University of Western Sydney, Hawkesbury

In Conjunction with

The Hong Kong Polytechnic University

A REVIEW OF THE AWARENESS, KNOWLEDGE, AND PRACTICE OF FALL PROTECTION IN ERECTING OR DISMANTLING TUBULAR STEEL SCAFFOLDING

BY

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Declaration of Originality

The following work has been completed by the author in the form of a coursework research project report as part of the Master of Applied Science (Safety Management) at the University of Western Sydney, Hawkesbury, in conjunction with The Hong Kong Polytechnic University under the supervision of Mr. Henry Lam.

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person nor material which to a substantial extent has been accepted for the award of any other degree or diploma of a university or other institute of higher education, except where due acknowledgement has been made in the text.

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Abstract

This study was initiated to assess the significance of scaffolding safety training in reducing the risk of accidents on erecting or dismantling of tubular steel scaffolding. A cross-sectional survey had been conducted by using a questionnaire to gather data from two individual groups of scaffolding workers, trained or untrained in scaffolding safety training, and a review had also been carried out to assess the differences between them, of types of safety training acquired, awareness of level of risk and potential hazards, knowledge of works and safety requirements, practice of fall protection, and accident records. The survey was commenced in mid-August 1998 and completed by mid-October 1998. A total of seventy scaffolding workers were interviewed on site and were asked for responses to a questionnaire. Results from questionnaires revealed that there were differences between trained and untrained workers. However, there was no significant evidence of reduction in accidents relating to scaffolding works found from a review of accident records. Scaffolding safety training highlighted the improved awareness of the level of risk and potential hazards, knowledge in safety requirements and correct procedure of works, and practice of fall protection measures for the workers of a trained group. In principle, scaffolding safety training could reduce the risk of accidents on erecting or dismantling scaffolding. The aim of this study was attained. Because of the significance of scaffolding safety training in reducing the risk of accidents, scaffolding safety training should be promoted to enhance awareness, knowledge, and practice of fall protection of scaffolding workers. Results in this study suggested that a further study with sufficient time and adequate sampling size should be extended to the construction industry of Hong Kong.

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Equations

(1) Chi-squared

$\chi^2 = \Sigma\ (|O-E|-½)^2/E$,

Where 'O' means the observed frequencies and 'E' denotes the expected frequencies.

(2) The degrees of freedom

$\nu=(r-1) \times (c-1)$

Where r = number of rows and c = number of column.

(3) Incidence Rate

$$\text{Incidence rate} = \frac{\text{Total number of accidents}}{\text{Number of persons worked}} \times 1,000$$

Definitions

The definitions of the following terms are adopted in this research report.

(a) Knowledge of Works

means the knowledge of ways of erecting or dismantling scaffolding.

(b) Potential Hazards

The situations for which harm are likely to occur associated with scaffolding works, i.e. falling, falling objects and structural instability.

(c) Practice of Fall Protection

means the usual method to prevent people from falling and to arrest the falling.

(d) Safety Requirements

The requirements laid down in regulations and code of practice for scaffolding safety.

(e) Scaffolding Experience

means the working experience in scaffolding works.

(f) Scaffolding Safety Training

A tailor-made safety training course conducted by the Local Industrial Training Authority for the scaffolding workers of ABC Construction Company. The course consists of a lecture and practical session in which the potential hazards associated with scaffolding works, basic requirements of regulations and code of practice for scaffolding safety, role of scaffolding worker, types and components of scaffolding, correct procedure of erecting or dismantling scaffolding, and use of fall protection equipment were covered.

(g) Scaffolding Workers

The workers are engaged in erecting or dismantling of tubular steel scaffolding.

(h) Site Experience

means the working experience in construction site.

(i) Status of training

means the training condition of workers, who are either trained or untrained in scaffolding safety training.

(j) Trained Workers

The scaffolding workers have received scaffolding safety training.

(k) Untrained Workers

The scaffolding workers have not received scaffolding safety training.

List of Abbreviations

CITA	Construction Industry Training Authority
CITB	Construction Industry Training Board
OSHA	Occupational Safety and Health Administration
U.K.	United Kingdom
VTC	Vocational Training Council
χ^2	Chi-squared

1. Introduction

The government and the general public have expressed their concerns about the safety in construction industry. Although the workforce employed in the construction industry was about 8% of the total industrial workforce, it has accounted for the most numbers of accidents and fatalities in comparison with other industries (Education and Manpower Branch, 1995). From the accident statistics of the construction industry for years 1988 to 1997 in Hong Kong, the accident rates per thousand workers were 369.3 and 227.4 in 1988 and 1997 respectively. They revealed that there have been some improvements within the construction industry in occupational health and safety aspects and a decrease in the number of accidents. However, a large number of accidents and about half of the fatalities in the construction industry were resulted from falling. The safety for working on the scaffolding is a major issue in the construction industry (Mak, 1998).

In ABC Construction Company have several projects in progress, including the construction of bridges and superstructures. It is obvious that the majority of construction activities in these projects have to be carried out at height. Different kinds of falseworks and tubular steel scaffoldings have to be applied as temporary accesses, working platforms and supporting structures, for the work at elevated positions. The associated risk of falling for people engaged in the work at elevated working areas is high. In spite of the fact that workers are required to wear safety belts issued to them, some of them have been found to be either not using them or not connecting their safety belts to fixed anchorage when working at great heights, particularly during the erection or dismantling of tubular steel scaffolding. It appears that workers are unaware of the falling hazard or are acting in an unsafe manner.

Usually, tubular steel scaffolding is erected manually. Scaffolding workers are often required to work on partially completed scaffolding until guard-rails, toe boards, boarding and access stairs have been fixed into position. Consequently, they may be working at height without proper fall protection and are exposed to a high level of risk. This uncontrolled risk may be contributing to unsafe and unwanted incidents, leading to the accidents, such as falling or falling objects from the scaffolding. Ferry stated "Accidents can be extremely costly, as well as having undesirable impacts on organisational morale, on organisational image, on productivity, and on fulfilling commitments." (1988, p.v). The impacts of consequences to the company, both in tangibles and intangibles, might be enormous, e.g. loss of life or damage to the company reputation. Such mal-practice aroused the concern of management in reviewing the present situation.

Training on basic site safety is usually given by the construction site safety officers in a half hour training session, at lunch time or during the tea break. Generally, the scaffolding workers do not receive a formal training course to acquire the basic knowledge and skills in erecting or dismantling scaffolding, as well as use of fall protection equipment. They almost always learn their skill in erecting or dismantling scaffolding by experience. Furthermore, there is no guidance or safety procedures obtained from scaffolding suppliers for fall protection in erecting or dismantling of tubular steel scaffolds. It may be an issue for the management and supervisory staff to ensure correct procedures in erecting or dismantling scaffolding and correct use of fall protection equipment.

Chan & Lau said, “Training helps minimise the occurrence of human errors of ignorance, misconception, and mistaken priorities.”(1997, p.206). In view of the high risk and consequences of accidents in erecting or dismantling scaffolding, the management attempted to enhance their awareness, knowledge, and practice of fall protection by providing specific training on scaffolding safety to the scaffolding workers so as to reduce their risk of falling on erecting or dismantling steel tubular scaffolding. A study was conducted to review the situation of scaffolding workers, including types of safety training acquired, awareness of the level of risk and potential hazards, knowledge of works and safety requirements, practice of fall protection being adopted as well as accident records, and to assess the significance of scaffolding safety training provided to scaffolding workers in reducing the risk of accidents.

It is expected that the scaffolding safety training provided to scaffolding workers may increase their awareness of potential hazards and risk level, and help them to understand the safety requirements, correct procedures and practice of fall protection in erecting or dismantling scaffolding. Unsafe practices and unsafe conditions should be eliminated and then their risk of falling on erecting or dismantling scaffolding would be reduced by this training.

2. Literature Review

Scaffolding is widely used in the construction industry to provide temporary platforms either as a place of work or for supporting works under construction. There are many types of scaffolding, which are commonly classified into categories of bamboo scaffolding, tubular steel scaffolding or aluminium tower scaffolding etc., used in the construction industry of Hong Kong.

Tong stated, “Bamboo scaffolding is one of China’s oldest construction craft skills.” (1998, p.44). As the high flexibility, low cost and speediness in construction are the features of bamboo scaffolding, it has been widely adopted for carrying out construction works and buildings’ renovation in Hong Kong for many years. Wong said, “Bamboo scaffolds are sometimes considered as a death trap on the construction site as collapse of scaffolds and falling of workers are frequently reported.” (1998,p.113). Recently, some people have advocated the banning of the use of bamboo scaffolding.

Because of the development of construction technology and methods, the use of tubular steel scaffolding has been increasingly adopted for temporary supporting structures or working platforms. There are two common types of system scaffolds, i.e. frame type scaffolding system and steel tube scaffolding system. The frame type scaffolding is assembled by fabricated steel frames and locking accessories. The frame shape and assembly components differ according to manufacturers. The steel tube scaffolding is composed of hot-dipped galvanised steel pipes of not less than 48mm diameter and connection fittings. The system of tubular steel scaffolding used for works is usually designed by the structural engineer and counter-checked by an independent checking engineer. The scaffolding materials, loading criteria and structural stability are the points commonly considered by engineers. However, the fall protection measures for the scaffolding workers on erecting or dismantling scaffolding are left out.

Fall protection on scaffolding has been a question in America. The Economic Analysis estimates about 9,750 injuries and 79 fatalities are related to scaffolds each year. Accidents relating to scaffolds accounted for about 9% of all fatalities in the construction industry (Occupational Safety and Health Administration, 1996a).

In the U.K., falls caused about half of the fatal accidents between 1974 and 1979 (King & Hudson, 1985a). Falling and falling materials are the cause of the majority of accidents in the construction industry (Hayward, 1977). Johnson said, “Many accidents have been caused by people attempting to work from incorrectly erected scaffolding”(1998, p.43).

In Japan, there were about 2,500 fatalities from the construction industry in the 1960s and the number of deaths were decreased to 1,000 cases in 1995. About 40% of these fatalities were resulted from falling. A large numbers of falling accidents occurred at the time of erecting working platforms (Yamasaki, 1997).

Falls cause a large number of lost time injuries in Australia. In 1994 to 1995, there were 635 accidents resulted from falling, which contributed to about 19.7% of all accidents in the construction industry. Falls accounted for 62.4% of injuries in respect to scaffolding. The largest proportions of accidents were suffered by elder workers, aged between 35 and 44, who suffered one-third of injuries and those aged between 25 and 34, sustained a quarter of injuries (Worksafe Western Australia, 1996b).

From the analysis of causes of accidents in the construction industry of Hong Kong in years 1989 to 1995, the three major causes of accidents were stepping on or striking against objects, handling without machinery, and falling (Lee, 1996a). Falls can cause serious bodily injuries, e.g. broken bones to limb and injuries to trunk, neck or head. The injury to the head is most serious and frequent. As a result of falling, many victims have suffered permanent disability or death.

There have been about two thousand five hundred cases of people falling, out of sixteen thousand accidents since 1993. The falls resulted in the most fatalities each year in the construction industry and half of them were falling from working platforms or platforms on scaffolds (Lee, 1996b). Lee stated, "Based on a total of 2,539 working-at-height accidents in 1995, accounting for some 25% of all accidents in the construction industry,…" (p.24, 1998). In the year 1997, accidents which involved falling were 3,458 cases and twenty victims died from falling (Mak, 1998).

These poor records bring the focus onto ways of protecting people from falling from scaffolding.

