SAFETY RESEARCH ON WORKERS AT CONSTRUCTION SITE

by

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ABSTRACT

The construction industry has always been one of the main sectors to boost Malaysia's economy and it will help to steer Malaysia into year 2020. However, before we can take pride of that achievement, we must take note of the lagging safety record in the construction industry. The website of Department of Occupational Safety and Health (DOSH) has records of occupational accidents which happened in recent years (refer to Appendix A). These accidents happened due to poor safety practices and human factors. Occurrence of such tragedies should never be regarded as necessary consequences of development and advancement. Instead, the major problems such as ignoring safety guidelines, carelessness, indiscipline and lack of supervision should be tackled. If strict standards have been set, enforcement has been carried out and procedures and regulations have been adhered to, the rate of accidents will definitely be reduced. Besides that, loss of lives could be avoided and financial losses could be cut. Therefore, this research will discuss the main factor of accident occurrences – HUMAN FACTOR and analyzes the various regulative institutions involved in occupational safety. It also studies the construction safety practices which will help to reduce the rate of accidents. These safety practices includes personal protective equipment, emergency response, fire protection and prevention, signs and barriers, scaffold, piling, cranes and excavation. Lastly, there are some suggestions in this thesis which might serve as good solutions to reducing accident occurrences. It is worth noting that all the players in this industry should always be sensitive towards this problem. They should cooperate and take necessary measures at site to resolve the problem.

ABSTRAK

Industri pembinaan merupakan salah satu sektor utama yang dapat meningkatkan ekonomi Malaysia dan ia akan membantu untuk mengemudikan Malaysia ke arah Wawasan 2020. Tetapi sebelum kita dapat berbangga dengan pencapaian ini, perhatian perlu diberikan kepada isu keselamatan yang ketinggalan dalam industri pembinaan. Laman web Jabatan Keselamatan dan Kesihatan Pekerjaan (JKKP) mempunyai rekod kemalangan pekerjaan yang berlaku kebelakangan ini (rujuk Appendix A). Kemalangan-kemalangan ini berlaku kerana amalan keselamatan yang tidak baik serta faktor manusia. Trajedi ini tidak boleh dianggap sebagai akibat daripada pembangunan. Sebaliknya, masalah utama seperti tidak patuh kepada langkah keselamatan, kecuaian, kurang disiplin serta kurang pengawasan perlu ditangani. Sekiranya piawai ketat ditetapkan, penguatkuasaan dijalankan dan peraturan dipatuhi, kadar kejadian kemalangan akan dapat dikurangkan. Selain itu, kehilangan nyawa juga dapat dielakkan dan kerugian wang dapat dikurangkan. Maka, kajian ini membincangkan faktor manusia yang mengakibatkan kemalangan dan institusi pengawalan yang memantau keselamatan. Ia juga mengkaji amalan keselamatan yang dapat mengurangan kemalangan. Akhirnya, beberapa cadangan telah diberi dan diharap dapat membantu penyelesaian masalah kemalangan di tapak bina. Semua pihak yang terlibat dalam industri pembinaan perlu sentiasa prihatin terhadap masalah ini. Mereka perlu bekerjasama antara satu sama lain untuk menangani masalah ini.

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1. INTRODUCTION

1.1 Overview

Since gaining independence in 1957, Malaysia has made tremendous progress economically. Malaysia's economic growth has been climbing at a very steady pace last year, giving rise to expectations that GDP this year will likely expand at a stronger rate than in recent years. This is certainly good news to Malaysians. According to ASIAINC magazine in August 2004, construction industry will be the 5th most significant sectoral contributor to our country GDP growth in 2005. Therefore, construction and development are important to ensure that our country would achieve Vision 2020 (when we will attain industrialized status in less than 20 years from now), as aspired by our former Prime Minister Dr. Mahathir. During this time, the construction industry has been able to largely meet the challenges associated with rapid physical development. Yet while other economic sectors have undergone tremendous transformation, the construction industry still lags in many respects, one of which is occupational safety and health.

According to the Department of Occupational Safety and Health (DOSH), compliance with OSHA 1994 and its regulations by the employers is still not up to the mark and needs further improvement, as said by YB Datuk Dr. Fong Chan Onn in the opening ceremony of "Regional Conference on Occupational Safety and Health" on 20th March 2001.

