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Rita Yi Man Li · Sun Wah Poon

Construction Safety

Springer

Rita Yi Man Li
Department of Economics and Finance
Hong Kong Shue Yan University
Hong Kong
People's Republic of China

Sun Wah Poon
Department of Real Estate
and Construction
The University of Hong Kong
Pokfulam, Hong Kong
People's Republic of China

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Preface

Construction safety is often regarded as a hard nut to crack issue. This book is the first of its kind which views the issue from the supply and demand perspective. In general, supply of safety measures includes safety management, regulations, and provision of safety knowledge while demand of safety measures includes high non-monetary and monetary costs of construction accidents.

Chapters 1 and 2 showcase the causes of construction accidents in several developed and developing countries. Chapter 3 sheds light on the supply of safety measures in some of the developing countries, such as Bermuda, China, Egypt, and Kuwait; as well as developed countries, for example, France, the United States, and Singapore. Chapters 4–6 study the effectiveness of various safety measures in Hong Kong with the help of questionnaires, case studies, and interviews. In view of the popularity of World Wide Web, Chaps. 7 and 8 study the safety knowledge sharing with Web 2.0 and information technology. By putting the lens on direct and indirect costs of construction accidents and court cases in the United Kingdom and Hong Kong, Chaps. 9–11 review the demand of the various safety measures. Lastly, Chap. 12 illustrates the impact of burnout on construction work safety.

Contents

Chapter 1
A Literature Review on the Causes of Construction Accidents

1.1 A Review on Global Construction Industry

Construction industry is a conglomeration of diverse fields with work ranging from simple renovation to major and complex engineering projects, such as high rises, bridges, power stations (Garrett and Teizer 2009; Sichombo et al. 2009). It envelops thousands of small companies which typically hire less than ten people (Garrett and Teizer 2009; Sichombo et al. 2009). Although the roles of construction industry in developing and developed countries are different, the coverage of construction industry is quite similar.

In Zambian, construction industry loosely lumps the five sectors: assembly, clientele, design, manufacturing, and supply (Sichombo et al. 2009). The Tanzanian construction sector constitutes all civil works related to construction, design, maintenance and rehabilitation of dams, roads, bridges, airports, irrigation systems, residential and commercial buildings. The sector is responsible for the procurement and subsequent utilization of construction plants and equipment, development and registration of contractors and construction industry professionals. It includes firms and individuals working as component producers, equipment suppliers, consultants, contractors and sub-contractors, merchants and builders (Eliufoo 2007). In the UK, construction work refers to the carrying out of any civil engineering, building or engineering construction work (The National Archives 2012).

No matter what elements are included in the construction industry, a mainstream of thoughts within the arena of construction economics views the construction industry as an important sector of socioeconomy around the globe (Ye et al. 2013). Construction spending in GDP first grows during the less developed period of time, reaches the apex on newly industrialized status, and eventually declines in advanced industrialization (Ye et al. 2013).

Today, construction industry hires a large workforce, generates much income and enhances economic development in developing countries (Solís-Carcaño and Arcudia-Abad 2013, forthcoming, Ye et al. 2013). For example, the industry shares 5–7 % of GDP and nearly 4 % of social employment in China (Ye et al.

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2013). In Kuwait, there is a consistent growth of the labor force in construction industry. Construction workers occupy about 9.9% of the total labor force from 2001 to 2007. The Instituto Nacional de Estadistica, Geografiae Informatica reports that the construction sector represents 7 % of the total value of goods and services in Mexico (Solís-Carcaño and Arcudia-Abad 2013, forthcoming). Despite a decline of construction industry's importance in developed countries, we cannot underestimate its contribution to their economy. For example, the U.S. construction industry in 2000 employed 6.7 million people with an expenditure of $650 billion dollars which was about 10 % of GDP (Ye et al. 2013).

Construction accidents on site, however, leads to much social costs which harm the society (Hallowell 2010). The adverse outcomes create the need for accident prevention that requires knowledge of accident causal factors, how these factors contribute to accident causation and the extent to which causal factors contribute to accidents (Manu et al. 2012). This chapter aims at reviewing the direct and indirect causes from literature.

1.2 Causes of Construction Accidents

There are many causes which lead to accidents. Generally speaking, we can classify them into two categories: direct (immediate) and indirect (distant) causes. The direct causes refer to causes which have an immediate effect on workers' safety condition, e.g., structural failures and insufficient PPE. Nevertheless, what gives room for these unsafe conditions on site depends on indirect causes such as poor organization and economic concerns (Fig. 1.1).

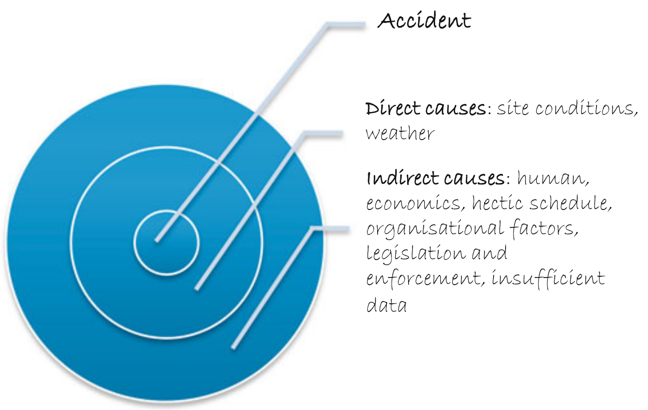

Fig. 1.1 Causes of construction accidents (*author's figure*)

1.2.1 Human

All safety and health initiatives must predicate human involvement (Langford et al. 2000).

1. Human error: workers response to risks and their perceptions affect their choices at work, subsequent actions, human error, misjudgments and wrong actions, finally leading to injuries (Zhi et al. 2003; Garrett and Teizer 2009). Previous research also shows that more accidents happening on Monday (Navon and Kolton 2006) is possibly due to decrease in safety awareness after a weekend hiatus (Card and McCall 1996).
2. Relationship with colleagues: previous research shows that workers with better relationships have better safety records than those who do not. Being able to share personal problems with someone has a positive effect on safety. Furthermore, workers who feel that their employer cares about their welfare usually have better safety records than those who feel otherwise (Debrah and Ofori 2001).
3. Immigrants: foreign migrant workers tend to be more prone to accidents. Many of them can speak only in their own dialects and find it difficult to understand safety rules on site (Debrah and Ofori 2001).
4. Insufficient safety training and education: in Australia, in response to the open-ended oral survey question "how did you learn to work safely?", the most often response was "common sense" (Wadick 2010). This reflects the lack of safety training and education. Nevertheless, it leads to safety problems on site. In Hong Kong, it has been a long history that traditional master-apprentice relationships in various construction trades provide the training of different skills. Such apprenticeship does not provide systematic training and varies from individual to individual (Chan et al. 2004). In China, many accidents happen because most of the workers and some of the managers do not have proper training or education in safety management (Liu et al. 2007). In Singapore, the large number of illiterates and untrained foreign workers in the industry who were farmers and fishermen before usually leave Singapore after working two to three years with all the training provided. Therefore, contractors do not spend time and money to train them and cause safety problems (Debrah and Ofori 2001).
5. Fatigue: in the research study conducted in China, 78 % of all stakeholders ranked fatigue as the most critical accident risk item which causes accidents (Chan 2011).
6. Workers' motives to derive short term benefits: such attitudes lower workers' perceptions of risk and underestimate their jobs' risk level (Gilkey et al. 2012, forthcoming).

1.2.2 Economic Consideration

Many contractors hold the view that time and money are the two major concerns on site. However, money is also a factor which is responsible for accidents on site. It is well-known that the higher the investment in safety, the better the safety performance would be expected. Nevertheless, economic constraints appear to affect the way people perceive risks (Lin and Mills 2001) and safety is often compromised when the contractor is under economic pressure (Debrah and Ofori 2001).

1. Developed and developing countries: although there is no singularly recognized definition of a developing country, developing countries usually refer to those countries with low average per capita income. The World Bank defines developing countries as countries with Gross National Income per capita below US$11,905 (White et al. 2011). In many developing countries, the use of traditional construction methods, such as wooden scaffolding gives rise to safety problems. In developed countries, on the other hand, advanced equipment and technologies used in the industry have greatly improved working conditions. The construction accidents occurred are mainly due to organizational factors and human failures (Chun et al. 2012).
2. Method of payment to workers: many contractors adopt piece rate as a method of payment as the amounts of work on sites are usually easy to count and it also motivates workers to work faster. Yet, this becomes one of the major causes which leads to accidents as workers want to receive more pay and may not spend time and effort on safety precautions (Debrah and Ofori 2001).
3. Low costs in accidents: in many developing countries such as China, safety may not be contractors' major concern. It is because contractors only need to compensate limited sums of money to workers if injuries happen (Liu et al. 2007). The relative low costs for accident compensation together with the presence of insurance is another problem. The taking up of insurance policies also contributes to the poor safety record. Some contractors are satisfied with the liability transfer for compensation to insurance companies. They neglect site safety and do not provide sufficient safety training and supervision and reduce the expenditures for protective tools at work. This practice continues despite the existence of evidence to show that main contractors can have a positive effect on safety. Larger construction companies tend to have better safety records as top management supports safety and appoints full-time safety officers (Debrah and Ofori 2001).