In according to the Construction Sites (Safety) Regulations of Hong Kong, the contractor is required to provide workers sufficient and suitable scaffolds for working at height. Such scaffolds should be properly constructed with safe means of access, suitable planking, and guard-rails. The scaffolding platform or walkway should be at least 400 mm wide and guard-rails should be fixed at a height of between 900 mm to 1150 mm above the working surface. Where safe working platforms are impracticable, safety nets or safety belts would be required for protection of falls.

Fall protection could be ensured by two major categories of engineering control measures, fall prevention and fall limitation. Fall prevention measures would prevent or restrain people from falling and fall limitation measures could limit the extent or arrest the fall (Riches, 1997).

Guard-rails and covers for openings are the preferred preventive measures to avoid persons being injured from falling. Scaffold Training Institute stated, "Guardrails are superior to harnesses and lanyards because they prevent the fall from occurring, rather than just catching someone after they fall."(1997, p.1). However, it is not practical to protect workers engaged in erecting or dismantling scaffolding in these ways. Worksafe Western Australia stated, "Scaffolding is one of the best ways of allowing workers to work safely at height, but scaffolding workers can be at risk themselves because they have no protection while erecting, altering and dismantling scaffolding."(1996a, p.1). The safety net system might be used to catch people falling and to minimise injury. It is very important that a safety net should be installed to have a minimum clearance of two-thirds of its shortest length or 2 metres beneath it for preventing contact with any lower surface on people falling in it (Factory Inspectorate Division, 1995). Because of there being limitations in the required clearance beneath the nets and suitable anchorages for the erection, the use of safety nets does not seem feasible in erecting or dismantling scaffolding. Personal fall arrest equipment is then required as a last resort. For temporary fall protection on erecting or dismantling scaffolding, the use of fall arrest equipment is in question because a proper anchorage point may not be available. A two metre scaffolding pole has been designed by the Master Builders' Association of Western Australia. This pole is attached to a scaffolding frame to hang a self-retracting device to the safety harness during erecting or dismantling scaffolding (Worksafe Western Australia, 1996a). Usually, safety belts and harnesses have been available for workers to use when working at height, but they do not commonly adopt them.

King & Hudson stated, “Two reasons for this have been:

- insufficient safe anchorage points for attachment of the belt or harness;
- severe restrictions on the movement of the worker when attached to any one anchorage point, and the constant need to change from one anchor point to another.”(1985c,p.364).

Some contractors often overlook the arrangement of fixed or continuous anchorages in the appropriate places. The successful design of anchorage points is to facilitate suitable, reliable, convenient and easy connections. This is also required by the Occupational Safety and Health Administration (OSHA) in that the secure anchorage point must be capable of supporting at least five thousand pounds, because a person falling for six feet will sustain up to 10 times of his or her body weight. Separate anchorage should be provided for each personal fall arresting equipment (Stice, 1996).

The development of anchorage lines, vertical or horizontal, provides continuous attachment for use of safety belts or harness, but it seems not applicable to the scaffolding being erected or dismantled.

The Occupational Safety and Health Administration has issued a revised safety standard for scaffolds 1926 (Federal Register #:61:46025-46075) to protect 2.3 million construction workers working on scaffolds. OSHA found that numbers of falling accidents would have been prevented by implementation of the revised standard. Fall protection, safe access and training requirements for workers involved in erecting or dismantling scaffolding have been addressed. A competent person is required to determine the feasibility and safety of providing fall protection and safe access for scaffolding workers (Occupational Safety & Health Administration, 1996b). Also, workers involved in erecting, dismantling, operating, maintaining or inspecting scaffolding must be trained by a competent person. Under the OSHA's fall protection standard, the fall protection training for scaffolding workers should cover the potential hazards associated with the work, the correct working procedures in dealing with the hazards, the role in the fall protection, the design and proper use of scaffolds, and the relevant requirements of provisions (Gunter, 1997). Awadalla and Roughton stated, "OHSA's goal: To provide greater flexibility in the use of fall protection systems and enhance protection for employees who work on scaffolds. The standard also aims to strengthen employee training."(1997,p.12).

Tubular steel scaffolding and falsework are only to be erected by trained scaffolding workers in U.K. The scaffolding workers must have acquired a proper scaffolders' training run by the Construction Industry Training Board (CITB) or equivalent and obtained a period of practical experience. There are three categories of scaffolders, i.e. trainee, basic and advanced scaffolders (King & Hudson, 1985b).

In Japan, the major contributory factor of falling accidents is human error, e.g. not using a safety belt, and short cut of working procedure etc. Fall prevention measures would be employed at shop floor level. Safety and health training has been one of the successful methods in reducing accidents (Yamasaki, 1997).

In Singapore, the scaffolding should only be erected, altered or dismantled by scaffolding workers who have undergone an approved training course (Labour Ministry, 1987). In order to reduce the number of accidents in construction sites, the Labour Ministry planned to introduce a special pass system in preventing untrained workers from entering danger zones, i.e. confined spaces, trenches and scaffolding. Workers who are trained to handle a specific job and pass a test will be issued with Permit-to-Work passes (Vasoo, 1997).

Under the Occupational Safety and Health Act 1984 in Western Australia, the employer has a general duty to provide employees information, instruction, training and supervision to enable them to work safely. Training in fall prevention and use of fall arrest system should be given to workers who are working at height (Worksafe Western Australia, 1997). Quinlan and Bohle stated, “Workers in some cases may be require to have completed training courses or tests and obtained official certification before they can legally perform certain types of work.”(1991, p.383). Scaffolders are required to obtain formal accreditation or certificate. Scaffolding over four metres height must be erected, altered, or dismantled by certified scaffolders (Worksafe Western Australia, 1997).

According to the Construction Sites (Safety) Regulations of Hong Kong, the contractor is required to ensure scaffolding is erected, altered or dismantled by competent workers with adequate experience under the immediate supervision of a competent person. However, there is no specific requirement laid down in the regulations for training workers involved in scaffolding works. The site investigation contractors’ committee of Hong Kong Construction Association set the requirements for scaffolding works in their safety and health manual.

Scaffolding should be erected, altered, or dismantled by suitably trained and experienced workers (Site investigation contractors' committee, 1997). There are guidelines set out in the Code of Practice for Scaffolding Safety issued by the Commissioner of Labour for the definitions of competent person and competent worker. The person competent should have undergone a formal training and had ten years or more experience in scaffolding work. The formal training defined in the code of practice is as follows:

1. The 3-years bamboo scaffolder apprenticeship scheme operated by the Vocational Training Council (VTC); or
2. The 1-year full time training course in bamboo scaffolding of the Construction Industry Training Authority (CITA); or
3. Other similar scaffolding training course/programme; or
4. The trade test on bamboo scaffolding of the CITA.

For the competent workers, they are required to obtain one of the above formal training programmes and have at least three years experience in scaffolding work. The number of competent scaffolding workers and person meeting the above requirements are seldom found in Hong Kong. Also, the scaffolding workers qualified under the requirements of the code of practice are unlikely to be competent for steel scaffolding (Wong, 1998).

CITA and VTC have jointly conducted a trade test scheme for skilled bamboo scaffolders with four years working experience since 1991 and for semi-skilled bamboo scaffolders who are having basic skills of 1998 (Mok, 1998). Some government departments have recognised the qualification of scaffolding workers who passed the trade test. The training or skill test for steel scaffolders is still not addressed. Mowatt said, "In Hong Kong there is no established scaffold training body to train scaffolders, and certify them in the safe and correct use of steel scaffolding."(1998, p.79). In the review of construction safety and health in Hong Kong, Anderson and Smith have advised to include scaffolding (bamboo or else) into the certification courses for workers working in hazardous trades (Anderson and Smith, 1996). The Hong Kong Polytechnic University and CITA have organised tailor-made training course in tubular steel scaffolding on request by construction companies.

Mccutcheon said, "Training…is an important way of achieving competence and helps to convert information into safe working practices."(1995, p.3). Training provides people the necessary skills and knowledge, and changes their safety attitude and awareness. Workers might apply the learning gained from the training to identify hazards, avoid their exposure to unsafe situations, and implement safety measures. Accidents attributable to human errors could be minimised (Chan & Lau, 1997). Quinlan and Bohle stated, "Workers generally require training in safety behaviours and procedures that are directly relevant to their work."(1991, p.383).

3. Hypothesis

Scaffolding safety training reduces the risk of accidents on erecting or dismantling of scaffolding.

4. Aim

To assess the significance of scaffolding safety training provided to scaffolding workers in reducing their risk of falling during erecting or dismantling tubular steel scaffolding.

5. Objectives

Three objectives of the study are:

- to evaluate types of safety training acquired by scaffolding workers;
- to evaluate awareness of level of risk and potential hazards, knowledge of works and safety requirements, and practice on fall protection of scaffolding workers, both trained and untrained in scaffolding safety training; and
- to review accident records of scaffolding workers, both trained and untrained in scaffolding safety training.

6. <u>Method</u>

A tailor-made scaffolding safety training course was designed by ABC Construction Company with the assistance of Local Industrial Training Authority in May 1997. The course consists of a lecture and practical session in which the potential hazards associated with scaffolding works, basic safety requirements of regulations and code of practice, role of scaffolding worker, types and components of scaffolding, correct procedure of erecting or dismantling scaffolding, and use of fall protection equipment are covered. The workers who are engaged in erecting or dismantling tubular steel scaffolding (they are called scaffolding workers) are usually the riggers of ABC Construction Company. Some of them were nominated by the company management and sent to the training centre of Local Industrial Training Authority for one day training in scaffolding safety. Two classes were conducted, 17 May 1997 and 22 June 1997 respectively. There was a total of thirty workers who received the training. They were issued with certificates after finishing the course and passing a test.

As the risk of falling is a major concern in scaffolding being erected and dismantled, it is the intention of the management to ensure scaffolding workers acquire appropriate training in preventing accidents from falling. Since the cost of scaffolding safety training for each worker is approximate HK$1,200.00, there would be a large expenditure if such training was provided to approximate 600 workers, who are involved in the scaffolding work of ABC Construction Company. To assess the significance of scaffolding safety training in reducing risk of accidents a survey was required, before a decision could be made on implementing a scheme of providing such training to all scaffolding workers.

A cross-sectional survey was conducted to assess the significance of scaffolding safety training in improving workers' awareness of level of risk and potential hazards, knowledge of works and safety requirements, practice on fall protection, and accident records in erecting or dismantling scaffolding. By using a questionnaire, the required data was gathered from the scaffolding workers interviewed. The scaffolding workers who received scaffolding safety training made-up the experimental group (trained workers), but the scaffolding workers who had not obtained such training made-up the control group. The scaffolding workers interviewed were randomly selected on sites from the two independent populations, the experimental group and control group. The selected workers of these groups were working on various sites of ABC Construction Company as the natures of construction works and the backgrounds of workers were similar.

A two-page questionnaire had been designed to collect data (See Appendix A) on:

1. The basic data of the subject;
2. Types of safety training acquired;
3. Practice of use of fall protection equipment;
4. Knowledge of works about erecting or dismantling scaffolding;
5. Knowledge of the requirements in regulations and code of practice for scaffolding safety;
6. Practice of fall protection measures;
7. Awareness about the risk of erecting or dismantling scaffolding;

8. Awareness about potential hazards of scaffolding works; and
9. Accident record.

The background information of the respondent was collected from the questions of items 1 to 3. The study variables of items 4 to 10 were collected for statistical analysis of the results. The questions for the study variables were designed to collect data of frequency of occurrence in various categories for non-parametric test Chi square.

