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Implementation of Safety Management System in Managing Construction Projects: Benefits and Obstacles

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Abstract

The safety management system (SMS) was introduced in the 1980s to reduce the risk of injuries and fatalities and minimise material waste in the construction industry. Further, construction companies have spent immeasurable resources on executing SMSs in the past 30 years. In this study, current industry practices were was reviewed to identify the benefits and obstacles of implementing SMS. Further, a questionnaire was conducted to identify the significant benefits and obstacles of implementing SMS. Results show that the top four benefits were safer working conditions, reduced harm to workers, regarding safety management as a part of project management, and better project management, while the top five obstacles were putting safety as a lower priority due to cultural differences in organizations, workers' high turnover rates, tight project schedules, obstruction by sub-contractors, and inactive participation for the SMS implementation by the project team members. This study contributes to the current body of knowledge of safety research by examining the benefits of and obstacles to implementing SMS in the construction industry. The findings from this study are beneficial to the industry as well, because they can enhance the industry practitioners' understanding on SMS and help them to improve the implementation of SMS in their workplaces.

Keywords: Safety management system; Construction industry; Benefits; Obstacles; Hong Kong.

1. Introduction

The construction industry is considered high-risk, as it involves dangerous and challenging

work, such as excavation, the erection of structural steel, and working at substantial heights (Hwang et al., 2017). Moreover, of the overall industrial fatal accidents in The United States, The United Kingdom, and Hong Kong between 2014 and 2016, 20 percent related construction activities (Bureau of Labor Statistics, 2016, Health and Safety Executive, 2017a, Labor Department, 2017). Particularly, in Hong Kong, 62% of industrial fatalities in year 2015 occurred in the construction sector, and a total of 3,723 accidents were reported related to construction work (Census and Statistics Department, 2017). The high accident and fatality rates in the construction industry can be attributed to hazardous environments and rapidly changing practices (Fan et al., 2014, Tam and Fung IV, 1998).

The safety management system (SMS) was introduced to mitigate workplace hazards, reduce injuries, and minimize material loss in construction industry in the 1980s (Health and Safety Executive, 1997). Taking the United Kingdom as an example, Health and Safety Executive (the local government responsible for workplace health, safety and welfare) has launched a series of national and international standards such as *BS OHSAS 18001:2007 Occupational health and safety management systems* and *BS EN ISO 9001:2008 Quality management system* to encourage the adoption of SMS across the country (Health and Safety Executive, 2017b). In Hong Kong, the Government conducted a comprehensive review on industrial safety in 1995, and the review results recommended that proper SMS implementation was essential for accident reduction and hazard controls in the workplace (Bunn III et al., 2001, Moorkamp et al., 2014, Yoon et al., 2013, Labour Department, 2002). In response to the review's findings, the Hong Kong Government introduced the Factories and Industrial Undertakings (Safety Management) Regulation in 1999. It empowered the mandatory implementation of SMS in several industries including construction.

An SMS refers to a comprehensive system designed to manage its safety elements in the workplace. It includes policy, objectives, plans, procedures, organizations, responsibilities and other safety improvement measures (Labour Department, 2002). The key goal of executing SMS is to eliminate workplace hazards and to reduce accidents in the construction sector. Despite the wide application of SMS worldwide (Fernández-Muñiz et al., 2007, LaMontagne et al., 2004), there were marginal reductions in the injury and fatality rates in the construction sector in recent years. Therefore, it is important and imperative to examine the status quo of the implementation of SMS in the construction industry, and to explore the perceived benefits and obstacles of implementing SMS. The aims of this study are to investigate the perceived benefits and obstacles in implementing SMS in the construction industry. Although there has been a wealth of research on construction safety (Chan and Choi, 2015, Chan et al., 2010, Yu and Hunt, 2002), it was rare that the benefits and obstacles of the deployment of SMS in construction industry being attempted (Robson et al., 2007). Therefore, this study can contribute to the current body of knowledge of construction safety. Furthermore, the findings from this study can provide in-depth understanding of implementing SMS for the industry practitioners and thereby benefiting the practice.

The remainder of the paper is structured as follows. The background section provides the overview of the SMS implementation around the world, summarises the potential benefits and obstacles in implementing SMS. Subsequently, the methodology section introduces data collection and data analysis approaches. Then, the identified benefits and obstacles are presented and discussed. Lastly, the concluding remarks, research limitation, as well as the future research directions are provided.

2. Background

2.1 Safety Management System

The SMS was first introduced to the construction industry by The European Union in the 1980s, with the intention of mitigating hazardous conditions and reducing the injury risk at construction sites (Vassie et al., 2000). Since then, SMS became popular to the construction industry and has been widely adopted by the majority of countries in the world, either mandatorily or voluntarily (Kogi, 2002). Currently, the SMS used by the construction industries in the countries around the world usually comply with the following international standards: *BS8800 - 2004 Guide to Occupational Health and Safety Management Systems*, *HS(G)65 - Successful Health and Safety Management, BS OHSAS 18001 - Occupational Health and Safety Management*, and *AS/NZS 4804:2001 Occupational health and safety management* (Lam, 2003). They mainly look at the following four types of elements in implementing the safety management: (1) overall management including occupational health and safety policy, goals and objectives, commitment from the management and allocation of resources, system integration, and communication system; (2) project planning including planning and development, safety manual and procedures, participation in executing safe working procedures, and procurement and contracting; (3) project operation including training , hazard control, and prevention and corrective action systems; and (4) performance review including performance measures, evaluation, continual improvement, and management review (Robson et al., 2007). An effective construction SMS makes all the difference in preventing injuries and illnesses in the workplaces. The outcome is lowered accident-related costs. Other benefits include reduced absenteeism, lower turnover, higher productivity, and improved employee morale (OSH Academy, 2017).

