HIRARC: A TOOL OF SAFETY IMPORVEMENT IN THE CONSTRUCTION INDUSTRY

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ABSTRACT: The construction industry plays a vital role in Malaysia's economy. However, construction industry has been labeled as extremely dangerous and highly risky. In Malaysia, the number of accidents occurred on construction sites is considered high in comparison to other industries. This paper reports on the study carried out to identify the effectiveness of the implementation of HIRARC in reducing accidents on construction sites, based on 10 different projects that implemented HIRARC. From structured interviews conducted to 10 safety personnel who implemented HIRARC in their projects, it has been found that the basic process of HIRARC was 100 % implemented and carried out. The study also revealed that each and all process of HIRARC was found to be "effective". In addition to that, another structured interviews conducted to 26 consultants engaged with construction projects on the effectiveness of the implementation of HIRARC shows that HIRARC is also "effective" in identifying all potential hazards; assessing all the risks of hazards; making adequate risk control and accident preventive measures; acting as an occupational safety and health management system; and reducing accidents on construction sites. Finally, a comparison is made on the safety performance between construction projects which implemented HIRARC and construction projects which did not implement HIRARC. The findings show that construction project with HIRARC is actually more effective in reducing accidents on construction sites. In conclusion, the implementation of HIRARC is indeed effective in reducing accidents on construction sites.

Keywords : Construction Safety, Project Management, Safety Management.

INTRODUCTION

Construction sites are generally complex and sometimes unsafe (*Teo et al, 2004*). Construction is even widely recognized as one of the most hazardous occupations for those who work in the industry and significant source of accidents for members of the general public who are affected by the industry's work *(Churcher and Alwani Starr, 1996)*

It is well known that construction projects have many work-related accidents and injuries (*Aksorn et al, 2007*). Workplace fatalities and injuries only bring great losses to both individuals and society (*Fang et al, 2004*). According to Haslam *et al* (2005), inadequate risk control and management causes accidents, and is an indicative of management failing. Providentially, studies by Tam and Chan (1999) have shown implementation of hazard identification and risk control in Hong Kong has reduced accidents drastically since 1986. At the same time, NIOSH (2005)

believe that accidents at construction at construction sites may be avoided or minimized given the proper planning and control of hazards, which can be done through proper management of risk using strategies of implementing hazard identification, risk assessment and risk control (HIRARC).

In Malaysia, the construction industry is a vital part of the economy. Chan (2008) reported that construction industry made a steady contribution for Malaysian Gross Domestic Product (GDP), with an average 2.9 % of contribution to GDP since the year 2001 until first quarter of 2007 and is expected to generate an annual growth of 3.5% between the years 2006-2010. However statistic record from SOCSO reveals that the rate of fatality in construction is always higher than in all industries with the average of 1.7 times higher between the years 2001-2004. Undeniable, construction sites have exposed a lot of hazards and risks to workers, which has caused to a high number of accidents. Occupational Safety and Health Act 1994 (OSHA94) which also covers the construction industry has been urging the implementation of occupational safety and health (OSH) in workplaces. Safety and Health Committee Regulations 1996 and Safety and Health Officer Regulations 1997 are among the regulations that stress on the important of safe working places. The implementation of HIRARC is among the tools to achieve safe working place and therefore can reduce accidents effectively.

BACKGROUND

The procedures of HIRARC in specific details are not mentioned in this paper. Briefly, HIRARC comprises the procedure of Strategic planning, Identify and Searching for Hazards, Determine the risk level, Prepare risk control action plan for high-risk activities, and Periodically review the adequacy and effectiveness of action plan (at least once in 3 months).

Under “strategic planning”, the management in the company establishes risk assessment team or a committee which included workforce representatives and competent personnel within the organization. All team members will be trained and briefed about their roles, objectives, and management’s safety policy, and scope of the

HIRARC. Methodology for risk assessments and planned against agreed timescale will be defined. From time to time, all relevant information and existing documentations regarding HIRARC will be collected. During any assessment, action plan being proposed for each evaluated and defined risk (*Loughborough University of Technology, 1994*)

Hazard identification is a process of finding possible harms which will lead to accidents. In construction sites, the hazard to be identified are those associated with machineries, equipments, tools, and others, which are categorized under health hazards and physical hazards. As some hazards may not be readily identifiable, hazard identification is conducted by reviewing the overall work activities and verify-onsite, and by using hazard evaluation models, hazards are then recorded. Safety and health officer shall review all the work activities, and conduct hazard identification trough brain storming method, Job safety analysis, What If analysis, Fault tree techniques and Accident investigation.

