2006; Li *et al*., 2012).

To ensure on hazard identification task at construction site, Site Safety Supervisor (SSS) play major role. Therefore as responsible person in safety performance at construction site, training for hazard identification are among the most important module that receive much attention by trainer, training providers as well as during the assessment of the training. Currently, training for OSH in Malaysia played by important stakeholder; NIOSH, and DOSH and all certified training provider by DOSH. Basically, training and competency examination for Occupational Safety and Health (OSH) controlled by NIOSH. NIOSH offers four main types of Occupational Safety and Health (OSH) training that are;

a. Safety Induction Training
b. Competency Training
c. Train the Trainer
d. Management Training

It is important that when improving the quality of the industry, the skill and the knowledge of its personnel are also improved. As part of a good safety and health management system in construction, all level of personnel shall be adequately trained. (CIDB Malaysia, 2013). Contractors should identify and develop general training curriculum/kit for construction workers, which should include but not limited to general awareness, tool-box talks, hazard identification techniques, basic first aid, handling and reporting of accidents, etc. (CIDB Masterplan, 2015). For Malaysian construction industry to be specific, the major role of OSH enforcement starts with the duty of Site Safety Supervisors (SSS). They should attend a prescribed course to register themselves as Site Safety Supervisors with the authorities. Registered Site Safety Supervisors will be required to attend at least one continuous education program course every year to renew their registration. As stated in Regulation 25 of BOWEC (1986) i.)main contractors are required to employ competent part-time Site Safety Supervisor at the place of work and ii.)sub-contractors with 20 or more workers must employ competent part-time Contractor's Safety Supervisor at the place of work (Regulation 26 of BOWEC 1986). Both of these regulations specify on the requirement of a Site Safety Supervisor in any construction project.

Furthermore, main task of site safety supervisor focusing to take control on hazard at construction site as his general duty. In detail, according to Factory and Machinery Act, FMA (1967) define that the Site Safety Supervisor shall be a person who is competent to perform duties specified in sub-regulations (3) and (4) which they should possess qualification and minimum of two years experiences\ a site foreman. The FMA (1967) stated that;

The Site Safety Supervisor (SSS) shall

a. Ensure the provisions of the act and regulations.
b. Promote the safe conduct of work generally within the worksite.

There are four main duties of a SSS:

a. Inspecting and Rectifying any unsafe place of work
b. Correcting any unsafe practice
c. Checking sub-contractors works to ensure compliance with act and the regulations
d. To liaise with contractors' safety supervisor appointed under regulations 26

Based on the above-mentioned statutory requirements, a standard training module based on the National Occupational Skill Standard (NOSS) for Construction Industry shall be developed. The ultimate goal of this course is to produce competent Site Safety Supervisors by equipping them with relevant knowledge pertaining to their roles and responsibilities as stipulated under Regulations 25 and 26 of Factories & Machinery (Building Operations and Works of Engineering Construction) (Safety), Regulations 1986. The need for competent Site Safety Supervisor is critical for projects costing less than RM 20 million. For these projects there are no requirements for appointment of safety and health officer under OSHA 1994 and hence the Site Safety Supervisor will be playing a crucial role in advising the employer on safety and health issues. Registered SSS should attend continuous education program as part of their registration renewal requirements.

CIDB urge all construction personnel and SSS not only should have the green card but they also need to gain significant numbers of OSH training, information and knowledge when they work at site. However, OSH training for construction could not meet desired outcomes. Training conducted was failed and ineffective to promote safety awareness among workers. (CIDB, 2015). Pertaining to these issues, undoubtedly that OSH education and training play major role as instrumental in reducing the rate of accidents per thousand workers.

This has urge, CIDB Master plan 2005-2010 to be introduced in regards of implementing Occupational Safety and Health for construction industry. One of the major concerns from this master plan is on the vital role of safety training. Prior to this there are many types of safety training recommended to be implement from this master plan. Training on safety personnel such as the SSS SHOC, GREEN CARD trainings are among the mandatory training for legal compliance. However, many unfold issues related pertaining to safety training that has practice. Analysis from the documents of CIDB Master plan 2005-2010 highlighted that they were trying to reduce the high number of incidents of injuries and fatalities amongst construction workers due to the nature of the works (evolving), weather condition and variety of hazards involved. Causes for the high number of incidents are because on the;

a. lack of competent site safety supervisors (SSS) on construction occupational safety and health matters;

b. lack of occupational safety and health information, training materials, courses and programs for the benefits of workers and supervisors in the construction industry;
c. lack of standard guidelines on construction industry requirements for the development of safety and health solutions in the industry;
d. lack of communication between those in charge of construction processes and the workers and supervisors executing them
e. lack of information and know-hows on occupational safety and health latest technology among workers and supervisor

(CIDB Master plan 2010-2015)

This is also consistent with the statement from Construction Industry master plan 2006-2015, which at this level the industry is still doubts with the effectiveness of safety training that has been implemented. The master plan claimed that it was a big fail to them on working for effective safety training for the industry due to weak implementation of the suggested safety training.

