CRITICAL FACTORS AFFECTING SAFETY IN THE SINGAPORE CONSTRUCTION INDUSTRY

Sze Ming Woo[1], Charles Y.J. Cheah[2] and Wai Fan Wong[3]
[1, 2, 3] School of Civil and Environmental Engineering, Nanyang Technological University, Singapore.

Abstract

Construction is one of the most hazardous industries due to its unique nature. Recent occurrences of highly publicised and criticized construction site accidents have highlighted the immediate need for the construction industry to address safety hazards. Safety used to be addressed as an isolated issue in the past, but the problem of safety is an emergent property of a system. In general, it seems that both industrial practitioners and government officials have tended to address safety by focusing on technical aspects and looking for immediate causes of accidents after they have taken place. The objective of this paper is to examine issues and critical factors that affect the safety standards from a holistic point of view. The job of making worksites safe should not just fall squarely on the contractors but should be shared by all parties in the value chain of construction activities.

Keywords: Construction safety, factor analysis, safety legislation, Singapore.

1. Introduction

All over the world, the construction industry is one of the most hazardous industries due to its unique nature [1]. When compared with other industries, construction is often classified as high risk because it has historically been plagued with much higher and unacceptable injury rates. Although the problem of construction safety is not unique to Singapore, the two highly publicized cases in 2004 – the collapse of Nicole Highway and accident at the Fusionpolis, have again put the issue of construction safety into the limelight. Based on the statistics published by the Ministry of Manpower (MOM), construction accidents had caused 24 deaths in 2005 alone.

The main legislation in Singapore that used to govern the safety matters in the construction site is the Factories Act (Chapter 104) and the Building Operations and Work of Engineering Construction (BOWEC) Regulations (Section 68 and 77). As evident by the ailing safety records, the legislation does not seem to be fulfilling its cause. On 1 March 2006, the Factories Act was repealed and replaced by the Workplace Safety and Health Act (although the BOWEC Regulations remain in force as of this writing). It is noticed that the safety framework is shifting from a highly prescriptive one to a descriptive one. Under the previous Factories Act, the industry follows faithfully a fixed set of safety guidelines. There is now a paradigm shift from the previous Act as the new Act rests on three guiding principles: reduce risk at source; instil greater ownership of safety and health outcomes by industry; and impose higher penalties for poor safety management. Under the new Act, every industry player in the construction process's value chain will be held responsible for safety. The Act also calls for a greater level of self-regulatory and puts more

responsibilities on companies to determine their in-house safety standards and practices. In the new Act, violators of safety practices shall be fined even if no accident has occurred.

The intent of this study is to research into the issues and critical factors that affected the safety standards from a holistic point of view. The burden of safety had traditionally been rested on the shoulders of the contractors, but it is felt that safety should be a shared responsibility among all industrial players and the government. In short, the objectives of this study are:

1. To seek the view of the various industry players on their opinion of the construction safety standard;
2. To investigate whether there is a common agreement among the industrial players on their roles in safety responsibilities;
3. To identify the underlying factors that affect the construction safety standard.

2. Research Methodology

From the information gathered through literature review, preliminary data on the issues and critical factors that affect the safety standards of the Singapore construction industry were identified. A pilot study questionnaire was prepared from this preliminary list of main factors and their sub-factors. These pilot questionnaires were first sent to various industrial practitioners for review and comment. A feedback session was then conducted with the participants of the pilot questionnaire. After the feedback session, modification and refinement were made to the pilot questionnaire. A finalised questionnaire was then prepared and sent out to suitable respondents for filling out. The questionnaires were sent via posted or electronic mail to the respondents. Quantitative techniques were subsequently employed to analyze the feedback before the research findings were finally concluded. Figure 1 shows the overall research methodology.