In considering the education level of respondents, the questions in the questionnaire were set in simple sentences using simple words. Closed questions were used where the respondent rates items on a range of criteria were applied to the list of study variables except the basic data of the subject. The questionnaire was translated into Chinese for easy understanding by the respondents, who preferred to read questions in Chinese (See Appendix B). The questionnaire was administered by an interviewer to assist the respondents in understanding questions and to fill in the answers chosen by them.

Prior to the survey being conducted on the trained and untrained groups of workers, ten general labourers who are not involved in the scaffolding works had been invited to fill in the draft questionnaire as a preliminary test for assessing answering time and validity of questionnaire. Questions and answers of the draft questionnaire were revised in consideration of the results of the preliminary test accordingly.

The scaffolding workers randomly selected from the experimental and the control groups. Each respondent was individually interviewed by an interviewer for filling up questionnaires on their respective sites. A clear explanation of the purpose of study, the duration of interview, the procedure of interview and the arrangement of information protection were given to each respondent. Respondents were also advised on their freedom in agreeing to participate, answering questions and discontinuing participation at any time. Consent was obtained before conducting the interview with each individual respondent.

All the questionnaires returned were examined for completeness. The data collected from the completed questionnaires was analysed and tabulated in order to determine the difference between the experimental and control groups. The chi-square test was applied to determine whether there was a significant difference between the experimental and control groups in the study variables. The data gathered (observed frequencies) for the study variables on both groups were recorded in a 2 X 2 contingency table. The expected frequency for each of the cells in the contingency table was determined by multiplying the row total and the column total and dividing by the grand total. Before conducting the chi-square test, all the expected frequencies in the cells should be checked to be at least five. The level of significance was set at 0.05 (Burns, 1997).

The review of accident records on both groups of workers was limited to the study period (from July 1997 to August 1998). The incidence rates were determined to distinguish the difference between the experimental and control groups in this period.

The data collected and results determined were only used for assessing the significance of scaffolding safety training. The negative results of the attitude, knowledge and practice of the respondents that revealed by this study would not subject them to disciplinary action or affect their promotion prospects. All the completed questionnaires and records were marked confidential and will be kept secure 5 years after the completion of the study. A survey had been conducted to assess the adequacy of security measures for keeping the completed questionnaires and records. Consent and approval was obtained from the local supervisor.

After the 5 years, all the records would be destroyed appropriately.

7. Results

The survey was commenced in mid August 1998. The method described in the above section was applied in this survey. Interviews were conducted with the scaffolding workers, selected at random from various ABC Construction Company's sites in Hung Hom, Tsing Yi, Kwai Chung, Yuen Long, Lung Cheung Road and Butterfly Valley. Interviews with scaffolding workers was completed and the finished questionnaires collected for analysis by mid October 1998.

A total of seventy workers who are involved in erecting or dismantling of tubular steel scaffolding were invited for interview and asked for responses to the questions in the questionnaire. They were required to provide their basic personal information comprising occupation, age, working experience, types of safety training acquired and accident record. They were also asked to express their views or opinions in awareness of level of risk and potential hazards, knowledge of works and safety requirements, and practice on fall protection. The workers of the experimental group (Trained workers) had received training in scaffolding safety but the workers of the control group (Untrained workers) had not obtained such training. There were twenty-four trained workers and forty-six untrained workers participating in the interviews and answering questionnaires. The data collected from the questionnaires were sorted into groups and tabulated for analysis in the following:

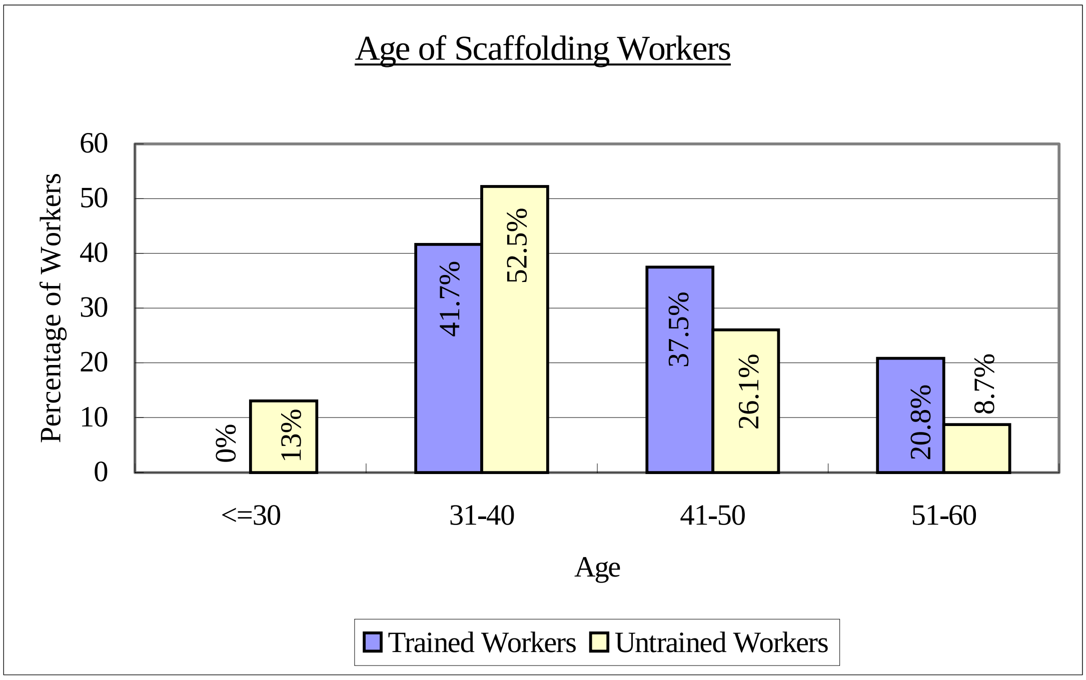
7.1 *Age of Workers*

The ages of scaffolding workers ranged from twenty-eight to fifty-nine. They were divided into four groups, i.e. thirty or younger, thirty-one to forty, forty-one to fifty, and fifty-one to sixty.

Table 1 – Age of Scaffolding Workers

Age	Trained Workers		Untrained Workers	
	Number	Percentage	Number	Percentage
<=30	0	0.0%	6	13.0%
31-40	10	41.7%	24	52.2%
41-50	9	37.5%	12	26.1%
51-60	5	20.8%	4	8.7%

Figure 1 – Age of Scaffolding Workers



The mean age of trained workers was 43.92 and the standard deviation was 5.67. The group of untrained workers had had the mean age of 43.48 and the standard deviation of 7.47.

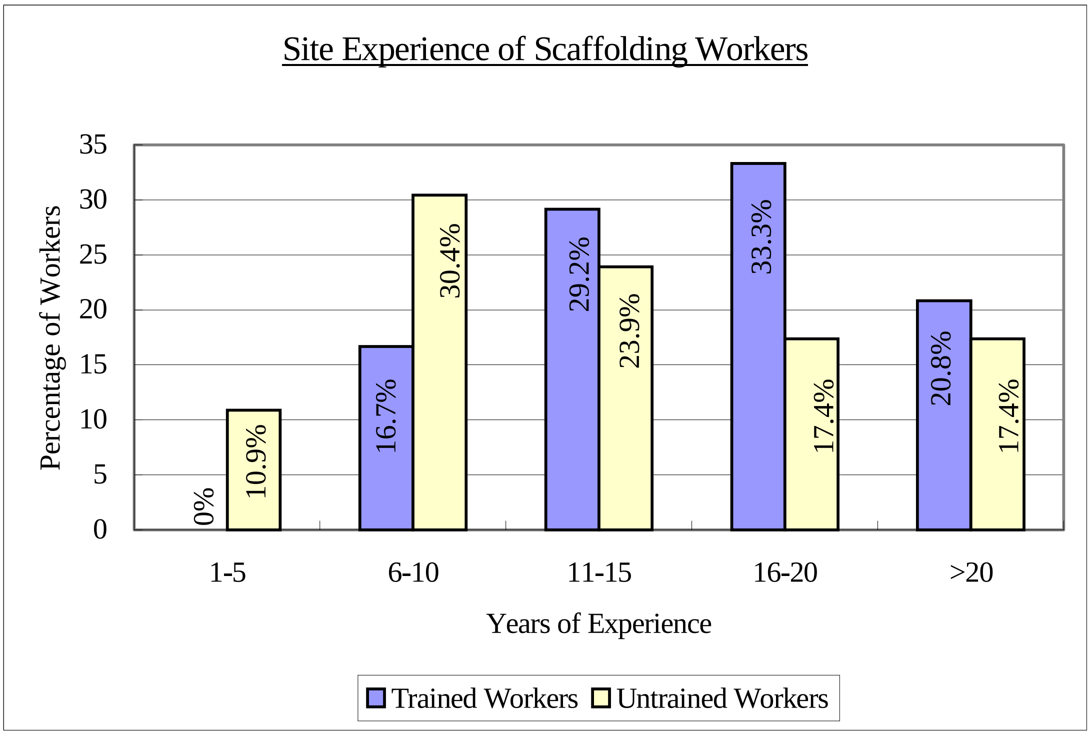
7.2 Working Experience in Construction Site

It was found that the scaffolding workers had been working for between two to thirty-five years in construction site. The working experience in construction site (called site experience) were divided into five groups, i.e. one to five, six to ten, eleven to fifteen, sixteen to twenty and more than twenty years.

Table 2 – Site Experience of Scaffolding Workers

Site Experience (Years)	Trained Workers		Untrained Workers	
	Number	Percentage	Number	Percentage
1-5	0	0.0%	5	10.9%
6-10	4	16.7%	14	30.4%
11-15	7	29.2%	11	23.9%
16-20	8	33.3%	8	17.4%
>20	5	20.8%	8	17.4%

Figure 2 – Site Experience of Scaffolding Workers



For both trained and untrained workers, the majority of them had been working in the construction field for over five years, and half of them have fifteen and more years site experience. The average site experience of trained workers and untrained workers were 17.17 years and 14.09 years respectively. The standard deviations for both trained and untrained groups were 7.03 and 7.60.

7.3 *Scaffolding Experience*

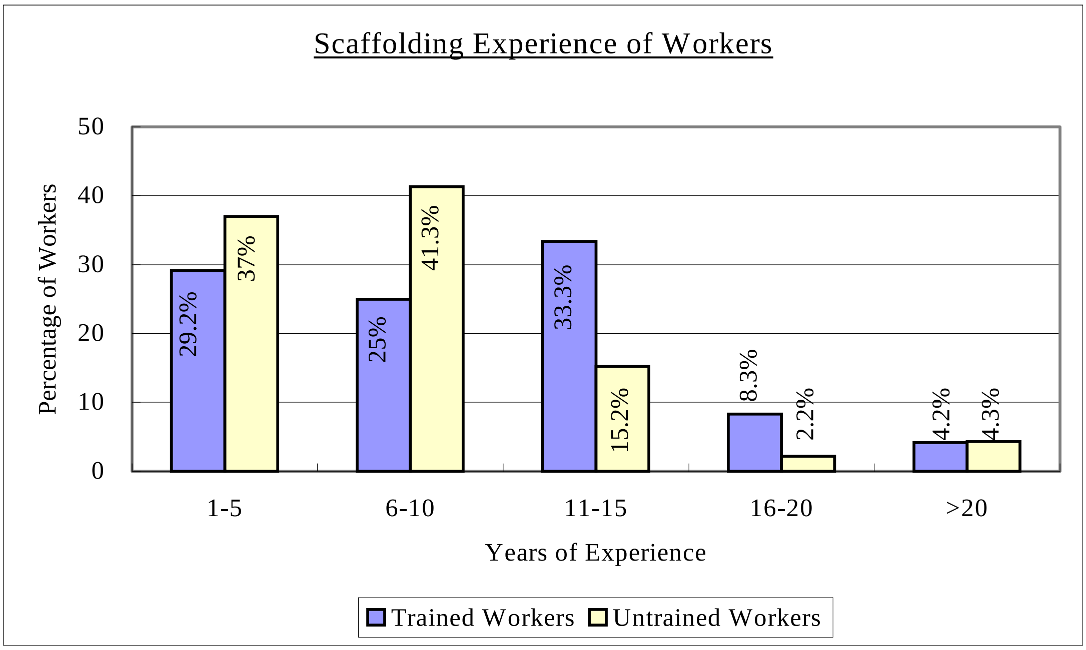
The scaffolding workers in both trained group and untrained group have had working experience in scaffolding works from between one to twenty-eight years. The working experience in scaffolding works is known as scaffolding experience. The data of scaffolding experience collected was also divided into five groups, i.e.

one to five, six to ten, eleven to fifteen, sixteen to twenty and more than twenty years.