2.2 The Implementation of SMS in the Construction Industry of Hong Kong

In Hong Kong, under the Factories and Industrial Undertakings (Safety Management) Regulation enacted on 24 November 1999 (Department of Justice, 2000), the Government established a clear framework of SMS with 14 elements for the development, implementation and maintenance of SMS in a company or a construction project. The 14 elements are (1) a safety policy that states the contractor's commitment to safety and health at work; (2) safety organisation structure that includes commitment to safety and health at work; (3) safety and health training programme that equips personnel with knowledge to

work safely and without health risks; (4) in-house safety and health rules that provides instruction to achieve safety management objectives; (5) safety Inspection programme that identifies hazardous conditions and modify any such conditions at regular intervals, or as appropriate; (6) hazard control programme that identifies workers' risk exposure and to provide suitable personal protective equipment as a last resort when engineering control methods are not feasible; (7) incident investigation programme that identifies the cause of incident and proposes arrangements to prevent any recurrence; (8) emergency preparedness programme that includes management and operative procedures for dealing with emergency situations; (9) control of sub-contractors that include arrangement to evaluate, select and control of subcontractors' safety responsibilities; (10) safety committees that reviews the implementation of safety measures at work; (11) analysis of job hazards that identify work hazards and evaluate the risk with the implementation of safety procedures; (12) safety promotion programme that promotes the safety and health awareness at work; (13) process control programme that includes procedures and control measures to eliminate work hazards and prevent accidents; (14) occupational health assurance programme that eliminates exposure from occupational health hazards. This framework embedded a series of predominant international standards and legislations focusing on SMS, such as BS8800:1996 Guide to occupational health and safety management systems, AS/NZS4360:1995 Australian/New Zealand Standard on Risk Management, OHSAS 18001:1999 Occupational health and safety management systems Specification, OHSAS 18002:1999 Occupational health and safety management systems Guidelines for the implementation of OHSAS 18001 (Labor Department, 2002). Therefore, the SMS suggested in Hong Kong is expected to be comprehensive coverage of worldwide standards.

These essential elements can be grouped into four categories: directive, operational, review and promotional. For directive purposes, company's top management committed in safety in terms of safety policy and safety organisation structure while competent safety practitioners assist in devising the in-house safety and health rules, organising and conducting training programme and executing the emergency preparedness plan. For better operation purposes, it is necessary to have well-organised safety inspection programme, hazard control programme and accident/ incident investigation programmes for the routine operation of the construction project. For the safety performance review purposes, the main contractor is needed to review the performance of sub-contractor and suppler through their evaluation, selection and control processes. The safety performance of SMS could be reviewed through regular safety committee meetings and evaluation process of job related hazards. Results of review actions will be considered for deciding directive and operational actions of the maintenance of SMS in project level or even at corporate level.

Regarding the implementation criteria of SMS in Hong Kong construction sector, a contractor or a sub-contractor with 100 or more workers in one single day; or a contractor or a sub-contractor with a contract value of HK$100 million (equivalent to US$13.3 million) or more is required to implement the elements no.1 to 10 of SMS in the corresponding

construction project and to conduct biannual safety audits, as described in the above paragraphs. On the other hand, a proprietor, contractor and a sub-contractor with 50 to 99 workers in a single day is required to implement element no. 1-8 of SMS and to conduct regular safety reviews, as indicated in the above paragraphs. Small-scaled contractors or sub-contractors, with less than 50 workers, are not required to implement their own SMS. Sub-contractors who worked for a main contractor with SMS implemented are expected to comply with the corresponding SMS. Furthermore, for the projects that are monitored by government departments and some private developers, the contractors are expected to have their own SMS with all 14 elements, regardless of the company and project size (Development Bureau, 2017).

2.3 Perceived Benefits of SMS Implementation

Benefits of implementing SMS have been shown by previous studies. There were nine more benefits identified through structured interviews before conducting the questionnaire survey (Yiu et al., 2017). Table 1 shows the perceived benefits, which can be categorized into five groups, accident reduction and hazard elimination, safety awareness and perception, operation efficiency, profit maximization, and recognition of compliance of safety standards (Yiu et al., 2017).

Table 1^. Perceived Benefits of Implementing SMS

Category	Benefits		References
Accident reduction and hazard elimination	B1	Lower accident rates	Bunn et al., 2001; Robson et al., 2007; Fernández-Muñiz et al., 2009; Yiu et al., 2017
	B2	Fewer near-miss and reported accidents	Choudhry et al., 2008; Yiu et al., 2017
	B3	Safer working conditions	Choudhry et al., 2008; Yiu et al., 2017
	B4	Reduced harm to workers	Fernández-Muñiz et al., 2009; Yiu et al., 2017
	B5	Improvement in accident investigations and analyses	Goh and Chua, 2013; Yiu et al., 2017
	B6	Improved emergency preparedness	Goh and Chua, 2013; Yiu et al., 2017
Safety awareness and perceptions	B7	Improved safety culture	Bunn et al., 2001; Yiu et al., 2017
	B8	Enhanced public OSH awareness	Kogi, 2002; Yiu et al., 2017
	B9	Employees' improved morale	Choudhry et al., 2008; Yiu et al., 2017
	B10	Employees' increased OSH awareness	Choudhry et al., 2008; Yiu et al.,

Category	Benefits		References
			2017
	B11	More supportive for training on OSH	Kogi, 2002; Yiu et al., 2017
Operational efficiency	B12	A safety organisation with clearly defined responsibilities and accountability for key personnel	Kogi, 2002; Yiu et al., 2017
	B13	Enhanced productivity	Robson et al., 2007; Yiu et al., 2017
	B14	Improved organisational competitiveness	Fernández-Muñiz et al., 2007; Fernández-Muñiz et al., 2009; Jua and Rowlinsona, 2014; Yiu et al., 2017
	B15	Improved cost allocation	Yiu et al., 2017
	B16	Better project management	Yiu et al., 2017
	B17	Less unnecessary suspension of work	Yiu et al., 2017
	B18	No delay in work progress	Yiu et al., 2017
	B19	Effective top-down communication	Yiu et al., 2017
	B20	The project team regarding safety management as a part of project management	Yiu et al., 2017
Profit maximisation	B21	Reduced material damages	Fernández-Muñiz et al., 2009; Moorkamp et al., 2014; Yiu et al., 2017
	B22	Reduced accident costs	Bunn et al., 2001; Robson et al., 2007; Fernández-Muñiz et al., 2009; Yiu et al., 2017
	B23	Improved profitability or financial performance	Fernández-Muñiz et al., 2009
Recognition of compliance of safety standards	B24	Efficient systematic framework	Chan et al., 2004; Champoux and Brun, 2003; Yiu et al., 2017
	B25	A positive change in quantitative audit scores	Bunn et al., 2001; Pearse, 2002; LaMontagen et al., 2004; Robson et al., 2007; Yiu et al., 2017
	B26	The company's improved public image and reputation	Smallman and John, 2001; Jua and Rowlinsona, 2014; Yiu et al., 2017
	B27	Better reputation of individual employees	Yiu et al., 2017
	B28	Improvement on employees' remuneration	Yiu et al., 2017
	B29	Better employment opportunity for individuals	Yiu et al., 2017