Specifically, the outcome of the occupational safety and health hazard identification training conducted was not consistent as it there is no rigid standardization in terms of how to handle the training effectively by various training provider (CIDB Master plan, 2005-2010). Each training provider has different types of facilities and approach. Even though, NIOSH has taken the responsibility in conducting the final assessment. Besides that, the occupational safety and health hazard identification training conducted were found less effective since the approach were heavily relying on the traditional classroom training. The abuse usage of training materials such as video, power point slides and brochure are less efficient to engage the participant during the training. Poor conducting on designing the training environment fail to capture the trainee understanding on construction process and hazard risk hazard training in construction training, (Burke *et al*., 2006).

(Bahn, 2012) found that ineffectiveness of occupational safety and health training for constructions due to the weak implementation of OSH training by the abuse of low engagement of OSH hazard training practices, this is include of having too much relying on YouTube videos and PowerPoint notes utilization during the training session.

This is also same which OSH hazard training practices in Malaysian context that high injuries and fatalities in the constructions industry owed to ineffective OSH hazard training since they are still struggling with the issues pertaining to passive training approach, lack of training facilities, poor training environment such as the planned site visit which fail to engage trainee on real scenario since hazardous work need to be “stop work”, obsolete training materials with technology updated and rigid exam oriented for training assessments.(CIDB, 2015).

Although effective training can improve safety knowledge, it is not sufficient by itself to yield expected benefits. This is because workers often fail to apply learned concepts and skills once they return to work (Blume *et al*., 2010). In other words, knowledge transfer is not equivalent to training transfer or the application of learned concepts in practice. A plausible explanation for this disconnect between safety knowledge gain and objective safety outcomes is the failure of training transfer.

Surprisingly, reports of OSH training in hazard identification from several countries shows significant rate of training transfer and confirm the effectiveness of OSH education and training recently begun promoting self-determined learning or also known as heutagogy approach. To reduce the costs of educational training, enterprises have also started to aggressively introduce OSH training via technology application and Internet of Things (IOT). Given the huge demand for heutagogy learning programs, IOT and technology adaptation have begun establishing e-learning, virtual learning and technology platforms gradually increase the demand form industry for effective, efficient and precise OSH training objectives.

In attempts to improve OSH training and education, virtual reality (VR) technologies have been applied and proved beneficial in various disciplines (Sampaio *et al*., 2010a). Conversely, very few studies have focused on the application of these technologies to OSH hazard training using the virtual reality platform. Current research findings show that the implementation of VR training approach is promising not only in reducing cost however it is promoting efficient, effective training effort but also able to aim towards accurate and precise training objectives.

1.3 Problem Statement

Studies show that accidents at workplace happen due to poor safety knowledge and hazards are remain unrecognized. There is strong relationship that informed effective hazard identification training should enhance workers awareness on their safety and health. However, training for hazard identification face many challenges in term of the effectiveness of the training that has been conducted. (Haslam *et al*., 2005; Lingard, 2002; Ruttenberg, 2013; Albert *et al*., 2014a). Failure of hazard identification training is because of the training itself. This is including the training approach adapted and training materials utilizing. Flaws in the training delivery limited the high rate of transfer. Training transfer is important because estimates reveal that only 10–15% of training investments translate into desirable workplace changes, practices, or benefits (Baldwin& Ford 1994; Cromwell& Kolb, 2004; Blume *et al*., 2010; Li *et al*., 2012). (Blume *et al*., 2010) stated that transfer of training may fail to occur on application of weak material and delivery of the training. A plausible explanation for this disconnect between safety knowledge gain and objective safety outcomes is the failure of training transfer. Given that only a small fraction of training expenditure translates into tangible safety benefits. Therefore, identifying and implementing training transfer elements that facilitate the transfer of training is particularly important for OSH training.

Despite all the effort taken to ensure on the efficiency of OSH implementation, CIDB claimed that more accidents at construction sites resulted to death and serious injuries among workers recently. Reasons of these were due to (a) falling from height, (b) hit by objects, (c) materials and machinery, (d) collapsed holes, (e) fire and (f) electrocution. The statistics in Figure 1.1 shows total industry accidents show that accidents still happen across sectors of OSH Act 1994, even though OSH promotion has been done rigorously by authorities and stakeholder recently. The figure depicts that three most industry that shows high rate of injuries at the workplace involve; manufacturing, construction and agriculture.