Risk assessment is a process of determining the significance or value of the identified hazards and risks to the workers. The methods for assessing risk may be formal or informal. Formal risk assessments which can be qualitative or quantitative takes into account the likelihood of injury and the outcome (consequence) of injury. An informal assessment might be done by a worker or the supervisor. However, such an informal assessment should not be accepted as the official risk assessment in managing OSH. It might often be based on wrong ideas ending in a near-misses or accidents of some kind.

Risk assessment as defined by Colling (1990) is to determine the probability level of the identified hazardous event, severity of the consequences of the hazard event, and finally to determine the risk level of an event. Basically, after the hazards have been identified, the effects of the hazard will be analyzed and the level of risk will be assessed. According to Colling (1990), risk is the product of frequency of occurrence and the severity of consequences. Frequency and severity are dependent each other in an inverse way, meaning more severe an accident, the less frequently it will occur. However, risk can be reduced by reducing either frequency or severity.

After the risks have been assessed, the risks should be controlled. When the risks is considered as intolerable, control action plan should be initialize to record any recommendation of control actions, and suitable

program implementation. Control measures can be by the options of elimination, substitution, isolation, engineering control, management control or the use of personnel protective equipment. According to Holt (2001), risks can be reduced through corrective measures.

HIRARC should be carried out continuously whenever there is a significant threat and uncertainty in the effectiveness. Action plan shall be viewed from time to time by the safety and health officers to control the risks. Where possible, the adequacy and effectiveness of the plan will be reviewed.

METHODOLOGY

To show the effectiveness of HIRARC in reducing accidents on construction sites, a few methods have been adapted in this study. Interviews had been made with 10 different key personnel who had implemented HIRARC in 10 different construction projects in Malaysia. To compare safety performance, the safety records of another 6 projects which did not implement HIRARC were sought and analyzed as well. Then, an analysis is made to get the feedbacks from the client's consultants from each construction projects that implementing HIRARC. At least one client's consultants were interviewed from each HIRARC-implemented project to get their opinions about the effectiveness of HIRARC, and how severe was the accidents affected the construction progress. These criteria were chosen to strengthen the findings when identifying the effectiveness of HIRARC. A total of 26 client's consultants were interviewed, as they would give non-biased feedbacks of the implementation when they were involved in the construction projects. This study consists of four parts based on demographic as briefly described below.

First Part: Level of Implementation

From the 10 projects which implemented HIRARC, the level of the implementation is based on the level of procedures being carried out as in accordance to the basic principles of HIRARC. The safety personnel who

implemented HIRARC was asked to tick the implemented process of HIRARC.

Second Part: Level of Effectiveness of HIRARC Implemented from the implementer's opinion

Miller (1991) defined effectiveness as the degree to which a system achieves its goals and objectives. Hence, when comes to see effectiveness of implementation of HIRARC is by seeing the reduction in number of accidents. This part is to see how effective the procedures being implemented in the implementer's point of view. The respondents were asked to make their opinions regarding the effectiveness for each process of HIRARC based on Likert Scale 1-5, and then calculations will be made to identify the mean score based on classification as shown in Table 1.

Third Part: Feedbacks from Consultants

To strengthen the identification of the effectiveness of HIRARC, a total of 26 respondents from the same 10 sites that implemented HIRARC were interviewed. The purpose of the feedbacks is to get a non-biased and a general view towards the effectiveness of HIRARC. Once again, questions will be asked about the effectiveness of HIRARC and the level of effectiveness will be made based on Likert Scale and classified based on Table 1.

Table 1: Classification of mean score (Levin and Rubin, 1998)

Level of Effectiveness	Class Range
Not effective	$1.000 \leq \bar{X} < 1.802$
Less effective	$1.802 \leq \bar{X} < 2.604$
Fairly Effective	$2.604 \leq \bar{X} < 3.406$
Effective	$3.406 \leq \bar{X} < 4.208$
Very effective	$4.208 \leq \bar{X} < 5.000$

Fourth Part: Comparing Safety Performance

The effectiveness of HIRARC in reducing accidents can be identified by comparing the safety performance of projects with HIRARC, and projects without HIRARC. The average issuance of stop work order, average

issuance of Notice of Improvement (NOI), average accident frequency rate, and average severity rate for HIRARC project and Non HIRARC projects are compared. The average number of these criteria will give a picture of the safety performance averagely.