^ This table is partly presented in the paper ''Implementation of safety management systems in Hong Kong construction industry – A safety practitioner's perspective'' (Yiu et al., 2017).

Under the category of accident reduction and hazard elimination and, lowered accident rates were the most significant benefits as it was mentioned by the most references (Bunn III et al., 2001; Robson et al., 2007; Choudhry et al., 2008; Yiu et al., 2017). This is because implementing SMS can improve the working conditions effectively and thereby reduce the ham caused to workers (Fernández-Muñiz et al., 2009). Furthermore, implementing SMS can also improve the corresponding stakeholder's capability in handling emergency and accident cases by having better planning in terms of well-defined and clear procedures (Goh and Chua, 2013; Labor Department, 2002).

Under the category of safety awareness and perception, the benefits of the SMS implementation mainly refers to the enhancement of individual's safety awareness. Kogi (2002) found that the implementation of SMS encouraged better safety culture and increased support for occupational safety and health (OSH) training and information. Choudhry et al. (2008) found that employees' morale and OSH awareness are promoted and enhanced as a result of the SMS implementation. Training on OSH matters and promotion of OSH matters are two necessary elements of SMS, which can lead to better safety perception and an improved safety awareness of employees (Choudhry et al., 2008;Labor Department, 2002; Yiu et al., 2017).

Under the category of operation efficiency, companies with SMS were found to be more competitive (Choudhry et al., 2008; Fernández-Muñiz et al., 2007; Fernández-Muñiz et al., 2009; Ju and Rowlinson, 2014; Yiu et al., 2017), either in sense of productivity (Robson et al., 2007) or in sense of organization readiness (Kogi, 2002). Project safety performance is considered one of necessary assessment criteria as early as the tender stage. This is because few accidents could save project cost and time spent on handling accidents and thereby improve the productivity of the company (Robson et al., 2007; Yiu et al., 2017). Furthermore, the organization chart showing project staff with necessary OSH roles and responsibilities is also considered one of the edges for a company, which is mainly attributed to the SMS implementation (Kogi, 2002; Yiu et al., 2017).

Under the category of profit maximization, the implemented SMS could produce some favorable results in terms of cost saving for the company and/ or construction project. The cost can be saved because of less material damage, fewer accidents. Therefore, the financial performance for a project as a whole can be improved (Fernández-Muñiz et al., 2007; Moorkamp et al., 2014; Bunn III et al., 2001; Choudhry et al., 2008; Robson et al., 2007; Yiu et al., 2017)

Under the category of recognition of compliance of safety standards, it has been found that SMS can help companies adapt to some mature management framework (e.g., Plan, Do,

Check, and Act, PDCA) more easily to help them attain a better implementation performance (Chan et al., 2004; Champoux and Brun, 2003; Yiu et al., 2017). Furthermore, SMS can also bring higher safety audit scores to companies (Bunn III et al., 2001; Robson et al., 2007; LaMontagne et al., 2004; Pearse, 2002; Yiu et al., 2017) and thereby create a better public image for companies (Smallman and John, 2001; Ju and Rowlinson, 2014; Yiu et al., 2017).

Comparing all five categories of benefits, the most widely perceived benefits were found to be the score increase of safety audit (Bunn III et al., 2001; Robson et al., 2007; LaMontagne et al., 2004; Pearse, 2002; Yiu et al., 2017), lower accident rates and reduced accident cost (Bunn III et al., 2001; Robson et al., 2007; Choudhry et al., 2008; Yiu et al., 2017), and higher organizational competitiveness (Fernández-Muñiz et al., 2007; Fernández-Muñiz et al., 2009; Ju and Rowlinson, 2014; Yiu et al., 2017). The key objectives of implementing SMS is to reduce the risk and accidents at the workplace, so it is consistent to the targets of lowered accident rates and reduced accident costs. Take Hong Kong as one example, it is mandatory to have biannual safety review or safety audit for contractors with 50 or more workers in a single day. The companies with well-established SMS are believed to have a higher capability to comply with the occupational safety and health regulations and good practices. The audit rating can then be improved. As long as the safety performance is one of the essential assessment criteria during the tendering stage, the better safety performance resulted from implementation of SMS will enhance the company competitiveness (Fernández-Muñiz et al., 2007; Fernández-Muñiz et al., 2009; Ju and Rowlinson, 2014.

2.4 Potential Obstacles of SMS Implementation

In addition to benefits, several obstacles to implementing SMS have also been investigated by previous studies. There were eight more obstacles identified through structured interviews before conducting the questionnaire survey (Yiu et al., 2017). Table 2 shows the obstacles, which can be categorized into three groups, namely project management and leadership, project constraint and system limitations, and competency profiles of the stakeholders (Yiu et al., 2017).

