A COMPREHENSIVE FRAMEWORK FOR ASSESSING WORKER’S BEHAVIOR MODIFICATION METHODS IN SAFETY PROGRAM

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ABSTRACT: The human factors area deals with how safely and effectively personnel interact with the processes. To minimize the influence of human factors to incidents, causal relationship of worker’s behavior to safety incidents must be understood. This includes having a methodology to identify potential worker’s behavior influences. Past experience are able provide valuable insight into the types of worker’s behavior that most often contribute to human error and to loss events. This paper suggests a comprehensive assessment framework that enables project managers to take a number of major qualitative factors into consideration when selecting appropriate worker’s behavior modification methods. This framework is based on the Analytic Hierarchy Process (AHP) methodology and a survey among construction engineers. The research reveals that training, safety reward, and campaign should be conducted simultaneously and equally to obtain effectiveness in behavior modification.

Keywords: Workers’ behavior, workplace accident, safety

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. This reflects that the safety practice in Indonesia is severe (PNRI, 2009).

Construction safety performance is influenced by many variables: individual, technical, environmental, and organizational at the micro, meso, and macro levels. 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 for workers as they move about the site. New workers are continuously arriving on the site to take the place of workers who have completed their specialized tasks. They are vulnerable to accidents, until they become aware of hazards on the site and learn how to cope with them.

A survey research method is applied in this study. The respondent is the construction engineers who are considered able to assess the risk of workplace accidents based on their experience. The characteristic of the sample is work experience more than 5 years in construction work. This characteristic is intended to provide information that can be regarded as an expert judgment. Data were then processed with the Analytic Hierarchy Process (AHP) methodology.

LITERATURE REVIEW

Two models that used as support in this study seemed to account for the important organizational, individual, environmental, and technical factors that are involved

Domino Theory

Herbert W. Heinrich (in Goldsmith 1987) proposed a theory of accident causation. It was the first comprehensive effort by anyone to explain the industrial accident phenomena scientifically. Before Heinrich, people believed that industrial accidents were a matter of fate. He conceptualized a domino theory of accident causation that states: "Injuries are caused by accidents.

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Accidents are caused by unsafe acts and conditions. Unsafe acts and conditions are caused by the faults of persons. Faults of persons are caused by the social environment and ancestry”.

Frank E. Bird revised Heinrich’s domino theory (in Goldsmith 1987). Bird’s model was a simple revision, but it was an important insight, because it introduced the thought of managerial error into the accident causation sequence. Bird’s revised domino theory is: “Injuries are caused by accidents. For every accident there are immediate causes that are related to operational errors. Operational errors are only symptoms of deeper underlying or basic causes related to management errors. The absence of a system of effective control permits the existence of the factors referred to as basic causes”.

Safety Behavior Model

Dedobbeleer (1985) hypothesized a safety behavior model where workers’ safety behavior depended on three primary factors: (1) predisposing factors that related to workers’ safety knowledge, attitudes, and other personal characteristics, (2) enabling factors that related to the availability of safety training, safety equipment, and safety instructions, and (3) reinforcing factors that related to management’s attitude toward safety, foremen’s enforcement of safe conditions and practices, and workers’ attitudes toward safety.

LaFlamme (1990) devised a four-level model based on a systems approach. The four levels are: (1) work organization, (2) working situation, (3) accidental sequence, and (4) the accident. According to LaFlamme, work organization is a spatial variable and working situation, accident sequence, and the accident are temporal variables. The work organization level involves structural background factors (human and technical) that influence safety performance. The factors at this level concern the design, organization, implementation, and control of work processes. The factors at the second level, working situation, concern the nature of the tasks to be performed, the work environment, the machines and tools required, and the characteristics of the persons who will do the work. The third level, accident sequence, starts when a disturbance occurs in the working situation (system). The sequence can be interrupted by any of the components in the system involved. An example would be an alert foreman who averts an electrical accident by pointing out an overhead power line to a mobile crane operator. If the accident sequence is interrupted, the system will recover to a safe state again. If the sequence is not stopped, it will end as an accident (the fourth level). The accident can result in an injury, property loss, or near-miss.