Improving occupational safety in the Malaysian construction industry will not be easy to achieve despite sufficient safety legislation and regulative institutions. **What matters most is the human factor**. Each and everyone involved in this industry needs to be instilled with self-awareness about occupational safety when they are at work. No matter how much regulative implementation is being done by the authorities, the effectiveness of occupational safety still depends largely to cooperation amongst architects, consulting engineers, contractors, management, workers and other related parties.

Besides human factor, some of the most common contributing factors are as follows: 1) physical hazards, 2) environmental hazards, 3) no safety regulations or poor ones, and 4) poor communication within, between and among the various trades working at a construction site.

According to the United States National Safety Council, work-related accidents cost the United States almost USD$50 million every year. This figure includes costs associated with lost wages, medical expenses, insurance costs and indirect costs. The number of persons injured in workplace accidents in a typical year is 3 per 100 persons working in construction. In the U.S. workplace, there is one accidental death approximately every 51 minutes, and one injury every 19 seconds.

We have to realize that accidents at construction sites do not only incur financial losses but also cause injuries and take lives away. Thus it is important to be sensitive

towards this issue and take necessary precautious as well as preventive measures to curb accidents.

1.2 Objectives

The objectives of this study are as follows:

1. To create self-awareness in those working in construction sites about the importance of occupational safety

2. To analyze various regulative institutions involved in occupational safety

3. To analyze safe working conditions and safety practices

4. To analyze safety measures and safety equipments

5. To provide suggestions for improvement

1.3 Research Scope:

This is a case study research about **Safety Research on Workers at Construction Site**. It requires getting information from these two sites, namely:-

i. Projek Pembinaan Pangkalan Polis Marin Zon Pulau Pinang at Batu Uban, Pulau Pinang by Wabina Construction & Engineering Sdn. Bhd. This project involves constructing reinforced concrete buildings, jetty, helicopter pad and steel structures.

ii. Projek Pembinaan Kilang Kimia Zue Huat at Taman Perindustrian Bukit Minyak, Pulau Pinang by South Island Building Sdn. Bhd. This project involves constructing steel structural factories.

The research had been done on existing sites. Workers' safety is the main concern in this research whereby their personal protective equipments and safety practices are being analyzed.

2. LITERATURE REVIEW

2.1 Factors affecting safety performance on construction sites

Safety at work is a complex phenomenon, and the subject of safety attitudes and safety performance in the construction industry is even more so. In the construction industry the risk of a fatality is five times more likely than in a manufacturing based industry, while the risk of a major injury is two and a half times higher. Each year, up to 120 people are killed on construction sites in the UK and there are about 3000 workers who suffer from a major injury in construction related accidents. Unfortunately, it is not only construction workers who suffer from accidents but, on average, one member of the public, including children, is killed each month, with a further 1200 major injuries reported under RIDDOR (Reporting of Injuries, Diseases and Dangerous Occurrence Regulations). Apart from the human cost of suffering an accident, the economic effect can be devastating. Every £1 of an accident cost, that an insurance company has to pay out, could cost the contractor from £5 to £50 in indirect costs. These indirect costs will range from product and material, to legal costs. Furthermore, it has been reported that there are over 370 million lost working days due to classified incapacity at work and over 15 million days are lost due to industrial injuries. In general, accidents at work occur either due to lack of knowledge or training, a lack of supervision, or a lack of means to carry out the task safely, or alternatively, due to an error of judgment, carelessness, apathy or downright reckless. In addition to these factors, the short term and transitory nature of the construction industry, the lack of a controlled working environment and the complexity and diversity of the size of organizations, all have an effect on safety

performance within the industry. In construction, it is suggested that `unsafe behaviour' is the most significant factor in the cause of site accidents and therefore provides evidence of a poor safety culture. Nevertheless, according to a report by the HSE (Health and Safety Executive), nearly 90% of all construction accidents leading to death could (or should) have been prevented, 70% by positive management action. The factors influencing safety on construction sites are discussed. The impacts of the historical, economical, psychological, technical, procedural, organizational and the environmental issues are considered in terms of how these factors are linked with the level of site safety.