1.2.3 Hectic Schedule

Many accidents happen because of the hectic schedule, partly caused by employees' negligence and employers' carelessness and irresponsible attitudes. As commented by a foreman in Joseph Smith (Pauper) v Charles Baker and Sons "the men ought to have stopped work while the stone was being jibbed round. That would be the safe way, [however], [i]f the men left their work every time the crane jibbed, it would take two and a half hours to do one hour's work". Carelessness and indifferent attitudes; ignorance or lack of training and working experience; lack of discipline; distraction; and poor communication are common causes (Debrah and Ofori 2001).

1.2.4 Organizational Factor

Organization management is one of the major factors affecting the success of a project in terms of profit. It also affects safety management on site (Chen and Jin 2012).

1. Subcontracting: subcontracting is a major feature of construction industry. Subcontractors make up approximately 90 % of workers in the construction industry. There is mounting evidence that subcontracting has negative health and safety effects on workers as monitoring and enforcement of OHS become more difficult at workplaces. It also increases the risk of "paper compliance" (Wadick 2010, Debrah and Ofori 2001; Toole 2002).
2. Size of the companies: Lin and Mills (2001), Holmes (1999), Lingard and Rowlinson (1994) concede that size of the companies is one of the major factors which affects the probability of accidents on site. Previous research shows that there are higher accident rates in small and medium-sized enterprises (SMEs) as compared with the larger ones (Arocena and Núñez 2010 and Kongtip et al. (2008). The problems faced by some of these companies include the lack of human resources, funds, limitation of technology and management (Kongtip et al. 2008). Nevertheless, research on this issue is not conclusive. For example, Kongtip et al. (2008) find that SMEs do not perform worse than the large scale companies in Thailand.
3. Temporary workforce: the construction industry relies on a mobile workforce; temporary organizations are set up at the point of consumption. Although it provides the best advantage to firms, excessive reliance creates difficulties for employers and employees, leading to higher accident rates (Dewlaney et al. 2012, forthcoming).
4. Separation between designers and contractors: contractual arrangement affects the management and communication on sites. Apart from Design and Built contract, building and design teams come from two different companies. Institutional separation between designers and constructors as such does not allow ready feedback. As the design of a building affects the method of construction, it may adversely affect safety condition on site (Atkinson and Westall 2010).

1.2.5 Legislation and Legal Enforcement

While safe working conditions are the result of proper prevention which is dictated by legal obligations (Hoła 2010), poor safety regulation is one of the causes of construction accidents on site (Rowlinson 1997; Chockalingam and Sornakumar 2011; Chan 2011). The research results of Esmaeili and Hallowell (2012) even shows that internal factors inside the organization are more important than external factor (i.e. legislation) in controlling safety issues on sites. In many places such as Hong Kong, the Labour Department advocates the policy of prosecution as the very last resort, which is carried out after fatal and serious accidents only. Such piecemeal nature of site safety legislation often leads to inadequate coverage, and the enforcement and low levels of fines (Chan et al. 2004).

In the UK, the introduction of the Construction and Design Management (CDM) Regulations in 1994 attempted to involve designers, or even clients to manage the construction risks (Morantz 2009). In Bermuda, the Occupational Safety and Health Act 1992 (consolidated 2004), Occupational Safety and Health Regulations 2002 and Occupational Health and Safety (Approved Code of Practice) Notice 1997 state clearly that employers not only have safety responsibility to their employees but also the general public, to mitigate their exposure to risks inherent in proximity to job sites (Bermuda 2011). Nevertheless, the effectiveness of these regulations has been criticized by construction practitioners (Morantz 2009).

Safety training seems to be designed for those who work on front line production processes only rather than those who are in an upstream project organization. The safety audit aims to find out risks or hazards at the technical or operational level only; less concern is placed at the managerial level. Safety campaigns are only provided for operatives rather than for those who are involved in design or concept phases of a construction project (Morantz 2009).

In the US, although federal enforcement significantly lowers the frequency of nonfatal construction injuries, it significantly increases occupational fatalities rates (Morantz 2009). The problem of legislation is even worse in developing countries. The absence of statutory requirement is also one of the major causes for safety problems. In India, there was no specific legislation in construction industry till 1996. Although the Building and other construction workers (Regulations of Employment and Condition of Service) Act was implemented on 1st March 1996, there is no enforcement at the states level (Chockalingam and Sornakumar 2011).

1.2.6 Insufficient Data

Inadequate safety data and analysis from the Labour Department often lead to the inability to measure the effectiveness of the safety teams' efforts and the lack of focus in safety campaigns (Chan et al. 2004). Some of the construction safety database are therefore established for this reason. For example, The OSHA

Database of United States is mentioned most was recognized as an effective tool to improve the level of construction management (Zhou et. al. 2012).

1.2.7 Site Condition and Ergonomics

Apart from the above indirect causes, direct causes refer to the causes which finally lead to accidents on site. Site condition, for example, is one of the important safety factors. A good site layout, for example, is vital to ensure the safety of the working environment (Sanad et al. 2008)

1. Structural failures: a considerable amount of literature has recorded that construction accidents on site arise due to structural failures of buildings under construction or temporary and non-standard supporting systems (Sun et al. 2008; Hintikka 2011, Hu et al. 2011). The evidence behind this link is, however, somewhat contradictory and ambiguous (Hintikka 2011).
2. Lack of protective measures: construction is always risky because of working at heights (Hu et al. 2011) and lack of protective measures (Beavers, Moore and Schriver 2009; Pritchard 1997). A 1988 UK health and safety executive study concluded that most people killed at work were killed from a lack of simple precautions and planning and that their deaths were avoidable (Pritchard 1997). In Tanzania, workers identified lack of protective and safety gear as one of the major problems on sites (Eliufoo 2007).
3. Buildings' design: LEED certified buildings have a recordable injury rate 9 % higher than the traditional non-LEED buildings. The distinct aspects of the design elements, means of construction to achieve LEED certification have negative impact on workers' safety (Dewlaney et al. 2012, forthcoming).
4. Other site conditions: continual changes in varying technologies, drawings and procedures, and the need for co-ordination between different operations and trades and work complexity lead to high accident rates (Choi et al. 2011; Chockalingam and Sornakumar 2011). Haslam et al. (2005), Toole (2002), Hu et al. (2011) agree that poor housekeeping is another major factor which leads to accidents.

1.2.8 Weather

Construction work is heavily influenced by factors such as weather which is quite difficult to plan and predict (Esteban et al. 2009). Some literature show that working surfaces and platforms are important factors and weather is the important factor which affects their conditions (Hu et al. 2011). In places such as Hong Kong, the summer weather is quite hot. While it is suggested that workers should rest for up to 75 % of the time in any hour (Chan et al. 2004; Navon and Kolton

Table 1.1 Summary of the previous literature on factors which lead to accidents

Accidents happen because:	Writers support	Writers disagree
Human system		
Human error	Garrett and Teizer (2009), Zhi et al. (2003), Navon and Kolton (2006), Card and McCall (1996)	
Lack of safety training and education	Chan et al. (2004), Debrah and Ofori (2001), Liu et al. (2007), Wadick (2010)	
Migrant workers	Debrah and Ofori (2001)	
Poor attitude towards safety	Toole (2002)	
Poor relationship with the crew	Debrah and Ofori (2001)	
Fatigue	Chan (2011)	
Motives to derive short term benefits	Gilkey et al. (2012, forthcoming)	
Ergonomics and site condition		
Poor housekeeping	Haslam et al. (2005), Toole (2002), Hu et al. (2011)	
Lack of protective measures	Toole (2002), Hu et al. (2011), Eliufoo (2007), Beavers et al. 2009, Pritchard 1997	
Structural failure	Sun et al. 2008, Hintikka 2011, Hu et al. 2011	
On site work complexity	Choi et al. (2011), Chockalingam and Sornakumar (2011)	
Weather		
Hot summer	Hu et al. (2011), Chan (2011), Navon and Kolton (2006)	
Organization level		
Tight schedule	Debrah and Ofori (2001)	
Subcontracting	Debrah and Ofori (2001), Rowlinson (1997), Toole (2002), Wadick (2010)	
Organization level		
Size of companies	Lin and Mills (2001), Holmes (1999), Lingard and Rowlinson (1994), Arocena and Núñez (2010)	Jannadi (1995), Kongtip et. al. (2008)
Design and build separation	Kongtip et. al. (2008), Arocena and Núñez (2010)	
Accidents happen because:	Writers support	Writers disagree
Legislation		
	Hola (2010), Rowlinson (1997), Chan et al. (2004), Chockalingam and Sornakumar (2011)	Morantz (2009)

(continued)

Table 1.1 (continued)

Accidents happen because:	Writers support	Writers disagree
Economic consideration		
Developed countries	Chun et al. (2012)	
Piece rate method of payment	Debrah and Ofori (2001)	
Low expenditure on safety	Debrah and Ofori (2001), Liu et al. (2007)	

2006), it is highly impossible in view of the hectic schedule on site thus leading to accidents (Navon and Kolton 2006).

1.3 Conclusion

Many construction accidents on site occur not because of one or two reasons but when one or more distant and immediate factors go wrong. Safety management, therefore, should not focus solely on the direct causes. The management should also spend effort on eliminating the indirect causes. Table 1.1 summarizes the factors leading to construction accidents.

