

IMPLEMENTATION OF SAFETY MANAGEMENT SYSTEMS IN THE HONG KONG CONSTRUCTION INDUSTRY – A SAFETY PRACTITIONER’S PERSPECTIVE

Nicole S.N. Yiu ^{a*}, N.N. Sze ^b and Daniel W.M. Chan ^a

^a Department of Building and Real Estate, The Hong Kong Polytechnic University, Hong Kong, People’s Republic of China

^b Department of Civil and Environmental Engineering, The Hong Kong Polytechnic University, Hong Kong, People’s Republic of China

**Corresponding Author: Nicole S.N. Yiu (Tel.: +852 3400-8445; Fax.: +852 2334-6389; Email: nico.yiu@polyu.edu.hk)*

ABSTRACT

In the 1980s, the safety management system (SMS) was introduced in the construction industry to mitigate against workplaces hazards, reduce the risk of injuries and minimize property damage. Also, the Factories and Industrial Undertakings (Safety Management) Regulation was introduced on 24 November 1999 in Hong Kong to empower the mandatory implementation of a SMS in certain industries including building construction. Therefore, it is essential to evaluate the effectiveness of the SMS in improving construction safety and identify the factors that influence its implementation in Hong Kong. A review of the current state-of-the-practice helped to establish the critical success factors (CSFs), benefits and difficulties of implementing the SMS in the construction industry, while structured interviews were used to establish the key factors of the SMS implementation. Results of the state-of-the-practice review and structured interviews indicated that visible senior commitment, in terms of manpower and cost allocation, and competency of safety manager as key drivers for the SMS implementation. More so, reduced accident rates and accident costs, improved organization framework and increased safety audit ratings were identified as core benefits of implementing the SMS. Meanwhile, factors such as insufficient resources, tight working schedule, and high labor turnover rate were the key challenges to the effective SMS implementation in Hong Kong. The findings of the study were consistent and indicative of the future development of safety management practice and the sustainable safety improvement of Hong Kong construction industry in the long run.

KEYWORDS: Safety management system; Construction industry; Safety practitioner; Safety commitment; Safety audit

1. Introduction

The incidence of accidents is higher in the construction industry when compared to other sectors of the world economy. More so, between the year 1996 and 2005, of the overall industrial accidents in Japan, South Korea, and Hong Kong, 20 percent were related to construction activities [1]. In Hong Kong, the total value of construction project was HK\$ 223,947 million (9.3% of the overall GDP of HK\$ 2,398,408 million where US\$1 = HK\$7.8). Meanwhile, 323,000 workers were engaged in the construction sector, which is 8.2 percent of the overall labor force in the year 2015. There were 3,723 accidents on the construction sites

in 2015. Also, 62 percent of industrial fatalities occurred in the construction industry [1,4]. The high accident and fatality rates in the construction industry could be attributed to its hazardous workplace environment and fast changing work practices [2,3]. Therefore, construction safety has been of great concern in occupational safety and health research.

In the 1980s, the SMS was introduced to mitigate against hazardous conditions, reduce the risk of injury, and minimize against materials wastages in the construction industry. For example, Accident Prevention Advisory Unit of Health and Safety Executive (HSE) of the United Kingdom approved the ‘Occupational Health and Safety Act’ to empower the introduction of the SMS in 1989 [5]. Meanwhile, per the “Code of Practice on Safety Management” prepared by the Hong Kong Labour Department, safety management refers to

“the management functions connected with the carrying on of an industrial undertaking that relates to the safety of personnel in the undertaking, including the planning, developing, organizing and implementing a safety policy; the measuring, auditing or reviewing of the performance of those functions.”

A SMS refers to a system that provides the safety management as stated earlier [6]. In the year 1995, a comprehensive review of industrial safety was conducted by the Hong Kong Government, and the results suggested that enterprises should embrace self-regulation and safety management. Afterward, the Factories and Industrial Undertakings (Safety Management) Regulation was adopted on the 24th November 1999 to empower the mandatory implementation of SMS in certain industries including the construction sector. Studies revealed that a SMS was essential to accident prevention and reduction, through the deployment of proper and consistent management program of safety planning, education and training, and inspection [6,7,8,9].

The accident rate is one of the key performance indicators in the SMS. Results indicated that there was a remarkable reduction in construction accident rate immediately after the introduction of SMS in Hong Kong. However, the decreasing rate was diminishing in recent years [10,11,12]. Therefore, it is necessary to examine the factors contributing to the success deployment of SMS, and thus achieving the sustainable safety improvement in the construction industry in Hong Kong.

