The Tenth International Conference on Construction in the 21st Century (CITC-10)

July 2nd-4th, 2018, Colombo, Sri Lanka

Effective way to reduce financial loss by safety investment: Concept from Safety Management System

Kai-Chi Thomas Ying
(PhD candidate, RMIT, Australia)
(Lecturer, Vocational Training Council, Hong Kong)
kc_ying@vtc.edu.hk

Guomin (Kevin) Zhang
(Professor, RMIT, Australia)
kevin.zhang@rmit.edu.au

Sejeeva Setunge
(Professor, RMIT, Australia)
sejeeva.setunge@rmit.edu.au

Abstract

Financial loss induced by construction accident has been widely discussed by researchers. To reduce financial loss of accident, efficient safety investment is suggested. Parameters of safety investment have been reviewed and identified based on a research study in Hong Kong. Key parameters to reduce financial loss in a combined effect by quantitative analysis have been generated. Meanwhile, investment in safety equipment, training and promotion are recommended and particularly effective to reduce financial loss of accident. Supporting statement for safety equipment, training and promotion from the Safety Management System (SMS) has been reviewed and presented in this paper. This paper provides concepts how the construction stakeholders, proprietors and participants, follow the frameworks to reduce financial loss by safety investment in training, equipment and promotion.

Keywords

Safety Management System, financial loss, safety investment, Hong Kong

1. Introduction

Accident cases happen unexpectedly and leads to direct and indirect loss. Accident is unpredictable as the severity both, so far, are difficult to. However, it is believed that sufficient safety investment does help to reduce financial loss. From literature, safety investment has been affected by staffing input (Number of safety personnel and their salary, equipment input into the project, training input, promotion input and others). The concept of financial loss has been reviewed and it included different parameters such as day loss & compensation, loss after resuming work, medical services, fines & legal expenses, lost times of others, equipment/ plant loss, damaged materials, idle machinery and other losses. (Ying KC et. al, 2016).

Structured interviews have been conducted to investigate the relationship between safety investment and financial loss from June to December 2013 which to investigate the project safety investment and accident

information in Hong Kong construction market. 109 projects and 940 accident cases have been recorded. Quantitative analysis has been applied to investigate the relationship between financial loss to independent variables. Statistical Package for the Social Sciences (SPSS) version 24 applied for analysing the data. Negative correlationship was found between financial loss and the independent variables. The relationship is an inversed parabolic shape curve and non-linear regression found that financial loss is significantly related to safety equipment, training and promotion input. Financial loss which is a monetary loss suffered from the contractor. The relationship between financial loss to independent variables has been generated. Relationship between financial loss to safety investment has also been investigated. It found that safety investments in safety equipment, training and promotion really help to reduce financial loss in construction industry. (Ying KC, 2018)

It is believed that sufficient safety input will not only improve the safety performance on construction sites, but also reduce the risk of major accidents, reduce the number of injuries of workers, control risk on construction sites, reduce the number of accidents & accident rate and finally, even reduce financial loss. In this paper, the writers introduces supporting statement according to the Safety Management System (SMS) in safety equipment, safety training and safety promotion respectively. The extracted idea is going to develop frameworks to let construction proprietors and participants know how to pay their effort in the three aspects.

Regarding safety equipment, safety training and safety promotion in Hong Kong construction industry, it should be refer to the code of practice on Safety Management (HKSAR 2002), guideline regarding inspection report of construction sites (HKSAR 2004a), local legislation requirement and the Factories & Industrial Undertakings Ordinance (F&IU Ordinance - Chapter 59 of the Hong Kong Legislation) (HKSAR 2017).