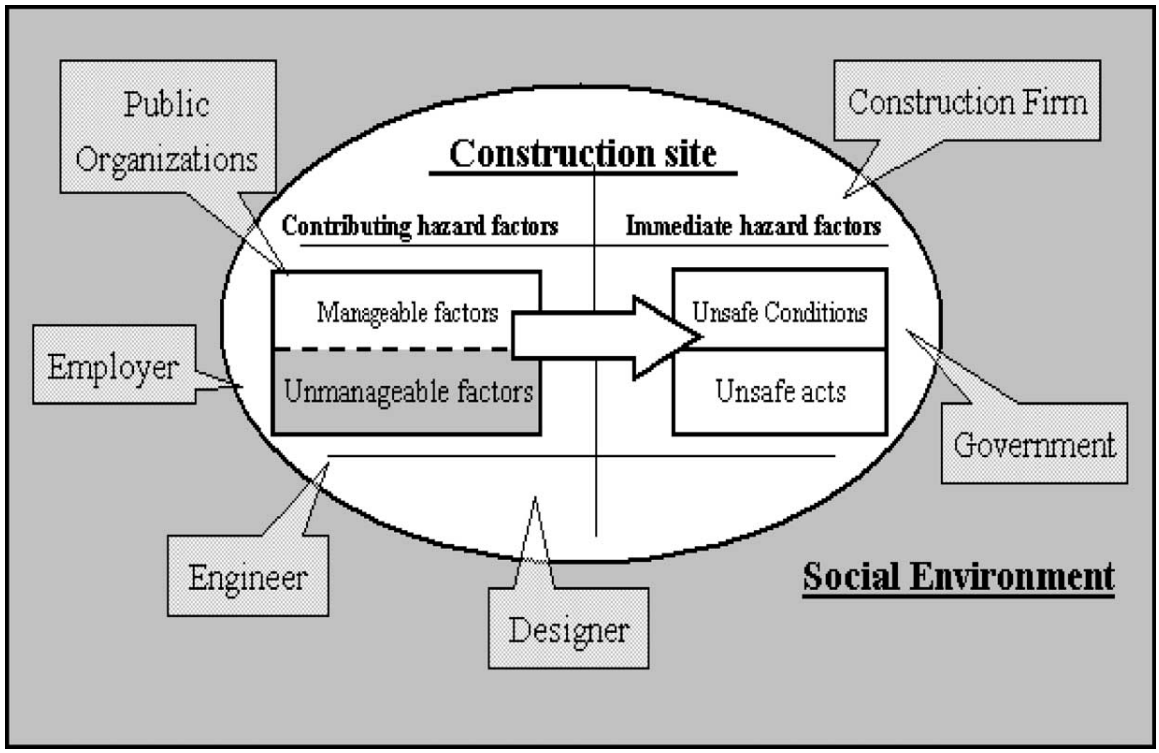


Figure 2.1.1: Hazard factors on construction site

(Source Fang et al., 2003)

2.2 Hazard factors

The causes of accidents had been grouped into two categories: *immediate causes of accidents* and *contributing causes of accidents*. The former includes unsafe acts and unsafe conditions, while the latter includes mental and physical conditions of the workers and the management policies. In construction industry, all unsafe conditions on construction sites are grouped into four categories: management actions/inactions, unsafe acts of worker or coworker, non-human-related event(s) and an unsafe condition that is a natural part of the initial construction site conditions.

As its definition indicates, hazard is real or potential cause of accidents. Therefore, hazard factors can be classified by referring to the classification of accident causes. The hazard factors outside the construction site are such as the safety involvement of the employer, designer, subcontractor, consultant, insurer and the public demand and concern on occupational health and safety. All onsite hazards, including the physical conditions and all on-site activities of mangers, workers and other organizations, are then grouped into two categories: immediate factors and contributing factors. An *immediate hazard factor* is a factor that can cause an accident physically and directly, whether the accident happens or not, including unsafe acts and unsafe conditions. A *contributing hazard factor* is a factor that can further explain immediate hazard factor, including safety management policy, manager and worker's mental or physical conditions, initial construction site conditions, and so on (Figure 2.1.1).

Among the contributing factors, those that are manageable to promote the workplace safety performance through reasonable project safety management efforts are grouped into *management factors*. This paper focuses on the safety performances of routine management factors on construction sites in China.