Indeed, there has been a lack of systematic review of the factors contributing to the success and the obstacles to the deployment of the SMS in the construction industry [13]. Therefore, this study attempts to identify the potential contributory factors to the effective implementation of SMS through the review of the state-of-the-practice. Afterward, the identified factors will be verified through a series of structured interviews with safety practitioners in the Hong Kong construction industry. For instance, (i) factors contributing to efficient deployment of SMS; (ii) benefits of the implementation of SMS in relation to both safety and operational performance; and (iii) difficulties of deploying SMS on the construction sites will be assessed. Moreover, the mandatory deployment of SMS has been introduced for more than 15 years, understanding the contributory factors to the efficient implementation of SMS would be essential to the sustainable improvement of construction safety in Hong Kong and other regions of the world in the long run.

The remainder of the paper is structured as follows. Section 2 describes the rationale and mechanism of the state-of-the-practice review. The design, procedures, and results of the structured interviews are detailed in Section 3. Thereafter, recommendations based on the findings of the state-of-the-practice review and structured interviews are presented in Section 4. Section 5 provides the concluding remarks and suggests the best possible ways forward.

2. State-of-the-Practice Review

This study involves an exhaustive review of construction safety literatures focusing on the SMS implementation. Databases such as Scopus and ISI Web of Knowledge were used. The keywords used for screening of relevant publications were “construction” and “safety management.” Selection criteria for publications in this review were that they focused on (i) application of SMS in the construction sector; (ii) identification of factors contributing to the successful SMS implementation; and (iii) impacts of SMS in term of the safety performance and project management. Therefore, 54 publications were selected. The publication years were between 1993 and 2014. The literature review covered the SMS implementation in Hong Kong, the United Kingdom, Singapore, and Mainland China. Mandatory SMS (or equivalent health and safety policy) implementation has been adopted in Hong Kong, the United Kingdom, and Singapore since 1999. In China Mainland, the National Occupational Health and Safety Management System (OHSMS) guidance committee were established by the State Commission of Economy and Trade. OHSMS guidance committee developed the pilot OHSMS standard and was responsible for the OHSMS accreditation and safety auditor registration [14].

2.1 Essential Elements of SMS in Hong Kong

This section outlines the core elements of SMS and their applications in Hong Kong. As shown in Table 1, there are 14 essentials SMS elements according to the guidelines set out by the Hong Kong Labour Department [6].

Table 1. Key elements of SMS in Hong Kong

No	Element	Description	Directive	Operational	Review	Promotional
			Actions			
1	Safety policy	To state the commitment of the proprietor or contractor to safety and health at work.	√			
2	Safety organization structure	To assure the implementation of the commitment to safety and health at work.	√			
3	Safety and health training program	To equip personnel with the knowledge to work safely and without risk to health.	√	√		
4	In-house safety and health rules	To provide instruction for achieving safety management objectives.	√			
5	Safety Inspection program	To identify hazardous conditions and for the modification of any such conditions at regular intervals or as appropriate.		√		

No	Element	Description	Directive	Operational	Review	Promotional
			Actions			
6	Hazard control program (Usually named as use of personal protective equipment)	To identify hazardous exposure or the risk of such exposure to the workers and to provide suitable personal protective equipment as a last resort where engineering control methods are not feasible.		√		
7	Incident investigation program	To find out the cause of any accident or incident and to develop prompt arrangements to prevent recurrence.		√		
8	Emergency preparedness	To develop, communicate and execute plans suggesting the operative management of emergencies.	√	√		
9	Evaluation, selection, and control of sub-contractors	To evaluate, select and control of subcontractor arrangement which ensured that subcontractors are aware of their safety responsibilities and are meeting them.			√	
10	Safety committees	To identify, recommend and keep under review measures to improve the safety and health at work.			√	
11	Evaluation of job-related hazards	To evaluate job-related hazards or potential hazards and development of safety procedures.		√	√	
12	Safety and health awareness program	To promote, develop and maintain safety and health awareness in a workplace.				√
13	Accident control and hazard elimination program	To eliminate hazards with the use of process control before exposing workers to any adverse work environment.				√
14	Occupational health assurance program	To protect workers from occupational health hazards.				√

As shown in Table 1, the 14 elements can be categorized into four groups: namely directive, operational, review and promotional. For example, safety policy and safety organization structure can be classified as the directive actions initiated by the senior management of a company, while in-house safety and health rules, training program and emergency preparedness plan can be classified as the directive actions initiated by the competent safety personnel of a company respectively. Besides, safety inspection program, and hazard control program are the routine operational actions carried out by the qualified safety personnel.