Table 2^. Potential Obstacles of SMS Implementation

Category	Obstacles		References
Project management and leadership	O1	Project team or subcontractors' resistance to change	Jua and Rowlinsona, 2014; Yiu et al., 2017
	O2	Insufficient resources	Kogi, 2002; Goh and Chua, 2013; Yiu et al., 2017
	O3	Tight project schedule	Goh and Chua, 2013; Jua and Rowlinsona, 2014; Yiu et al., 2017
	O4	Inactive for continuous OSH improvement	Yu and Hunt, 2002; Jua and Rowlinsona, 2014; Yiu

Category	Obstacles		References
			et al., 2017
	O5	Inadequate commitment to OSH	Goh and Chua, 2013; Yiu et al., 2017
	O6	Obstruction by sub-contractors	Yiu et al., 2017
	O7	Only willing to meet minimum statutory or contractual requirements	Yiu et al., 2017
	O8	Rigid management style	Yiu et al., 2017
	O9	Low priority given to safety issues	Yiu et al., 2017
Project constraints and system limitations	O10	Putting safety as a lower priority due to cultural differences in organizations	Kogi, 2002; Yu and Hunt, 2002; Yiu et al., 2017
	O11	Too narrowly focused	Kogi, 2002; Yu and Hunt, 2002; Champoux and Brun, 2003; Yiu et al., 2017
	O12	Assumed safety personnel to take all safety responsibilities	Yu and Hunt, 2002; Yiu et al., 2017
	O13	Paperwork-intensive operation	Champoux and Brun, 2003; Yiu et al., 2017
	O14	Unavailability of construction equipment	Yu and Hunt, 2002; Yiu et al., 2017
	O15	High turnover rate of workers	Yiu et al., 2017
	O16	A lack of professional support from the Labour Department and client in promoting OSH at the frontline level	Yiu et al., 2017
	O17	Insufficient care on OSH matters in the local construction industry	Yiu et al., 2017
Competency profile of the stakeholders	O18	Inadequate risk concepts or safety knowledge for the project team	Kogi, 2002; Yiu et al., 2017
	O19	Project team's poor OSH attitude	Kogi, 2002; Kheni et al., 2010; Yiu et al., 2017
	O20	No common language developed for communication (particularly in multi-site organisations)	Yu and Hunt, 2002; Yiu et al., 2017
	O21	A lack of competent workers in the construction industry	Yiu et al., 2017
	O22	Poor understanding of OSH by government and society	Yiu et al., 2017

^ This table is partly presented in the paper ''Implementation of safety management systems in Hong Kong construction industry – A safety practitioner's perspective'' (Yiu et al., 2017).

Under the category of project management and leadership related obstacles, most of the obstacles were related to the companies and projects. Currently, the majority of the

construction companies adopt tight management style to have better control of site progress because most of the working schedules awarded from the clients were tight (Goh and Chua, 2013; Ju and Rowlinson, 2014; Yiu et al., 2017). Other than the tight management control and working schedule, the obstacles of implementing SMS may be caused by the lack of momentum for continuous improvement (Ju and Rowlinson, 2014; Yu and Hunt, 2002; Goh and Chua, 2013) For some smaller construction firms or construction projects, there were insufficient resources available for working purpose, thus making the management staff might not have sufficient commitment on OSH (Goh and Chua, 2013). Other than the obstacles resulted from the projects, lack of motivation of individual project staff could contribute to the obstacle for the implementation of SMS as well. Project team may resist to change as they feel the procedures established in SMS to be redundant and unnecessary in some cases (Ju and Rowlinson, 2014).

Under the category of project constraints and system limitations, the effective implementation of SMS were potentially affected by provided project conditions and implementation criteria of SMS itself. Putting safety as a lower priority due to cultural differences in organizations (Yu and Hunt, 2002; Kogi, 2002; Yiu et al., 2017), insufficient coverage of the SMS framework for implementation (Kogi, 2002; Yu and Hunt, 2002; Champoux and Brun, 2003; Yiu et al., 2017), inactive participation for the SMS implementation by the project team members (Yu and Hunt, 2002; Yiu et al., 2017), too paperwork-intensive for operation of SMS (Champoux and Brun, 2003; Yiu et al., 2017) and non-availability of suitable construction equipment for site work (Yu and Hunt, 2002; Yiu et al., 2017) were considered as obstacles of effective implementation of SMS at organisational and project. Project team usually included different roles, namely project manager, site agent, safety officer, safety supervisor, project engineer and foreman. For some organizations with relatively weak safety culture, project team members, excluding safety officers and safety supervisors, usually concentrated on the progress and quality of works. Thus, most of the project team members put safety at a lower priority and isolated the safety job duties to the safety officer or other safety practitioner of the construction project (Yu and Hunt, 2002; Kogi, 2002). In addition to the obstacles relating to the manpower getting involved in SMS, proper selection of site activities and construction equipment could help the elimination of hazard and risk level. Thus, the absence of construction plant and equipment that necessary for the safe working practices could contribute to obstacle to the implementation of SMS (Moorkamp et al., 2014). Other than the constraints contributed by the project, there were two obstacles induced by the operation of SMS itself. The framework SMS was found too narrowly focused, so the coverage of SMS might not be well monitored the hazards at the workplace. Furthermore, SMS induced too heavy documentation work, and would in turn discourage the implementation of SMS in the construction projects (Yu and Hunt, 2002; Kogi, 2002; Champoux and Brun, 2003). In addition, there were more obstacles contributed by other stakeholders, including government, society and public. A lack of competent workers in the construction industry (Yiu et al., 2017), and poor understanding of OSH by government and society (Yiu et al., 2017) were also agreed as obstacles for effective implementation of SMS.

Under the category of competency profiles of the stakeholders, stakeholders, including government, project management staff, workers and society, were found important in the effective SMS implementation. There four obstacles contributed at the project level by either the project management staff or frontline workers – insufficient safety knowledge or risk concepts for project team (Kogi, 2002; Yiu et al., 2017), poor occupational safety and health (OSH) attitude by project team (Kogi, 2002; Krause, 1994; Yiu et al., 2017), no common safety language developed (Yu and Hunt, 2002; Yiu et al., 2017) and a lack of competent workers in the construction industry (Yiu et al., 2017). The project team were expected to work as a team in hazard control as early as the planning stage. For the elements 11 and 13 of SMS, i.e. job hazard control and process control programme, knowledge about risk concept and risk management would definitely help the proper implementation of SMS (Labour Department, 2002). In addition, safety attitude also related to individual safety awareness and safety behaviour (Fang et al., 2006). Therefore, project team with poor attitude in OSH was an obstacle in the SMS implementation. Project team might consist of members with different nationalities, especially in international main contractors and specialist sub-contractors. Companies with staff of different nationalities or multi-sites might have difficulties when developing common languages in managing OHS matters and SMS (MTR Corporation, 2017). Further to the project associated obstacles, one more obstacle was particular found in Hong Kong construction industry - poor understanding of OSH by government and society (Yiu et al., 2017). This highlighted the insufficient support from government and public in Hong Kong construction industry. Their support were particularly important in order to ensure sufficient space and project duration allowed for the project completion in a safe manner (Yiu et al., 2017).