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Chapter 2
Why Do Accidents Happen? A Critical Review on the Evolution of the Construction Accident Causation Models

2.1 Introduction

High accident rate in construction is a universal problem which needs to be tackled by all parties concerned (Poon et al. 2008). Although in the last decade there was a downward trend in construction accidents in many places such as Hong Kong due to implementation of numerous safety schemes, improvement in construction accident records is still necessary (Figs. 2.1, 2.2). A previous research study in Hong Kong has shown that an accident imposes huge costs on the society (UK HM Revenue and Customs Department 2011) and over $10 million of compensation was paid for non-fatal accidents each year during 2004–2008 (Table 2.1). The direct financial costs of accidents are only the tip of the iceberg when compared with the indirect ones. The injured employees and their families suffer from loss of earnings and grief. Accidents on site also lower staff morale, induce negative corporate image and lead to extension of time in the project because of work re-arrangements (Li 2006). This chapter aims at studying and analyzing the evolution in accident causation models.

2.2 Changes in Construction Industry 1960: Present

2.2.1 From Low-Rise Building to the Tower of Babylon

In early 20th century, structural members were designed to carry primarily the gravity loads. Advances in structural design and building materials reduce building weight; taller building construction which can house more people has gained its popularity. Among the fifty tallest buildings in the world, only one was constructed in 1960s and the majority were constructed in 1980s and after (Toole 2002). Nevertheless, building slenderness increases also implies that lateral loads consideration becomes more important (Debrah and Ofori 2001a, b).

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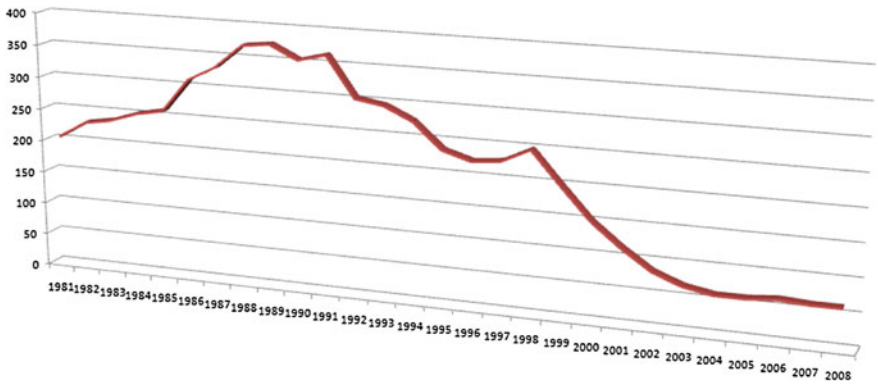

Fig. 2.1 Construction accident rates and safety scheme

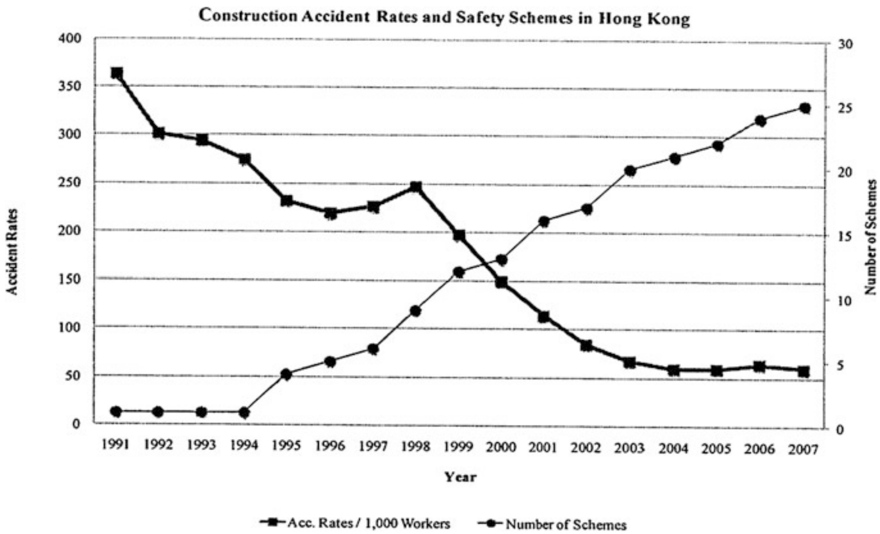

Fig. 2.2 Construction accidents per 1,000 employees in Hong Kong (Holmes 1999; Poon et al. 2008; Jannadi 1995; Sharma and Jha 2012)

2.2.2 From Traditional Procurement to Integrated Procurement

Before 1980s, building firms enjoyed post-war expansion due to rebuilding, capital investment catch-up and increasing levels of immigration, which provided economic buoyancy. Clients were led by their design team—they were not encouraged to be involved in a significant degree during decision making in design and construction, design and construction were separated (Zhu et al. 2010). Between 1980 and 1999, traditional procurement method was losing ground (Kim and Rhee 2009),

Table 2.1 Construction accident compensation in Hong Kong (Goodhart and Hofmann 2008)

Years	Total number of non-fatal accidents	Total PSLA ('000)	Total loss of earning ('000)	Total loss of earning capacity ('000)	Total special damages ('000)	Total future treatment ('000)	Total deductions from ECC and victims' faults ('000)	Total sum of compensation ('000)
2008	29	6,779	26,964	267	610	584	4,005	32,443
2007	16	3,400	13,980	950	530	279	890	15,937
2006	19	7,260	20,234	875	1,378	2,669	7,640	39,643
2005	23	6,085	24,645	2,404	506	382	7,771	25,725
2004	14	2,940	11,283	431	211	116	5,174	10,998

design and build gained popularity. The time, cost and quality became part of the construction service ethos. Since 1999 practitioners in Australia and UK, Latham stressed more on construction productivity and efficiency and multi-skilling of the trades to reduce disputes between unions and trades (Zhu et al. 2010). Clients seek solutions rather than pure construction services (Lingard and Rowlinson 1994). Concepts from manufacturing such as best practice, quality assurance benchmarking and re-engineering have influenced the construction industry, pre-qualification criteria for consultants, contractors and sub-contractors adopted. Integrated forms of procurement based on the principles of concurrent engineering (CE) which promotes cooperation and collaboration between project participants from the outset of a project have been advocated. Moreover, with the client's and project advisor's involvement during design development, the project team can jointly develop the project goals and objectives (Zhu et al. 2010).

2.2.3 From Conventional Construction Method to Complicated Ever Changing Digital and Prefabricated Construction

Construction industry has long been regarded as a labor intensive industry. Construction of bridges, buildings, dams etc. has been done by a great number of workers. International Alliance of Interoperability (IAI) founded in the USA in 1995 turned on the engine of digital construction, system-independent exchange of information between all stakeholders was developed (Lin and Mills 2001).

In the ten years' time since mid-1990s, information technology has changed the world of construction industry. CAD drawing has replaced handmade drawing, Video conferencing has replaced frequent freight face-to-face meeting, digital take-off has replaced traditional black and white take-off, and dynamic building information modeling has replaced static building design. Within this decade, man-made construction and design methods have been replaced by "n" kinds of software for quantity surveyors, architects, engineers, form workers and architects. If we view each of these from the system point of view, there are many new born subsystems each day in different parts of the globe. The World Wide Web even helps us to share the new building knowledge in a blink of an eye. All these technologies help us build faster but complicate the whole construction process at the same time—what the best method today does not mean it is the best for tomorrow. We are all trying to catch up with the latest technology.

Moreover, all the building services installations are carried out on site before 1980, with the help of modern technology, off-site fabrication of some building services components has become possible (Hwang et al. 2010). Design of tall, asymmetric and specially shaped buildings has gained popularity (Rowlinson 1997). Building technical complexity has also increased (Chun et al. 2012), profound understanding of the force flow in these types of structures is not easy as the building plan is not constant along the height of the building (Rowlinson 1997).

2.3 Evolution Theory

According to Darwin, "… each new variety, and ultimately each new species, is produced and maintained by having some advantage over those with which it comes into competition; and the consequent extinction of less favored forms almost inevitably follows" (Crotty 2009). The evolution theory of Darwin and Wallance is based on the mechanism of natural selection where such process stresses that organisms better adapted survive and breed (World Bank 2010), human evolution is one of the very good examples (Cecchetti 2009). Lamarckian Evolution states that a change in environment may lead to changed patterns of behavior which can necessitate new use of structures (Central Intelligence Agency 2010). Academic researchers developed construction accident causation models as early as 1960. Since then, many different accident causation models appear in journals and books. Complexities in building construction due to increase in building height, construction procurement and technology have led to a number of construction accident causation models developed over time. Our building and construction environment has become more complicated, so are our accident causation models (Fig. 2.3).

