CONSTRUCTION SAFETY PROGRAM: HIRARC IMPLEMENTATION ON THE CONSTRUCTION SITE OF CAMPUS II POLITEKNIK NEGERI UJUNG PANDANG

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ABSTRACT: This report reviews the implementation of Hazard Identification, Risk Assessment and Risk Control (HIRARC) on the construction site of Campus II, Politeknik Negeri Ujung Pandang. The key findings of the report are that the construction industry is one of the major industries with significant injury risk; moreover, the Occupational Health and Safety performance of the construction industry is unacceptable. HIRARC analysis is carried out by identifying hazards, and thereby accidental events that may lead to unwanted consequences. The analyst must also identify design criteria or alternatives that may eliminate or reduce the hazard. There are 85 hazards were identified and assessed prior to construction process and during prior to construction process. Before the construction process were executed, majority of hazards are categorized as not acceptable. However, risk control that were taken during construction process reduce the hazard level that facing construction workers.

Keywords: hazard identification, risk assessment, risk control.

1. Introduction

Safety and occupational health issues in sectors which prone to accidents such as the construction industry, has not been a part of Indonesian culture. This is reflected in data that the number of work accidents in 2009 in Indonesia is more than 54,000 cases. Among them, the totals of 20,086 cases are caused by violations of occupational health and safety (OHS) regulation (Solo Pos, 2010). On the other hand, research conducted by International Labor Organization pertaining to OHS standards reveals that Indonesia ranks 152 out of 153 countries which examined.

In construction site, the problem of running a safe job is complicated by the fact that the nature of the work, the environment that it is conducted in, and the people involved constantly change. The safety requirements can be totally different from one construction task to another, and the requirements constantly change as the work moves from one stage to another. As the physical environment is transformed, new hazards and obstacles are created with various levels of risk. Construction workers generally consider the use of safety equipments are in contrast to their productivity, so they tend to ignore the safety equipments which should be provided. However, when accidents happen, the consequences have worse impact on their productivity. On the other hand, not only the victims of accidents that affect productivity, but the productivity of workers around the crash site were also affected due to the accident which distracts them from the tasks.

2. Risk Management

Risk management is recognized as an integral part of good management practice. It is an interactive process consisting of steps, which, when undertaken in sequence, enable continual improvement in decision making. Risk management is the term applied to a logical and systematic method of establishing the context, identifying, analyzing, treating, monitoring and communicating risks associated with any activity, function or process in a way that will enable organizations to minimize losses and maximize opportunities. Risk management is as much about identifying opportunities as avoiding or mitigating losses (Ramli 2010).

Modern safety legislation is built around a risk management framework. Whereas in the past legislation was prescriptive and defined very specific requirements for employers, the current approach requires that hazards are identified, risks are assessed and responded accordingly. A hazard is defined as the potential for harm or a potentially damaging energy source. Therefore there are many hazards in a workplace because of the fact that work activities are being undertaken. The issue is not whether hazards exist but whether a risk is posed by a particular hazard. Risk is defined as the likelihood of harm...
occurring and involves both a consideration of the consequences which might flow from the existence of a particular hazard and also the likelihood of occurrence. Risk management, therefore, in its most basic form is simply asking and answering the following questions:
1. How and why might it happen?
2. What can happen?
3. What are the consequences likely to be? (typical case)
4. What is the expected likelihood?
5. Does this pose an unacceptable level of risk?
6. If so, what is to be done?
7. Who is going to do it?
8. When is it going to be done?

In the majority of situations it is simply enough to identify the existence of hazards, roughly rank the risk and set in place priorities for action. It is important in undertaking risk management activities that the focus is not solely on the physical layout and conditions of the workplace. The majority of significant workplace hazards exist in the tasks that people undertake. It is important to observe and consult with workers to identify hazards existing in work tasks and deal with these accordingly. Having identified hazards and developed methods for controlling risk, work procedures can then be defined to ensure that workers are given clear guidance on how to manage risk (Danaher 2002).