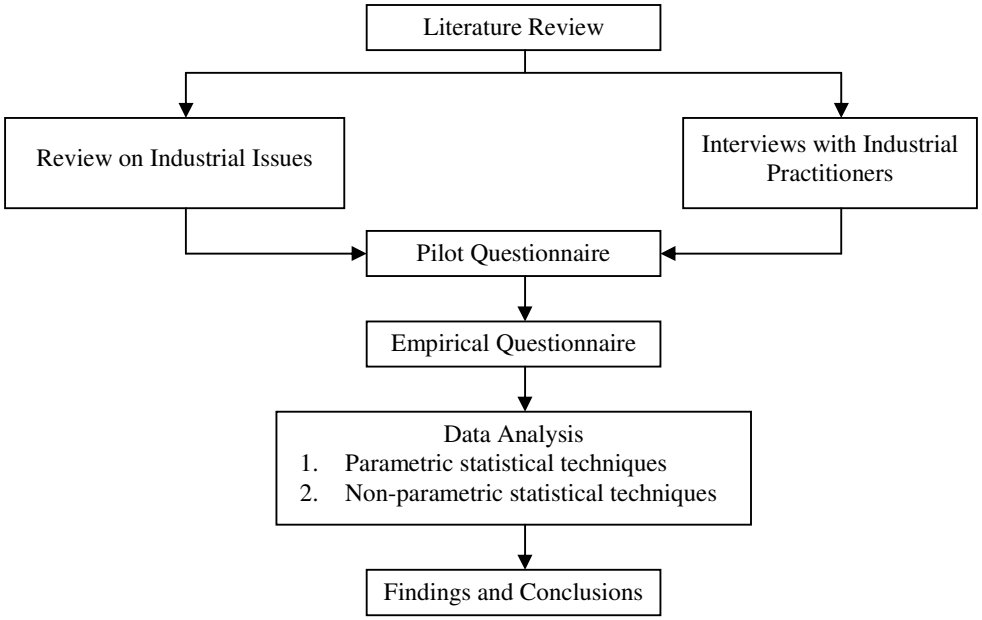

Figure 1: Research Methodology of Study

3. Literature Review

Several research papers that were of resemblance to this research topic were identified for an in-depth study. These papers provided insights on the appropriate research methodology to adopt, the design of the questionnaire and the analytical techniques. However, the methodology and findings of these research papers should be referred to with caution as they were designed to suit the locality and conditions of the country where the research was conducted. The cultural context of Singapore and construction industry itself must be duly considered in the design of the questionnaire subsequently.

Sawacha *et al*. [2] provides an in-depth study of the attitudinal aspects of safety among workers in the U.K. construction industry. The specific objectives of this paper are to correlate the workers' background and attitude towards safety with their accident records and also to determine the group of factors that have the most impact on site safety. The information and data necessary for the research study were collected through a questionnaire survey. The top five issues found to be associated with site safety were: management talk on safety; provision of safety booklets; provision of safety equipment; providing safety environment; and appointing a trained safety representative on site. Effectively, site managers and supervisors must engage in regular talks with the workers on site in order to have better safety. The importance of providing workers with a safety booklet or manual when joining a company is also emphasized and verified. Their research also indicates that the provision and use of the correct type of protective equipment and clothing are pre-requisite for improving safety performance. The workers should also be trained for the correct trades or construction tasks. The importance of a clean and tidy site for improving safety performance cannot be overlooked – this is a part of improving working conditions in order to minimise safety hazards. Finally, this research also indicates that having a well-trained safety representative on site can improve safety performance by undertaking fault spotting and insisting on corrective actions being taken.

Zeng *et al*. [3] discusses construction site safety in China and identifies the factors that affected safety in the Chinese construction industry. The information and data necessary for their study were collected by a structured questionnaire survey and interviews. The questionnaires were sent to the safety representatives of the Chinese construction firms. The interviews were conducted with Chinese government officials in charge of safety. This study shows that the main factors affecting safety performance in China are: poor safety awareness of top management; lack of training; poor safety awareness of project manager; reluctance to input resources to safety; and reckless operation. First, it is concluded that safety awareness of top management and project managers in most Chinese construction firms is of grave concern. Apparently, most contractors do not implement a proper safety management system laid down in the safety manual. It is found out that only a small percentage of contractors provide adequate personal protective equipment for their workers and offer systematic safety training. Essentially, the management lack emphasis on safety as revealed by their infrequent attendance to safety meetings. This research also reveals that the percentage of workers being trained is very low in China. Safety training programs help workers to carry various activities effectively, establish a positive safety attitude and integrate safety with construction and quality goals.