2. Literature Review

A good safety management system in a construction company is highly recommended and supported by scholars over the past decade. One of financial consideration related to the inclusion of a good safety management system is that it leads to a better safety performance on the construction site (low number of accident, low accident rate and less fine & claim). Safety management is an important aspect required by of OHSAS 18001 (Occupational Health and Safety Assessment Series 18001) and ISO 14001 (International Standard Series 14001). It is believed that good implementation of a safety management system does help to improve safety performance and hence reduce the financial loss of accident caused by accidents. Since safety equipment, training and promotion are parameters of Safety Management System, it found that effective safety input in safety equipment, safety training and safety promotion do help to improve the safety performance of construction project.

Hinze and Harrison (1981) who suggested a formal safety training and safety awards are good motivation to mitigate site accident. Sawacha et al. (1999) discussed the safety performance can be improved by adopted safety management system in UK.

Choudhry RM et al. (2008) summarized that effective implementation of an Safety, Health and Environmental (SH&E) system is likely to reduce the number of injuries, minimize the risk of major accident, control risks of activities, minimize production interruption, reduce materials & equipment damage, reduce the cost of insurance premium and cost of employee absences, minimize legal cost of accident, fines and reduce investigation time of accident. It not only provides a positive image to the company, good effect to reduce accident rate, but also induce a better competitiveness performance and economic- financial performance of the company.

Ismail Z. et al. (2012) summarized different safety factors, which are respected in different Safety Management System (SMS) from different countries. Meanwhile, Safety training (train to use safety equipment) and safety promotion are significant factors to improve the SMS. They summarized that safety equipment included Personal Protective Equipment (PPE), equipment to ensure safe work activities, first aid, emergency shutdown system, control system. In training, it included on-job training, toolbox meeting, briefing, seminar, and train up session to use safety equipment or PPE. Regarding safety promotion, they summarized as bonus, promotion, campaigns, motivation, merit rating and incentive. In their finding, better design and application of equipment and PPE contribute the best improvement in SMS.

Jannadi M.O. (1996) summarized 19 factors which affecting safety performance. In his findings, safety training is in a top rank factor to improve safety performance in both survey results from the Safety Officers and workers. Educating works to have good safety habits (input in safety promotion) and keeping tolls and equipment in good working condition (input in safety equipment) are both in high rank. In his findings, investment in safety training, safety equipment and safety promotion do help to improve safety performance of overall safety performance.

Sawacha E. et al. (1999) found out that provision of safety booklet is important for workers to understand the safety policy of the company, which is a sort of good safety promotion. Safety equipment is also important in their findings. However, safety training is rare important which is a bit different from other researchers. Researchers investigated elements of safety planning and control (SPC) model to improve safety performance where training and equipment are important elements. Further, (Lu CS and Yang CS, 2010) stated that training and promotion are important to improve safety behaviour which can help to improve overall safety performance by considering research study from container terminal experience in Tai Wan.

There are 14 elements of the Safety Management System (SMS) in Hong Kong (HKSAR 2002) which is believed to be a qualitative reference for good safety management. Safety Auditor and Safety Officers follow the concept and suggestion to inspect and revise the safety program of construction companies and projects.

In summary, researchers pinpointed different findings regarding factors in safety performance in different study. Safety equipment, training and promotion are identified as key parameters to improve the overall performance. The key parameters (safety equipment, training and promotion) can ready help to reduce financial loss of accident as well as safety performance.

3. Safety Equipment

Safety equipment is one of important safety input to improve safety performance in construction industry (Langford et al. 2000, Choudhry RM et al. 2008 and Ismail Z et al. 2012). Safety equipment includes hardware and software which is defined by Sawacha E et al. (1999) which pinpointed that good safety performance can reduce the economic loss due to accident and it can save 5 to 50 times of direct cost according to their study. They mentioned good safety performance included safety equipment, Personal Protective Equipment (PPE), first aid equipment, fire-fighting equipment, Emergency Shut-Down (ESD) and control system and any requirements of the industry are help to improve safety performance of construction project.