Table 3 – Scaffolding Experience of Workers

Scaffolding Experience (Years)	Trained Workers		Untrained Workers	
	Number	Percentage	Number	Percentage
1-5	7	29.2%	17	37.0%
6-10	6	25.0%	19	41.3%
11-15	8	33.3%	7	15.2%
16-20	2	8.3%	1	2.2%
>20	1	4.2%	2	4.3%

Figure 3 – Scaffolding Experience of Workers



The average scaffolding experience of trained workers was 9.63 years and the standard deviation was 5.57. The mean of scaffolding experience for the untrained workers was 8.33 years and the standard deviation was 5.60.

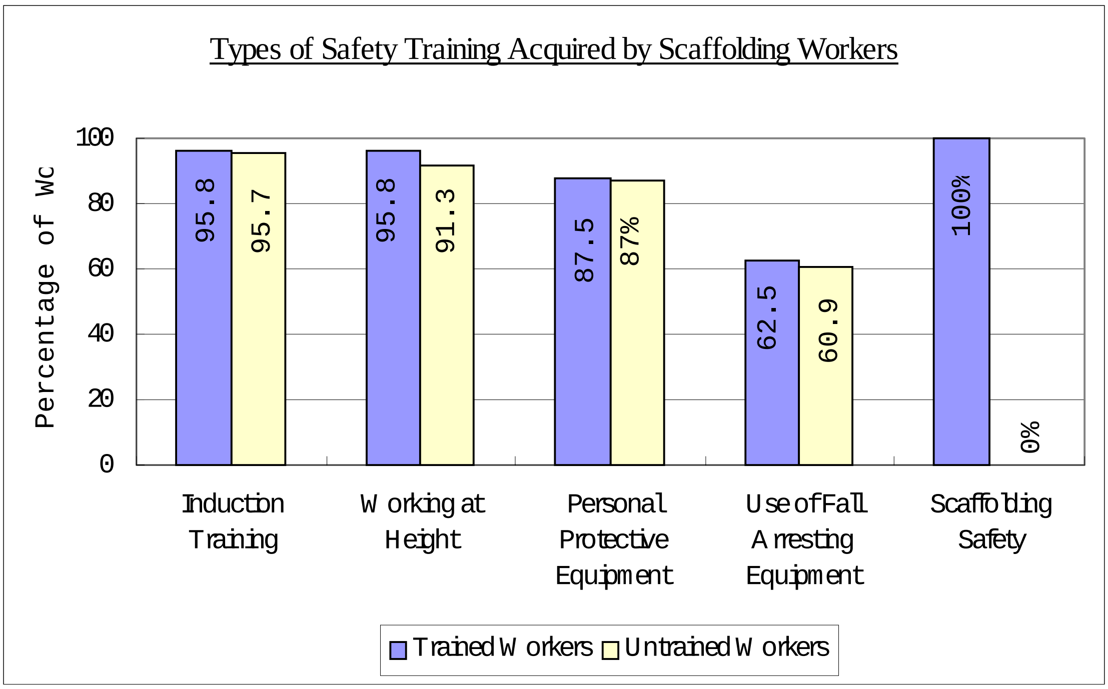
7.4 Types of Safety Training Acquired

Scaffolding workers were asked to answer training acquired of the types set in the question (3) of questionnaire. The numbers of workers were counted and the percentages of workers were determined from respective types of safety training for both trained and untrained groups. These data sorted by types of safety training and groups of scaffolding workers were tabulated in the following Table 4.

Table 4 – Types of Safety Training Acquired by Scaffolding Workers

Type of Safety Training	Trained Workers		Untrained Workers	
	Number	Percentage	Number	Percentage
Induction Training	23	95.8%	44	95.7%
Working at Height	23	95.8%	42	91.3%
Personal Protective Equipment	21	87.5%	40	87.0%
Use of Fall Arresting Equipment	15	62.5%	28	60.9%
Scaffolding Safety	24	100%	0	0%

Figure 4 – Types of Safety Training Acquired by Scaffolding Workers



It was found that the scaffolding workers both in trained and untrained groups had received at least one kind of safety training listed in the question. About 96% of scaffolding workers had received induction training. Most of respondents were trained for safety in working at height and the use of personal protective equipment. About 60% of the respondents were trained in the use of fall arrest equipment.

All twenty-four workers of the trained group had received training in scaffolding safety but the other forty-six workers of the untrained group had not obtained such training.

7.5 Awareness of Level of Risk

The interviewees expressed their views on the level of risk in erecting or dismantling scaffolding in option order, i.e. “Very Low”, “Low”, “Medium”, “High”, and “Very High”. The reply either “High” or “Very High” meant that it is considered that the worker was highly aware of the risk in doing their job and was counted in the category of “aware of risk”. The answer of either “Medium”, “Low”, or “Very Low” would be included in the category of “not aware of risk” in which the worker did not pay particular attention to the risk involved in scaffolding work.

In the trained group, more concerns were expressed about the risk of erecting or dismantling scaffolding. Twenty out of twenty-four workers answered “Very High” and “High”, and the other eight workers replied that the level of risk is “Medium”. Only seventeen out of forty-six untrained workers thought that scaffolding works is a high risk job. However, twenty-nine of them thought that the level of risk is “Medium” or lower.

Figure 5 – Awareness of Level of Risk

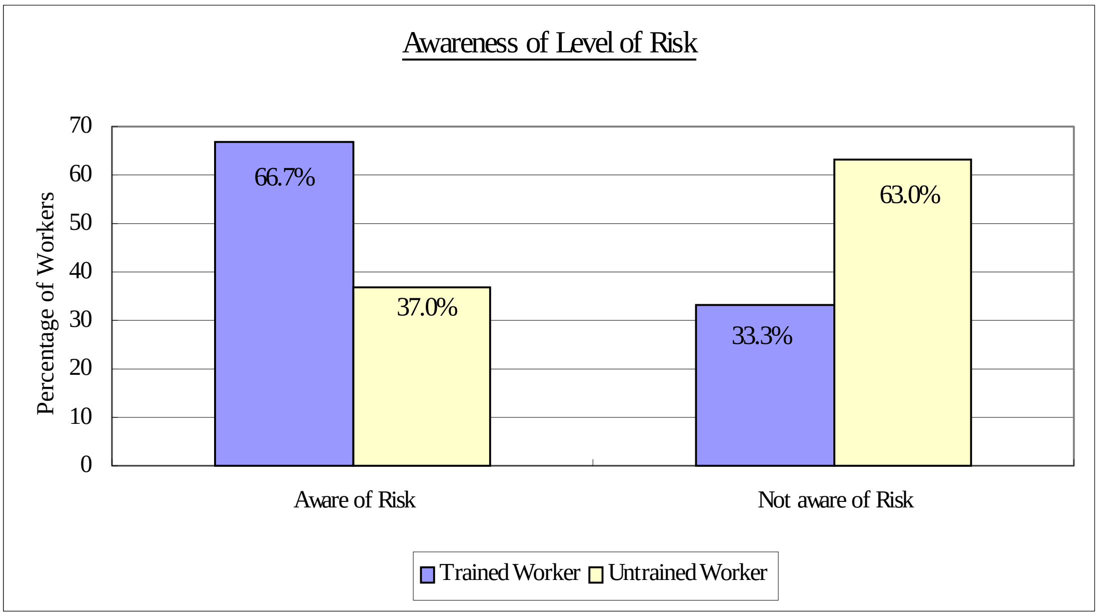


Table 5 – Awareness of Level of Risk

	Aware of risk		Not aware of risk	
	Number	Percentage	Number	Percentage
Trained Worker	16	66.7%	8	33.3%
Untrained Worker	17	37.0%	29	63.0%

Chi-square (χ^2) test was applied to determine these two variables, ‘status of training’ and ‘awareness of level of risk’, for independence. Since there was a 2 X 2 contingency table, Yate’s continuity correction was considered (Rees,1995).

The formula used was

Calculated $\chi^2 = \Sigma (|O-E|-½)^2/E$ (1)

‘O’ means the observed frequencies and ‘E’ denotes the expected frequencies.

Null hypothesis H_0: P(Trained)=P(Untrained)

It can be expressed that the variables ‘statue of training’ and ‘awareness of level of risk’ are independent, i.e. there is no association between the variables.

H_1: ‘Status of training’ and ‘aware of level of risk’ are not independent, they are associated.

The level of significance is 0.05.

The expected number of trained workers who aware of level of risk is

(24X33)/70=11.31

The expected number of trained workers who are not aware of level of risk is

(24X37)/70=12.69

The expected number of untrained workers who aware of level of risk is

(46X33)/70=21.68

The expected number of untrained workers who are not aware of level of risk is

(46X37)/70=24.31

Table 6 – Observed and Expected Frequencies of Awareness of Level of Risk

	Aware of risk	Not aware of risk	Row Totals
Trained Workers	16 (Observed) 11.31 (Expected)	8 (Observed) 12.69 (Expected)	24
Untrained Workers	17 (Observed) 21.68 (Expected)	29 (Observed) 24.31 (Expected)	46
Column Totals	33	37	Grand Total 70

All the expected values in the table are greater than 5.

χ^2 =(|8-12.69|-½)^2/12.69+(|29-24.31|-½)^2/24.31+(|16-11.31|-½)^2/11.31

+(|17+21.69|-½)^2/21.69

χ^2 =1.38+0.72+1.55+0.81=4.46

The degrees of freedom ν=(r-1)(c-1) (2)

Where r = number of rows and c = number of column.

For the 2 X 2 table, the degree of freedom is (2-1)X(2-1)=1

The χ^2 obtained from the chi-square distribution table (Ronald 1995, p.A18) of 0.05 level of significance is equal to 3.84.

Since Calculated χ^2 > Tabulated χ^2, therefore the null hypothesis is rejected. The 'status of training' and the 'awareness of level of risk' are significantly associated.

It was concluded that there is a significant difference between the trained and untrained workers in the awareness of level of risk in erecting or dismantling scaffolding.

7.6 Awareness of Potential Hazards

Scaffolding workers, both trained and untrained, were asked to express their views on potential hazards associated with erecting or dismantling scaffolding. Three common hazards "Fall of Person", "Falling objects" and "Structural Instability" were set in the question for a quiz. Results were summarized and shown in the following Table 7.