3. Research Methodology

A combination of qualitative and quantitative methods was used to achieve the goals of this study. First, a systematic literature review and a series of structured interviews were conducted to identify the perceived benefits and obstacles for implementing SMS. Second, based on the identified benefits and obstacles, a questionnaire was developed and disseminated to the safety management professionals in the construction industry of Hong Kong to gauge their views of implementing SMS (Yiu et al., 2017). The questionnaire consisted of three sections. The first section asked about the background information of the respondents. The second section requested the respondents to indicate their endorsement of the identified benefits according to their practical OSH experience within the construction industry of Hong Kong, using a five-point Likert rating scale (i.e., 1 = strongly disagree; 2 = disagree; 3 = neutral; 4 = agree, and 5 = strongly agree). The third section requested the respondents to give their endorsement of the identified obstacles using the same five-point Likert ratings scale. To ensure the quality of the data, the potential respondents for the questionnaire were those who were well-experienced safety practitioners in different aspects, such as client, consultant, and contractor. There were

altogether eighteen experts participated in the questionnaire survey. The background information of the experts was summarized as Table 3. In order to make the key viewpoints more representative, the selection criteria for the experts were strict and covered a wide range of scope in terms of their knowledge, availability and willingness (Ameyaw et al., 2016). As indicated in Table 3, all experts had more than 8 years of working experiences in executing SMS in the construction industry. This suggested that the expert panel were highly experienced. Furthermore, fourteen of them had working experiences in executing SMS in at least two types of construction projects. This implied that the viewpoints of the expert panel are of high diversity as different types of construction project had been involved.

Table 3. Background information of the respondents of the questionnaire

Respond-ent	Role	Position	Experience in SMS			
			Government Building	Private Building	Civil Engineering	Repair & Maintenance
1	Client	Safety Consultant	√	√	√	√
2	Client	Senior HSE Officer	√		√	
3	Client	Assistant Safety Manager		√	√	√
4	Client	Senior Safety Manager (Currently Retired)	√	√	√	√
5	Client	Resident Engineer (S&E)			√	
6	Client	Senior Engineer			√	
7	Consultant	Principal Safety Consultant	√	√	√	√
8	Consultant	Principal Safety Consultant	√	√	√	√
9	Consultant	Engineer	√	√	√	√
10	Consultant	Senior Engineer (Safety) (Currently Retired)	√	√	√	√
11	Consultant	Principal Consultant	√	√	√	√
12	Contractor	Senior Safety Officer	√	√		√
13	Contractor	Divisional Safety Manager		√		
14	Contractor	Assistant Safety Manager	√		√	
15	Contractor	Quality, Safety and Environmental Manager		√		
16	Contractor	Head of Safety Department	√	√	√	√
17	Contractor	Senior Safety Officer (Department Head)				√
18	Contractor	Assistant Safety and Environmental Manager	√	√	√	√

4. Results and Discussions

4.1 Benefits of SMS Implementation

Table 4 shows assessment results of all benefits and benefit categories. For the result of each category, it was computed by averaging all the benefits within the category. "Accident reduction and hazard elimination" was assessed as the most significant benefit category for implementing SMS, receiving the highest category value of 3.78. This implied the positive impact of the SMS implementation for the hazard control and accident reduction. Under this category, "B3 safer working conditions" and "B4 reduced harm to workers'' were found to be the most significant benefits. These two benefits were also ranked as the most important benefits among three categories of benefits.

Safer working conditions are mainly reflected by the compliance of legal and contractual requirements in safety aspects. These indicators were consistent with the implementation criteria of SMS. The common practicable ways to justify the compliance of legal and contractual requirements are to consider the number and penalties from safety-related prosecutions from the authorities, to count the number of non-compliance items identified from the independent auditor, and to consider the reportable accident rates (Yiu and Chan, 2016; Yiu et al., 2017). These addressed the potential association between safety performance of working environment and the implemented SMS. In addition, safer working environment could be indirectly quantified and qualified at the construction projects with or without the implemented SMS. With the implemented SMS, projects were found with safer working environment, particularly in the construction stage. Behm et al. (2017) stated that hazards could also be eliminated in the design stage and the ability to reduce the hazards would decrease significantly in the later stages of construction project. Thus, additional effort on the innovative design in safety at the project's planning stage should be encouraged in the SMS for the safer and healthier working environment.
The benefit of reducing harm to the workers for the implementation of SMS mainly refers to the reduction of potential ill-health conditions and job risk to the workers. Unlike accidents, occupational health hazards could be developed in both the short-term and long-term depending on their exposure levels (Bunn III et al., 2001; Choudhry et al., 2008; Fernández-Muñiz et al., 2009; Robson et al., 2007). This supports the proposed theory and critical review by Pillay (2010) and Pillay (2014) respectively. As mentioned by Pillay (2010) and Pillay (2014), the way to reduce the number of accidents, incidents and near miss included the adaptive factors and apply the sophisticated measure to reduce the harm to the workers. Thus, harm reduction usually requires construction companies to execute SMS effectively and effectively. The organization culture, working team, machinery and tools, working environment, procedures and conditions should also be well planned. This is to ensure the workers to be free from potential ill-health and risk (Choudhry et al., 2008; Fernández-Muñiz et al., 2009; Pillay, 2010; Pillay, 2014).