2.3 Evaluation of scaffold safety at construction sites

One hundred and thirteen scaffolds were evaluated between April 2001 and February 2002 that had construction workers at work and scaffolds present that appeared to be in use. The number of workers on the construction sites ranged from 1 to 1,000. The number of workers on the scaffold ranged from 0 to 360. Scaffold sizes ranged from a single buck 10 ft high to a scaffold 500 feet long, 8 ft wide and 280 feet high. Work ranged over the spectrum of construction tasks with the most common activities being masonry (44 sites, 39% of sites), carpentry (33 sites, 29%), and painting (14, 12%). Other types of work performed from scaffolds included plastering, tuck pointing, sheet metal work, welding, pipefitting, roofing, glazing, and decorative painting. In order to classify scaffold safety, scaffolds were rated as unacceptable or acceptable by the researchers based on the danger to the worker on the scaffold. If there was a risk of serious injury or death, the scaffold was classified as unacceptable. This could include both imminent hazards and serious hazards. Examples of imminent hazards are workers on a single plank where a slip could result in a fall, workers on scaffolds without railings or fall arrest systems, and severely overloaded or scaffolds without ties. An example of a serious but not imminent hazard would be missing railings, on the same platform as the workers, but more than 10 feet away from them. If there were no hazards of any kind on

a scaffold, the scaffold was rated as acceptable. If the scaffold had various errors, but they were not obviously fatal to the worker (e.g., a ladder egress was not three feet above its platform, or there were missing toe-boards or only a couple of improper base plates) the scaffold was also rated as acceptable. Of 113 scaffolds, 77 (68.1%) were rated as acceptable and 36 (31.9%) were rated as unacceptable. Almost three quarters of the unacceptable scaffolds involved imminent hazards.

Scaffold sites in nine locations in the eastern United States were visited. These were classified into three geographic regions: (a) central Connecticut, Philadelphia, and Providence were classified as the Northern geographic region; (b) Birmingham, Jacksonville, New Orleans, and south Florida were classified as the Southern region; and (c) Baltimore and Washington, DC were classified scaffolds, or scaffold collapses. Of the 113 scaffolds, 30 (27%) had one or more structural flaws (e.g., the scaffold was out of square, not properly tied to the building, or had one or more missing or improper base plates). Some flaws, such as a few improper base plates, were considered acceptable unless some other factor such as overloading was present. Other flaws, such as lack of proper ties to the building where required, were always unacceptable. The second major category of scaffold safety problems are defined as fall protection problems (e.g., errors in planking, guardrails, or access that could result in the worker falling off the structure). According to Halperin and McCann, 2004, four factors were found to be highly statistically significant in correlation to a high overall scaffold safety rating. These were: (a) the scaffold safety training of the competent person present on the site; (b) who

erected the scaffold; (c) the type of scaffold; and (d) the number of workers present on the site.

Results on scaffold safety

This study evaluated the safety of 113 scaffolds and factors affecting their safety. On the one hand, more than two thirds of the scaffolds were acceptable. On the other hand, almost a third of the scaffolds were unacceptable and 23% – almost one scaffold in every four – had errors that could result in immediate tragedy. The correlation between the presence of a competent person who has scaffold safety training and scaffold safety is crucial. OSHA defines a competent person as one who is ‘‘capable of identifying existing and predictable hazards in the surroundings or working conditions that are unsanitary, hazardous or dangerous to employees, and who has authority to take prompt corrective measures to eliminate them.’’ The results of this study show that most scaffold competent persons do not have adequate training to allow them to ascertain when a scaffold is unsafe. This study clearly indicates a need for OSHA to specify what training is required for competent persons. Another important finding is that outside scaffold erection contractors manufacture safer scaffolds. Some large contractors maintain special crews who specialize in erecting scaffolds for that contractor. Such trained crews would likely erect safer scaffolds than workers who do not have much experience. Our study could not identify such experienced crews.

Given the limited resources available in construction safety, a triage method for scaffold inspections should be developed, in which every scaffold is inspected using the

rapid four-factor method (a) planking, (b) railings, (c) access, and (d) tying off to buildings. Those found to be perfect on these four factors could be waived for further inspection, and those found to be lacking in any of these areas could then be assessed for more serious inspection, with recommendations for repair.