Ergonomic tools are highly recommended in construction industry in recent year. However, it is rare to apply ergonomic tools in construction industry when compared with manufacturing and transportation

industry, which may because of high initial and implementation cost. Researchers suggested introducing the concept of ergonomic tools in safety equipment to improve safety performance. In this paper, the writers pinpoint the concept extracted from the SMS and highlight how safety equipment helps to improve safety performance. Regarding the Safety Management System (SMS), summary of concern area has been shown in Table 1.

Area	Description
In-house safety rule	• Introduction of general safety rule: maintenance of plant, machinery and equipment; provision, use and maintenance of personal protective equipment
Inspection programme	• To identify equipment deficiencies, such as problems caused by normal wear and tear and abuse or misuse of equipment arrangements for the preventive maintenance of plant and equipment
Hazard control programme	• Identifying training needs: the introduction of new equipment or technology • Reactive monitoring data (for example: where is the equipment placed) • The proprietor or contractor of the relevant industrial undertaking should carry out a programme to protect the workers in question by means of suitable personal protective equipment • Proper selection of PPE • satisfy legal and reporting requirements
Emergency preparedness	• An emergency control center – its location and resources (Necessary equipment stored) • facilities and equipment to meet the needs of emergencies (eg: fire-fighting equipment)
Evaluation, selection & control of sub-contractors	• Tender document: sub-contractors should provide PPE to workers
Job-hazard analysis	• Recent changes in procedures, standards or legislation • Recall method: invite designers, engineers, supervisor & workers (users) to identify the hazard • Procedures and measures to ensure the proper use of personal protective equipment (PPE) as the last resort
Accident control & hazard elimination	• Complete & written information concerning process material • Information should include code & legislation • In operation procedures & instruction should include the applicable safety precautions & contain appropriate information on safety implication • Plant & equipment should be used in proper way • Mechanical integrity programme should be provided
Occupational health assurance programme	• Information and advice from suppliers of equipment, chemicals and other materials used at work

	• Minimization of risk by means of personal protective equipment as a last resort • Consulting the suppliers of substances, plant and equipment about minimizing exposure

Table 1: Summary regarding safety equipment according to Safety Management System

4. Safety Training

Safety training is important. Choudhry RM et al. (2008) did a questionnaire survey in year 2005 and investigate the effectiveness of safety training for twenty construction sites in Hong Kong. They suggested end of module test and first aid training are useful. They studied only one company but provided good insight about how to improve safety training in construction industry.

Safety program includes reducing physical work demands and worker injuries through train up the workers to use relevant equipment. Sufficient safety training should be provided to the participants/ workers to train them how to use the Personal Protective Equipment (PPE) or the safety equipment. Researchers pointed out that ineffective training was a non-intentional error where the root cause is lack of a well-structured training program. Therefore, a comprehensive design in training program is necessary. The paper pinpoints the concerned area in safety training according to the SMS and shown in the Table 2.

Area	Description
Safety structure	**Senior management**: • Senior management of the company should have adequate information regarding the resources allocation for training. • Senior management of the company is encouraged to be understandable in safety matter. • Senior management is encourage to invited safety expert to formulate safety policy, safety training issue for the company • They should consult to safety advisor regarding the updated requirement and government policy **Manager & supervisor**: • Managers and Supervisors are encouraged to attend induction and on-going safety training. • They should allocate time and resource for their team member to attend safety training **Worker:** • They should participate in toolbox meetings and other safety activities • They should participate in the mandatory basic safety training according to the legislative requirement
Safety Training	• The company safety department prepares a safety training policy • The company safety department prepares setting out safety training objective • The company safety department prepares devise a plan to implement the policy and arrange for employees to receive the necessary training