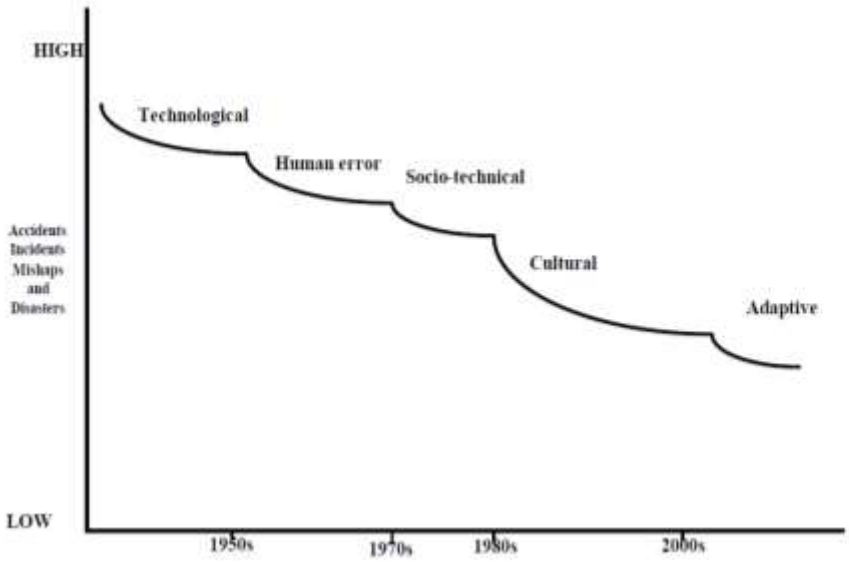

Figure 1. The five ages of safety (Adopted from Pillay et al., 2010)

''Operational efficiency' was assessed as the second most significant benefit category for implementing SMS. Under this category, ''B16 better project management'' and ''B20 regarded safety management as part of project management'' were assessed as the most significant important benefits. These two benefits were also ranked as the third and fourth important benefits among all individual benefits for the implementation of SMS. The benefits of "regarded safety management as part of the project management" and "better project management" were supplemented by the panel of experts during the pilot survey study. These benefits strongly facilitate the operation efficiency (Fernández-Muñiz et al., 2007; Fernández-Muñiz et al., 2009; Ju and Rowlinson, 2014; Robson et al., 2007). Regarding the safety management as part of the project management, it refers to the integration of safety management practice into the routine construction operations. This implies the importance of participated project engineering staff and the needs of well-cooperated teamwork in between project engineering staff and safety personnel on construction site basis. Usually, Clients and Consultants worked at office basis, which is far away from construction sites while Contractors always stationed at site. So the project staff have a stronger recognition of the importance to manage SMS and understand better the constraints of control workplace hazards (MTR Corporation, 2017). For such integration of SMS to project management, project engineering staff should be of considerable safety awareness and be equipped with knowledge on safety and risk management. Thus, they could work together with the safety personnel in identifying the job hazards, assessing the associated risks, and reviewing the implemented safety controls and performance, etc.

The benefits of "better project management" could result from the SMS implementation. This supports the project management principles stated by Meng (2012), Mir and Pinnington (2014) and Yiu et al. (2017). The effective implementation of project management was one of the critical success factors of project management. With clearly defined roles and responsibilities of individuals and well-planned safe work procedures, a

construction project could have a more realistic project schedule and thus facilitate the operation efficiency of the project. In addition, job risks were also found effectively monitored and assessed by the integrated project planning and management on scope and schedule of work, costing and logistic arrangement of site materials and equipment (Papke-Shields and Boyer-Wright, =2017). Thus, a construction project should be implemented with SMS. As recommended by Kontogiannis et al. (2017), the life cycle of a construction project should be incorporated with safety and quality standards to ensure project with higher efficiency and better productivity. In addition, adapting safety management concepts in construction projects could prevent accidents and thus improve the organisational reputation (Kontogiannis et al., 2017; Yiu et al., 2017).

Table 4. Overall Results of Perceived Benefits in Implementing SMS

Category	Code	Assessment of individual benefit					Assessment of benefit category	
		Mean (all respond-ents)	Rank (all respond-ents)	Mean (client group)	Mean (consult-ant group)	Mean (contract-or group)	Mean	Rank
Accident reduction and hazard elimination	B1	3.61	13	3.83	3.40	3.57	3.78	1
	B2	3.50	19	3.17	4.00	3.43		
	B3	4.22	1	4.50	4.40	3.86		
	B4	4.17	2	4.33	4.20	4.00		
	B5	3.56	16	4.00	3.60	3.14		
	B6	3.61	13	4.17	3.40	3.29		
Safety awareness and perceptions	B7	3.67	12	3.50	4.00	3.57	3.65	3
	B8	3.33	23	3.67	3.20	3.14		
	B9	3.78	8	3.67	4.40	3.43		
	B10	3.89	6	3.83	4.20	3.71		
	B11	3.59	16	3.80	3.40	3.57		
Operational efficiency	B12	3.78	8	3.67	3.40	4.14	3.67	2
	B13	3.39	22	3.50	3.80	3.00		
	B14	3.83	7	4.00	3.60	3.86		
	B15	3.61	13	3.50	3.80	3.57		
	B16	4.00	4	3.67	4.40	4.00		
	B17	3.56	16	3.67	3.60	3.43		
	B18	3.28	25	3.33	3.40	3.14		
	B19	3.50	19	3.17	3.40	3.86		
	B20	4.11	3	4.17	4.00	4.14		

Category	Code	Assessment of individual benefit					Assessment of benefit category	
		Mean (all respond-ents)	Rank (all respond-ents)	Mean (client group)	Mean (consult-ant group)	Mean (contract-or group)	Mean	Rank
Profit maximisation	B21	3.22	26	3.33	3.60	2.86	3.44	4
	B22	3.78	8	4.17	3.80	3.43		
	B23	3.33	23	3.33	3.20	3.43		
Recognition of compliance of safety standards	B24	3.72	11	3.67	3.60	3.86	3.29	5
	B25	3.44	21	3.17	3.60	3.57		
	B26	3.94	5	4.00	4.00	3.86		
	B27	3.11	27	3.00	2.80	3.43		
	B28	2.50	29	2.17	1.60	3.43		
	B29	3.00	28	3.17	2.60	3.14		

4.2 Obstacles in SMS Implementation

Results of literature review identified that obstacles to implementing SMS were project management and leadership, competency profile, and project constraint and system limitation. The findings of the questionnaire indicated by Table 5 were consistent to literatures' findings. Like the comparison of the groups of benefits, the individual overall assessments of each category's obstacles are shown in Table 5. ''Project management and leadership'' was assessed as the most significant obstacle category for implementing SMS, receiving the highest category value of 3.85. This implies the importance of project management and leadership. Poor project management and weak leadership would certainly be considered as challenges for an SMS implementation. Under this category, ''O1 project team or subcontractors' resistance to change'', "O3 tight project schedule'' and ''O06 obstruction by sub-contractors'' and ''O07 only willing to meet minimum statutory/contractual requirements'' were found to be the most significant obstacles with the highest scores among this category. These top obstacles were selected with a criterion of 4.0 of an average rating on the Likert scale.