Emergency preparedness and incident investigation activities are the operational actions conducted jointly by the project management and the skilled safety personnel in an emergency. Also, review actions refer to evaluation, selection, and control of subcontractors, regular safety performance review by the safety committee and assessment of job-related hazards. Results of these review actions will then inform the best practices of the directive and operational actions under the SMS framework. Last but not the least, safety and health awareness program, accident control and hazard elimination program, and occupational health assurance program are the promotional actions.

Table 2 summarizes the SMS implementation requirements in Hong Kong by the project size. As shown in Table 2, a proprietor, contractor or subcontractor having 100 or more workers in a single day, regardless of the number of sites; or with contract value of HK\$100 million (US\$1 is equivalent to HK\$7.8) or above is required to implement SMS essential element No. 1-10 (presented in Table 1); and to conduct a regular safety audit. On the other hand, a proprietor, contractor or sub-contractor having 50 to 99 workers in a single day, regardless of the number of sites is required to implement SMS essential element No. 1-8 (presented in Table 1) and to conduct a regular safety review. Proprietor, contractor, and sub-contractor have the flexibility to decide the timing of implementing the remaining SMS essential elements one year after the initial establishment of respective SMS. Nevertheless, a contractor having 49 workers or less is not required to apply any SMS element, considering the effect of economies of scale [6].

Table 2. SMS Implementation Criteria by Distinct Categories

Category	Threshold	Essential Elements of SMS Required	SMS Review Requirement
1	100 workers or above on one day on one single site OR Contract value of HK\$100 million or above	Element No. 1-10	Safety audit
2	50 – 99 workers on one day on one single site	Element No. 1-8	Safety review
3	100 workers or above on one day on two or more sites	Element No. 1-10	Safety audit
4	50 – 99 workers on one day on two or more sites	Element No. 1-8	Safety review

Safety audit and safety review are the two safety assessment methods that can enable a contractor to reflect on the current practice, reinforce and maintain good practices, and enhance the capability for continuous risk reduction under the SMS framework. For instance, safety audit refers to the collection, assessment, and verification of information on the efficiency, effectiveness, and reliability of SMS. However, safety review relates to the conduct of an efficiency evaluation of SMS [6]. Apparently, safety audit is a more vigorous process, and a safety auditor must be registered to ensure compliance with the requirements of the Hong Kong Labour Department [6].

2.2 Critical Success Factors (CSFs) of SMS

A review of 54 literatures on the SMS implementation in the construction sector revealed 24 CSFs as outlined in Table 3. As shown in Table 3, the 24 CSFs were grouped into five categories: namely safety commitment, competency profile, safety climate, project management, and safety requirement. For instance, (1) safety commitment which included “*visible senior management commitment*” [7,12,13,16,17,18,19,20,21,22,23] and “*cost spent on safety issues*” [12, 13, 21, 22, 25, 26], were more cited as factors contributing to the success of SMS. Besides, (2) competency profile, in terms of “*personal quality of safety manager*” [13, 25, 29], “*personal competency of safety manager*” [13, 25, 26] and “*safety leadership of senior management*” [30,31]; (3) project management in term of “*well-functioned communication system*” [27,28,29]; and (4) safety climate in term of the “*awareness of employees and key personnel*” [21,29] were also often cited as the essential factors contributing to the success of SMS. Nevertheless, the effects of external factors such as financial incentives, legal requirements, contractual requirements and accreditation requirements should not be neglected, although they were given adequate considerations in previous studies [2, 13, 26].

2.3 Perceived Benefits of SMS Implementation

Table 4 summarizes the perceived benefits of SMS implementation as deduced from the literature review. The perceived benefits were stratified into five groups, namely hazard elimination and accident reduction, safety perception and awareness, operation efficiency, cost reduction and profit maximization, and standard compliance. As shown in Table 4, factors such as “*lower accident rates*” [7,13,21], “*reduced accident cost*” [7,13,21], “*improved organizational competitiveness*” [20,22,34], and “*increase in safety audit score*” [7,13,19,35] were mostly cited as the benefits of SMS implementation. One of the primary goals of SMS is to reduce the accident risk using a systematic approach. Therefore, there is no doubt that SMS implementation can result in fewer accident cases and thus the reduction in accident cost. Besides, a contractor having a well-established SMS often has a higher capability to comply with the respective requirements of the safety audit. Hence, the audit rating can be improved. In Hong Kong, financial incentives are often given from the clients for the SMS implementation, for example, the “Pay for Safety Scheme” of the public housing projects. Hence, benefits of the SMS implementation in Hong Kong also include easier to follow with systematic framework [26,36], reduced material damage [8, 22], public attention to occupational safety and health [14], and better company reputation [37].