2.4 Accident Causation Models

2.4.1 Energy Model (1961)

Haddon suggested that accident happens when there is an excess energy transfer (Lin and Mills 2001). Accident causing agents such as electrical, mechanical and

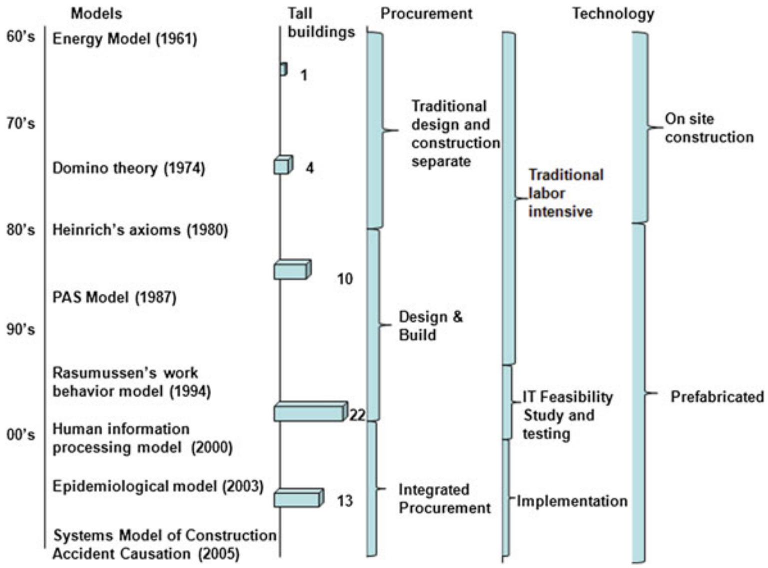

Fig. 2.3 Accident causation models, distribution of year of construction for the 50 tallest buildings in the world, procurement method and technology Timeline (Toole 2002; Zhu et al. 2010; Rowlinson 1997; Kim and Rhee 2009)

thermal, energy can lead to accidents. This model suggests that the occurrence of an accident basically follows the laws in physics: it happens after there is an excess amount of uncontrolled energy and consequences depend on the amount of energy (Briere et al. 2010).

Yet this model has received some complaints from Lingard and Rowlinson (2005) who pinpoint that the abstract nature of this model fails to lay down a good foundation in identifying hazards in routine work. It also fails to suggest the appropriate safety measures under different circumstances (Briere et al. 2010).

2.4.2 Bird' Domino Model (1974)

In 1974 suggested that an accident can be viewed as the last domino in the 'domino sequence' where an accident is the result of a sequence of events. The first domino falls on the second one and the second one's fall leads to the fall of the third domino, so on and so forth. Bird suggested that workers will be safe so long as the first domino, i.e., site management does not fall (Briere et al. 2010). However, other researchers point out that there are many factors which lead to accidents. It is inappropriate to regard accidents as the last event in a sequence (Li 2006). It can be the case like the last straw being placed on the camel (Fig. 2.4).

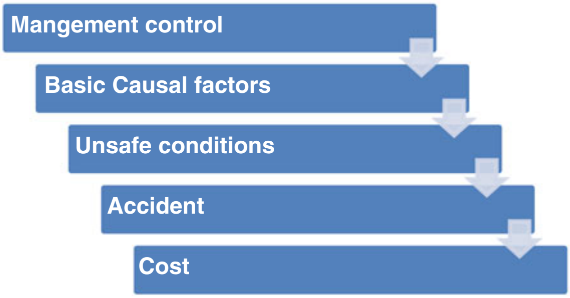

Fig. 2.4 The domino sequence (Edwards and Nicholas 2002)

Pheng and Shiua (2000)'s contention was that these unsafe conditions were symptoms of management oversight and mismanagement in planning, organizing, commanding, coordinating and control. Nevertheless, such model has failed to make a clear relationship between various relations among personal and organizational factors. Readers of domino sequence may misunderstand that personal factors and mental stress play the same role in accidents. Hence, such theory often leads to a false interpretation on the underlying accident causation factors. This is particularly true for those high rank officers who usually do not have to work on site and lack safety knowledge in depth (Briere et al. 2010).

2.4.3 Heinrich's Axioms (1980)

Heinrich (1980) proposed that more than one-fifth of the accidents are caused by a series of unsafe acts which finally lead to accidents occurs. He further elaborates that the degree of injury is a matter of probability. Nevertheless, Cooke and Lingard (2011) suggest that Heinrich's model focuses too much on the immediate circumstances surrounding the incidents, it fails to include unsafe conditions which also have systemic and organizational causes. Furthernmore, it is misguided to attribute incidents to interaction of multiple causes.

2.4.4 Potential Accident Subject Model (1987)

Leather (1987) proposes that both endogenic and exogenic factors might affect the potential accident subject's acts and thoughts which might lead to accidents in Potential Accident Subject (PAS) model. The PAS stresses the dynamic relationship between various stakeholders on accidents, e.g., workers, managers within the construction companies or even those people who work outside the construction companies. Under PAS model, any person even the victim himself can be the "Potential Accident Subject". Furthermore, people's behaviors and attitudes

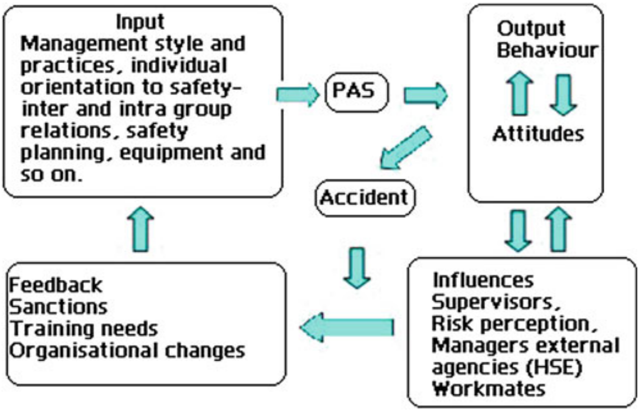

Fig. 2.5 PAS model (Peckitt 2004)

are affected by reward, management systems, punishment, training, and instructions given by seniors and so on. Some rewards for finishing tasks quickly may induce workers to take short cuts and ignore the possible sources of risks (Li 2006) (Fig. 2.5).

2.4.5 Rasumussen's Work Behavior Model (1994)

Rasmussen suggested that construction laborers' work is shaped by economic, functional, safety related objectives and constraints. The model identifies three zones: safe zone, (where the workers' behaviors comply with safety rules) hazard zone and loss of control zone. Most of the construction managers on site work along the cost gradient and the worker searches for the least effort gradient. All these end up with a systematic migration toward the boundary of acceptable performance only. In view of this, safety plans on site are often designed to act against the pressures outlined in the model. Nevertheless, the pressures that push workers toward the safe zone require a continuous effort. Rasmussen therefore proposes that accident prevention should focus on error tolerant work systems development which makes the boundary of loss of control reversible and visible (Eun and Resnick 2009) (Fig. 2.6).

2.4.6 Human Information Processing Model (2000)

Kjellen (2010) sheds light on human and environment interaction from an operator's point of view. Under this model, people are viewed as an information processor who makes their own judgment in response to environment risks,

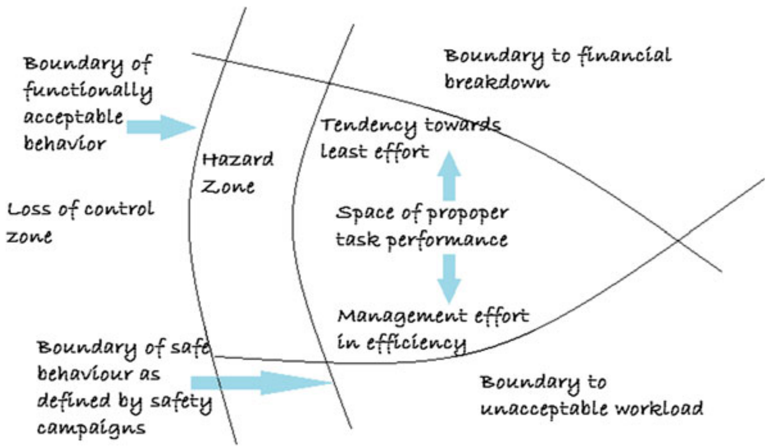

Fig. 2.6 Rasmussen's work behavior model (Mitropoulos et al. 2005)

hazards or deviations. Accidents happen when people are unable to handle information under complicated circumstances. Accident analysis is a very good practice to identify and evaluate the safety risks on site and provide suitable safety measures in turn.

Yet, this model suffers from two very major drawbacks. Firstly, the model only sheds light on 'cold' variables with regard to human cognitive processes which does not conform well with real life situations. In reality, emotional variables such as threat do affect people's capability in problem solving and accident prevention. Secondly, internal information processes are absent. Interpretation by actual behavior observations and interviews becomes necessary but this requires expertise. Because of the two aforementioned problems, application of this model is limited to in-depth investigation with experts participation (Li 2006).

2.4.7 Epidemiological Model (2003)

Conventional safety theorists put the lens on finding out accidents and injuries. There is, however, a trend in encompassing environmental factors which may be possible to cause an accident. Based on this idea, the Epidemiological Model views accidents as a disease entity which arise as a product of interaction between the agent, environment and the host (Goetsch 2003). Nevertheless, whether the agent in accidents can be meaningfully separated from its environment is in doubt (Hacker and Suchman 1963).