3. HIRARC Methodology

Since the HIRARC analysis is carried out in an early stage of the project, a limited amount of information about the specific system will normally be available. For a construction site, the process concept has to be settled before the analysis is initiated. At that point in time the most important chemicals and reactions are known, together with the main elements of the process equipment (vessels, pumps, etc) (Rausand 2000).

3.1. Required information

The HIRARC analysis must be based on all safety related information about the system with respect to design criteria, equipment specifications, specifications of materials and chemicals, operational procedures, previous accidents, previous hazard studies of similar systems, etc., that are available at the time when the analysis is performed. The following input information should be available:
1. Design sketches, drawings, and data describing the system and subsystem elements for the various conceptual approaches under consideration.
2. Functional flow diagrams and related data describing the proposed sequence of activities, functions, and operations, involving the system elements during the contemplated life span.
3. Background information related to safety requirements associated with the contemplated testing, manufacturing, storage, repair, and use locations and safety related experiences of similar previous programs or activities. (Rausand 2000)

3.2. Performing the Hazard Identification

The HIRARC analysis is carried out by identifying hazards, and thereby accidental events that may lead to unwanted consequences. The analyst must also identify design criteria or alternatives that may eliminate or reduce the hazard. During the analysis the following factors must be considered:
1. Hazardous plant equipment and materials (e.g., fuels, highly reactive chemicals, toxic substances, explosives, high pressure systems, and other energy storage systems)
2. Safety-related interfaces between plant equipment and materials (e.g., material interactions, fire/explosion initiation and propagation, and control/shutdown systems)
3. Environmental factors that may influence the plant equipment and materials (e.g., earthquake, vibration, flooding, extreme temperatures, electrostatic discharge, and humidity)
4. Operating, testing, maintenance and emergency procedures (e.g., human error importance, operator functions to be accomplished, equipment layout/accessibility, and personnel safety protection)
5. Facility support (e.g., storage, testing equipment, training, and utilities)
6. Safety-related equipment (e.g., mitigating systems, redundancy, fire suppression, and personal protective equipment)

HAZID is basically a brain-storming technique, but an organized approach may help starting the process, e.g., by asking questions like (Azar 2013):
1. Are there any hardware hazards?
2. Are there any software hazards?
3. Are there any human-induced hazards?
4. Are there any procedure-related hazards?
5. Are there any obvious interface hazards between software, hardware, and humans?

Some hazards can further be identified by:
1. Examining similar existing systems
2. Review existing checklists and standards
3. Consider energy flows through the system
4. Consider inherently hazardous materials
5. Consider interactions between system components
6. Review previous hazard analyses for similar systems
7. Review operation specifications, and consider all environmental factors
8. Use brainstorming in teams
9. Consider human/machine interfaces
10. Consider usage mode changes
11. Try small scale testing, and theoretical analyses
12. Think through a worst case what-if analysis

3.3. Risk Assessment

In this step of the risk management process the level of risk determined in the analysis process is compared against criteria to decide whether the risk is:
1. acceptable (i.e. no action is required);
2. tolerable (risks are prioritized for action and made as low as reasonably practicable); or
3. intolerable (i.e. the activity must be stopped).

For some hazards, risks may not be fully understood and it may be difficult to make accurate projections. Where decisions must be made when there is significant uncertainty about potential outcomes a precautionary approach is advisable. While the objective of risk management is to minimize work-related ill health and injury, it is not practical to reduce all health and safety risks to zero. Risk is inherent in all activity. Zero risk implies zero activity (and even zero activity is not risk free). In the evaluation step, judgment must be made on when risks have been reduced sufficiently (Rausand 2000).

3.4. Risk Control

The most effective form of risk control is to eliminate the hazard altogether, or to replace a hazardous process or substance with a safer one. Reducing the time or extent of exposure to the hazard is also effective. If elimination or substitution is not practical then design or engineering controls may be used. This means that a change is made to the work environment, equipment or work process to reduce the risk.
Engineering and design controls include the use of air conditioned or soundproof cabins, machine guarding, or other barriers to keep people away from a hazard, also the use of interlocks, the isolation or enclosure of a hazard and other technological approaches to risk reduction.