Recommendations for safer scaffolding

Based on the findings of this study, several recommendations can be made as practical measures leading to safer scaffolding by Halperin and McCann, 2004.

1. Hire an outside scaffold erector.
2. Assure the presence of a competent person on the scaffold site who is trained with at least an OSHA scaffold user course.
3. Consider the appropriateness of frame scaffolding for the task. Using the most widely available scaffolding does not appear to lead to site safety.
4. Implement the *rapid four-factor inspection method*.

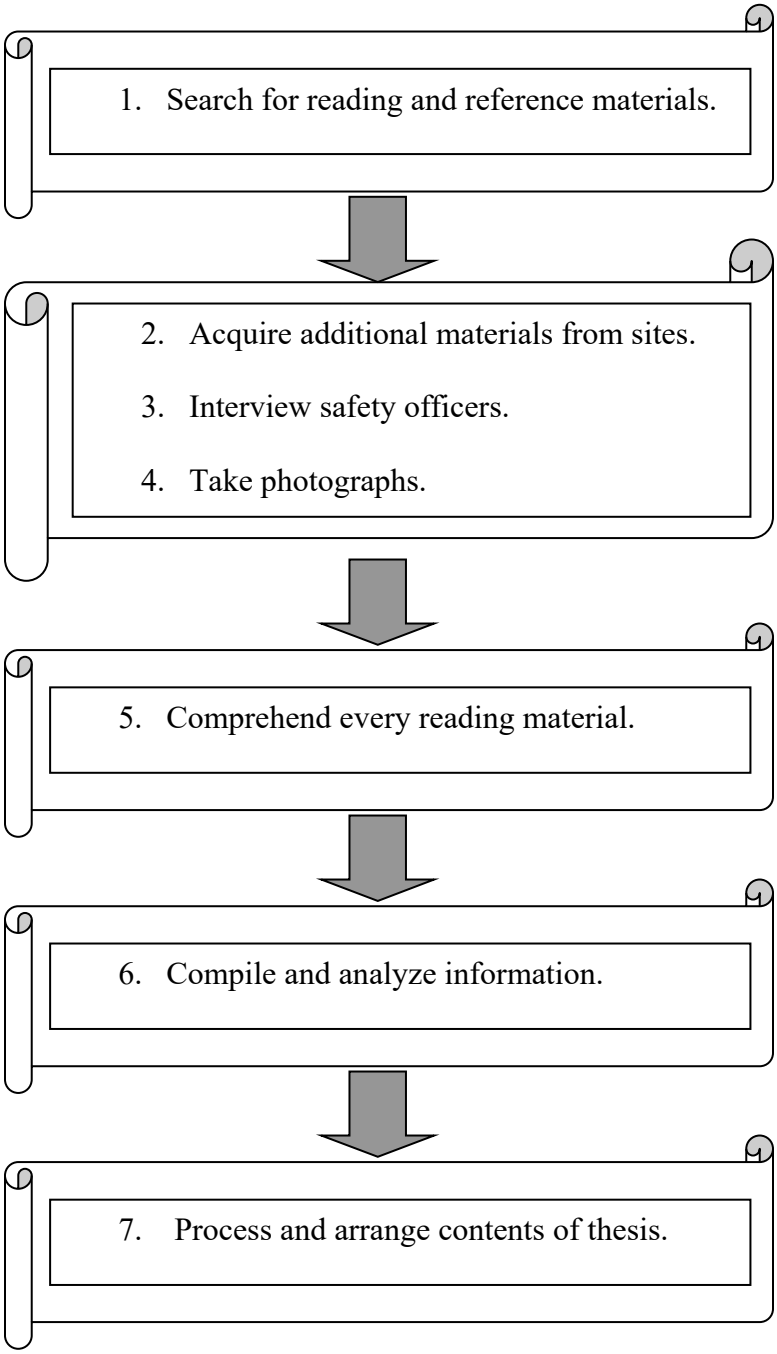
Impact on construction industry

Implementation of the above recommendations would result in safer scaffolds, reducing the number of deaths and injuries due to the use of scaffolds in construction. In particular, using the 4-factor method of scaffold inspections could result in a cost-effective way to identify one of the more dangerous problems in construction safety.