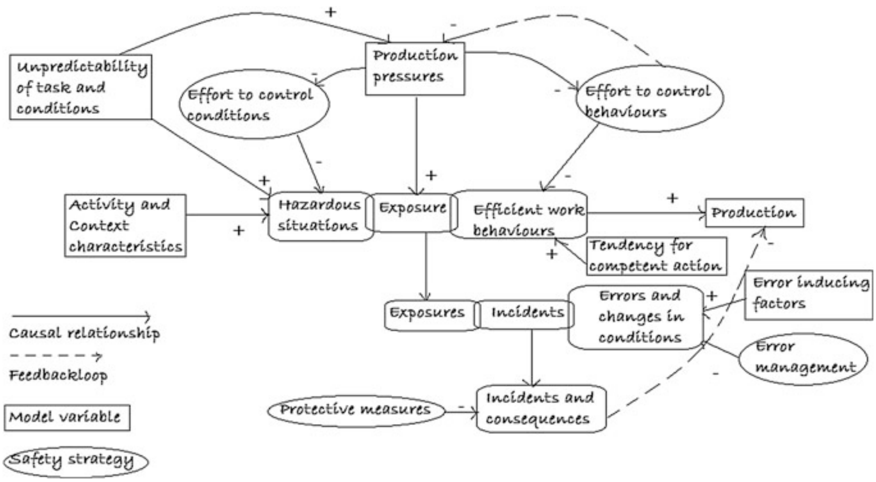

Fig. 2.7 System model of accident causation (Eun and Resnick 2009)

Table 2.2 Changes in accident causation models

	Initial accident causation models	Latest accident causation models
Direction	One	Multiple
Categories	Few	Multiple
Factors	Few	Multiple

2.4.8 Systems Model of Construction Accident Causation (2005)

Building on Rasmussen's model and various construction accident causation models in the past, this model identifies various variables which influence the probability of accidents during a construction activity. While the arrows in the figure indicate cause-effect relationships, the signs show the directions of the relationship between different factors. A positive sign indicates that when there are changes in factor X, Y changes in the same direction. A negative sign signifies the effect of changes in an opposite way. This model proposes that unpredictable tasks and environments increase the likelihood of accidents as it increases the likelihood of errors hazardous situations and production pressures (Eun and Resnick 2009) (Fig. 2.7).

2.5 Conclusion

To conclude, all the seven writers suggest that accidents are not random occurrences. Accidents happen because of failure in one or more factors. Nevertheless, when we take a closer look at the development of accident causation models over the years from 1961, we can see an interesting phenomenon: the models are getting more and more complicated (see Table 2.2). Accident causation models before mid-80s were a lot simpler than the later models, i.e., complicated models "survive" in natural selection. It is predicted that future accident causation models will be more complicated when high technological tools are used on site, and construction procurement and height of buildings have changed, i.e., Lamarckian Evolution also takes place in causation models.

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Chapter 3
Supply of Safety Measures in Developing and Developed Countries: A Global Perspective

3.1 Introduction

Construction industry has recorded the highest accident rates among various major industries in many countries (Choi et al. 2011) and has often led to high compensation. There are numerous benefits in improving construction safety conditions on site, in terms of efficiency, competitiveness, disputes, conflicts and profitability with reduction in delays (Choudhry 2012, forthcoming). It seems logical that many costs can be avoided if accidents are prevented. Preventing occupational accidents should therefore make good sense for the society as well as good business practice for companies (Rikhardsson 2006). It is no wonder the improvement in health and safety standards within the organizational context is an important global concern (Zhu et al. 2010). Nevertheless, previous research shows that different countries have different root causes of construction accidents. It implies they should adopt different construction safety measures. Coupled with the challenge to develop work systems that can achieve high levels of productivity at the same time (Mitropoulos and Cupido 2009), construction safety improvement has proven to be a difficult task for many years (Weil 2001). In general, modern safety measures include safety policy, regulations, training, penalties, meeting, equipment, training and so on (El-Mashaleh et al. 2010).

1. Organizational safety policy: Organizational safety policy is the most influential factor that motivates people to work safely on sites. It includes detailed safety programmes and training (El-Mashaleh et al. 2010).
2. Safety regulations: A previous study points out that safety control is the most important element in accident prevention (Navon and Kolton 2007). Usually, their designs depend on the country's construction industry and they vary from country to country (Pheng and Shiua 2000). They can be divided into three elements which include enforcement, compliance behavior and standards in addressing the safety outcomes (Weil 2001).
3. Safety committees: safety committees often consist of subcontractor, employer and worker representatives. They find out unsafe practices and problems through regular inspection and safety patrol, trust improvement, communication and interaction between the parties (Lin and Mills 2001).

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Periodical formal safety meetings organized by safety committees improve safety performance at the project level (El-Mashaleh et al. 2010).

4. Occupational health and safety management system: effective management develops safer systems of construction, reduces injuries (Lin and Mills 2001), mitigates and identifies on-site work hazards and risks (Zou 2011). Lin and Mills (2001) suggest that effective management measures can be divided into quantitative and qualitative measures. Quantitative measures are used to calculate the insurance premiums of companies. They consist of experience modification rating, lost time and severity rates. Qualitative ratings are determined by OHS assessors, and consist of below-average, average, and outstanding project performance. Zhou et al. (2012, forthcoming) found that the number of safety accidents could be decreased significantly via effective management of near-misses.
5. Safety training: previous research shows that accidents are likely to happen when there is inadequate training of workers (Ai et al. 2004). Therefore, Safety training is important to reduce construction fatalities (Ling et al. 2009).
6. Safety equipment: many construction accidents happen because safety equipment are not available on construction sites. Both active and passive measures are useful in reducing construction accidents. For example, fall injuries which are associated with unguarded openings, removal of protections, lack of complying scaffolds, inappropriate protection and improper use of personal protective equipment (El-Mashaleh et al. 2010).
7. Safety inspection: safety performance is affected by safety compliance inspection. Increase in number of safety inspection improves safety performance (El-Mashaleh et al. 2010)
8. Safety incentives and penalties: El-Mashaleh et al. (2010) comment that safety incentives are among the top five high-impact zero accident techniques. These usually include monetary and non-monetary incentives and increase in fine to workers with poor safety performance (El-Mashaleh et al. 2010).
9. Information technology: The existing 2D drawings and the lack of construction process information have been identified as problems in hazard identification. The use of visualization approaches can provide a potential solution (Chun et al. 2012). Nevertheless, some stakeholders in the industry are not convinced of the impact of implementing technology on the success of a project and they adopt IT at a slow pace (Evia 2011).
10. Method of construction: In offsite construction, workers only need to carry out simple assembly tasks on site, this significantly lowers the number of construction accidents by 35 % accident rates as compared with traditional labor intensive methods of construction (Court et al. 2009).
11. Safety regulations: To , contractors began to invest in safety programmes. For example, it was found that injuries were reduced dramatically since the legislation of the Occupational Safety and Health Act of 1970 in the US. (Esmaeili and Hallowell 2012, forthcoming).

3.2 Global Review on Construction Safety Measures

3.2.1 Australia

The Federal Safety Commissioner promotes occupational safety in relation to building work; disseminating information, monitoring and promoting compliance with the Building Code in relation to occupational health and safety. The Commissioner may engage persons with suitable experience and qualifications as his consultants (Commonwealth of Australia 2011). The Building and Construction Industry Improvement Act 2005 states clearly the construction safety measure requirement in Australia. Each of the states in Australia has some regulations which are unique and designed according to their specific needs. For example, Occupational Health and Safety Act was introduced in Victoria in 1985 based on the findings of the Roben Committee of Inquiry in the UK. It focuses on the various stakeholders' needs to prevent work-related illnesses, injuries and deaths. It also provides mechanisms for consultation between employees and employers on health and safety issues (Lin and Mills 2001). Australian OHS statutes stipulate that there must be workplace committees and employee health and safety representatives in medium to large companies (HSRs). The New South Wales risk assessment regulation in 2001 entails explicit consultation requirements and is the single most important source of worker involvement in construction safety in Australia (Saksvik and Quinlan 2003) (Fig. 3.1).

Fig. 3.1 Construction site in RMIT University, Melbourne (*author's photo*)

3.2.2 Singapore

The Factories (Building Operations and Works of Engineering Construction) Regulations (BOWEC) 1994 laid important grounds for construction safety practices in Singapore. The BOWEC Regulations list 13 major elements which constitute good construction safety management on sites. These 13 elements include safety policy, working practice, promotion, training, group meetings, incident investigation and analysis, in-house rules and regulations, control of contractors, safety inspection, maintenance regime, hazard analysis, hazardous materials, and emergency preparedness (Pheng and Shiua 2000). Besides, Singapore's regulations stipulate that contractors must include safety budgets and measures in their tenders. As many of the accidents relate to cranes (there were 63 such accidents in 1997, 42 in the first half of 1998). The new Factories (Operation of Cranes) Regulations replaced the 1993 regulation on 1 March 1999. The new regulations state that all mobile and tower crane operators must register with the Department of Industrial Safety of the Ministry and renew every two years. Supervisors of the lifting operations must attend approved courses (only persons who have been trained will be allowed to be employed for these tasks from 1 September 2000 onwards). Contractors undertaking the repair, installation or dismantling of lifts must seek approval from the Chief Inspector of Factories. The law also stipulates different legal requirements according to the scale of the projects (Fig. 3.2):

1. Contractors' projects worth at least S$5 million must hire a full-time safety supervisor for safety promotion and supervision of safety work.
2. Contractors' projects worth at least S$10 million have to implement a safety management system covering such areas such as hazard analysis, safety policy, in house safety rules, safety inspections, safety work practices, and maintenance of machinery and equipment.