A less desirable approach, but one that may sometimes be required, is to introduce administrative controls for risk. This means reducing or eliminating risk by means of procedures or instructions. Administrative controls depend on appropriate behavior for their success. Personal protective equipment (PPE) can be used as a control for risk in association with other controls or when all other controls are impractical, but it is often the least effective risk control measure. It should be a secondary rather than primary means of defense. Effective use of personal protective equipment depends on the equipment being chosen correctly, fitted correctly and used at all times when required (Rausand 2000).

3.5. Documenting Results

The results from a HIRARC analysis are usually presented in a specific HIRARC work-sheet, identifying the hazards, the causes, the potential consequences and possible improvements and precautions. In most applications it is relevant to start with the accidental events. A generic list of hazard may often be useful to support the brainstorming process to identify potential accidental events.

4. Result and Discussion

A Risk Score calculator is utilized for analyzing and evaluating risk. The objective of analyzing risk is to determine whether the risk is acceptable. It provides a qualitative tool that assists in prioritizing risk. The Risk Score Calculator determines the level of risk by defining consequence and probability. The consequence of risk is identified using a score listed in Table 1. In addition, the risk probability is assessed based on the description in Table 2.

<table>
<thead>
<tr>
<th>Probability</th>
<th>Example</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Catastrophic</td>
<td>Minor abrasions, bruises, cuts, first aid type injury</td>
<td>1</td>
</tr>
<tr>
<td>Fatal</td>
<td>Disabling but not permanent injury</td>
<td>2</td>
</tr>
<tr>
<td>Serious</td>
<td>Serious non-fatal injury, permanent disability</td>
<td>3</td>
</tr>
<tr>
<td>Minor</td>
<td>Approximately one single fatality, major property damage if hazard is realized</td>
<td>4</td>
</tr>
<tr>
<td>Negligible</td>
<td>Numerous fatalities, irrecoverable property damage and productivity</td>
<td>5</td>
</tr>
</tbody>
</table>

Table 1. Probability rating

<table>
<thead>
<tr>
<th>Probability</th>
<th>Example</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inconceivable</td>
<td>Is practically impossible and has never occurred</td>
<td>1</td>
</tr>
<tr>
<td>Remote</td>
<td>Has not been known to occur after many years of exposure</td>
<td>2</td>
</tr>
<tr>
<td>Conceivable</td>
<td>Can be envisaged to occur after many years of exposure.</td>
<td>3</td>
</tr>
<tr>
<td>Possible</td>
<td>Has a good chance of occurring and is not unusual</td>
<td>4</td>
</tr>
<tr>
<td>Most likely</td>
<td>The most likely result of the hazard / event being realized</td>
<td>5</td>
</tr>
</tbody>
</table>

The risk score is obtained by multiplying the probability rating to consequence rating. The higher the risk score the greater priority to control the hazard. If risk score is below 6, then the hazard is categorized acceptable. A hazard identified as acceptable may be considered as a low risk and further reduction may not be necessary. However, if the risk can be resolved quickly and efficiently, control measures should be implemented and recorded.

There are hazards has been identified assessed prior to construction process executed. Figure 1 shows scatter diagram of the hazards before the risk control was implemented. It clearly shows that the majority of hazards are categorized as NOT acceptable. Therefore, it requires a planned approach to controlling the hazard and applies temporary measure if required.
Risk control requires actions to be taken to eliminate or reduce the likelihood that exposure to a hazard will result in injury or disease. When determining control solutions consultation shall occur between competent persons undertaking the risk management process, employees affected health and safety representatives and the zone health and safety committee when required.

Figure 2 shows scatter diagram of the hazards after the risk control was implemented. Among 85 hazards identified, 94.25% of hazard are categorized as acceptable. It indicates that the hazards level were reduced.

5. Conclusion

HIRARC analysis is carried out by identifying hazards, and thereby accidental events that may lead to unwanted consequences. The analyst must also identify design criteria or alternatives that may eliminate or reduce the hazard. There are 85 hazards were identified and assessed prior to construction...
process and during prior to construction process. Before the construction process were executed, majority of hazards are categorized as not acceptable. However, risk control that were taken during construction process reduce the hazard level that facing construction workers

References

Danaher, B. (2002), Cost Effective Implementation Of A Health And Safety Management System