2.4 Potential Difficulties of SMS Implementation

The challenges faced in the implementation of SMS were grouped into three (3) categories as summarized in Table 5. These included project management and leadership, competency profile, and project constraint and system limitation. The most frequently cited constraint was that the focus of SMS was too narrow [12,14,36]. Besides, poor project management and leadership in terms of the lack of resources [14,23], “*tight project schedule*” [23, 34], and “*the lack of momentum for continuous improvement*” [12,34], and competency profile in term of “*poor occupational safety and health attitude by the project team*” [14,38], and project constraint in term of “*the difference in the goals among project team members*” [12, 14] were also considered as the obstacles and challenges to the SMS implementation.

Table 3. Critical Success Factors (CSFs) of SMS

Category	Critical Success Factors (CSFs)	References
Safety commitment	Visible senior management commitment	Edkins, 1998 [16]; Yassi, 1998 [17]; Alsop & LeConteur, 1999 [18]; Bunn et al., 2001 [7]; Yu & Hunt, 2002 [12]; LaMontageen et al., 2004 [19]; Fernández-Muñiz et al., 2007 [20]; Robson et al., 2007 [13]; Choudhry et al., 2008 [21]; Fernández-Muñiz et al., 2009 [22]; Goh and Chua, 2013 [23]
	Cost spent on safety issues	Krause, 1999 [22]; Mohamed, 1999 [25]; Yu and Hunt, 2002 [12]; Chan et al., 2004 [26]; Robson et al., 2007 [13]; Choudhry et al., 2008 [21]
	Allocation of adequate manpower	Yu & Hunt, 2002 [12]; Chan et al., 2004 [26]; Robson et al., 2007 [13]
	Provision of adequate time	Yu & Hunt, 2002 [12]; Chan et al., 2004 [26]
Competency profile	Personal quality of safety manager	Mohamed, 1999 [25]; Robson et al., 2007 [13]; Eleonora et al., 2009 [29]
	Personal competency of safety manager	Mohamed, 1999 [25]; Chan et al., 2004 [26]; Robson et al., 2007 [13]
	Training and education of project manager	Mohamed, 1999 [25]; Eleonora et al., 2009 [29]
	Safety behaviors of the project manager	Mohamed, 1999 [25]; Ismail et al., 2012 [31]
	Safety leadership of the senior management	Lu & Yang, 2010 [30]; Ismail et al., 2012 [31]
Safety climate	Workers participation in safety issues	Robson et al., 2007 [13]
	Safety awareness of the key personnel	Choudhry et al., 2008 [21]; Eleonora et al., 2009 [29]
	Safety awareness of employees	Choudhry et al., 2008 [21]
	Personal attitude of employees	Eleonora et al., 2009 [29]
	Safety culture of the construction project	Fan et al., 2014 [2]
Project Management	Well-functioned communication system	Redinger & Lerrine, 1996 [27]; Redinger & Lerrine, 1998 [28]; Eleonora et al., 2009 [29]
	Teamwork	Robson et al., 2007 [13]

Category	Critical Success Factors (CSFs)	References
	Safety organization showing the responsibilities and accountabilities of key personnel	Choudhry et al., 2008 [16]
	Frequent staff group meetings	Eleonora et al., 2009 [29]
	Strategic subcontractor selection	Goh and Chua, 2013 [23]
Safety requirement and incentives	Incentives from clients	Chan et al., 2004 [261]; Robson et al., 2007 [13]
	Incentives from company itself	Chan et al., 2004 [26]; Robson et al., 2007 [13]
	Legal requirements	Fan et al., 2014 [2]
	Contractual/ Client requirements	Fan et al., 2014 [2]
	Requirement to certify the safety management system, e.g. OHSAS 18001	Fan et al., 2014 [2]