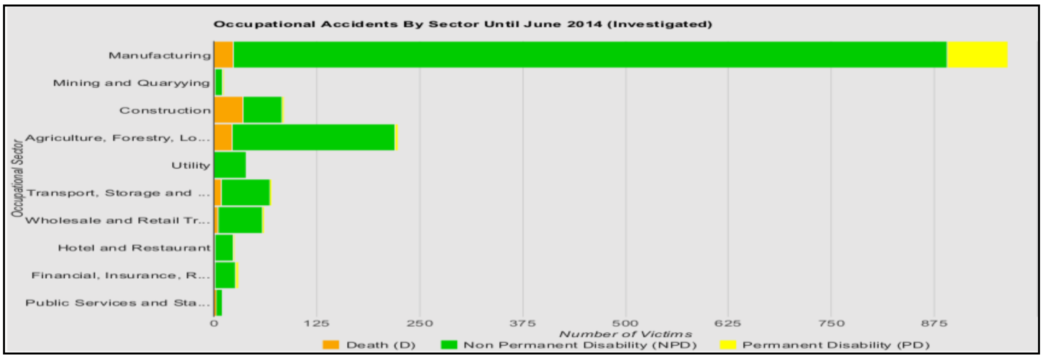

Figure 1.1: Statistics of Occupational Accidents in Malaysia (DOSH, 2017)

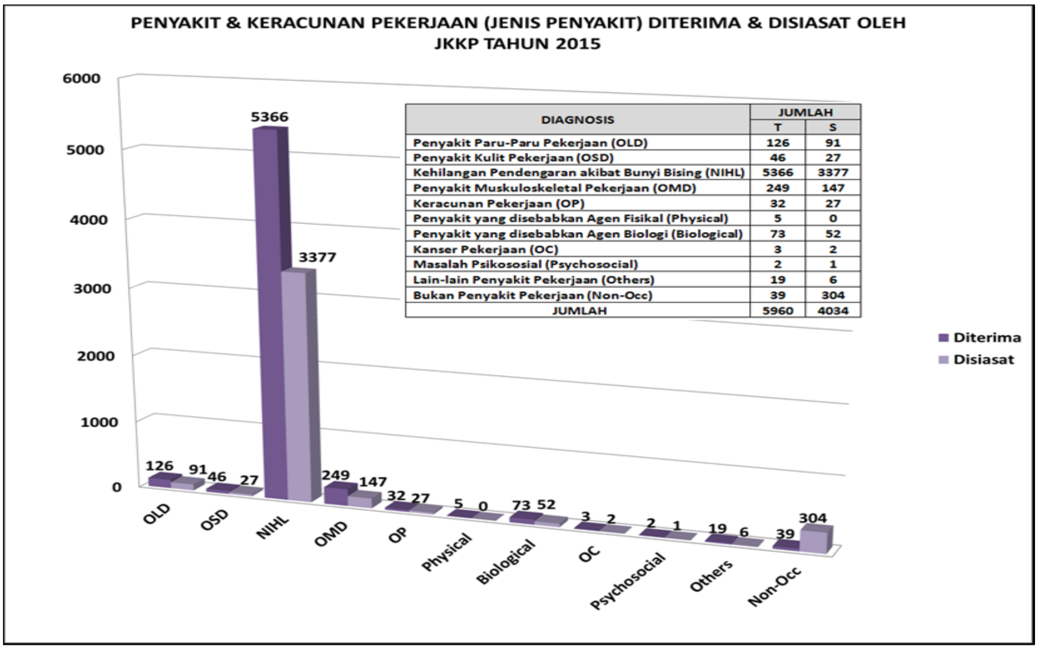

Figure 1.2: Statistics of Occupational Diseases in Malaysia (DOSH, 2016)

To add, Figure 1.2 presents the statistics on Occupational Diseases in Malaysia show three types of occupational health diseases reported are. The most reported occupational health diseases in Malaysia industry are occupational skin diseases, occupational lungs diseases and hearing loss. Occupational Diseases in

Malaysia DOSH, 2014; DOSH 2015). Even though all workers form industry compulsory to attend OSH courses such as safety induction, safety passport card however injuries and accidents, occupational diseases been kept happen among the workers. For this reason, DOSH (Department of Occupational Safety and Health) with the ministry of human resource are still happening recently works hard for the implementation of OSHMP2020 which emphasis more on preventive culture through effective training and education. Therefore, hazard identification training is among the focus for OSH training efforts in Malaysia.