3 METHODOLOGY

3.1 Flowchart

The methodology to do this research is shown as the diagram below.



3.2 Elaboration

1. Search for reading and reference materials which are useful from books, magazines and websites. These materials will be used as references.

2. Acquire additional materials from sites. These materials include excavation permit, crane permit, company safety policies and program, and workers'safety data.
    i. Projek Pembinaan Pangkalan Polis Marin Zon Pulau Pinang at Batu Uban, Pulau Pinang by Wabina Construction & Engineering Sdn. Bhd.
    ii. Projek Pembinaan Kilang Kimia Zue Huat at Taman Perindustrian Bukit Minyak, Pulau Pinang by South Island Building Sdn. Bhd.

3. Interview safety officers at construction sites about the safety equipments that they have and safety measures which they must take during specific activities. Safety officers also told me about things which they do not use.

4. Take photographs which can explain and support thesis contents.

5. Comprehend every reading material by analyzing and making conclusions.

6. Compile and extract useful information from materials.

7. Process and arrange contents of thesis.

4. RESULTS AND DISCUSSION

4.1 Factors Causing Accidents

Some of the most common contributing factors are as follows: 1) physical hazards, 2) environmental hazards, 3) no safety regulations or poor ones, and 4) poor communication within. However, the most important aspect to be looked upon is **human factor**. Human factor is the main reason of accidents happening.

Human Factors

The human factors attribute accidents to a chain of events caused by human error. It consists of 3 factors that lead to human error: overload, inappropriate response and inappropriate activities.

Overload

A person's capacity is the product of such factors as his or her natural ability, training, state of mind, fatigue, stress and physical condition. The load that a person is carrying consists of tasks for which he or she is responsible and added burdens resulting from environmental factors (such as noise and distractions), internal factors (personal problems, emotional stress and worry) and situational factors (level of risk or unclear instructions). The state in which a person is acting is the product of his or her motivational arousal levels. Overload amounts to an imbalance between a person's capacity at any given time and the load that person is carrying in a given state.

Inappropriate Response

How a person responds in a given situation can cause or prevent an accident. If a person detects a hazardous condition but does nothing to correct it, he or she has responded inappropriately. Such responses can lead to accidents. In addition to inappropriate responses, this component includes tool and equipment incompatibility. The incompatibility of a person's workstation with regard to size, force, reach, feel and similar factors can lead to accidents and injuries.

Inappropriate Activities

Human error can be the result of inappropriate activities. An example of an inappropriate activity is a person who undertakes a task that he or she does not know how to do. Another example is a person who misjudges the degree of risk involved in a task and proceeds based on that misjudgment. Such inappropriate activities can lead to accidents and injuries.