Table 4. Perceived Benefits of SMS Implementation

Category	Perceived Benefit	To Company	To Project	To Individual	References
Hazard elimination and accident reduction	Lower accident rates	√	√		Bunn et al., 2001 [7]; Robson et al., 2007 [13]; Fernández-Muñiz et al., 2009 [22]
	Fewer near miss and reported accidents		√		Choudhry et al., 2008 [21]
	Safer working conditions			√	Choudhry et al., 2008 [21]
	Reduced harm to workers			√	Fernández-Muñiz et al., 2009 [22]
	Improvement in accident investigation and analysis	√	√		Goh and Chua, 2013 [23]
	Improvement in emergency preparedness	√	√		Goh and Chua, 2013 [23]
Safety perception and awareness	Better safety culture	√	√		Bunn et al., 2001 [7]
	Public attention to occupational safety and health (OSH)			√	Kogi, 2002 [14]
	Improved employees' morale			√	Choudhry et al., 2008 [21]
	Increased employees' OSH awareness			√	Choudhry et al., 2008 [21]
	Increased support for OSH training and information	√	√		Kogi, 2002 [14]
Operation efficiency	Clear safety organization with defined responsibilities and accountabilities of key personnel		√		Kogi, 2002 [14]
	Enhanced productivity	√	√		Robson et al., 2007 [13]

Category	Perceived Benefit	To Company	To Project	To Individual	References
	Improved organizational competitiveness	√			Fernández-Muñiz et al., 2007 [20]; Fernández-Muñiz et al., 2009 [22]; Jua and Rowlinsona, 2014 [31]
Cost reduction and profit maximization	Reduced material damage		√		Fernández-Muñiz et al., 2009 [22]; Moorkamp et al., 2014 [8]
	Reduced accident cost	√	√		Bunn et al., 2001 [7]; Robson et al., 2007 [13]; Fernández-Muñiz et al., 2009 [22]
	Improved economic / financial performance or profitability	√	√		Fernández-Muñiz et al., 2009 [22]
Standard compliance	Easy to follow with systematic framework (Plan, Do, Check, Act)	√	√		Chan et al., 2004 [26]; Champoux and Brun, 2003 [36]
	Positive change in the scores from a quantitative audit			√	Bunn et al., 2001 [7]; Pearse, 2002 [35]; LaMontagen et al., 2004 [19]; Robson et al., 2007 [13]
	Better company's public image and reputation	√			Smallman & John, 2001 [33]; Jua and Rowlinsona, 2014 [29]

Table 5. Potential Difficulties of SMS Implementation

Categories	Potential difficulties	By company	By project	By individual	References
Project management and leadership	Resistance to change by project team or sub-contractors			√	Jua and Rowlinsona, 2014 [34]
	Insufficient resources	√	√		Kogi, 2002 [14]; Goh and Chua, 2013 [23]
	Tight project schedule		√		Goh and Chua, 2013 [23]; Jua and Rowlinsona, 2014 [34]
	Tight management control		√		Goh and Chua, 2013 [23]
	Lack of momentum for continuous improvement	√	√		Yu & Hunt, 2002 [12]; Jua and Rowlinsona, 2014 [34]
	Insufficient commitment to OSH issues	√	√		Goh and Chua, 2013 [23]
Competency profile	Insufficient safety knowledge or risk concepts for project team			√	Kogi, 2002 [14]
	Poor OSH attitude by project team			√	Kogi, 2002 [14]; Kheni et al., 2010 [38]
	No common safety language developed (especially in multi-sites organization)	√	√		Yu & Hunt, 2002 [12]
Project constraint and system limitation	Different goals expected by project team members		√		Kogi, 2002 [14]; Yu & Hunt, 2002 [12]
	Too narrowly focused	√			Kogi, 2002 [14]; Yu & Hunt, 2002 [12]; Champoux and Brun , 2003[36]
	Isolated in the hands of safety professionals who assume all responsibilities for safety issues	√	√		Yu & Hunt, 2002 [12]
	Paperwork-intensive operation	√	√		Champoux and Brun, 2003 [36]
	Non-availability of construction equipment			√	Yu & Hunt, 2002 [12]

3. Structured Interviews

A series of structured interviews were conducted to verify the factors and attributes that were relevant to the SMS applications in Hong Kong, based on the perceptions of local safety practitioners. In the interview, there were three open-end questions. They were to gauge the perceptions and attitudes of safety practitioners towards (i) the critical success factors; (ii) the perceived benefits; and (iii) the potential difficulties of implementing SMS. Besides, information on the current SMS assessment methods and attitudes towards the SMS application in Hong Kong construction industry were also elicited.