Demographics

For the ten construction projects implementing HIRARC, ten personnel who consist of safety officers and site safety supervisors were interviewed. In addition to that, at least one consultant from each of the projects was interviewed. On the other hand, For six construction projects without implementing HIRARC, six personnel consist of safety officers and site safety supervisors were interviewed as well. Type of respondents interviewed were; client's consultants 61.9 % (26 person), SHO 26.2% (11 person) and site safety supervisors 11.9 % (5 person). The client's consultant's field of specializations were; Architect 23.1% (6 person), civil engineer 19.2 % (5 person) quantity surveyor 19.2 % (5 person), Project Management Consultant 7.7 % (2 person), Resident Landscape Architect 3.8 % (1 person), M&E Engineer 19.2 (5 person), Safety Consultant 3.8 % (1 person) and Environment Specialist Consultant 3.8 % (1 person). According to the years of experience 21.4 % (9 people) of the total respondents had practiced 0-5 years , 40.5%(17 person) had practiced 6-10 years , 23.8% (10 person) had practiced 11-15 years , 7.1 % (3 person) had practiced 16-20 years, and finally 7.1 % (3 person) had practiced more than 20 years in construction field.

Background of projects

The background and the characteristics of HIRARC projects are shown in Table 2, while non HIRARC projects are shown in Table 3. For standardization purposes, the status of these projects dated on 31st January 2008 was obtained, and all projects at least have reached physical completion.

Table 2: Type of construction projects that implemented HIRARC

Project	Type of Project	Cost of project (RM Million)	Status on 31st January 2008
A	High Rise	80	Physical Completion
B	Office Building	15	Physical Completion
C	High Rise	78	Physical Completion
D	Sludge Treatment Facility	1.5	Completion on site. (Hand Over to client)
E	Immigration and Custom Center	1266	Completion on site. (Hand Over to client)
F	Commercial Centre	112	Completion on site. (Hand Over to client)
G	Factory	112	Completion on site. (Hand Over to client)
H	Shop Office	27.5	Completion on site. (Hand Over to client)
I	Shopping Complex	200	Completion on site. (Hand Over to client)
J	Petrol Station	1.57	Completion on site. (Hand Over to client)

RESULTS AND DISCUSSIONS

To identify the effectiveness of implementation of HIRARC in reducing accidents on construction sites, the research had been designed in 4 parts which is vital to reach the objective. Hence, the key word of the research itself is: Implementation, Effectiveness, and Accident Numbers. Analysis must be done on the implementation, and the outcome of the implementation to see its effectiveness. The results are shown below:

Table 3: Type of Construction Projects without HIRARC

Project	Type of Project	Cost of project (RM Million)	Status on 31st January 2008
A'	Stadium	12.5	Completion on site. (Hand Over to client)
B'	4 storey school	3.9	Completion on site. (Hand Over to client)
C'	High Rise	80	Completion on site. (Hand Over to client)
D'	High Rise	10	Completion on site. (Hand Over to client)
E'	High Rise	8.5	Completion on site. (Hand Over to client)
F'	Shop office	4.9	Completion on site. (Hand Over to client)

a. Level of implementation of HIRARC

There are six main procedures in HIRARC such as: "Strategic Planning", "Classify and Analyze the Work Activities", "Identify and searching for Hazards" "Risk Assessment", "Risk Control", "Periodically Review the Adequacy and Effectiveness of Action plan". Results from the survey reveals that these six main procedures were 100% implemented in these ten projects.

b. Level of Effectiveness of HIRARC Implemented from the implementer's opinion

All sub process under "Strategic Planning" had reached the level of "effective", and all sub process under "Classify and analyze the work activities" had reached the level of "effective", and under the main process of "Identify and searching for hazards", all sub process reached level of "effective". Followed by the main process of "Risk assessment", all sub process reached the level of "effective". Under the main process of "Risk control", all the sub process reached the level of "effective". And finally, under the main process of "Periodically review the adequacy and effectiveness of action plan", all the sub process reached the level of "effective". From here a deduction can be made whereby HIRARC was effective in its process and objective in reducing accidents.