Fig. 3.2 A construction site near Farrer Park MRT Station with safety banner

3. Contractors' projects worth S$30 million have to hire an independent external auditor to audit the safety management system on a half yearly basis (Debrah and Ofori 2001).

Employment of migrant labour was quite common on sites in Singapore. Many of them come from Bangladesh, China, India, Myanmar and Sri Lanka. The differences in labor's traditions and cultures affect human relations, and work habits cause difficulty in communications which give rise to safety problems on site (Cheah 2007). Since 1 April 1993, all foreign construction workers in Singapore have to attend a half-day Construction Safety Orientation Course before issue of a work permit (it was changed to a full day since November 1997 because of the high accident rates on site). The course is conducted in Malay, Thai, English and Mandarin with the aid of video presentations. It covers basic safety hazards and accident case studies which aim at introducing the hazards on construction sites; developing a positive safety attitude; the importance of good housekeeping and safe excavation, and hands-on sessions on the proper use of personal protective equipment. Starting from 1998, all project managers of contracts with S$10 million or above have to complete a 30-hour safety course (Debrah and Ofori 2001).

Being the largest construction client in Singapore, the Housing Development Board (HDB) has used its influence to foster the safety culture development. It has hired full-time site safety supervisors to oversee safety organization on site, prepare a safety programme, issue inspection schedules, conduct safety meetings and document the safety records for several years (Debrah and Ofori 2001). The HDB has set up a Safety Unit in its Structural Engineering Department since 1976 to reduce accident frequency rates on its sites, from 7.18 accidents per million manhours worked to 0.66 in the ten-year period 1982–1992. The following highlights some of the important aspects in safety:

1. Safety promotion and training: promoting safety awareness among workers, contractors and supervisory staff, participation of regular safety meetings and safety orientation courses on site is compulsory;
2. Development of new safety measures: providing safety measures to ensure a safe working environment;
3. Safety management: employing safety supervisors to ensure that safety is everyone's responsibility and practising proactive management;
4. Safety audit: HDB's Safety Unit conduct checks to prevent accidents (Debrah and Ofori 2001).

3.2.3 The United States

To reduce the frequency and severity of construction accidents, firms select subcontractors carefully, and implement safety programmes that include orientation and training, written safety plans and management. Construction sites adopt the following preventive measures (Hallowell 2010):

1. Upper management support: the upper management should consider worker safety and health as the primary goal of the firm. It can be shown by participation in regular safety committees and meetings and provision of sufficient funding.
2. Subcontractor selection and management: it has to consider subcontractors' safety and health performance during the selection process and management.
3. Employee involvement and evaluation: all the employees should be included in the formulation and execution of safety elements and safe working behavior evaluations.
4. Job hazard analyses (JHA) Review: it highlights the potential hazards, records construction activities and documents safe work practices which prevent injury.
5. Project-specific meetings and training programmes: it establishes and communicates project-specific safety plans, goals and policies before construction.
6. Frequent site inspection: inspection visits are performed by an OSHA consultant, contractor's safety committee, safety manager, representative of the contractor's insurance provider to identify uncontrolled hazardous exposures.
7. Employment of a safety and health professional: hiring individuals with experience and/or formal education background of safety and health who can serve as a resource for employees; an individual with construction safety and health knowledge.
8. Substance abuse programmes: prevention and identification of substance abuse of workforce which includes random testing and testing after a construction injury.
9. Safety and health committees: they usually have the power to initiate change and set safety policies. They consist of workers, supervisors, owner representatives, representatives of key subcontractors, OSHA consultants to address on sites health and safety issues.
10. Safety and health orientation or training: participation of all new hires or transfers in orientation and training sessions with a specific focus on company's safety work practices.
11. Written safety and health plan: development of a documented plan which identifies the unique hazards on site, project-specific safety objectives and methods to achieve safety goals and targets.
12. Record keeping and analyses: regular report of the specifics of all accidents including information such as location, cause, time and work-site conditions.
13. Emergency response plan: creation of a plan which documents the company's procedures and policies in the case of a serious incident such as an incident involving multiple serious injuries or a fatality.

The following Table displays the monetary sums of money spent on the safety measures in the US. Employment of safety manager is the most expensive item whereas emergency response plan stands the lowest among all (Table 3.1).

Implemented at the end of May 2008, the "Safety4Site" programme in the US is designed to reduce injuries and workers' exposure to OSH hazards. This

Table 3.1 Construction safety measures monetary spending on 26 construction sites (Hallowell 2010)

	25th quartile	Mean	Median	75th quartile	Standard deviation
Safety committees	$325	$1,813	$900	$1,500	$2,904
Emergency response plan	$100	$825	$500	$1,000	$1,087
Employee involvement	$400	$1,541	$1,000	$2,000	$1,619
Inspections	$600	$2,623	$1,000	$2,000	$5,526
Job hazard analyses (JHA)	$800	$1,664	$1,000	$1,750	$1,966
Orientation and training	$500	$1,531	$1,000	$2,000	$1,799
Record-keeping	$200	$1,442	$1,000	$2,500	$1,313
Safety manager	$975	$2,666	$1,275	$5,000	$2,697
Subcontractor management	$181	$998	$750	$1,500	$1,009
Substance abuse programmes	$200	$1,316	$1,000	$2,000	$1,442
Training and regular mtgs	$700	$2,449	$1,000	$2,000	$3,555
Upper management support	$269	$1,623	$1,000	$2,000	$2,130
Written plan	$500	$1,196	$1,000	$2,000	$880

programme aims to enforce on site safety management and encourages practitioners to report any violation for 20 non-negotiable behaviors (The 20 non-negotiable behaviors in four major categories: falls, caught-in-between, electrical and struck-by. Most of them are typical safety violations regulated by OSHA, such as riding on equipment not designed for multiple passengers, improperly using a stepladder, working within 10 feet from power lines and so on). The non-negotiable behaviors (e.g., improperly using a stepladder) are considered as the major contributing factors to the Focus 4 hazards. After implementing the programme for the initial two years, there was an improvement in safety performance on construction sites, and the programme also received positive feedback from peers and trade associations with several industry safety awards.

The programme enhances safety awareness, safety attitude and culture improvement and accountability of the general contractors' employees, all hired subcontractors, and materials suppliers of all tiers, while achieving positive and enthusiastic changes in safety attitude and behavior. It integrates several basic elements from safety management approaches, e.g., Behavioral Based Safety, KTY, etc.). The long-term goal is to create a lasting impact on construction workplace safety. There are 3 major elements in the programme:

1. Eye protection: it is required of all workers at all times on site except during scheduled breaks away from potential eye hazards or while in a trailer.
2. Daily "huddle" meetings: there is a required daily "huddle" meeting (tool-box meeting) where team members from the general contractors (including foremen, crew members, and/or the superintendent and project manager) can update their daily work plan and the status of their work. This meeting is mandatorily required of each subcontractor before every work shift.
3. Accountability for near misses, incidents and accidents: the programme emphasizes the accountability for incidents, accidents and near misses by

identifying 20 unsafe non-negotiable behaviors within the Focus 4 categories and holding all employees accountable for their safety and health responsibilities.

There are three different levels of training: a three-hour manager implementation training programme has been designed for over 100 senior project managers in the general contractor's (GC) organization. These project managers then become trainers and facilitators of this programme for lower-tier management staff. The training focuses more on conflict management, understanding of managers' needs, and identification of available programme resources rather than on the technical aspects of accident prevention and safety management.

The 4-hour OSHA Focus 4 Hazards Training for the GC's employees includes approximately 450 management staff and 450 craftspeople. During the training, the programme is introduced to the attendees, feedback is solicited for improvement, and commitment to attend the programme is obtained. All subcontractors' employees receive training on "Safety4Site" through huddle meetings, jobsite kick-off meetings, external consultations, and contractor orientations.

A violation can be reported by management staff, peer workers, and/or a representative. The "Safety4Site" commitment is visualized through specially designed safety banners, flags, posters, signs, hardhat stickers, tapes, measures, etc. When workers violate the rules for the first time, they are immediately removed from the jobsite for one day after violation is observed and/or reported. They must return to the jobsite the following morning to lead the huddle meeting on the "Safety4Site" non-negotiable violation. Individual review of the "Safety4Site" programme and discussion is to be carried out between the management staff and the workers who has committed the violation. They will then be required to sign the engagement letter for the programme and be allowed to work again. This enhances the two-way communication and worker involvement.

In case of second-time violation, the GC's employees are separated from the GC for 30 days without pay or benefits, but are eligible for rehiring. Nevertheless, if they work for subcontractors, they will be dismissed from all the GC's projects for one year. For subcontractors with a higher violation record, it is mandated by the contract to have a plan of action for correction as well as a full-time safety specialist/competent person on the project at no additional cost to the owner or to the GC. The breach of contract will lead to termination of the contract.

By September 2009, approximately $300,000 had been spent on implementing the "Safety4Site" programme, covering all of the education activities ($200,000) and marketing expenses ($100,000). These expenses were reasonable in consideration of the total revenue (approximately $700million) of projects that were being put into place by the GC during the programme launch period (Chen and Jin 2012, forthcoming).