A total of thirteen (13) safety practitioners participated in the interviews. The criteria to participate in the interview were for the respondent to have at least eight (8) year working experience in the implementation of SMS in Hong Kong construction industry, and working in a sizeable firm with more than 500 employees. Eventually, 11 participants (response rate was 85%) accepted the invitation and completed the survey. The demographic details of the 11 interviewees are shown in Table 6. More so, the majority of the interviewee (6, 55%) have between 16 to 20-year experience; meanwhile, two respondents (18%) have more than 20-year experience of implementing SMS. Regarding the scope of work, five respondents (45%) were from consultancy firms, and another five (45%) are of directorate or managerial positions in their firms.

Table 6. Summary of Participants of Structured Interviews

Role	Interviewee	Position	Year of Experience
Client	1	Managing Director	> 20 years
	2	Senior Health and Safety Officer	8 years
	3	Principal Safety Consultant	16-20 years
Consultant	4	Senior Engineer (Safety)	16-20 years
	5	Principal Safety Consultant	> 20 years
	6	Engineer (Safety)	16 years
	7	Engineer (Safety)	16-20 years
	8	Principal Safety Consultant	10 years
Contractor	9	Assistant Safety Manager	16 - 20 years
	10	Senior Safety Officer	8 years
	11	Safety Manager	16-20 years

The interviews were conducted between 1st May and 30th June 2015. The results of structured interviews are presented in Tables 7-9 and subsequent sections 3.1-3.3.

3.1 Critical Success Factor (CSFs) of SMS

Based on the literature review, 24 candidate critical success factors were identified. Table 7 compares the number of citations between the literature review and the structured interviews for each factor. More so, 19 out of the 24 (79%) identified CSFs were considered by the respondents as crucial to the SMS implementation in Hong Kong. Overall, the respondents' perceptions were

consistent to that of the literature, in term of citation numbers of individual factors. For example, safety commitment regarding visible senior management commitment and cost spent on safety issues were mostly recognized as essential by the respondents. Besides, factors including the provision of adequate manpower and personal competency of safety manager were also highly cited by the respondents as pivotal.

Table 7. Critical Success Factors of Implementing SMS

Category	Critical Success Factors	Number of Citations in Literature Review	Number of Citations in Structured Interview
Safety commitment	Visible senior management commitment	12	8
	Cost spent on safety issues	6	4
	Allocation of adequate manpower	3	3
	Provision of adequate time	2	1
Competency profile	Personal quality of safety manager	3	2
	Personal competency of the safety manager	3	3
	Training and education of project manager	2	1
	Safety behaviors of the project manager	2	1
	Safety leadership of the senior management	2	0
Safety climate	Workers participation in safety issues	1	1
	Safety awareness of the key personnel	2	0
	Safety awareness of employees	1	1
	Personal attitude of employees	1	1
	Safety culture of the construction project	1	1
Project management	Well-functioned communication system	3	2
	Teamwork	1	1
	Safety organization showing the responsibilities and accountabilities of key personnel	1	0

Category	Critical Success Factors	Number of Citations in Literature Review	Number of Citations in Structured Interview
	Frequent staff group meetings	1	0
	Strategic subcontractor selection	1	0
	Project planning and construction methods	0	1
Safety requirement and incentives	Incentives from clients	2	1
	Incentives from company itself	2	2
	Legal requirements	1	2
	Contractual/ Client requirements	1	2
	Requirement to certify the safety management system, e.g. OHSAS 18001	1	0

3.2 Benefits of SMS Implementation

Based on the literature review, the potential benefits of SMS implementation were grouped into various categories of hazard elimination and accident reduction, safety perception and awareness, operation efficiency, cost reduction and profit maximization, and standard compliance. Table 8 compares the number of citations between the literature review and the structured interviews for each benefit. Similarly, the respondents' perceptions were consistent to that of the literatures. The benefits that were most highly cited by the respondents were hazard elimination regarding reduced accident rate and reduced near miss and reported accidents. Therefore, the construction accident rate reduced remarkably immediately after the introduction of SMS in Hong Kong [10,11]. However, factors such as operation efficiency in term of better project management, and standard compliance in terms of systematic planning framework with slight mentions in the literatures were considered as the important benefits to Hong Kong construction industry by the respondents.