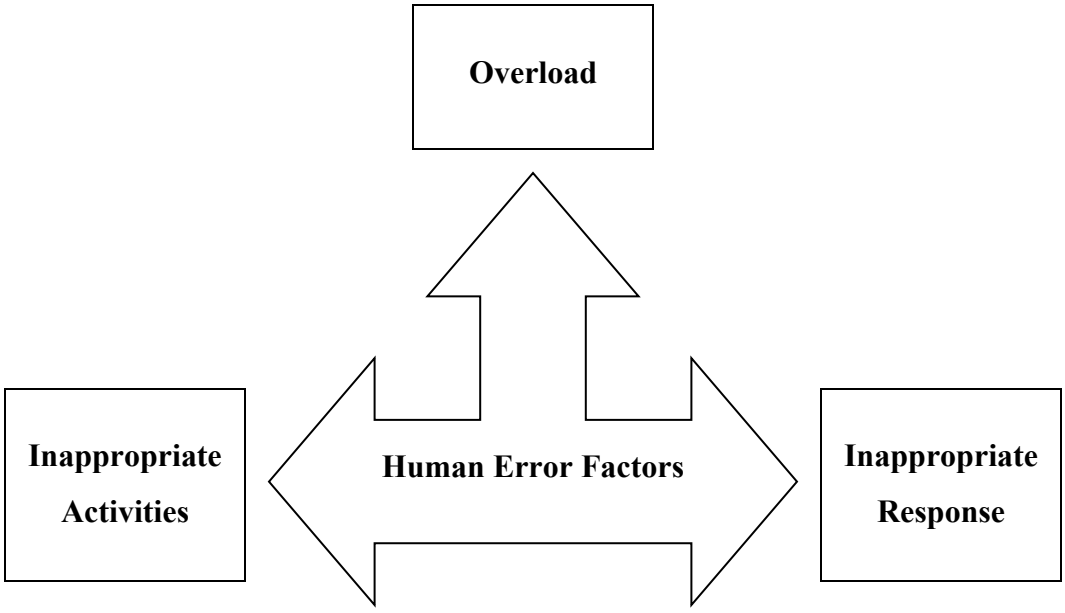


Figure 4.1.1: Factors that lead to human factors

4.2 Regulative Act/ Institutions

i. *Occupational Safety and Health Act 1994*

The new legislation on occupational safety and health was made in the year 1994. Occupational Safety and Health Act 1994 (Act 514) was approved by the Parliament in 1993 and was gazetted on February 1994. This legislation was made considering the fact that the Factory and Machinery Act 1967 only covers occupational safety and health in the manufacturing, mining, quarrying and construction industries, whereas the other industries are not covered. Workers that are covered by Factory and Machinery Act 1967 consists only of 24% of the nation's total man power, while Occupational Safety and Health 1994 would cover 90% of the nation's total man power and would exempt those working on ships and in the armed forces.

With the approval of this Act, starting from April 1994 the Department of Factory and Machinery has been renamed as the Department of Occupational Safety and Health (DOSH) and the Inspectors are called Occupational Safety and Health Officers.

OSHA 1994 complements rather than replaces all existing safety legislation and regulations such as the Workers Act 1966, the Factories and Machinery Act 1967, the Workers Social Security Act 1967 and the Factories and Machinery (Building Operations and Works of Engineering Construction) (Safety) Regulations of 1986. The objectives of this Act are:-

a) To secure the safety, health and welfare of persons at work against risks to safety or health arising out of the activities of persons at work.

b) To protect persons at a place of work other than persons at work against risks to safety or health arising out of the activities of persons at work.

c) To promote an occupational environment for persons at work which is adapted to their physiological and psychological needs.

d) To provide the means whereby the associated occupational safety and the health legislations may be progressively replaced by a system of regulations and approved industry codes of practice operating in combination with the provisions of this Act designed to maintain or improve the standards of safety and health.

In accordance with OSHA 1994, main contractors must take the initiative to familiarize themselves with whatever is permissible. They are required to formulate occupational safety and health policies, and inform the Department of Occupational Safety and Health (DOSH) of the specific measures that will be taken for each new project. Internal safety committees, responsible for ensuring that safety measures are implemented, have to be established on sites where the number of workers exceeds 40.

ii. The Department of Occupational Safety and Health (DOSH)

The DOSH, under the Ministry of Human Resources, is responsible for ensuring that all economic sectors abide by the safety legislation. This department is responsible for ensuring the occupational safety, health and welfare of people at work as well as protecting other people from the safety and health hazards. It is empowered to inspect

workplaces, enforce safety laws and prosecute offenders. The department is a government agency responsible for the administration and enforcement of legislations related to occupational safety and health for our nation, with a vision of becoming the organization which leads the nation in creating a safe and healthy work culture that contributes towards enhancing the quality of working life.

Objectives of DOSH:

- To draft (legislation) and regularly review via a tripartite process the policies, laws, codes of practice and guidelines pertaining to occupational safety, health and welfare as a basis for ensuring safety and health at work.

- To ensure, through enforcement and promotion activities, that employers, self-employed persons, designers, manufacturers or suppliers, importers and employees always practise a safe and healthy work culture and constantly comply with the existing laws, codes of practice and guidelines.

- To assist and provide specialist services in promotion activities, training, information dissemination and research activities organised by government and non-governmental agencies, institutions of higher learning, and associations of employers, employees and/or professionals in the effort to further upgrade the standard of occupational safety, health and welfare.

