

# RESEARCH BRIEF

2004/014

## The Impact of Safety Management Systems on Construction Safety Levels

### OBJECTIVES

The objective of this research project is to devise a method to evaluate the effectiveness of Safety Management Systems (SMS). This is achieved by developing and testing a Construction Safety Index (CSI).

### RESEARCH METHOD

The research project involved several steps. It started with a review of the various SMS, standards and guidelines from Australia, Hong Kong, Singapore, UK and USA. Possible attributes affecting the effectiveness of SMS were categorized, and 4 factors emerge: policy, process, personnel and incentives (3P+I).

A questionnaire was designed to validate the 3P+I model. Respondents were requested to provide information relating to safety aspects for one of their recently completed projects. Respondents were asked to rate the extent to which each of the 50 variables influenced the site safety performance of the project, on a five-point Likert scale, where 1 = 'not important at all' and 5 = 'very important'. The developed questionnaires were sent to randomly selected general building contractors.

From the survey results, a CSI framework was invented, and tested through site audits.

### SURVEY RESULTS

The population comprised registered building contractors that are operating in Singapore. Questionnaires were sent by post to 420 randomly selected building contractors. 60 usable responses were received within two months (response rate of 14%).

The designations of the respondents were: upper management (20%), middle management (48%): safety personnel (17%): technical staff (15%). The average working experience in the construction industry of the

respondents was 12 years. The minimum and maximum working experience were one and 34 years respectively. In addition, 60% of the respondents had more than 10 years of working experience.

### FINDING 1: 3P+I MODEL

The variables were input into the SPSS software and factor analysis was carried out, to ascertain if there was any further relationship among the many proposed safety strategies. The results are summarized in Figure 1.

The main finding of the survey is that the effectiveness of SMS is affected by four main factors: company safety policy (P); construction process (P); personnel management with regard to safety (P); and incentives (I). In terms of safety policies, it is recommended that contractors implement policies relating to SMS and OHSMS. They should also manage the construction process well, especially in the day-to-day activities on site. Next, three parties must be committed to safety: management, supervisors and workmen. Underpinning these three factors is the incentive factor. The incentive factor acts as a source of motivation to the enhancement of safety for the workers.

### FINDING 2: CSI FRAMEWORK

Based on the 3P+I model, the CSI framework was designed. The CSI framework is underpinned by the multi-attribute value technique (MAVT). Each of the four factors was hierarchically split into multiple levels of attributes. For the first level factors and second level attributes, the weights were determined through Analytic Hierarchy Process (AHP). The lower level attributes' weights were determined based on the 5-point Likert Scale. Data for the weights were collected by interviewing industry experts.

The rating methods were also designed, using the 0/1 (Yes/No) and 0-1 formats. The rating methods that were assigned to each of the attributes were tested for their objectivity through field audits, conducted by safety inspectors/auditors.

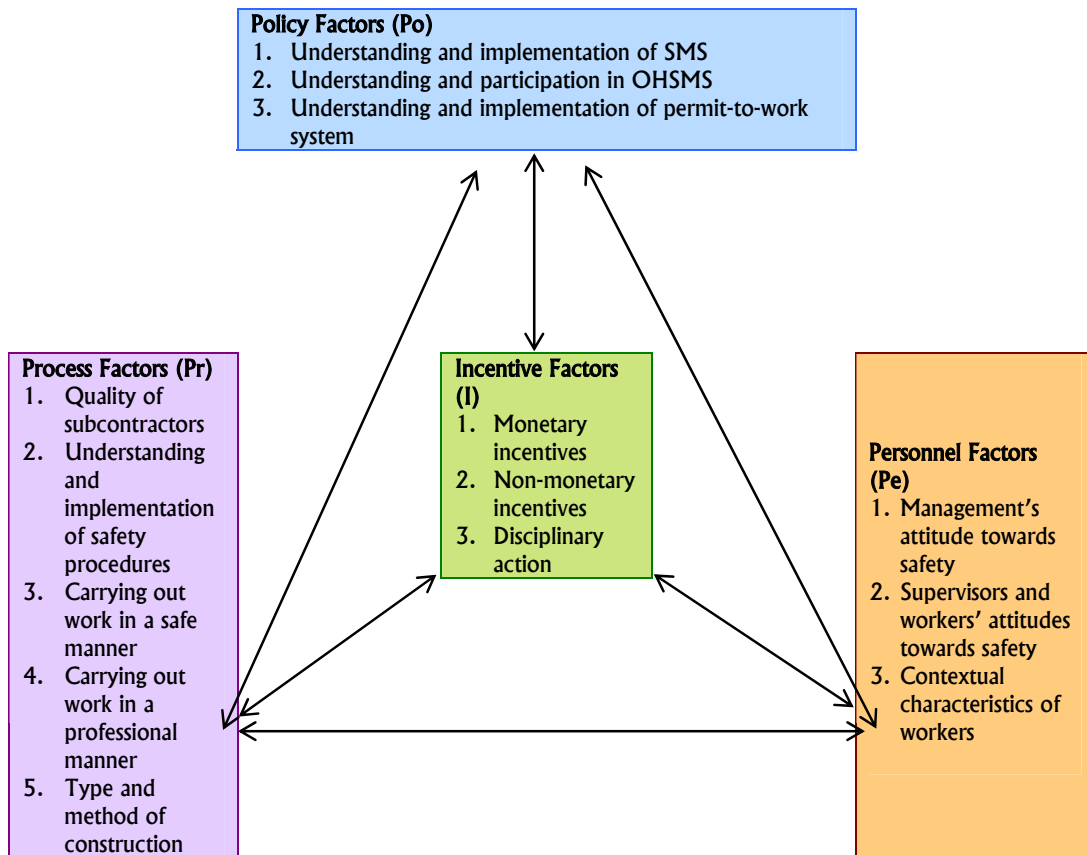


Figure 1. 3P + I Model.

The CSI is a quantitative score that reflects the effectiveness of a construction firm's SMS. An attribute's score is first obtained by multiplying its importance weight with its rating (obtained from the site audit). The CSI is a summation of the scores of all attributes.

From the field audits, the CSI was calculated for each site. The scores of the different site inspectors were compared. The standard deviations of the CSI varied very minimally, ranging from 0.019 to 0.057. The implication of this finding is that the rating methods proposed are objective. The auditors also provided feedback on the comprehensibility of the CSI Checklist, and some modifications were made to further improve the CSI Checklist.

## CONCLUSION

The CSI and its underlying 3P+I Model had been

successfully developed and tested. To facilitate the implementation of the CSI, the CSI Manual, CSI Checklist, and CSI calculation template have also been developed. The CSI can act as an objective measure of different sites for management and appraisal purposes.

## CONTACT DETAILS

**Dr TEO Ai Lin Evelyn and**

**Dr LING Yean Yng Florence**

Department of Building  
National University of Singapore

4 Architecture Drive

Singapore 117566

Tel: (65) 6874 1008

Fax: (65) 6775 5502

E-mails: [bdgteoal@nus.edu.sg](mailto:bdgteoal@nus.edu.sg) and

[bdglyy@nus.edu.sg](mailto:bdglyy@nus.edu.sg)