Table 7 – Awareness of Potential Hazards

Potential Hazards	Trained Workers		Untrained Workers	
	Number	Percentage	Number	Percentage
Fall of Person	23	95.8%	33	71.7%
Falling Objects	24	100%	29	63%
Structural Instability	20	83.3%	25	54.3%
All of the above hazards	19	79.2%	14	30.4%

Most of the workers in the trained group were aware of the potential hazards. Twenty-three workers (95.8%) knew the hazard of falling, twenty-four workers (100%) recognised the hazard of falling objects, and twenty workers (83.3%) were aware of structural instability. The percentage of untrained workers was less than the percentage of trained workers in choosing of these potential hazards. Thirty-three workers (71.7%) were aware of the hazard of falling, twenty-nine workers (63%) knew the hazard of falling objects and twenty-five of them (54.3%) recognised the risk of structural instability.

Nineteen out of twenty-four trained workers (79.2%) identified all the three potential hazards while only fourteen out of forty-six untrained workers (30.4%) were able to select such potential hazards.

Figure 6 – Awareness of Common Potential Hazards

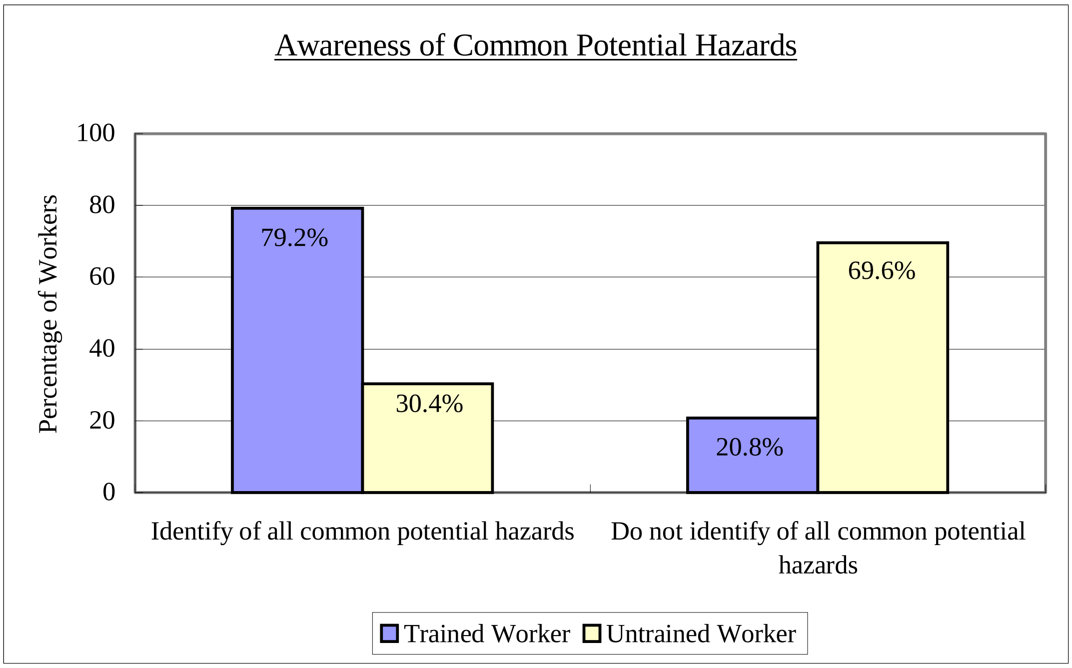


Table 8 – Awareness of Common Potential Hazards

	Identify of all common potential hazards		Do not identify of all common potential hazards	
	Number	Percentage	Number	Percentage
Trained Worker	19	79.2%	5	20.8%
Untrained Worker	14	30.4%	32	69.6%

A chi-square test was done to determine whether there is a significant difference between the trained and untrained workers in identifying all common potential hazards set in the quiz.

Since there was a 2 X 2 contingency table, the formula applied was

Calculated $\chi^2 = \Sigma\ (|O-E|-½)^2/E$ (1)

Null hypothesis H_0: There is no significant association between 'status of training' and 'identification of common potential hazards'.

H_1: 'Status of training' and 'identification of common potential hazards' are not independent, they are associated.

The level of significance is 0.05.

Table 9 – Observed and Expected Frequencies of Awareness of Common Potential Hazards

	Identify of common potential hazards	Do not identify of common potential hazards	Row Totals
Trained Workers	19 (Observed) 11.31 (Expected)	5 (Observed) 12.69 (Expected)	24
Untrained Workers	14 (Observed) 21.69 (Expected)	32 (Observed) 24.31 (Expected)	46
Column Totals	33	37	Grand Total 70

All the expected values in the table are greater than 5.

$\chi^2 = (|19-11.31|-½)^2/11.31+(|14-21.69|-½)^2/21.69+(|5-12.69|-½)^2/12.69$

$+(|32-24.31|-½)^2/24.31$

$\chi^2 = 4.56+0.74+4.07+2.12=11.5$

The degrees of freedom is (2-1)X(2-1)=1

The χ^2 obtained from the chi-square distribution table (Ronald 1995, p.A18) of 0.05 level of significance is equal to 3.84.

Since Calculated χ^2 > Tabulated χ^2, the null hypothesis is rejected. The 'status of training' and the 'identification of common potential hazards' are significantly associated.

It was concluded that there is a significant difference between the trained and untrained workers in the identification of common potential hazards.

7.7 Knowledge of Safety Requirements in Regulations and Code of Practice

The scaffolding workers, both trained and untrained, were questioned about the knowledge of the requirements in regulations and code of practice for scaffolding safety. All the workers (twenty-four workers) in the trained group expressed their understanding of the safety requirements in scaffolding safety. Only twenty-four out of forty-six workers in the untrained group claimed that they knew such requirements.

Figure 7 – Knowledge of Safety Requirements in Regulations and Code of Practice

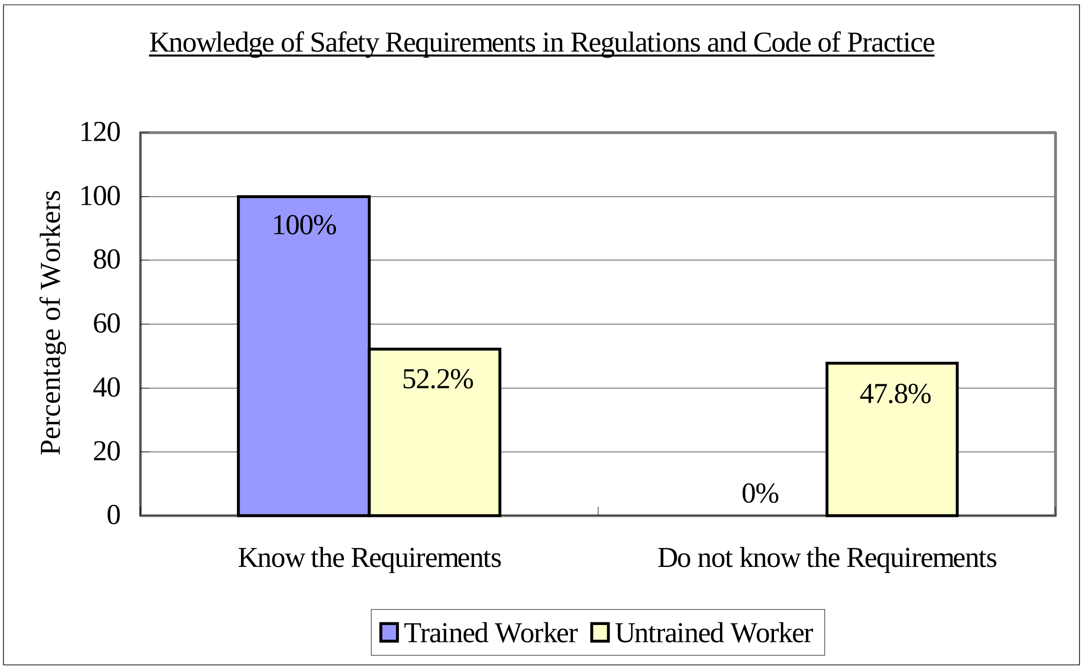


Table 10 – Knowledge of Safety Requirements in Regulations and Code of Practice

	Know the Safety Requirements		Do not know the Safety Requirements	
	Number	Percentage	Number	Percentage
Trained Worker	24	100%	0	0%
Untrained Worker	24	52.2%	22	47.8%

A chi-square test was done to determine whether there is a significant difference between the trained and untrained workers in knowledge of the requirements in regulations and code of practice for scaffolding safety.

Since there was a 2 X 2 contingency table, the formula applied was

Calculated $\chi^2 = \Sigma\ (|O-E|-½)^2/E$ (1)

Null hypothesis H_0: There is no significant association between 'status of training' and 'knowledge of the requirements in regulations and code of practice for scaffolding safety'.

H_1: 'Status of training' and 'knowledge of the requirements in regulations and code of practice for scaffolding safety' are not independent, they are associated.

The level of significance is 0.05.

Table 11 – Observed and Expected Frequencies of Knowledge of the Requirements in Regulations and Code of Practice for Scaffolding Safety.

	Know the Safety Requirements	Do not know the Safety Requirements	Row Totals
Trained Workers	24 (Observed) 16.46 (Expected)	0 (Observed) 7.54 (Expected)	24
Untrained Workers	24 (Observed) 31.54 (Expected)	22 (Observed) 14.46 (Expected)	46
Column Totals	48	22	Grand Total 70

All the expected values in the table are greater than 5.

$\chi^2 = (|24-16.46|-½)^2/16.46+(|24-31.54|-½)^2/31.54+(|0-7.54|-½)^2/7.54$

$+(|22-14.46|-½)^2/14.46$

$\chi^2 = 3.01+1.57+6.58+3.43=14.59$

The degrees of freedom is (2-1)X(2-1)=1

The χ^2 obtained from the chi-square distribution table (Ronald 1995, p.A18) of 0.05 level of significance is equal to 3.84.

Since Calculated χ^2 > Tabulated χ^2, the null hypothesis is rejected. The 'status of training' and the 'knowledge of the requirements in regulations and code of practice for scaffolding safety' are significantly associated.

It was concluded that there is a significant difference between the trained and untrained workers in knowledge of the requirements in regulations and code of practice for scaffolding safety.

7.8 Knowledge of Works about Erecting or Dismantling Scaffolding

Both trained and untrained workers were questioned about their knowledge of works in erecting or dismantling scaffolding. It was found that the majority of scaffolding workers have been carrying out scaffolding works by experience, following the working of co-workers, following the procedure/guidance obtained, or following the supervisor's instruction.

Table 12 – Knowledge of Works

Knowledge of Works	Trained Workers		Untrained Workers	
	Number	Percentage	Number	Percentage
Experience	15	62.5%	33	71.7%
To follow the working of co-workers	10	41.7%	29	63.0%
To follow procedure/guidance obtained	16	66.7%	36	78.3%
Under the instruction of foreman	20	83.3%	45	97.8%
Knowledge from training	23	95.8%	14	30.4%

Sixteen (66.7%) and twenty (83.3%) of the trained workers would be following procedure/guidance and supervisor's instruction respectively on erecting or dismantling scaffolding. Ten workers (41.7%) would be doing their works by following co-workers and fifteen workers (62.5%) would be working by experience.

Almost all the workers in the untrained group would be doing scaffolding works by following the instruction of their supervisor (forty-five workers, 97.8%). Thirty-six workers (78.3%) would be following procedure and guidance obtained. There were more than half of untrained workers who would be carrying out their works by following co-workers (twenty-nine workers, 63%) or by experience (thirty-three workers, 71.7%).

Twenty-three out of twenty-four workers (95.8%) in the trained group replied that they would apply the knowledge learnt from training. Fourteen untrained workers expressed that they would adopt the knowledge from training.