c. Feedbacks from Consultants regarding to the Effectiveness of the Implementation of HIRARC on Construction Sites

The effectiveness of HIRARC implementation was measured based on the following aspects:

- Effectiveness of HIRARC in making adequate risk control and accident preventive measures on construction site;
- Effectiveness of HIRARC in reducing accidents on construction sites;
- Effectiveness of Implementation of HIRARC in identifying all potential hazards on the construction site;
- Effectiveness of HIRARC to act as an occupational safety and health management system in promoting a safe and healthy workplace, and

- Effectiveness of HIRARC in assessing all the risks of hazards on the construction sites. deduce

Results from the survey reveals that implementation of HIRARC to the ten sites is found to be "effective" as classified in Table 1. It can be deduced that the consultants are satisfied and convinced with the effectiveness of HIRARC in managing safety.

d. Comparison of Safety Indicators between HIRARC-Projects and Non HIRARC Projects.

From Figure 1, it can be seen that HIRARC project averagely has a better safety performance compared to non HIRARC project. Non HIRARC project averagely has higher NOI, stop work order, near miss, accident frequency rate, and severity rate compared to HIRARC project.

CONCLUSIONS

From the level of implementation, the effectiveness of the implementation, and the feedbacks from the client's consultants, and the result and comparison of HIRARC with Non-HIRARC projects, HIRARC has shown its effectiveness in reducing accidents on construction sites. It can be conclude that the implementation of HIRARC is indeed effective in reducing accidents on construction sites. When managing safety on construction sites, HIRARC should be encouraged and made compulsory. While gaining credentials from consultants as well the implementers themselves, HIRARC is proven to be effective in controlling hazards and leads to the minimization of construction accidents.

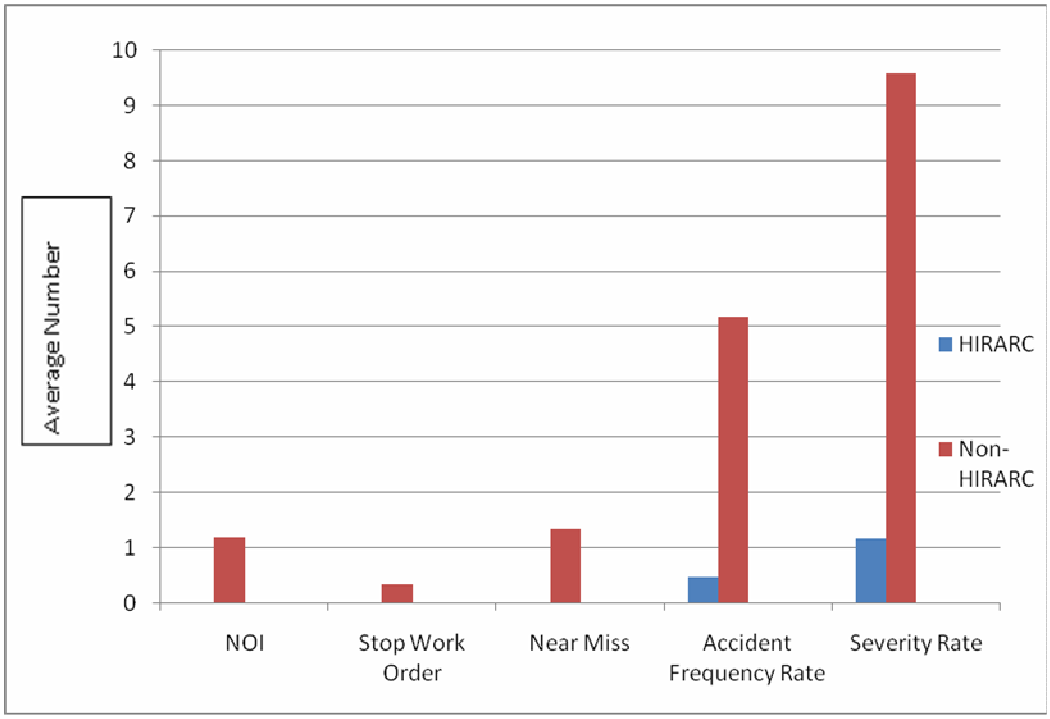

Figure 1: Comparison of average number for criteria evaluating effectiveness between HIRARC and Non-HIRARC project

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