Current training design of hazard identification involve classroom training based and site visit. Classroom based training relying so much on pictures, video and lecture method. These methods have been criticized by literature (Bunch, 2007; Gambatese, 2003; Perdomo *et al.*, 2005) as passive instructional methods that fail to engage workers, and that they can inculcate toward negative attitudes among workers towards safety issues. Besides that, (Perdomo, 2005) assume that with the current practice of hazard identification training that are considered as teaching tools are unable to sufficiently include, realistic scenarios.

Currently, training for safety personnel involve classroom training based and site visit. This activity during OSH training is to assist trainee to conduct hazard recognition however majority of the programs on site safety hazard identification utilize teaching strategies that have been criticized for being passive, boring, and not sufficiently motivating However both of these training method practiced unable trainees to access to full learning experience on hazard identification activities since some of the activities at construction sites not allowed to trainee , hazardous work environment to trainee, safety issues. Due to this OSH training conducted currently fail to provide optimum safety training experience to the trainees.

Most of the time not all hazard learned during could not be observed and not all hazard can be observed due to the nature of construction process that are dynamic and rapidly evolve. (Haslam, 2005; Blume, 2010; Li *et al.*; 2012). Besides OSH training quality issues, most of training provider has difficulties to access to the sites or workplace due to financial implication, logistics cost and transportation problems.

(Bunch 2007; Gross & Jovanis, 2008) also agreed that the current practice of hazard identification training limit safety experience and resulted to deficiency on hazard identification practice at work.

For traditional relied on field trips to illustrate construction on site, these site visits are both challenging because of unwieldy logistics and inherently too short for students to gain exposure to various construction stages over time and gain a deep understanding of multiple project construction facets (Torres, 2007; Nikolic *et al*., 2011; Jin & Nakayama, 2013).

Recent research, has demonstrated innovative attempts aimed at bringing real construction site experience into the classroom. This initiative brings the experience of a construction site into the classroom by employing multimedia technologies to build a construction image database (Bouchlaghem *et al*., 2002; Nikolic *et al*., 2011)

This is supported by the recent work of (Burke *et al*., 2011) study investigated the impact of safety training and workplace hazards on safety knowledge and safety performance. They found that the technology-based method of safety training delivery had an effect. It is believed that training will be more effective when it is engaging and results in 'greater knowledge acquisition, a higher level of safety performance, and a greater reduction in accidents and injuries' (Burke *et al*., 2011; Bahn & Barratt-Pugh, 2014).

Consequently, safety and health training method still lack been found qualitatively discussed the metanalyses by (Burke *et al*., 2011, 2013) found that the training design and development that increase the effectiveness of training tool findings show that inconsistency of significant findings. Therefore, this study is designed to analyze and suggest on the integration of technology towards betterment of the safety training.

1.4 Aim of the Study

This study aims to design and develop virtual reality for Occupational Safety and Health and evaluate hazard identification training among Site Safety Supervisors for the Malaysian industry

1.5 Research Objectives

Below are the research objectives of this study to be achieved at the end of the study.

1. To identify perceptions on current practices in OSH training for hazard identification approach among OSH trainee.

2. To design and develop mobile OSH Hazard training tools using virtual reality approach, HI-VRS (Hazard Identification-Virtual Reality Simulation).

3. To determine level of SSS trainee satisfaction during training for construction occupational safety and health hazard training using mobile HI-VRS (Hazard Identification-Virtual Reality Simulation).

4. To compare level of construction occupational safety and health (OSH) hazard identification knowledge among SSS trainee before and after training using mobile HI-VRS.

5. To assess occupational safety and health (OSH) hazard performance among SSS trainee at construction sites before and after training for construction occupational safety and health hazard identification using mobile HI-VRS.

6. To examine the influence of HI-VRS towards learning and OSH performance using mobile HI-VRS.

1.6 Research Questions

Research questions for this study constructed from listed research objectives;

1. What are the perceptions on current practices of OSH in Constructions Hazard training among SSS trainee?

2. How is the design and development mobile OSH Hazard Identification training tools using virtual reality approach, HI-VRS?

3. What is level of among SSS trainee satisfaction during training for construction occupational safety and health hazard training using mobile HI-VRS?

4. What is the level of OSH hazard identification knowledge among SSS trainee before and after training using mobile HI-VRS?

5. What is the OSH hazard performance among SSS trainee at construction sites before and after training for OSH hazard identification using mobile HI-VRS?

6. What is the influence the training design of HI-VRS towards SSS trainee learning performance on OSH performance using mobile HI-VRS?