The problem of reluctance to invest resources for safety is closely associated with the operational nature of construction firms in China. Almost all Chinese construction firms of

different sizes compete for the same jobs in China. This results in excessive competition and thin profit margin. This vicious cycle hinders safety standards. Reckless operation, which occurs largely during building demolition, has also been identified as one of the most important factors in safety. Finally, it is suggested that the Chinese government should play a more critical role in stricter legal enforcement of safety legislation and organizing safety training programs.

Kartam *et al*. [4] evaluates existing safety regulations, describes safety procedures adopted by owners, designers, contractors and insurance companies and assesses the suitability of these regulations and procedures for Kuwait's environment and workforce. Different research activities like field visits, questionnaires and interviews have been used to collect the necessary information and data related to this research. It was observed that the factors contributed to the poor safety standard are: disorganized labour; poor accident record keeping and reporting system; extensive use of foreign labour; extensive use of sub-contractors; lack of safety regulations and legislation; low priority given to safety; the small size of most construction firms; competitive tendering; and severe weather conditions during summer. The employment of migrant labour is a characteristic of construction site in Kuwait. The differences in labour cultures and traditions reflect on human relations and work habits and cause difficulty in communications. These give rise to safety issues. There is also a lack of official safety data and records of construction accidents at sites, which indirectly makes safety the last issue of concern of contractors and owners. The construction industry in Kuwait depends mainly on a foreign labour force that has no union or community to defend its rights. The workers are not aware of their rights to safe working conditions. The absence of a unified set of safety regulations adversely affects the enforcement of safety on job site. The main concern of a contractor is how to save money and reduce costs. Safety is usually considered a secondary priority in the company's plan. Small construction firms with less than 10 employees accounts for about 60% of construction firms in Kuwait. This high proportion of small firms is a handicap to the spread and adoption of safe working practice. Contractors often feel that their bids will be considered even if they do not make proper provisions for safety costs during competitive tendering. Most contractors do not consider the cost of implementing safety systems and practices in their tender unless this is explicitly itemized in the contract documents. Safety hazards in Kuwait also arise from extreme weather conditions in summer, when temperature is usually greater than 110°F, often adversely affecting the workers' state of mind and attention.

The literature review also included most of the construction safety incidents occurred over the past three years in Singapore. This was done by a search conducted over the internet with the help of the search engines and subscribed service to the archived news of the local papers or news stations. The safety system implemented and the trend in safety standards in Singapore were also studied through information published by the Ministry of Manpower (MOM), Building and Construction Authority (BCA), Statistic Singapore (Singstat), and other non-governmental bodies that are involved with the construction safety issues.

4. Questionnaire Design and Preliminary Analysis

4.1 Content of questionnaire

There are three sections in the questionnaire:

- Section I – Background information about the respondent;
- Section II – General opinions on safety issues;
- Section III – Specific questions for Factor Analysis.

Section I contains questions on the general information of the respondents, such as the respondent's job designation, profession and company information. Section II seeks the respondents' opinions on general construction industry safety issues. The respondents were asked to rate the safety standard in terms of injuries/deaths/accidents frequency and to give their views on the safety responsibilities among the various significant groups of construction personnel. In Section III, significant factors that had been gathered through literature review and interviews were compiled and the respondents were asked to rate the level of impact on safety due to these factors. The response to each question was measured on a five-point Likert scale ranging from "lowest impact" to "highest impact". The study consists of eight main categories and forty-five factors. Due to limitation of space, subsequent discussions of research findings are limited to the results for Section II.

4.2 Sample size

The targeted respondents of the survey were middle management, professionals and executives from the construction industry, comprising project managers, architects, engineers, quantity surveyors, project coordinators, government registered safety officers and site supervisors. These people represent the significant groups of industry practitioners that play an important role in the construction value chain. Table 1 gives a summary of the questionnaire replies.