Table 8. Perceived Benefits of Implementing SMS

Category	Perceived Benefit	Number of Citations in Literature Review	Number of Citations in Structured Interview
Hazard elimination and accident reduction	Lower accident rates	3	4
	Fewer near miss and reported accidents	1	3
	Safer working conditions	1	2
	Reduced harm to workers	1	0
	Improvement in accident	1	0

Category	Perceived Benefit	Number of Citations in Literature Review	Number of Citations in Structured Interview
	investigation and analysis		
	Improvement in emergency preparedness	1	0
Safety perception and awareness	Better safety culture	1	1
	Public attention to occupational safety and health (OSH)	1	0
	Improved employees' morale	1	0
	Increased employees' OSH awareness	1	0
	Increased support for OSH training and information	1	0
Operation efficiency	Clear safety organization with defined responsibilities and accountabilities of key personnel	1	1
	Enhanced productivity	1	0
	Improved organizational competitiveness	3	0
	Better cost allocation	0	2
	Better project management	0	4
	Few suspensions of work/ No delay of work progress	0	2
	Effective top-down communication	0	1
Cost reduction and profit maximization	Reduced materials damage	2	1
	Reduced cost of accidents	3	0
	Improved economic / financial performance or profitability	1	0
Standard compliance	Easy to follow with systematic framework (Plan, Do, Check, Act)	2	4
	Positive change in the scores from a quantitative audit	4	0
	Better company's public image and reputation	2	1

3.3 Difficulties in SMS Implementation

The analysis of factors derived from the review of the literature grouped the potential challenges of implementing SMS into three categories. These included project management and leadership, competency profile, and project constraint and system limitation. Table 9 compares the number of citations between the literature review and the structured interviews for each potential obstacle. Challenges such as insufficient resources (project management and leadership), different goals expected of the various team members (project constraint), tight project schedules (project management), and narrow focus (project constraint) were all highly cited by both the literature and the study's respondents. However, factors such as high turnover rate and insufficient safety knowledge or risk concepts for the project team were suggested by the study's respondents suggested as challenging issues in executing SMS in Hong Kong which was not identified in the literature corpus. Therefore, accident reduction rate was diminishing over the years [12].

Table 9. Potential Difficulties of SMS Implementation

Category	Difficulty	Number of Citation in Literature Review	Number of Citation in Structured Interview
Project management and leadership	Resistance to change by project team or sub-contractors	1	2
	Insufficient resources	2	3
	Tight project schedule	2	2
	Tight management control	1	1
	Lack of momentum for continuous improvement	2	1
	Insufficient commitment to OSH issues	1	0
Competency profile	Insufficient safety knowledge or risk concepts for project team	1	2
	Poor OSH attitude by project team	2	0
	No common safety language developed (especially in multi-sites organization)	1	0
	Insufficient safety knowledge or risk concepts for project team	0	2
Project constraint and system limitation	Different goals expected by project team members	2	3
	Too narrowly focused	3	2
	Isolated in the hands of safety professionals who assume all responsibilities for safety issues	1	2
	Paperwork-intensive operation	1	0
	Non-availability of construction	1	0

Category	Difficulty	Number of Citation in Literature Review	Number of Citation in Structured Interview
	equipment		
	High turnover rate of workers	0	1

3.4 Compliance of SMS in Hong Kong

The perceptions and attitudes of the safety practitioners toward the level of compliance of SMS implementation in Hong Kong were gauged during the structured interviews. The level of compliance was highly correlated to the drivers and perceived difficulties, and the impacts on compliance can be stratified into two levels: namely corporate and project.

From the perspective of corporate management, all respondents agreed that most of the construction companies in Hong Kong complied with current legal requirements and code of practice [6], that is, the 14 essential elements presented in Table 1. However, respondents also expressed concerns on the emphasis on administration and documentation, in term of human resource and funding allocation, rather than the performance improvement brought by SMS implementation. For instance, some of the construction companies focused only on the documentation.

From the perspective of project management, a generic SMS framework offers flexibility to the senior project management team but poses difficulties to the site supervisors and labors. A set of in-house safety rules might not apply to every trade of work. A generic SMS framework and in-house safety rules might be feasible for small-sized projects with a few trades of work only. On the other hand, projects with short duration, which are common in Hong Kong is noted to induce a high degree of stress to the site supervisors. There was also a trade-off between SMS commitment and operational efficiency. Therefore, there was a lack of financial commitment and momentum for continuous safety improvement.

More so, regarding the effectiveness evaluation of SMS, the accident rate is the most common performance indicator in use in the Hong Kong construction industry. Nevertheless, other possible indicators are the inspection rate, the number of safety training, internal safety reviews, near miss incidents, and the number of prosecutions.

4. Discussions

Based on the results of the literature review and structured interviews, critical success factors, perceived benefits, and potential difficulties of the SMS implementation were established. Such results were indicative to the feasibility of the application and future development of safety management for the Hong Kong construction industry.