3.2.4 France

The French system of Worker Compensation was established in 1898 for workers in private sector. It is based on the principle that the employer is presumed to be strictly liable for accidents at work. Therefore, they have to pay the monetary compensation to the victim. Basically, the French system covers two categories of accidents: accidents occuring during work hours on site and accidents happening during commuting between home and work. French legislation also recognizes serious medical incidents and suicides on sites. Social protection includes health insurance and work compensation. It is furnished by several different administrative bodies. It covers distinct populations according to company, private or public sector or occupation. In the private sector, there is a mandatory requirement for the employer to report any workplace accident to the victim's social insurance fund. The fund will then determine if the accident is work-related. In the public sector, the victim (permanent civil servant)'s superior has send a report of the accident to a departmental committee for the determination of the accident to be related to work. In case of fatal accidents, compensation includes an annuity paid to the victim's heirs (Briere et al. 2010) (Fig. 3.3).

Today, most of the health and work compensation funds have digitalized the details of accidents' claims, determinations about liability and compensation. Yet, there are some problems in the French workers' compensation system. First, most of the self-employed workers are not protected by their social insurance against the risks of workplace and commuting accidents. Second, some work-related health problems are under-reported and may be influenced by a variety of factors, such as group pressure (e.g., the company adopts a ''zero accident'' plan at the company or from the work group) and individual factors (e.g., fear of losing one's job). Finally, each of the social insurance funds functions independently and data may be inconsistent as there is no point of centralization (Briere et al. 2010).

Fig. 3.3 A construction site in Paris with artistic picture covered (*author's photo*)

3.2.5 Bermuda

The Construction Association of Bermuda (CAOB), Craft and Apprenticeship Training, together with the National Training Board (Construction Association of Bermuda 2011) are responsible for the direction and oversight of construction safety. Trainees who are not registered as official apprentices with the National Training Board must meet the eligibility requirements of their respective Training Units as a minimum requirement. It is mandatorily required that all trainees and apprentices must register with the NCCER and the CAOB. The CAOB points out that recruitment, selection, hiring and training of all the individuals in the programme should not discriminate against any national origin, religion, race, color, sex, disability or sexual orientation. Apprentices and their employers are bound by the conditions and terms of the National Training Board Act 1997 as well as all the subsequent amendments. CAOB is firmly committed to operating all of its programmes in a safe manner according to all the safety regulations. The main goal is to provide a safe learning environment, free of recognized hazards. Each of the training Units has its own Health and Safety Policy Statement and Plan as required, the conditions and variables which are applicable to their area of expertise are addressed. All trainees are mandatorily required to attend classes promptly as scheduled, in accordance with the Health and Safety Act 1982 (Construction Association of Bermuda 2012).

3.2.6 China

The "Administrative Regulations on the Work Safety of Construction Projects" Decree No. 393 of the State Council of the People's Republic of China came into force on 1 February 2004. It introduces a remarkable change in the health and safety requirements on construction. For instance, it regulates the safety responsibilities of the contractor, owner, supervisor, designer and relevant stakeholders. Any organization which fails to comply with the laws may lead to penalty. The "Regulation on Work Safety Licenses", Decree No. 397 of the State Council of the People's Republic of China came into force on January 13, 2004. This regulation requires the contractor to establish and improve the safety system at work; ensure that safety training is provided to the employees; improve work safety system and provide professional safety management staff; pay insurance premiums for the employees and buy employment injury insurance according to law; supervise, identify and evaluate major hazards at work, work safety condition according to the rules and regulations and compile the emergency programmes. On top of that, the employer and contractor have to increase the expenditure on work safety (Zhou et al. 2011).

The "Safety Specification on Temporary Power Usage on Construction Sites", Code No. JCJ46-2005 of Industrial Standards of the People's Republic of China came into force on 1 July 2005. It updates the requirements on fire protection and management of temporary power usage (Zhou et al. 2011).

The "Management Methods on Documents of Production Safety" states the scope for site safety inspections, encourages construction practitioners to take photographs as a proof of unsafe production and submit safety information on-line. Besides, four emergency programmes were launched from 2003 to 2005: the Emergency Plan on Production Safety, Fire Protection, Acute Occupational Disease and Acute Occupational Poisoning. These programmes help the managerial staff and the employees to act quickly in any emergency situation so as to reduce the chance of accidents (Zhou et al. 2011).

The education style of safety training has increased the interaction. A "video" has been used in the safety training from 2007 to let the workers understand what is being shown and workers' comments are encouraged. A collection of playing cards with safety knowledge, skills and tips shown at the back remind the workers to work safely. Furthermore, there are a series of safety promotion campaigns which strengthen the safety training in the whole year: March is identified as the "safety education month" where there are more safety training and safety promotion as the work schedule is not as tight as other months after the Chinese New Year. May is called "Safety Month" while June is the "National Production Safety Month". From October to December, a safety promotion campaign "Accident Free in One Hundred Days" is implemented. The "Workers' Night School" was established in 2006 and educates on safety issues (Zhou et al. 2011).

3.2.7 Ghana

The Ghanaian construction OH&S administration includes five ministries which are responsibile for implementing OH&S laws. The Factory Inspectorate Department is solely responsibile for OH&S. Others include the Environmental Protection Agency, the Labour Department, the Attorney General's Department and Occupational Health Service Unit. In Ghana, there are 4 major problems in construction safety. First, construction safety regulation is piecemeal and scattered in many rules and regulations: the Environmental Protection Agency Act, Mining Regulations and Labour Act. Generally speaking, "[the] OH&S statutes evolve without careful planning, resulting in fragmentation, inconsistencies in OH&S laws and overlapping areas of jurisdiction. Ghana lacks a policy defining the responsibilities government, employers and employees. Therefore, it would be difficult to secure decent work environment in the SME-dominated informal sector". Second, many workers are illiterate and are not covered by insurance schemes. They do not belong to any form of labor unions. Third, many construction companies rely on temporary workforce. The poor design and piecemeal law is another well-recorded problem (Kheni et al. 2010). In another study conducted by Kheni et al. (2008), over half of the owners or managers were not sure if their procedures met the safety provisions of Ghana's main health and safety legislation.

3.2.8 Kuwait

The Kuwaiti labor law states that the right to join the labor trade union is confined to Kuwaiti citizens only (Chap. 13, Kuwait Private Sector, Kuwait Labor Law). Yet, most of the workers on construction sites are non-Kuwaitis where laws and regulations fail to cover their rights. Article 95 Chap. 15 of the general provisions of Kuwaiti private sector labor law states that officials have the right to inspect, supervise, execute and implement laws of labor safety rights. Nevertheless, many contractors agree that most of the safety inspections are done by site engineers who work for the owner or the owner's representative (Al-Humaidi and Tan 2010).

The amount of accident compensation ranges between US$360 and US$720 for each of the affected workers. Many professionals believe that an increase in the monetary sum of the compensation would help increase safety on site (Al-Humaidi and Tan 2010).

In 2005, a new law was passed. It prohibits workers from working between noon and 4 p.m. in June, July, and August to prevent dehydration due to hot weather in summer (Al-Humaidi and Tan 2010). Further, injuries are classified into three categories: injuries, permanent disabilities, and deaths. Injured workers are compensated according to the number of days needed for recovery. Permanent disabled workers are compensated according to the percentage of disability determined by the medical board for salary of 2,000 days or approximately Kuwaiti dinar 13,333 which is equivalent to $48,000 whichever is greater. In case of death, the worker is entitled to a maximum amount of KD 10,000 equivalent to $36,000 or a full pay for 1,500 days. Insurance in Kuwait covers most of the injuries because monetary compensation of injuries is minimal and competition among insurance companies is very high (Al-Humaidi and Tan 2010).

On-site safety standards are specified in the conditions of the contract which the project stakeholders agree to. Some projects follow OSHA regulations, others follow British Safety Standards. Kuwaiti safety standards, however, do not comply with international codes and standards. There is no doubt that the lack of standards and codes account for current safety problems in Kuwait's construction. Moreover, The Workers' Affairs Department fail to provide detailed reports of accidents. They only provide accounts for the government's needs to impose stricter legislation, rules and construction standards. (Al-Humaidi and Tan 2010).

In general, Al-Humaidi and Tan (2010) identify four major areas which need to improve and modify. First, rules regarding compensation of workers injured or killed in accidents. Second, labor unions have to protect the rights of laborers. Third, a competent person as defined by OSHA regulations who is responsible for safety on construction sites is needed. Fourth, a detailed database which records all construction-related accidents and the results of investigations into the causes of accidents is necessary to improve on-site safety practices and minimize accidents in the future.

3.2.9 Egypt

The Ministry of Labor Force and Training is responsible for the enforcement of Labor Law provisions which include safety regulations in Egypt. Employers are not responsible for safety record keeping, and informing employees about safety issues and standards. Employees' rights concerning safety issues are limited (Hassanein and Hanna 2008).

Employees cannot exercise their safety rights, comment on standards or request inspection. Employers employing 15–49 workers do not need to keep detailed information for each of the accidents; they only need to provide a summary on injuries, illnesses and grave accidents that occur over the past 6 months. Employers with more than 50 workers have to provide detailed information on individual accidents. Accident statistics are not posted on work sites. The abovementioned accident data, however, do not provide any cost or accountability information. There is no inspection carried out by the industrial safety offices to ensure the enforcement of safety provisions. Penalties for construction accidents are low, typically range from US$4 to $9 per violation, and are obviously inadequate (Hassanein and Hanna 2008).