1.7 Research Hypothesis

This research hypothesis of this study only formulated from research question no. 3 until research question no.6;

Research Question 3

What is level of among SSS trainee satisfaction during training for construction occupational safety and health hazard training using mobile HI-VRS?

Hypothesis 1:

There is significance difference of OSH knowledge and skills before and after using of HI-VRS in OSH training.

Research Question 4

What is the level of OSH hazard identification knowledge and skills among SSS trainee before and after training using mobile HI-VRS?

Hypothesis 2:

There is significance difference of OSH performance before and after using of HI-VRS in OSH training.

Research Question 5

What is the safety performance among SSS trainee at construction sites before and after training for OSH hazard identification using mobile HI-VRS?

Hypothesis 3a:

There is positive relationship between HI-VRS features and learning performance.

Hypothesis 3b

There is positive relationship between HI-VRS features and OSH performance.

Hypothesis 3c:

Effect of HI-VRS features on OSH performance mediated by hazard identification learning performance

Research Question 6

What is the influence the training design of HI-VRS towards SSS trainee learning performance on OSH performance using mobile HI-VRS?

Hypothesis 4a:

There is positive relationship between HI-VRS Immersion and learning performance.

Hypothesis 4b:

There is positive relationship between HI-VRS Immersion and OSH performance.

Hypothesis 4c:

Effect of HI-VRS immersion and OSH performance mediated by hazard identification learning performance.

Hypothesis 5a:

There is positive relationship between HI-VRS Interaction and learning performance.

Hypothesis 5b:

There is positive relationship between HI-VRS Interaction and OSH performance.

Hypothesis 5c:

Effect of HI-VRS interaction and OSH performance mediated by hazard identification learning performance.

Hypothesis 6:

There is positive relationship between Learning and OSH performance.

1.8 Scope of Study

This research examines the implementation of Occupational Safety and Health training that only focusing to construction industry, Site Safety Personnel and the ability of effective Occupational safety and health hazard identification training utilizing mobile virtual reality training approach. the scope of study also only limited to two main duty of SSS which their ability is to recognize hazard effectiveness of training for Site Safety Supervisor at constructions site. From the perspectives of OSH, training should cover on two aspects, which are safety and health within nine industries that enacted under the OSH act 1994. However, for this study the training sessions only covers at construction industry. This research did not investigate also focused at the lowest level of safety personnel at constructions site. Training for safety officers, engineers and management are not the main concern. Moreover, the training content investigated only focused to the hazard identification topic, other topics of OSH training is not prioritized for this study.

The effectiveness of safety training of this study only focused on the utilization of stimulation training from virtual reality applications. Hence the training method assess for this study will only focused on simulation and hand-on type of safety training. This research also will not cover other factors such as trainee' interest, age, gender, and social background. In fact, trainee is chosen on a voluntary basis.

1.9 Significances of The Study

The proposed training design utilizing on the technology besides it is expected to give significant impact on the trainees' reaction towards hazard identification training and learning performance.

The adaptation of Kolb Experiential Learning Theory will help to add the values of technology based on learning experience process. Therefore, this study is expected to understand on how technology could influence learning process and enhance learners transfer of training through experience that they gained.

The design and development of technology instead off traditional training for hazard identification is believed to increase transfer of training rate to workplace; this is will increase the OSH performance. Results from conducting methodology of PLS-SEM help to validate and proposed the conceptual model. Moreover, the contribution to the field of knowledge on the impact of training design alone could impact OSH performance.

A robust training and development program must consider the full spectrum specially to increase safety knowledge, skills and awareness towards hazard identification at construction sites that this also could help the industry to reduce numbers of accidents and fatalities. Furthermore, implication of this study can be recognized as part of effort in nurturing and producing high skilled workers in the industry which. Stakeholders in the industry could benefit from this study especially for training providers, safety trainers as well as construction's company in order to enhance safety performance in the industry and at the same time to reduce on issues and constraints related to hazard identification course.

Second, this study represents one among the few studies that evaluated the effects of training on objective safety training outcomes. Unlike previous efforts that relied on proxy measures of training effectiveness such as industry relevance and knowledge gain, this study evaluated the effect of training on two objective training outcomes: hazard recognition performance and safety performance. Proactive measures may lead to improvements in hazard recognition, safety risk perception, and safety performance. (Tixier *et al*., 2014).

1.10 Definition of Terms

Training

Training is systematic development of the knowledge, skills and attitudes required by an individual to perform adequately a given task or job". (A Handbook of Human Resource Management Practice, Kogan, 2001), a vocational instruction for employed person to perform job.

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