Figure 8 – Adoption of Knowledge learnt from Training

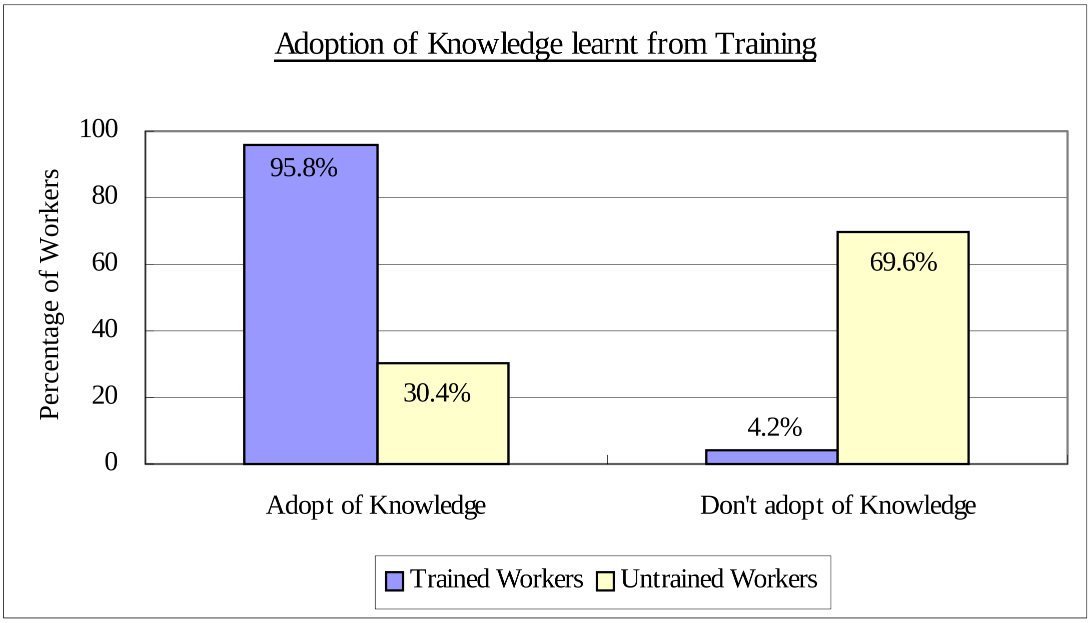


Table 13 – Adoption of Knowledge learnt from Training

	Adopt Knowledge learnt from Training		Do not Adopt Knowledge learnt from Training	
	Number	Percentage	Number	Percentage
Trained Workers	23	95.8%	1	4.2%
Untrained Workers	14	30.4%	32	69.6%

A chi-square test was done to determine whether there is a significant difference between the trained and untrained workers in adoption of knowledge learnt from training.

Since there was a 2 X 2 contingency table, the formula applied was

Calculated $\chi^2 = \Sigma (|O-E|-½)^2/E$ (1)

Null hypothesis H_0: There is no significant association between 'status of training' and 'adoption of knowledge learnt from training'.

H_1: 'Status of training' and 'adoption of knowledge learnt from training' are not independent, they are associated

The level of significance is 0.05.

Table 14 – Observed and Expected Frequencies of Adoption of Knowledge learnt from Training

	Adopt	Do not Adopt	Row Totals
Trained Workers	23 (Observed) 12.69 (Expected)	1 (Observed) 11.31(Expected)	24
Untrained Workers	14 (Observed) 24.31 (Expected)	32 (Observed) 21.69 (Expected)	46
Column Totals	37	33	Grand Total 70

All the expected values in the table are greater than 5.

$\chi^2 = (|23-12.69|-½)^2/12.69+(|14-24.31|-½)^2/24.31+(|1-11.31|-½)^2/11.31$

$+(|32-21.69|-½)^2/21.69$

$\chi^2 = 7.59+3.96+8.51+4.44=24.51$

The degrees of freedom is (2-1)X(2-1)=1

The χ^2 obtained from the chi-square distribution table (Ronald 1995, p.A18) of 0.05 level of significance is equal to 3.84.

Since Calculated χ^2 > Tabulated χ^2, the null hypothesis is rejected. The 'status of training' and the 'adoption of knowledge learnt from training' are significantly associated.

It was concluded that there is a significant difference between the trained and untrained workers in adopting knowledge learnt from training.

7.9 Practice of Fall Protection Measures

Scaffolding workers were asked to select appropriate measures of fall protection on erecting or dismantling scaffolding. Six common fall protection measures were given in the question for a quiz. The results of workers' selections were summarized and listed out by number and percentage in the following Table 15.

Table 15 - Practice of Fall Protection Measures

Fall Protection Measures	Trained Workers		Untrained Workers	
	Number	Percentage	Number	Percentage
Guard-rails	24	100.0%	46	100.0%
Toe board	23	95.8%	38	82.6%
Planking	22	91.7%	35	76.1%
Access and egress	21	87.5%	34	73.9%
Safety netting	22	91.7%	37	80.4%
Fall arresting equipment	21	87.5%	42	91.3%

Guard-rails was the only choice selected by all the interviewees, both trained and untrained. The percentage of trained workers was more than the percentage of untrained workers in choosing of toe board, planking, access and egress, and safety netting as the fall protection measures. However, more untrained workers (91.3%)

had preferred to use fall arresting equipment compared to trained workers (87.5%). Nineteen out of twenty-four trained workers identified all the six fall protection measures while half the untrained workers (Twenty-three out of forty-six workers) were able to select such fall protection measures.

Figure 9 – Identification of Common Fall Protection Measures

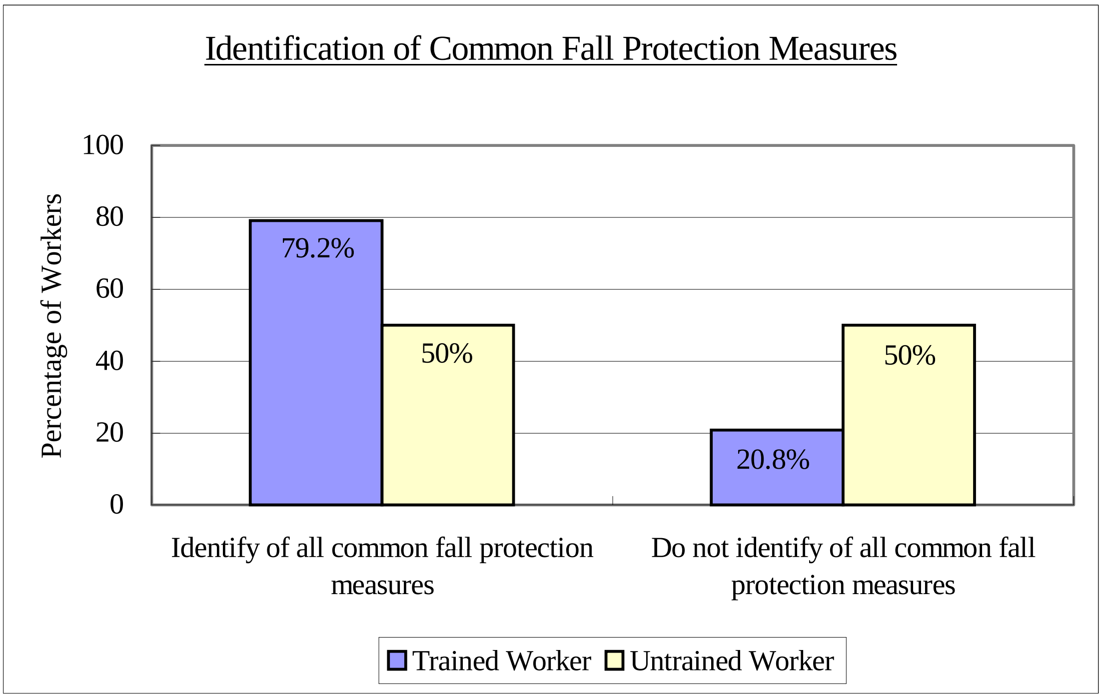


Table 16 –Identification of Common Fall Protection Measures

	Identify of all common fall protection measures		Do not identify of all common fall protection measures	
	Number	Percentage	Number	Percentage
Trained Worker	19	79.2%	5	20.8%
Untrained Worker	23	50%	23	50%

A chi-square test was done to determine whether there is a significant difference between the trained and untrained workers in identifying of common fall protection measures.

Since there was a 2 X 2 contingency table, the formula applied was

Calculated $\chi^2 = \Sigma (|O-E|-½)^2/E$ (1)

Null hypothesis H_0: There is no significant association between 'status of training' and 'identification of all common fall protection measures'.

H_1: 'Status of training' and 'identification of all common fall protection measures' are not independent, they are associated.

The level of significance is 0.05.

Table 17 – Observed and Expected Frequencies of Identification of Common Fall Protection Measures

	Identify of all common fall protection measures	Do not identify of all common fall protection measures	Row Totals
Trained Workers	19 (Observed) 14.4 (Expected)	5 (Observed) 9.6 (Expected)	24
Untrained Workers	23 (Observed) 27.6 (Expected)	23 (Observed) 18.4 (Expected)	46
Column Totals	42	28	Grand Total 70

All the expected values in the table are greater than 5.

$\chi^2 = (|19-14.4|-½)^2/14.4+(|23-27.6|-½)^2/27.6+(|5-9.6|-½)^2/9.6$

$+(|23-18.4|-½)^2/18.4$

$\chi^2 = 1.17+0.61+1.75+0.91=4.44$

The degrees of freedom is (2-1)X(2-1)=1

The χ^2 obtained from the chi-square distribution table (Ronald 1995, p.A18) of 0.05 level of significance is equal to 3.84.

Since Calculated χ^2 > Tabulated χ^2, the null hypothesis is rejected. The 'status of training' and the 'identification of all common fall protection measures' were significantly associated.

It was concluded that there is a significant difference between the trained and untrained workers in identifying of all common fall protection measures.

7.10 Practice of Use of Fall Protection Equipment

The respondents were given four options for answering the frequency of use of fall protection equipment, i.e. "Never", "Occasionally", "Often", and "Always". If the reply was either "Often" or "Always", it was considered that the worker usually uses the stated personal protective equipment at work and he would be classified into the used group. Answering of either "Never" or "Occasionally" would be counted as the unused group in which the worker had used the said personal equipment at times or had not used such equipment.

Table 18 – Use of Fall Protection Equipment

Type of PPE	Trained Workers		Untrained Workers	
	Used	Unused	Used	Unused
Safety Helmet	24	0	45	1
Safety Belt	22	2	22	24
Safety Harness	0	24	0	46
Lifeline	10	14	13	33

Most of the scaffolding workers both in trained and untrained groups had usually used safety helmets at work. Safety harnesses were never used by the scaffolding workers questioned. There were only 40% of trained workers and 28% of untrained using a lifeline. Safety belts were the type of fall arresting equipment usually used by the trained workers: thirteen workers answered "always", nine workers replied "often" and the other two workers replied "Occasionally". Twenty-two untrained workers claimed that they always or often use safety belts. Twenty-four of them would be using safety belts occasionally.