Respondent Groups	Questionnaires sent out	Replies received	Response rate	Usable responses	Usable rate
Government Agencies	25	8	32%	7	28%
Developers/Property Managers	25	10	40%	9	36%
Consultants	40	20	50%	18	45%
Contractors / Sub-contractors	50	44	88%	37	76%
Suppliers	10	0	0%	0	0%
Non-governmental Safety Personnel	20	9	45%	9	45%
TOTAL	**170**	**91**	**54%**	**80**	**48%**

Table 1: Summary of Questionnaire Replies

5. Results and Discussions

5.1 General outlook of the safety standard in Singapore

The findings gathered under Section II of the questionnaire effectively depict the general outlook of the safety standard in Singapore. Respondents from the different groups were asked to rate the safety standard of the construction industry in terms of injuries/deaths/accidents frequency on a scale ranging from "very bad (1)" to "very good (5)". The average results for each group are tabulated as follows:

Respondent Groups	Government Agencies	Developer / Property Management	Consultants	Contractors / Sub-contractors	Non-governmental Safety Personnel
Mean value of measure (Scale 1 – 5)	3.00	3.00	3.17	3.24	2.56

Table 2: Average Feedback on Safety Standard by Each Group

It is seen that non-governmental safety officers is the most sceptical group about the safety standard in Singapore. Government agencies and developers/property management felt neutral about the issue. Consultants rated the safety standard second best to the rating given by the contractors, who had the most optimistic view about the safety standard.

The accident rate in the construction industry has not shown much improvement even after the implementation of the Safety Management System (SMS) in 1994. Over the last 25 years, the construction sector underwent two business cycles. The first cycle was in the 1980s when construction demand peaked in 1983. The second business cycle started from the early 1990s when construction demand rose sharply to peak in 1997. Shortly after this peak, the Asian Financial Crisis struck. The construction sector had not made much recovery since.

The common yardstick to measure safety standard is the number of accidents per million man-hours worked. A downward trend was actually observed from the statistics of Industrial Accident Frequency published by the Ministry of Manpower (MOM). Although this seems to suggest that the safety standard has improved since the implementation of the SMS in 1994, further scrutiny into the number of construction fatalities between 1997 and 2004 does not actually reflect an improving safety record. A comparison was made between the value of construction projects and the number of workers employed against the number of construction accidents for the period of 1997-2004. This is tabulated in Table 3:

Percentage of Change using 1997 as Benchmark							
	1997-98	1997-99	1997-00	1997-01	1997-02	1997-03	1997-04
Value of Contract	3.08%	-10.32%	-16.06%	-17.45%	-31.06%	-36.48%	-40.75%
No. of workers employed	-0.60%	-7.96%	-6.39%	-14.07%	-19.57%	-27.21%	-30.77%
No. of accidents	-0.39%	-2.21%	-9.30%	-5.40%	-13.07%	-22.43%	-20.94%

Table 3: Comparison of Value of Contract, No. of Workers Employed & No. of Accidents

From Table 3, it can be seen that the drop in number of workers employed has been in tandem with the shrinkage in value of construction projects. However, the occurrence of accidents was not reducing by the same proportion. The rate of reduction in the number of accidents was indeed less than the rate of reduction in the value of construction projects and number of workers employed. In 1997, the value of construction project was approximately S$19.2 billion and in 2004, the value of the construction project was

approximately S$11.4 billion; the drop was about 41%. During the same period, the number of workers employed fell from approximately 214,000 to 148,000; the drop is about 31%. There was also a fall in accidents from 1538 cases to 1216 cases; the drop is only about 21%. Thus, the lower number of construction fatalities from 1994 to 2004 may not due to an improvement in safety standard, but merely due to much fewer construction projects and workers! However, this fact was clearly not reflected in the opinions of the respondent groups except the non-governmental safety personnel group who rated the safety standard as not too satisfactory (refer Table 2).

5.2 Feedback on Safety Responsibilities

The respondents were also asked to rank the various roles in the construction industry in terms of their level of safety responsibilities on a scale ranging from "most responsible (1)" to "least responsible (6)". The result for each responding group was calculated by using the sample mean. The final ranking was worked out by summing the results from each of the individual group. These are tabulated in Table 4:

		SAFETY RESPONSIBILITIES of					
		Gov. Agencies	Developers/ Property Management	Consultants	Contractors/ Sub-contractors	Non-Gov. Safety Personnel	Workers
RESPONSES from	Government Agencies	3	6	5	2	4	1
	Developers/ Property Mgmt.	3	2	4	1	5	1
	Consultants	4	5	6	2	3	1
	Contractors/ Sub-contractors	4	3	6	2	5	1
	Non-Governmental Safety Personnel	4	3	5	1	6	2
	Total Score	18	19	26	8	23	6
	SAFETY RANK	***3***	***4***	***6***	***2***	***5***	***1***

Table 4: Ranking of Safety Responsibilities among Various Industry Players

Most respondents felt that the workers who are executing works at the construction site should assume the highest responsibility for their own safety. Contractors who employ those workers should be the second most responsible party. Government who frames the legislation that governs the safety system is the third most responsible party; whereas the least responsible party as far as safety is concerned is the consultant.