	• The company safety department prepares standard of performance of the training • The company safety department prepares monitor & review the effectiveness of training • The company safety department prepares monitor & review training plan • The company safety department prepares adequate & proper documentation • The company safety department prepares on and off job training • Decide whether training is needed (eg: marine works, confine space etc...) • Organizational training need, Job related training & individual training • Training, instruction, coaching & problem-solving skills relevant to safety & health • Formulation training objective and methods • Determine what level of training should be provided • Evaluation of the effectiveness of training • Documentation of training record
Hazard control programme	• Adequate training when use PPE • Training record for the PPE usage
Accident/ incident investigation	• Record of training
Evaluation, selection & control of sub-contractors	• Training programme & standard of sub-contractor • Worker training requirement • Sub-contractor safety & health training programme • Monitoring system
Accident control & hazard elimination	• Training & competency of worker

Table 2: Summary regarding safety training according to Safety Management System

5. Safety Promotion

This is no restricted guideline regarding safety promotion according to the inspection report on construction site. Table 3 provides a summary extracted from the Safety Management System (SMS) manual which suggested area to be improved. From the idea of (Fang DP et al. 2006, Choudhry RM et al. 2008), safety promotion aims to improve safety attitude of workers and letting the workers know company policy and updated safety issue. Implementation of safety issue according to the legislative requirement is to let workers know the senior management of the company is concerned about safety.

Area	Description
Safety structure	• Senior Management: policy, resource, culture, company awareness • Manager, Supervisor: implementation of policy • Worker: mindset

Safety committees	• Organization of safety promotion activities such as safety competitions, exhibitions, safety incentive schemes, and safety suggestion schemes
Safety & health awareness	• Safety promotion approach: meetings & seminar • Promotion of safety to individuals • Promotion of safety through safety publications, posters • Promotion of safety through campaigns • Monitoring, record, review

Table 3: Summary regarding safety promotion according to Safety Management System

In Hong Kong, The Development Bureau and the Labor Department organize "Considerate Contractors Award Scheme", "Construction Safety Week" and "Construction Industry Safety Awards Scheme" every year to promote safety. The promotion scheme is not only a target of construction companies and workers but also of worker's family and stakeholders. Those promotion schemes raise the concern of construction safety to the public, and have therefore have a good reputation.

The Hong Kong Special Administrative Region (HKSAR) launched a "Pay for Safety Performance Merit Scheme (PFSPMS)" since year 2013. The aim of the scheme is to make the contractor pay more attention to safety. This merit scheme is a task-tie payment scheme, which is not linked to previous safety performance of the company but the particular project. The scheme is let the contractor strive for better safety performance of the project. (HKSAR, 2016). The scheme provides extra 1.7% of total contract sum for promotion provided that the contractor has:

- No reportable accident in the a month
- No notice of safety/ environmental prosecution received in a month
- Compliance of silver card for workers of specified trades in a month
- Half-yearly review of safety performance
- 12 month rolling accident frequency rate < 0.25 per 100,000 man hour
- Yearly review of safety performance. eg: no fatal accident in a year
- Achievement in safety campaign activities
- Final review of safety performance is good

6. Conclusion

A huge financial loss was generated in construction industry every year. To improve this matter, it is encouraged stakeholders (government department, clients, and concern groups) to pay more attention to the safety issue. Comprehensive structured interviews have been conducted from June – December 2013 in Hong Kong. Safety investment of Client, developers and contractors has been investigated through structured interviews. Meanwhile 109 valid projects and 940 accident cases have been recorded in the research study. Quantitative analysis method has been applied to investigate the relationship between safety investment and financial loss. According to the findings, it indicated that financial loss could be significantly reduced by safety equipment, training and promotion whereas important factors in the Safety Management System (SMS). Safety equipment, safety training and safety promotion are encouraged to be invested to reduce the financial loss of accident. (Ying KC, 2018).

This paper summarized the concept of safety equipment, safety training and safety promotion according to the Safety Management Plan (SMS) whereas Hong Kong as a reference. The paper also introduce the description of framework to guide the industrial participants how to work with effective safety equipment,

safety training and safety promotion. The aim of the framework is also to provide guideline to (i) senior management how to reduce financial loss by providing safety equipment, training and promotion in more detail and (ii) the participants understand their right and obligation in construction site and how to equip themselves properly.