Figure 10 – Use of Safety Belt

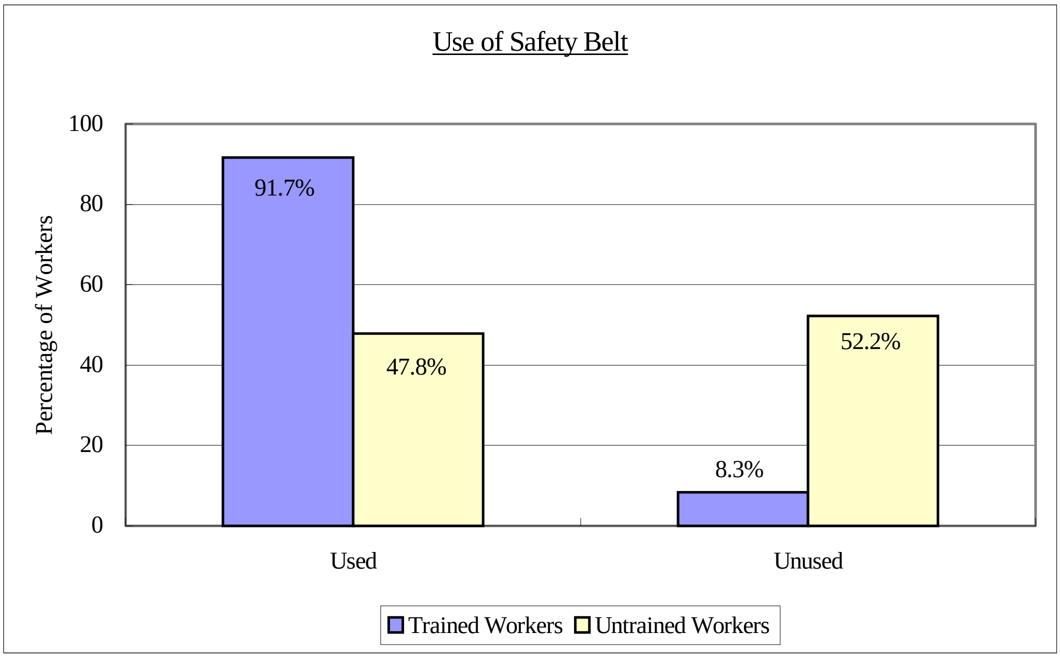


Table 19 – Use of Safety Belt

	Used		Unused	
	Number	Percentage	Number	Percentage
Trained Workers	22	91.7%	2	8.3%
Untrained Workers	22	47.8%	24	52.2%

A chi-square (χ^2) test was done to determine whether there is a significant difference between the trained and untrained workers in practice of using safety belt.

Since there was a 2 X 2 contingency table, the formula applied was

Calculated $\chi^2 = \Sigma (|O-E|-½)^2/E$ (1)

Null hypothesis H_0: There is no significant association between 'statue of training' and 'practice of use of safety belt'.

H_1: 'Statue of training' and 'practice of use of safety belt' are not independent, they are associated

The level of significance is 0.05.

Table 20 – Observed and Expected Frequencies of Practice of Use of Safety Belt

	Used	Unused	Row Totals
Trained Workers	22 (Observed) 15.09 (Expected)	2 (Observed) 8.91(Expected)	24
Untrained Workers	22 (Observed) 28.91 (Expected)	24 (Observed) 17.09 (Expected)	46
Column Totals	44	26	Grand Total 70

All the expected values in the table are greater than 5.

$\chi^2 = (|22-15.09|-½)^2/15.09+(|22-28.91|-½)^2/28.91+(|2-8.91|-½)^2/8.91$

$+(|24-17.09|-½)^2/17.09$

$\chi^2 = 2.73+1.42+4.62+2.41=11.17$

The degrees of freedom is (2-1)X(2-1)=1

The χ^2 obtained from the chi-square distribution table (Ronald 1995, p.A18) of 0.05 level of significance is equal to 3.84.

Since Calculated χ^2 > Tabulated χ^2, the null hypothesis is rejected. The ‘status of training’ and ‘practice of use of safety belt’ were significantly associated.

It was concluded that there is a significant difference between the trained and untrained workers in practice of using safety belt.

7.11 <u>Accident analysis</u>

From the results of the survey, it was revealed that there was one accident involving trained workers and two accidents involving untrained workers recorded in the studying period.

Table 21 – Accident Records of Trained and Untrained Workers

	Suffered from Accident	Did not suffer from Accident
Trained Workers	1	23
Untrained Workers	2	44

Because the expected values for trained and untrained workers who suffered from accidents were 1.03 and 1.97 respectively, the chi-square test was not done to determine the association between the two variables ‘status of training’ and ‘frequency of accidents’.

The incidence rate is the common indicator of safety performance, which is adopted by the Labour Department of Hong Kong. For easy reference, incidence rates of trained and untrained workers were calculated and compared, to establish the difference between these two groups of workers. Since

$$\text{Incidence rate} = \frac{\text{Total number of accidents}}{\text{Number of persons worked}} \text{ X } 1{,}000 \qquad (3)$$

(Boyle, 1986), therefore the incidence rates as shown in the Table 21 for twenty-four workers from the trained group and forty-six workers from the untrained were 41.7 and 43.5 respectively.

Table 22 – Incidence Rates of Trained and Untrained Workers

	Number of Accident	Number of Workers	Incidence rate
Trained Workers	1	24	41.7
Untrained Workers	2	46	43.5

8. <u>Discussion</u>

A total of twenty-four questionnaires obtained from the workers who had trained in scaffolding safety were classified as the experimental sample (trained group), which constituted about 80% of the target population, thirty trained scaffolding workers. Another forty-six questionnaires answered by the workers who had not received scaffolding safety training they were classified as the control sample (untrained group). This is approximate 8% of the population of about six hundred scaffolding workers of ABC Construction Company.

The ages of the trained and untrained groups were divided into five ranges and were shown in the Table 1 and Figure 1. The mean ages of the two groups were comparable, 43.92 of trained group and 43.48 of untrained group. There was no obvious difference in the experience of workers either in construction sites or scaffolding works between the experimental and control groups. About 90% of workers have had over five years site experience and half of the workers have been working in the construction field for fifteen years or more. It appeared that almost all of them have less experience in scaffolding works compared to those with site experience. The average scaffolding experience and standard deviation of both groups was about 9 years and 5.60. About 65% of workers, both trained and untrained, have had over five years scaffolding experience and about 17% of them have been working in scaffolding work for fifteen years or more.

Scaffolding workers in both trained and untrained groups had usually received induction training. Most of the workers surveyed have been trained for basic safety training on working at height, personal protective equipment and use of fall arrest equipment. The percentages of workers trained in the induction and basic safety training in both groups were similar (refer to Table 4). All twenty-four workers of the trained group had received training in scaffolding safety but the other forty-six workers of untrained group had not received such training.

The awareness of level of risk on erecting or dismantling scaffolding was asked in question (10) of the questionnaire, the views of scaffolding workers was reflected in the choice of five degrees of risk level. It was found that the 'status of training' and 'awareness of level of risk' are significantly associated ($P<0.02$). There was a significant difference between the trained and untrained workers in respect of the awareness of risk level. In Table 6, the trained workers observed were more than the expected one under the null hypothesis in concerning the risk level in erecting or dismantling scaffolding, while the opposite was true for the untrained workers. More of trained workers were aware of the high level of risk in scaffolding works, but the majority of untrained workers believed that there was a medium or lower level of risk in doing their works. It was concluded that the scaffolding safety training could train the workers to have batter concept of risk level and arouse their awareness of risk.

Besides the awareness of risk level, the interviewees were also questioned for their views on potential hazards in question (11) of the questionnaire. This question was to test their awareness of common potential hazards of scaffolding works. Results, it indicate that the percentage of trained workers was greater than the percentage of untrained workers in identifying of potential hazards, e.g. falling, falling objects or structural instability. Falling was usually recognised by the scaffolding workers. Some workers in the untrained group were unaware of the potential risks in falling objects and structural instability of scaffolds. About 79% of trained workers recognised all three hazards listed in the question while about 30% of untrained workers knew all the common potential hazards. The chi-square test showed that there was a significant difference between trained workers and untrained workers in identifying of common potential hazards ($P<0.01$). More trained workers than expected were able to identify the common potential hazards associated with erecting or dismantling scaffolding, and vice versa. It revealed that the scaffolding workers' awareness of potential hazards could be improved by scaffolding safety training.

The untrained workers did not really understand the level of risk and potential hazards associated with scaffolding works. However, the workers trained in scaffolding safety were well aware of the common potential hazards and the high level of risk in association with erecting or dismantling scaffolding.

Understanding of the safety requirements in regulations and code of practice for scaffolding safety is essential in order to ensure a good of safety standard and practice adopted by the scaffolding workers on erecting or dismantling scaffolding. It was found by the chi-square test that there was a significant association between 'status of training' and 'knowledge of the requirements in regulations and code of practice for scaffolding safety' ($P<0.01$). All the trained workers knew the safety requirements while the untrained workers were less than the expected frequency in understanding of such requirements for scaffolding safety. It could be concluded that the scaffolding workers would learn the knowledge of safety requirements in regulations and code of practice from the scaffolding safety training.

While erecting or dismantling scaffolding, the higher proportion of untrained workers compared with the trained workers would be working by experience, following the co-workers, following the procedure/guidance and following the supervisor’s instruction. However, almost all the workers of trained group would be applying their learning from training. It was also confirmed by the chi-square test that there was a significant association between the ‘status of training’ and ‘adoption of knowledge learnt from training’ ($P<0.01$). More of the trained workers than the expected frequency were adopting knowledge learnt from training, but it was opposite for the untrained workers. It appeared that the trained workers have relied on their knowledge learnt from the training. They would be doing their jobs by knowledge learnt rather than adopting past experience from trial and error. But as the control workers had not obtained adequate information and knowledge in erecting or dismantling scaffolding, perhaps they might be doing this by their own experience, following co-workers, and instruction given by their supervisor. It revealed that scaffolding safety training could enhance the knowledge of works.

For the practice of fall protection measures, the workers interviewed were required to select the appropriate fall protection measures in their answers for the question. All the workers in both trained and untrained groups have adopted the guard-rails as the major fall protection measures. It was found that the ‘status of training’ and ‘identification of common fall protection measures’ were significant associated ($P<0.02$). More trained workers than expected were able to identify all the fall protection measures listed in the question (9) of questionnaire, but only half of the untrained workers identified all the common fall protection measures. Also, the percentage of trained workers was greater than the percentage of untrained workers in identifying toe board, planking, access and egress, and safety netting as the fall protection measures. It could be concluded that the scaffolding workers could improve their practice of fall protection measures by attending scaffolding safety training.

In three kinds of fall arresting equipment described in question (4) of the questionnaire, the safety belt was commonly adopted by the scaffolding workers both trained and untrained but the safety harness was seldom used by them. It was found that there was a significant difference between the trained and untrained workers in using of safety belt ($P<0.01$). As the workers of trained group have a better concept of potential hazards, understanding of risk and adequate knowledge, they were found always using the safety belt while working. In the untrained group, half of them would be using their safety belt at times. The untrained workers might not have recognised the need, usage and function of fall arresting equipment. Scaffolding safety training could improve scaffolding workers practice in the use of fall arresting equipment.

From the above, there were significant differences between the trained and untrained groups of awareness of level of risk and potential hazards, knowledge of works and safety requirements and practice of fall protection. The workers of the trained group are well aware of the common potential hazards and level of risk associated with the erecting or dismantling tubular steel scaffolding. Also, they understood the requirements in regulations and code of practice, and the appropriate fall protection measures in carrying out scaffolding works. Though almost all the scaffolding workers, both trained and untrained, had acquired the induction training and basic safety training on working at height, personal protective equipment and use of fall arresting equipment, there were weaknesses found in the scaffolding workers of the untrained group on awareness of level of risk and potential hazards, knowledge of works and safety requirements, and practice of fall protection. Perhaps, these kinds of safety training did not arouse the awareness of the workers and provide adequate knowledge to them in erecting or dismantling of scaffolding. However, it was essential that scaffolding safety training changes the attitude and behaviour of trained workers. The trained workers have become accustomed to using safety belts when erecting or dismantling scaffolding and would apply the knowledge learnt from the training at work. They could identify potential hazards, take appropriate actions, and avoid risk taking. Hence, the scaffolding safety training should be deemed to be enhancing scaffolding workers awareness, knowledge, and practice of fall protection, by which they will have positive attitude in carrying out their jobs correctly and safely.