4.1 Feasibility of Application in Hong Kong

Salient factors such as visible senior management commitment, sufficient manpower allocation, and competency profile regarding personal quality and competency of safety managers were found to be the crucial success factors for SMS implementation. The analysis revealed that a good organization and management hierarchy and recruitment of qualified safety manager were essential; and consistent with the findings of previous studies that emphasized the importance of

safety commitment and manpower allocation for a successful SMS implementation [12,13]. Furthermore, studies also indicated that competency profile of safety manager regarding personal quality and skill were the essential selection criteria in the recruitment process [13,25].

The potential benefits of SMS implementation were the reductions in the rate of accidents and near miss incidents and enhanced operation efficiency. Therefore, the remarkable accident reduction could be achieved after the implementation of SMS. As revealed in the current trends of operational and safety performance of Hong Kong construction industry, the numbers of the days of project suspension and project deferral had been declining. More so, productivity and cost-effectiveness have improved since the implementation of SMS [13,22]. Similarly, the level of compliance with the current code of practice was enhanced. Hence the overall productivity and competitiveness could be improved [20,22,31].

The potential difficulties included different goals among the project team members and tight work schedules. It could be attributed to the high turnover rates of the skilled labors in Hong Kong construction industry, because of the aging population and labor shortage. Therefore, the workers might not be familiar with the in-house safety requirements due to insufficient training. This scenario has induced the trade-off between safety compliance and commitment to project completion [12,14]. Moreover, the cost of implementing regular safety training and management were increased [25].

4.2 Effectiveness Evaluation and Performance Indicators

Accident rate and near miss incidents are two common performance indicators for SMS implementation. In Hong Kong, for every construction site, accident rate, with well-defined formulation, are always accurately recorded. However, there is no precise definition and a good record for near miss incident. Similarly, there is currently no legal requirement for the use of other possible indicators including the inspection rate, number of safety training, frequency and assessment criteria of internal safety reviews, and number of prosecutions. Therefore, a comprehensive safety monitoring system should be established to improve the effectiveness of safety management. For instance, the clear definition and good record for the primary safety performance indicators are required.

Safety audits and safety reviews are two common SMS assessment tools. In Hong Kong, all contractors are required to conduct either safety audit or review in accordance with the number of employees and contract sum. Indeed, a safety audit must be carried out by the personnel who is independent of the contractor while a safety review can be conducted by an internal project team member. Therefore, the credibility and robustness of the safety review are questionable. The potential drawbacks of the internal safety review on the revealed safety performance should not be neglected. It is recommended that an independent and competent team be appointed to undertake the safety audits and reviews [6].

4.3 Future Development of SMS

In Hong Kong, SMS has been introduced in the construction industry since November 1999. Accident rate and safety audits are the common performance indicators and assessment tools. However, the senior project managers have focused on administration and documentation, instead of the occupational health and safety performance. It is essential to promote the safety climate and culture; for example, the creation of a safer and more healthy work environment for the construction workers from the perspective of ergonomics and personal health and hygiene. More so, the promotion of safety awareness by the senior management, and the establishment of

an institutional cooperation framework among the client, consultant and contractor [10,11]. This could address the problem of high turnover rate due to the labor shortage, and compliance of safety manager, supervisor and workers, short project durations, and high level of work stress. More so, client engagement in term of contractual flexibility could also relieve the stress of committing project completion [12,13,21,24,25,26].

5. Conclusions

SMS was introduced to mitigate against the hazardous conditions, reduce the risk of injury and fatality, and minimize material wastages in the construction industry. In this study, the critical success factors, perceived benefits and potential difficulties of the SMS implementation were identified based on the state-of-the-practice review and structured interviews. The findings indicated that visual senior management commitment and competency of safety managers as drivers (CSFs) to the SMS implementation. Perceived benefits of SMS include a reduction in accidents, improvement in safety audit compliance, and better cost allocation and project management.

Moreover, potential difficulties and challenges were high stress for project completion and high turnover rates of labor. These might be the possible causes of diminishing accident reduction because of the lack of financial commitment and momentum for continuous safety improvement. Moreover, to improve the future development of SMS implementation in Hong Kong, a flexible safety management framework, and a comprehensive safety monitoring system should be established. Therefore, a remarkable safety improvement could be sustained. The current study is limited to a relatively small sample of interviewees, and the respondents were mainly from the senior management cadre. It would be worth exploring the perception and attitudes of frontline safety supervisors and labors towards the SMS when comprehensive information on the safety awareness and behavior are available from an extensive survey in the future.

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