All respondents ranked that the most challenging obstacle in implementing SMS was putting safety as a lower priority due to the cultural differences in organizations. Cultural differences could result in different goals to be expected by the project team. For companies with strong commitment on safety, safety awareness of project team members was usually higher as these companies spent much money on safety promotion and training. For companies with less commitment or limited resources spent on safety, project team members usually put safety at a lower priority. In such cases, project staff mainly concentrate on the project progress and ensure the project quality to avoid project delay, etc.

The possible way to overcome this obstacle was to offer enough incentives to project team members. To facilitate the positive move of the culture change, the incentives should be provided using the top-down approach, initiating from top or senior management to the frontline workers. This highlighted the importance of the promotion of safety culture of an organisation and the safety leadership skills of the senior management.

The obstacle of ''tight project schedule'' for the implementation of SMS was also one of most challenging obstacles in the construction sector of Hong Kong. Currently, most clients implemented contractual penalty schemes for any project delay, so contractors usually worked in tight project schedule to avoid any additional cost due to the project delay. This implies a hidden psychological obstacle for some project team to put safety at the top priority. Client incentive was one of the possible solutions to offer additional project duration to encourage the project staff to implement safety measures and SMS effectively and efficiently. Certainly, the additional project duration should be well justified before its approval. This facilitated the well cooperation of client and contractor groups in maintaining a working environment free from occupational safety and health hazards.

The obstacle of ''obstruction by sub-contractors'' indicated the necessary support from sub-contractors when implementing and maintaining SMS. Due to the unique working nature in different trades of a construction project, most workers were directly employed by the sub-contractors and instructed by the main contractors. Therefore, sub-contractor's cooperation was particularly important for the SMS implementation to project. In general, sub-contractors were resistant to change and lack of motivation on continuous site safety improvement. Contractual conditions with clear criteria for the SMS implementation could help the overcome these obstacles. In addition, workers and supervisors of sub-contractors were recommended to be consulted as early at the development and review stage of SMS. They should be encouraged to participate in the regular safety inspection, safety meetings and promotional events.

The obstacle of ''only willing to meet minimum statutory/contractual requirements'' indicated the organisations with limited effort on the implementation of SMS. No doubt, organisations committed to fulfil the legal requirements on SMS to avoid prosecution and associated penalties; and meet the contractual requirements on SMS to prevent contractual liability and associated penalties. The safety audit, which is the existing evaluation tool of SMS, is the critical step to proof the proper implementation and maintenance of SMS to the authorities and clients. An independent experienced safety auditor is required to be appointed to conduct the regular safety audit with reference to the selected independent safety audit scheme, i.e. a set of audit questions. The main processes of the safety audit involved interviews with project staff and workers, site observations for the frontline operations and documentation check to verify the safety performance. In Hong Kong, most audit scheme involved hundreds of questions. Heavy documentation work was induced from the questions as a kind of evidence. To guarantee a pass in the safety audit, the organisations could potentially concentrate on the documentation work only. Physical

conditions could be marginally improved unless there were enough on-site safety monitoring of the work operations. Thus, SMS should be well-fitted to the project scope and needs while the safety audit schemes should be adjusted accordingly to the unique nature of the project and the coverage of SMS. The authorities and clients should encourage the contractors to fully reflect the actual operations and continuously improve the site safety. Unlike getting certification of international safety standards, such as OHSAS 18001, auditors of SMS must be appointed subject to trade specific and experienced enough to give comments on the potential improvement on SMS to resolve the technical and systematic constraints of the projects. The optimal goal of SMS was not to fulfil the designated requirements, but to achieve a higher safety standard to promote a zero-harm working environment.

In addition, regardless the obstacle category,''O12 assumed safety personnel to take all safety responsibilities'', ''O15 high turnover rate of workers'', ''O09 insufficient safety knowledge or risk concepts for project team'', and ''O10 lack of motivation by project team or sub-contractors'' were also assessed significant obstacles for the SMS implementations. These obstacles mainly contributed by the project constraints and competency profiles of project management staff (Kogi, 2002; Yu and Hunt, 2002). This indicated that a potential positive relationship between the implementation of SMS and project management.

The obstacle of 'assumed safety personnel to take all safety responsibilities'' could potentially be contributed by individual, organisational and external factors. Personal commitment on safety highly depended on the individual safety awareness and knowledge. Organisational or senior commitment on safety could affect the safety climate and motivate the project staff in executing SMS. Incentives from client and regulatory requirements from authorities also motivated the project staff at different roles and levels to participate actively in SMS. One of the good examples would be the ''Pay for Safety'' scheme introduced by the Hong Kong Housing Authority (HKHA). Contractors are financially supported to develop, implement and maintain SMS at project level. Resident HKHA staff, contractor's project staff and workers from sub-contractors could reimburse the money when working on items that improving site safety. The paid item suggested are not limited to training sessions, inspections and meetings. Flexible paying scheme should be extended to innovative safety measures for site safety improvement.

The obstacle of ''high turnover rate of workers'' for the implementation of SMS was also one of the most challenging obstacles in Hong Kong construction sector. Most workers were well-trained in specific work trade. According to the frequent changing of site activities, the working schedule of skilled workers must match with the actual project's life cycle. Thus, workers could hardly station on one construction site for prolonged period and resulted in high turnover rates of workers in construction projects. This implies the difficulty in monitoring occupational safety and health of frontline workers in construction projects. When SMS and related safety strategies being developed and implemented on a construction site, reasonable and practicable steps must be taken to overcome this obstacle.