REFERENCE

Cheng Ching Wu, Leu Sou Sen, Lin Chen Chung and Fan Chih hao (2010) "Characteristic analysis of occupational accidents at small construction enterprise", Safety Science, Vol(48) pp698-707

Choundhry Rafiq M., Fang DongPing and Ahmed Syed M (2008) "Safety Management in Construction: Best Practices in Hong Kong", Journal of Professional issues in Engineering Education and Practice, Vol134, No.1, pp20-32

Dempsey Patrick G. and Mathiassen Svend Erik (2006) "On the evolution of task-based analysis of manual materials handling and its applicability in contemporary ergonmics", Applied Ergonomics Vol(37), pp33-43

Fang D.P., Chen Y. and Wong L. (2006) "Safety Climate in Construction Industry: A case study in Hong Kong" Journal of Construction Engineering and Management, Vol 132; pp573-584

HKSAR (2002) "Code of Practice on Safety Management"

HKSAR (2004a) "Reference Manual for Inspection Reports on Construction Sites"

HKSAR (2012a) "Factory and Industrial Undertaking (Safety Management) Regulations", The Hong Kong Special Administrative Government

HKSAR (2012b) "Hong Kong Annual Digest of Statistics (2012), The Hong Kong Special Administrative Government

HKSAR (2016) "Project Administration Handbook for Civil Engineering Works" Civil and Environmental Engineering Department, The Hong Kong Special Administrative Government

HKSAR (2017) Hong Kong e-registrations system, Department of Justice,
Available on https://www.elegislation.gov.hk/hk/cap59 [28 Dec 2017]

Hinze J and Rabound P. (1988) "Safety on Large Building Construction Projects" Journal of Construction Engineering and Management, Vol 114 (2), pp286-293

Hon K.H.C, Chan A.P.C. and Yam M.C.H. (2014) "Relationships between safety climate and safety performance of building repair, maintenance, minor alteration and addition (RMAA) works", safety science. Vol. 65, pp10-19

Ismail Zubaidah, Doostdar Smad and Harun Zakaria (2012) "Factors influencing the implementation of a safety management system for construction sites" Safety Science Vol 50, pp418-423

Jannadi M.O (1996) "Factors affecting the safety of the construction industry", Building Research and Information, Vol24(2), pp108-112

Jensen Lilli Krikeskow and Friche Claus (2007) "Effects of training to implement new tools and working methods to reduce knee load in floor layers", Applied Ergonomics Vol(38), pp655-665

Langford D., Rowlinson S. and Sawacha E. (2000) "Safety Behaviour and Safety Management: its influence on the attitudes of workers in the UK", Engineering Construction and Architectural Management, Vol 7 (2), pp133-140

Lu CS and Yang CS (2010) "Safety Leadership and safety behaviour in container terminal operations", Safety Science, Vol(48), pp123-134

Sawacha Edwin, Naoum Shamil and Fond Daniel (1999) "Factors affecting safety performance on construction sites" International Journal of Project Management. Vol 17(5) pp309-315

Scott Patricia A. and Renz Miriam C. (2006) "A combined field and laboratory investifation for the effective application of ergonomics in situ", Applied Ergonomics Vol(37), pp785-792

Ying K.C., Zhang, K.G.M. and Setunge S. (2016). “Key Parameters on Financial Loss of Construction Accidents in Hong Kong Construction Industry”. Proceedings of the 21st International Symposium on Advancement of Construction Management and Real Estate(CRIOCM 2016), 14-16 Dec 2016, Hong Kong. pp 957 - 967
Ying K.C (2018) “Benchmark of financial loss of construction accident and safety investment in Hong Kong”, PhD thesis, RMIT Australia (In press)