The chief causes of industrial accidents are well-known: unsafe act coupled with unsafe conditions and a lack of coordination of work processes. Indirectly, the results of Table 4 support this proposition. Workers who are executing the physical work at construction site should be held most responsible for their own safety. These workers have gone through a fair amount of safety training and have been provided with personal protective equipment. However, this does not ensure that the workers would put it into practice. This lack of commitment from the workers by indulging in unsafe acts often contributed to worksite accidents. Contractors who employ the workers have moral and legal responsibilities to ensure that the workers must not work under any unsafe working conditions. They must

equip the workers the necessities for them to perform their safely, like safety training and personal protective equipment. The contractors must also coordinate their work processes to eliminate any potential safety hazards. The third most responsible party judged from the survey result is the government. Some managers, supervisors and workers from the contractors continue to ignore and neglect safety measures and systems, despite the importance of human lives and financial losses incurred from the accidents. It is essential that the government put in place a strong regulatory framework.

The ability of developers to assume safety responsibilities depend on the procurement arrangement and their level of technical expertise. Some developers have in-house technical experts who are actively involved in every stage of the project. Some developers do not have any technical expertise, leaving the project management function to its consultants and adopt a "hands-off" approach. Undoubtedly, developers do not create any safety hazard (unlike the contractor, consultants and workers) directly at the construction sites where accidents happen. However, their stand on safety issues of their projects will have a direct impact on the contractors and consultants and indirectly, the workers. Most will agree that they have a major influence on the safety culture of the projects that they promote. For example, in one real project, the client was willing to allocate a reasonable sum of money towards promoting safety awareness onsite and it challenged the contractor to match its funds. The total pool of money was then distributed as safety awards that were handed out weekly. This incentive scheme strongly motivated the workers to pay more attention to safety and the 10-month project enjoyed a zero incident record.

The fifth most responsible party for safety from the survey results is non-governmental safety personnel. Some functional department of the contractors' companies shy away from safety responsibilities, leaving it to their safety departments or the safety officers. However, site accidents cannot be prevented solely based on the efforts of the safety departments or the safety officers. Safety can only be improved through cooperation with the other functional departments and management commitment of the contractor's company.

The least responsible party for safety from the survey results is the consultants. Still, it should be mentioned that the design of a building has a direct impact on the safety of a project.

The Latham Report, a study conducted by Sir Michael Latham and commissioned by the United Kingdom (U.K.) government in 1994, painted a picture of distrust and conflict – not just between developer and contractor, but also between the design and construction team and within the construction team itself. In the Interim Report of the Joint Government/ Industry Review of Procurement and Contractual Agreement in the UK Industry in 1993, Latham described a debilitating culture of conflict:

> *"…The industry has deeply engraved adversarial attitudes. The culture of conflict seems to be embedded, and the tendency towards litigiousness is growing….disputes and conflicts have taken their toll on morale and team spirit. Defensive attitudes are a common place*."

This problem of uncertainty and adversity that is inherent in the construction industry still holds true until today. Developers often worry that the contractors are cheating on them and not getting the "best value for money" building that they wanted. Professional consultants

often fear that they will be held responsible by the developers for any unforeseeable extra cost or time delay on the projects that they advised. Contractors often feared underpayment by developers and overcharging by specialist sub-contractors. The lack of both trust and money created an adversarial culture and confrontational environment between developers, consultants, contractors and workers. This had a negative impact on the safety management in construction projects. For moral reasons and practical financial risk management reasons, construction safety should be the concern of all individuals and organizations involved in construction projects.