RESULTS AND DISCUSSIONS

Decomposition of the problems that developed based on the results of interviews and literature studies describing the chain of goal, intermediate objectives and alternative solutions. Translation of the problem described in the hierarchy tree as follows:

- Accident prevention behavior
  - Discipline
    - Adequate education
    - Safe habits
    - Motivation
    - Awareness
  - Health
    - Sensory skills
    - Psychomotor skills
    - Sufficient workload
    - State of alertness
  - Concentration
    - Sensory skills
    - Psychomotor skills
    - Sufficient workload
    - Awareness

Fig. 1 Hierarchy tree of Analytic Hierarchy Process

The Role Of Worker’s Behavior Against Accidents Due To Human Error

Accidents due to human errors can be inferred not only due to internal conditions of the workers. Because the internal conditions of workers may be affected by their work environment, so the responsibility for worker safety cannot be imposed solely on the worker. Two major factors of the environment that affects the behavior of the workers are ergonomic conditions of work sites (lighting, noise, interference) and the workload which can lead to decreased concentration, alertness, and health. Both of these factors as the trigger of accident can only be reduced by the policy and management commitment in efforts to prevent accidents. Application of management policies that govern the basic concepts
which guarantee the implementation of safety programs including reporting and recording systems, and safety standards that specify minimum requirements and the practice of operating conditions to be met are the methods that can be applied in reduction of the workers’ external factors as a trigger for accidents.

Exposure to a hazardous situation

- Yes

Perception of hazard

- Yes

Cognition of hazard

- Yes

Decision to avoid

- Yes

Ability to avoid

- Yes

Unsafe behaviour

Safe behaviour

Accident

Chance

No accident

**Fig. 2 Sequential model of accident occurrence**

In addition, management also has responsibility to stimulate the behavior of workers in order to establish the safe actions of the workers. The success of the safety program also relies on the support from workers’ behavior since these behaviors may interrupt a series of conditions that can cause accidents. Figure 2 shows the role of workers’ behavior as an accidents preventing factor when confronted with hazardous situations.

**Target Behavior Modification**

The study has identified four targets for behavioral modification that theoretically have a significant influence as a preventing factor to accidents due to human error, ie, discipline, experience, health, and concentration.

AHP analysis shows that the discipline has the largest priority value which should be used as a target for behavioral modification (Fig. 3). This can be caused by internal disciplinary working conditions of workers which are shaped by attitudes, culture and education of workers, and directly forms the motivation to safe act such as comply to operating standards and safety regulations.

**Following behavior as the second priority as a target for behavioral modification is the workers’ experience on their task. This can be caused by the working experience age that will determine the ability of workers to detect a risk or hazard contained in their work so that workers can prepare themselves to face the hazard that may occur.**

**Discipline** 42.00%

**Experience** 37.10%

**Health** 5.40%

**Concentration** 15.50%

**Fig. 4 Priority of intermediate objective against goal**

The third and fourth priority is the concentration and health of workers respectively. Although the last both behavior have small priority value but these behaviors also have a significant effect on safety. This is because the concentration and workers health affect alertness and motor awareness of workers which needed in execution of his task. In addition, the both behaviors are not purely formed by the internal conditions of the workers but also shaped by the conditions of employment, so that behavioral modification indirectly applied by modification of the external conditions of workers (good housekeeping, ergonomic location) and also by the modification of internal conditions in the objective of disciplines and experience.
Solution Alternatives

Synthesis of AHP against the priorities of alternative solutions has conducted and showed in Fig. 4. In general, the attempt to modify the workers’ behavior, there are three methods that show priority value that is not much different among others. In other words, there is no a dominant one to another or they have similar role. Those priority values respectively are the training of 32.4%, the compensation of 34.1% and campaign of 33.5%. Therefore, to modify the four workers behaviors as internal factors to reduce the occurrence of accidents due to human error, three of these methods must be applied simultaneously in the safety program.

For a specific target in an attempt to modify the behavior of workers, such as discipline, compensation method is a method that has the highest priority value of 46.3%. Optimistically, through the concept of reward and punishment in the compensation method applied able to stimulate motivation and obedience to operating standards and worker safety regulations. Optimal methods to modify worker’s experience is conduct the training (priority score 44.8%). Since through the training, the workers’ understanding of the tasks, conditions and hazards contained in the work will be increased, thus it forms a sensory skill to detect hazard and alerts workers. Health behaviors of workers optimally modified by compensation (priority score 45.3%), this is mainly due to workers' health is strongly influenced by the workload to which it aspires. Concentration behavior is optimally modified by a campaign that has a priority value of 43.1% through warnings hazard on the job site, safety talk, safety slogan, and toolbox meetings.

CONCLUSION

Accidents, especially due to human error, are not solely due to negligence of workers but also due to workers' behavior that is formed by influences of work environment. This work environment can only be modified by policy and management commitment in efforts to prevent accidents.

To modify workers’ behavior as internal factors working to reduce the occurrence of accidents due to human error, the training methods and campaigns should be implemented simultaneously in the safety program. In contrast, the method of compensation does not give significant effect on worker behavior modifications.

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