DOSH also has the power to prosecute errant main contractors in court. Even though it has lost cases on technical grounds or interpretation of the statute, DOSH officials opined that simply taking these violators to court is itself a victory as the importance of safety would have been impressed on the other party. DOSH does not keep a record of repeat violators as it is hoped that they would eventually change of their own accord. In addition to DOSH, there is the National Institute of Occupational Safety and Health (NIOSH). Established in 1992, its functions among others are to conduct training programmes, disseminate information, and provide consultation and other related services. So far as the construction industry is concerned, NIOSH targets major client organizations and main contractors as they can wield influence on main contractors and subcontractors respectively to follow safety procedures.

iii. The Construction Industry Development Board (THE CIDB)

In operation since 1995, the CIDB was formed to ensure that the construction industry in Malaysia develops in a proper manner in line with national aspirations. The CIDB has undertaken various initiatives, for instance, the “green card" programme launched in May 2000 with an allocation of RM 16 million. In terms of this program all CIDB-registered site personnel are required to undergo a one-day safety course conducted either by CIDB personnel or CDIB-accredited independent trainers, following which they are issued with a green registration card (as opposed to white for those who have not done so). Green card holders are automatically covered by a CIDB-arranged insurance scheme against industrial accidents. Ultimately, the CIDB hopes to make the “green card" a passport to enter construction sites.

iv. Social Security Organization (SOCSO)

Contractors are required to obtain a Workmen's Compensation Insurance (WCI) policy prior to commencement of work for every construction project that they undertake. The insurance covers every worker on site, including those of subcontractors. In addition, the Social Security Act 1969 stipulates that every employee earning less than RM2000 a month must contribute to SOCSO. All enterprises employing five or more persons are covered by the Act. The Employment Injury Insurance Scheme covers industrial accidents, occupational diseases and commuting accidents whereas the Invalidity Pension Scheme covers invalidity or death from whatever causes.

Social Security Concept

Employees are exposed to various contingencies which cause hardship in their lives. Accidents which result in disablement or death, occupational diseases and others not only results in problems to the employee but also affects the lives of the dependants. Employees have to be protected by social insurance to reduce the sufferings and to provide financial guarantees and protection to the family as a whole.

Contribution to SOCSO

The principal employer must make a monthly contribution for each eligible employee according to the rates specified under the Act. The employee's share of 0.5% of wages should be paid for coverage under the Invalidity Pension Scheme while the employer pays 1.75% for the Employment Injury Insurance Scheme and the Invalidity Pension Scheme. The rate of contribution is based on the monthly wage of the employee in

accordance to 24 categories. Contributions should be made from the first month the employee is employed.

Employee

A person employed under a contract of service or apprenticeship is an employee under the Act. An employee earning a monthly wage of RM2000 or less must compulsorily contribute to SOCSO.

There are two situations regarding employees who earn more than RM2000 monthly. They are:-

- Employees who have been previously registered and have contributed to SOCSO must compulsorily continue to contribute even if the present wage exceeds RM2000 per month. These employees will be protected in line with the principle of "once covered always covered" to preserve their rights accumulated under the Invalidity Pension Scheme.
- Employees who receive a monthly wage exceeding RM2000 and who have not previously registered or paid contributions to SOCSO are given an option to be covered under the Act. Both the employer and employee have to consent to the coverage, by filling the necessary form.

4.3 Construction Safety Practices

This section elaborates various personal protective equipment and how these equipments help prevent accidents. Besides these, this topic also discusses safety practices that have to be followed by employers as well as employees who are involved with construction works. These safety practices are precautionary measures to reduce occurrence of accidents at site.

4.3.1 Personal Protective Equipment

Safety helmets / hard hats

The figure below shows the safety helmets which are being worn by everyone at construction sites:

Figure 4.3.1: Safety helmets (Source: South Island's site)

Everyone at construction site has to wear a safety helmet / hard hat because they are exposed to downward vertical blows as well as side blows. These blows can be caused by falling objects or stationary objects.

These helmets cannot be simply painted for decoration because certain paints have chemical contents which can weaken the strength of these helmets by changing the structure and causing it to brittle.

Figure 4.3.2: Inside protection of safety helmet

(Source: www.galeton.com)

Holes cannot be simply punctured into a helmet as it can affect the strength of withstanding blows. Safety helmets cannot be over-exposed to heat as it will weaken the helmet and cause it to brittle.

Hand and Arm Protection

Hand protection is provided by hand gloves. Gloves should be used when cutting, welding and bar-bending.

Figure 4.3.3: Worker wearing gloves while doing welding

(Source: South Island's site)