The data presented in Table 4 also indicates that there is no uniform agreement on the construction safety responsibilities that should be assumed by each group. There are two possible explanations for this lack of shared expectations on construction safety roles:

- There are no detailed expectations about safety roles written in project contracts, governmental standards, or anywhere else. The only portion of project contracts that typically mentions about site safety is General Conditions in the Preliminary Section. The General Conditions, however, typically do not clearly establish the safety responsibilities of a developer, consultant, contractor, non-governmental safety officer and workers.

- Recent literature has also been arguing for an increased level of design professionals' safety obligations. Several construction management researchers have published a stream of articles that argue that designers should proactively consider site safety during design stage [5], [6], [7], [8]. These researchers have identified ways that designers can influence site safety during construction by making better decisions during the design stage. This is however a paradigm shift for most consultants as they are traditionally not responsible for safety. This shift infers a natural extension to their legal liability on construction safety and also duties on safety during physical construction activities.

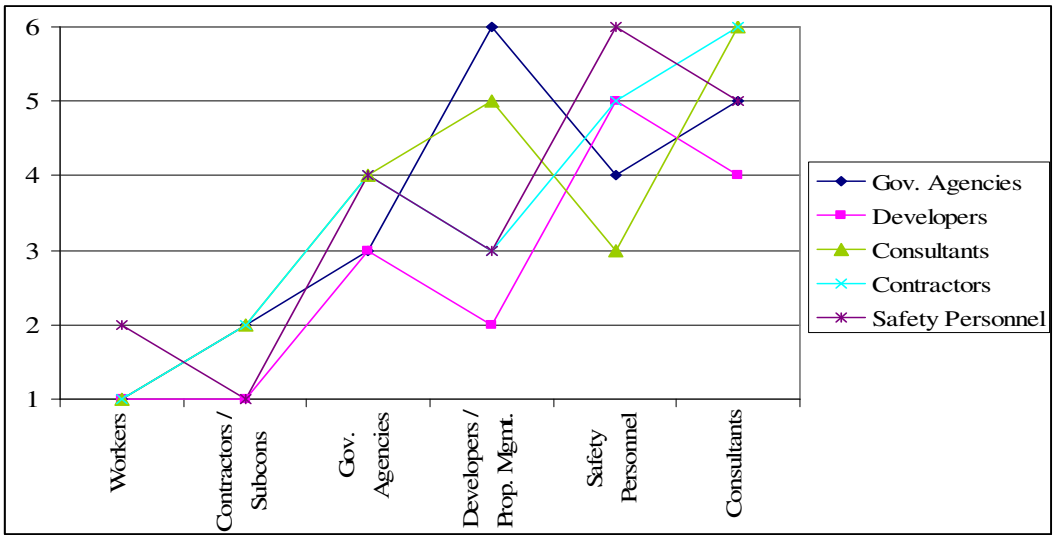

Figure 2: Measuring Disparity in Opinions on Safety Responsibilities of Each Party

The disparity in opinions on safety responsibilities can also be represented graphically. In Figure 2, the role of safety assigned to the top three most responsible parties – workers,

contractors and government fluctuate within a "narrow band". It shows that the respondents within the group manage to reach a relatively higher consensus on these top three most responsible parties for safety. There is more controversy within the group on the safety roles for developers and non-governmental safety personnel. As can be seen from the figure, responses for these two parties fluctuate rigorously along a wider band.

Interestingly, almost all of the respondents felt that consultants have the least role to play when it comes to construction safety. Still, responses drawn from the group for consultants fluctuate rigorously along a wide band (similar to those for the developer and non-governmental safety personnel). As mentioned earlier, many researchers have already recognized the role that the consultants can play in construction safety particularly during the design stage.

5. Conclusion

The statistics of fatalities and incidents in the construction industry may not tell the whole story as the volume of contracts and the number of workers employed have also dropped since 1997. Based on the survey results, there is some disparity in opinions on the level of responsibility to be assumed by different project stakeholders. Overall, the approach to safety has to be a holistic one that draws cooperative efforts from all parties. A strong legislative framework should be put up by the government. Safety considerations should be given as early as during the design stage, instead of relying on the traditional role of the contractors to safeguard safety onsite. Support should be garnered from the project's client (developer), who has a great power to promote safety indirectly. Most importantly, however, the workers themselves need to be educated so that they could understand the importance of safe working practices.

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