Effective communication system should be set up to broadcast and explain the safety rules to workers level, including the workers newly joined and/ or inexperienced to the working environment. Incentive programmes are also recommended to adapt to the specific safety training, safety inspection and safety promotion programmes of SMS.

The obstacle of ''insufficient safety knowledge or risk concepts for project team'' addressed the competency levels of the project team. In general, safety practitioners were competent in terms of relevant academic background and working experiences. Other than safety practitioners, the competency of project team members were in doubt. Hardison et al. (2014) highlighted the importance to have additional competencies of 30-hour OSH training for construction supervisors through policy enforcement and education programme. The 30-hour OSH training should include topics like ''communication, risk control, pre-job planning''. In addition, it would be good if this OSH competency course could be embedded into the undergraduate programmes in construction disciplines. The potential supervisors, engineers and architects could equip themselves with basic safety knowledge and safety awareness before their graduations.

The obstacle of ''lack of motivation by project team or sub-contractors'' implies the insufficient incentives and encouragement from authorities, clients and senior management of organisations. Participation rates of safety campaigns and involvement status of SMS could truly reflect the supporting levels from the project team and sub-contractors. Client and contractor groups are the roles to motivate the project team and sub-contractors in participation of safety events and executing SMS. Clear roles and responsibilities could be defined in safety manuals and explained in regular safety meetings. Incentive schemes could be implemented to motive the safety performance on site.

For the newly developed of SMS or continuous improvement of existing SMS, attention should be paid to the obstacles as stated in this study. There were two obstacles that were disagreed by the experts, namely ''poor understanding of OSH by government and society'' and ''non-availability of suitable construction equipment for site work''. These two obstacles were supplemented by the well-experienced experts during the pilot study of the questionnaire. This implied that the construction projects might not often encounter obstacles due to the poor understandings of OSH by the government/ society and poor arrangement of the construction equipment on the construction sites. Senior management of the organization should commit on safety and allocate more resources to overcome the obstacles with a high ranking (Alruqi et al.,2018). For example, introducing safety incentives and contractual requirement could encourage the active involvement of all project team members in the implementation of SMS and relevant safety matters in construction projects (MTR Corporation, 2017; Development Bureau, 2017).

Table 5. Overall Results of Obstacles in Implementing SMS

Category	Code	Assessment of individual obstacle					Assessment of obstacle category	
		Mean (all respond-ents)	Rank (all respond-ents)	Mean (client group)	Mean (consultant group)	Mean (contract-or group)	Mean	Rank
Project management and leadership	O1	4.06	8	3.67	4.20	4.29	3.85	1
	O2	3.83	9	3.67	3.80	4.00		
	O3	4.22	3	4.50	4.60	3.71		
	O4	3.72	11	3.67	4.20	3.43		
	O5	3.33	17	3.50	3.40	3.14		
	O6	4.17	4	3.83	4.40	4.29		
	O7	4.11	6	4.00	4.00	4.29		
	O8	3.67	12	3.50	3.80	3.71		
	O9	3.50	15	3.67	2.80	3.86		
Project constraints and system limitations	O10	4.39	1	4.50	4.20	4.43	3.53	2
	O11	3.67	12	3.33	4.20	3.57		
	O12	4.17	4	4.50	4.00	4.00		
	O13	3.67	12	3.33	4.20	3.57		
	O14	2.72	21	2.33	3.20	2.71		
	O15	4.28	2	4.00	4.80	4.14		
	O16	3.06	18	3.50	2.60	3.00		
	O17	3.06	18	3.00	2.80	3.29		
Competency profile of the stakeholders	O18	4.11	6	4.00	3.80	4.43	3.41	3
	O19	3.78	10	3.50	4.00	3.86		
	O20	3.00	20	3.50	3.40	2.29		
	O21	3.44	16	3.33	2.80	4.00		
	O22	2.72	21	2.83	2.60	2.71		

5. Conclusions

SMS has been introduced to eliminate workplace hazards, reduce injuries and minimize the material loss since 1980s. In this study, perceived benefits and obstacles of development, implementation and maintenance of SMS were first identified from the literature review and then verified by the questionnaire survey. The most highly

ranked benefits were ''safer working conditions'', ''reduced harm to workers'', ''regarded safety management as part of project management'', and ''better project management'', while the highly ranked obstacles were ''putting safety as a lower priority due to cultural differences in organizations'', ''high turnover rate of workers'', ''tight project schedule'', ''obstruction by sub-contractors'', ''inactive participation for the SMS implementation by the project team members'', ''only willing to meet minimum statutory/contractual requirements'', ''insufficient safety knowledge or risk concepts for project team'', and ''lack of motivation by project team or sub-contractors''. For a company implemented with a well-established SMS, it could be beneficial with better hazard control and safer working conditions, and thus reduced accidents and better project management (Bunn III et al., 2001; Choudhry et al., 2008; Fernández-Muñiz et al., 2007; Fernández-Muñiz et al., 2009; Ju and Rowlinson, 2014; Robson et al., 2007). However, particular attention should be paid on the obstacles for the implementation of SMS. The organization culture could hesitate the development and implementation of SMS due to an unsatisfactory ranking and participation in safety matters (Kogi, 2002; Yu and Hunt, 2002). The enhancement of safety awareness and promotion of safety culture could help to overcome these obstacles for the successful implementation of SMS at the workplace.

All data was collected first hand from the experienced safety practitioners in Hong Kong. Therefore, the results should fit with the local context of Hong Kong construction industry. The results were generally consistent with and supplement the findings of previous literatures. With the consideration of benefits and obstacles suggested in this study, the strategical framework for the implementation of SMS could be improved. The policy makers could refer to the results of this study to encourage the effective and efficient development and implementation of the mandatory and voluntary implementation of SMS. The results also indicated a potential linkage of the implementation of SMS and project management; thus, the key components of the SMS implementation could be further studied for the continuous safety improvement in construction industry.

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