From the accident data collected about both trained and untrained groups, it was found that three accidents related to erecting or dismantling of scaffolding were recorded during the studying period. An accident was reported by a trained worker and the other two accidents were recorded by the untrained group. Two of the injured workers suffered contusion from falling objects and the other fell from a broken timber board. Because of the expected values of accident frequency in both trained and untrained groups were less than 5, the chi-square test was not conducted to determine the association of 'status of training' and 'frequency of accidents'. The incidence rate commonly applied in the construction industry of Hong Kong was used to determine the accident performance of both trained and untrained groups. It was shown that the incidence rates for the trained and untrained groups of scaffolding workers were 41.7 and 43.5 respectively. The analysis of accident data was unable to confirm whether there was any significant difference between the trained and untrained groups of accident records in the studying period to support the hypothesis. The reasons for this may be insufficient data was obtained due to the short study period and the small study population.

The incidence rate of the untrained group was slightly higher in comparison with the incidence rate of trained group. However, it was difficult to determine any significant change, increasing or decreasing of the incidence rate, of the experimental group (trained workers) from this slight difference.

9. Conclusion

There was no major difference in the age or working experience between the workers of trained and untrained groups. Almost all the scaffolding workers, both trained and untrained, had attended safety induction training and most of them had obtained the basic safety training on working at height, personal protective equipment and use of fall arresting equipment. All twenty-four workers of the experimental group had received training in scaffolding safety, however it was noted that none of forty-six scaffolding workers of the control group had obtained such training. The scaffolding workers, except the workers of trained group, of ABC Construction Company are without training on scaffolding safety.

From the results drawn from the above, there is significant differences between the trained and untrained groups of awareness of level of risk and potential hazards, knowledge of works and safety requirements and practice of fall protection. The scaffolding workers of untrained group were found to have weaknesses in awareness of level of risk, awareness of potential hazards, knowledge of the requirements in regulations and code of practice for scaffolding safety, knowledge of works about erecting or dismantling scaffolding, practice of fall protection measures, and practice of use of safety belt.

It was found that an accident was reported by a trained worker and two accidents were recorded by the untrained workers in the studying period. The incidence rates of trained workers and untrained workers were 41.7 and 43.5 respectively. Dereamer said, "…a large percentage of industrial accidents are due to poor work habits and a lack of knowledge or skill about the job."(1980,p.160). Although the hypothesis could not be confirmed by the accident records, we have noted that scaffolding safety training has improved the trained workers awareness of level of risk and potential hazards, knowledge in safety requirements and correct procedure of works, and practice of fall protection measures. Moreover, it was quite important to note that the trained workers have got into the habit of using safety belt at work and have adopted the knowledge learnt from the training. These changes in the attitude and behaviour of trained workers will enable them to avoid exposing themselves to hazardous situations, doing their jobs according to the correct procedure and using fall protection equipment properly. The risk of falling on erecting or dismantling scaffolding should therefore be reduced to a reasonable level. Though there may be insufficient evidence to confirm the significance of scaffolding safety training in reducing accidents, scaffolding safety training helps the trained workers to minimise their risk from falling. Hence, the risk of accidents could then be reduced as they are working to proper procedure with adequate fall protection on erecting or dismantling scaffolding. It was concluded that the scaffolding safety training would reduce the risk of accidents when erecting or dismantling scaffolding. Therefore, the hypothesis should be accepted in principle and the aim of this study was attained.

In spite of the significance in reducing the risk of accidents, the scaffolding safety training could enhance the scaffolding workers awareness of level of risk and potential hazards, knowledge of works and safety requirements, and practice of fall protection in erecting or dismantling scaffolding. Else said, “If an organisation wishes to remain globally competitive in the knowledge era it would be wise to invest in the development of its employees as learners and to find ways of simulating and harnessing their creativity in the workplace."(p.16, 1998). In order to minimise the risk of falling from scaffolding works, all the scaffolding workers of ABC Construction Company are recommended to attend the scaffolding safety training.

Since there are limitations of time and budget of the study, the accident data collected in this study might not be enough to represent the accident performances of both trained and untrained groups accurately. Sufficient time and adequate sampling size should be provided in the further study. The appropriate safety training is not only the necessity for the scaffolding workers of ABC Construction Company, but it is also a need for all workers involved in scaffolding works of Hong Kong. It is suggested that the study should be extended beyond the projects run by ABC Construction Company to the construction industry of Hong Kong. Also, a systematic observation should be conducted in the further study to ascertain whether there are significant changes in the attitude and behaviour of trained workers upon receiving scaffolding safety training.

However, this study does give us a view and a direction for further study. The aim of further study is not only observing the training but also to have views on the standard and design of scaffolding as well as the management of scaffolding works.

10. Recommendations

Based on the findings and limitations of the study, it is recommended that:

(a) All scaffolding workers should attend the scaffolding safety training.

(b) It is suggested that the recommendation in the review report from Mr. Anderson and Mr. Smith of International Safety Council should be followed to include the scaffolding training into the certification courses for workers working in hazardous trades run by CITA or other institutions (Anderson and Smith, 1996).

(c) The limitations of the review of accident records should be noted for further evaluation's use.

(d) Sufficient time and adequate sampling size should be provided in further study.

(e) A similar study should be conducted for the construction industry of Hong Kong.

(f) A systematic observation should be conducted in the further study to ascertain attitude and behaviour changes of trained workers.

END

Prepared by Ma Chi-Sing

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Appendix (A)

Confidential

Questionnaire for Assessment of workers
Engaged in erection/dismantling scaffolding

Interviewer: ___________________ Ref.: ___________________

Note: This questionnaire is prepared to collect information for assessing significance of scaffolding safety training. Your opinions are very valuable. The completed questionnaire will be kept confidential and used for the assessment only. It may be destroyed after the results have been determined.

Occupation: ____________________ Age: __________

(1) How long have you been working in construction site? ☐☐ Years

(2) How long have you been working in metal scaffolding? ☐☐ Years

(Please tick the appropriate answer in the following questions)

(3) Which of the following safety training have you received?

a. Induction training	Yes______	No______
b. Working at height	Yes______	No______
c. Personal protection equipment	Yes______	No______
d. Scaffolding safety	Yes______	No______
e. Use of fall arresting equipment	Yes______	No______

(4) How often do you use the following safety protection equipment at work?

	Never	Occasionally	Often	Always
a. Safety helmet	______	______	______	______
b. Safety shoes	______	______	______	______
c. Safety belt	______	______	______	______
d. Safety harness	______	______	______	______
e. Lifeline	______	______	______	______

(5) How do you erect or dismantle scaffolding?

a. By experience	Yes______	No______
b. To follow the working of co-workers	Yes______	No______
c. To follow the procedure/guidance obtained	Yes______	No______
d. Under the instruction of foreman	Yes______	No______
e. By knowledge learnt from scaffolding training	Yes______	No______

(6) Do you obtain the procedure of erection or dismantling scaffolding before work?

Yes______ No______

(7) If <u>Yes</u> in Question (6),
How do you acquire the procedure or guidance?

a. Given by your immediate supervisor Yes______ No______
b. Required from your immediate supervisor Yes______ No______
c. Obtained from the scaffolding supplier Yes______ No______
d. Obtained from the co-worker Yes______ No______

(8) Do you know the requirements of statute law and code of practice in scaffolding safety?

Yes______ No______

(9) How do you think the appropriate measures of fall protection on erection or dismantling scaffolding?

a. Guardrails Yes______ No______
b. Toe board Yes______ No______
c. Planking Yes______ No______
d. Access and egress Yes______ No______
e. Safety netting Yes______ No______
f. Fall arresting equipment (e.g. safety belt) Yes______ No______
g. None of the above Yes______ No______
h. Others______________________________

(10) How do you think the level of risk on erection or dismantling scaffolding?

Very low____ Low_____ Medium_____ High_____ Very High_____

(11) How do you think the hazards of erection or dismantling scaffolding?

a. Fall of person Yes______ No______
b. Falling objects Yes______ No______
c. Structural instability Yes______ No______
d. Others______________________________

(12) Have you had any injury related to the erection or dismantling scaffolding?

Yes______ No______

If Yes, please give details

a. Accident happened on ______________________________

b. Cause of accident ____

<u>END</u>

保密文件

評估從事搭建及拆卸金屬棚架工人的調查問卷

調查員:______________________ 編號:____________________

注意: 此問卷調查是爲了收集資料用來評估棚架安全訓練的意義及重要.
你的意見是十分有價值的. 完成的問卷會被保密及只會用於評估.
當結果完成後, 問卷將會被銷毀.

職業: ________________________ 年齡: ______________

(1) 你在建築地盤工作了多久? ☐☐年

(2) 你在架設棚架方面工作了多久? ☐☐年

(請在下列問題的適當答案上加 號)

(3) 你接受了下列那些安全訓練?

a. 基本安全訓練	是 ______	否 ______
b. 高空工作	是 ______	否 ______
c. 個人防護設備	是 ______	否 ______
d. 棚架安全	是 ______	否 ______
e. 防止下墮設備的使用	是 ______	否 ______

(4) 在棚架工作時, 你怎樣使用下列的安全防護設備?

	沒有使用	間中使用	經常使用	一定使用
a. 安全帽	______	______	______	______
b. 安全鞋	______	______	______	______
c. 安全帶	______	______	______	______
d. 降傘式安全帶	______	______	______	______
e. 救生繩	______	______	______	______

(5) 你如何搭建或拆卸棚架?

a. 憑經驗	是 ______	否 ______
b. 跟隨一起工作的工友	是 ______	否 ______
c. 按照獲得的工序或指引	是 ______	否 ______
d. 依照管工的指令	是 ______	否 ______
e. 從棚架安全訓練中得到的知識	是 ______	否 ______

(6) 在工作前, 你是否獲取搭建或拆卸棚架的工作程序?

是 ______ 否 ______

(7) 如在問題(6)中選答 ‘是’, 你如何獲得此工作程序?

a. 由所屬管工給予而獲得 是 ______ 否 ______
b. 向所屬管工要求而獲得 是 ______ 否 ______
c. 從棚架供應商獲得 是 ______ 否 ______
d. 從工友中獲得 是 ______ 否 ______

(8) 你是否對棚架的法例及安全工作守則的要求有所認識?

是 ______ 否 ______

(9) 在搭建棚架時, 你認爲下列那些是合適的防止下墮方法?

a. 圍欄 是 ______ 否 ______
b. 踢腳板 是 ______ 否 ______
c. 蓋板 是 ______ 否 ______
d. 出入通道 是 ______ 否 ______
e. 安全網 是 ______ 否 ______
f. 防止下墮設備 (如安全帶) 是 ______ 否 ______
g. 以上皆不是 是 ______ 否 ______
h. 其他 ______________________________

(10) 你認爲搭建或拆卸棚架有多少風險程度?

非常低______ 低______ 普通______ 高______ 非常高______

(11) 你認爲下列那些是搭建或拆卸棚架的危險?

a. 人體下墮 是 ______ 否 ______
b. 物件下墮 是 ______ 否 ______
c. 棚架結構不穩定 是 ______ 否 ______
d. 其他 ______________________________

(12) 你是否曾經因搭建或拆卸棚架而受傷?

是 ______ 否 ______

如選答 ‘是’, 請提供有關資料

意外發生日期 ____________________________________

意外的成因 ____

完