Table 3.2 Summary of construction safety measures in different countries

Country	Safety measures
Australia	Each of the states in Australia has some regulations which are unique and designed according to their specific needs. For example, Occupational Health and Safety Act was introduced in Victoria in 1985 based on the findings of the Roben Committee of Inquiry in the UK
Singapore	Employment of migrant labour was quite common on sites in Singapore. Training courses are provided in different dialects. There is strict requirement on safety management
US	The "Safety4Site" programme in the US was designed to reduce injuries and workers' exposure to OSHA Hazards. This programme aimed to enforce onsite safety management and encourage practitioners to report any violation and enhance safety awareness
France	The French system of Worker Compensation was established in 1898 for workers in private sector. Employers have to pay the monetary compensation to the victim
Bermuda	The Construction Association of Bermuda (CAOB), Craft and Apprenticeship Training, together with the National Training Board. provides direction and oversight of the construction safety.
China	The "Administrative Regulations on the Work Safety of Construction Projects" Decree No. 393 of the State Council of the People's Republic of China came into force on 1 February 2004
Kuwait	The Kuwaiti labor law states that the right to join the labor trade union is confined to Kuwaiti citizens only (Chapter XIII, Kuwait Private Sector, Kuwait Labor Law). Yet, most of the workers on construction sites are non-Kuwaitis.
Egypt	There is no inspection carried out by the industrial safety offices to ensure the enforcement of safety provisions and penalties for construction accidents are low

3.3 Conclusion

The research shows that developed countries such as the US, Singapore, Australia and France have well-established legal systems on construction safety. Nevertheless, for some of the developing countries such as Kuwait, even though the current safety regulations cover citizens only, most of the workers on sites are not citizens. There is no inspection carried out by the Egyptian safety offices to ensure the enforcement of safety provisions. Penalties for construction accidents are low (Table 3.2).

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Chapter 4
Effectiveness of Safety Measures in Reducing Construction Accident Rates

4.1 Introduction

Though construction accidents have dropped significantly in Hong Kong, the number of injuries on site remains high. Apart from safety measures developed locally, some measures are imported from other countries, e.g., Site Safety Cycle. Undoubtedly, the construction industry has spent huge amounts of money and effort on implementation of safety measures in recent years. Each safety measure has its own merits and shortcomings. The crux of the issue lies on whether these safety measures can effectively reduce the chances of accidents. This chapter investigates 9 relatively new safety measures: Total Quality Management based Safety Management System, Behaviours Based Safety Management System, Independent Safety Audit System, Occupational Health and Safety Assessment Series 18001, Site Safety Cycle, Site Safety supervision Plan System, Performance Assessment Scoring System and Pay for Safety Scheme, and Safety education, training and promotion. Results indicate that ISAS, OHSAS and SP can effectively reduce construction accidents. While the first 8 are tools of construction companies or clients in ensuring safety on site, the target group of the remaining 3, i.e. safety education, training and promotion are construction workers.

4.2 Characteristics of Various Construction Safety Measures

4.2.1 Total Quality Management Based Safety Management System (TQM Based SMS)

The backbone for the development of a TQM-based SMS is: (1) Safety is built when work commence. (2) Safety is required to conform with safety rules. (3) Accidents are avoidable. (4) Goal is 0 accidents. (5) All employees are engaged in accident prevention. (6) Customer satisfaction in safety is the focal point. (7)

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Continuous safety improvement is the aim. TQM based SMS is based on the assumption that all accidents are avoidable (Hunt and Yu 2004). As TQM and SMS are customarily viewed as 2 distinct principles, safety officers therefore have difficulty to cope with the 2 technical concepts; many large scale construction organizations in Hong Kong do not incorporate TQM into Safety Management System despite the possible merits of TQM (Hunt and Yu 2004). Whilst TQM calls for a leveled organizational structure which emphasise meeting customers' needs, construction organizations in Hong Kong have established their own bureaucratic structures already (Hunt and Yu 2002, 2004), high power distance culture in Hong Kong has become one of the resistance in successful implementation. Another major problem in implementation of TQM based SMS is heavy investment in time and resources. Not only senior management might not be able to afford such change, staff usually refuse to accept any change which may increase their workload. The failure cases in TQM are also very high. Two-third of American companies reported that TQM had failed in their companies (Jacob 1993).

4.2.2 Behaviours Based Safety Management System (BBS)

Although it is difficult to control the accident rates on site, around 80–95 % of all accidents are caused by unsafe acts and behaviors (Cooper 1993). BBS aims at discerning and altering people's behaviors through organizational transformation. It improves the site conditions and persuades people to follow safety regulations and rules. In most of the cases, safety risks associated with the workers' are found and identified (Bolton and Kleinsteuber 2001). Behaviors based safety management improves site safety effectively in Hong Kong (Cooper et al. 1994). It also acts as a safety initiative among workers (Bolton and Kleinsteuber 2001).

The report of defects or unsafe conditions is an inevitable factor of a good behavioral safety system as the workplace observers will be brought to their attention by their colleagues during their observation. Since the behavioral safety system takes effect and matures, the use of positive consequences becomes important. For instance, feedback can be given to individuals; a numerical index can be graphed and monitored. Finally, the final outcome of successful implementation of BBS will lead to decrease in rates of accidents or incidents and damages which in turn leads to improvement in safety behaviors and the reduction in accident costs (Cooper 2005). However, Lingard and Rowlinson (1997) argue that if construction workers are unable to perceive hazards on site, BBS cannot function properly.

4.2.3 Independent Safety Audit Scheme (ISAS)

In 1994, the Works Branch and Hong Kong Construction Association initiated the implementation of Independent Safety Audit Scheme (ISAS). After a trial in three contracts, the new scheme was formally introduced in 1996 to public works contracts in parallel with the Pay for Safety Scheme (PFSS). The Occupational Safety and Health Council was engaged as the scheme manager whose primary tasks were to set up a registration scheme of safety auditors and to develop the Works Bureau Safety Auditing System (Provisional CICB Secretariat 2001).

Though most of the safety officers agree that ISAS can effectively reduce the accident rate, some of them criticize the unclear content of audit which leaves room for auditors to interpret the requirements of safety. As different auditors have different interpretations, it induces the problem of unfairness (Li 2006).

4.2.4 The Occupational Health and Safety Assessment Series 18001 (OHSAS 18001)

OHSAS 18001 was developed in response to customer demand for an occupational health and SMS standard against which their management systems can be assessed and certified. The elements of OHSAS 18001 consist of OH&S policy planning preparation, execution and operation, checking and remedial action, management evaluation and ultimately recurrent perfection. Though inconsequential safety incidents may not cause severe injury, they are sufficient to cause construction delays. Massive savings can be realized if such negligible events are decreased. The foremost value of OHSAS 18001 over other safety management systems lies in its necessity for frequent improvement. 18,001 auditors provide useful suggestions regarding areas that can be changed to fabricate a better safety management system. Although there is initial set-up cost of registering 18,001, long-term benefits to companies can result in considerable money and time savings (O'Connell 2004).

4.2.5 Site Safety Supervision Plan System (SSSPS)

Under Sect. 2 (1) of the Building Ordinance, a supervision plan lays down the plan of safety management of building works. Four statutory agents: the Authorised Person (AP), Registered Structural Engineer (RSE), Registered Geotechnical Engineer (RGE) and Registered Contractor (RC) monitor the safety issues on construction sites. The AP/RSE/RGE carries out periodic supervision while the RGBC/RSC is required to carry out continuous supervision. The aim of such frequent inspection is to ensure the compliance with the Building Ordinance, the approved supervision plans, orders made, and conditions of approval and consent. Each stream would appoint technically competent persons (TCP) to carry out the inspections. In general, TCP consists of five levels. TCP T4 and T5 carry out engineering safety supervision to ensure compliance of design requirements. TCP T1 to T3 perform periodic safety supervision to make sure the construction method is in compliance with approved method statements, and preventive and protective measures (Lam 2007). SSSPS is, however, not without problems. Duties and responsibilities of each party specified in SSSPS are often ill-defined. There are overlapping responsibilities between the system and other safety ordinances. There is also difficulty in controlling information flow and safety audit (Li 2006).

4.2.6 Site Safety Cycle (SSC)

Site Safety Cycle (SSC) was formally launched in 2001 after two years trial in the construction industry. It applies to all public work project contracts including Design and Build contracts in Hong Kong after 15 August 2002. SSC is modeled from Japan's "Site Safety Cycle". It improves communication among workers on safety and health matters, alerts workers' safety awareness and improves housekeeping on sites. Generally speaking, it consists of 3 cycles: Daily Cycle, Weekly Cycle and Monthly Cycle. Daily Cycle consists of 8 elements: (1) pre-work safety meeting and exercise, (2) hazard identification activity, (3) pre-work site safety checks, (4) site safety by Site Agent or his representatives, (5) supervision during work, (6) safety synchronization meeting, (7) daily tidying up and cleaning of the site, (8) checking of construction site after each day's work. Weekly Cycle consists of: (1) weekly safety walk by safety officer and site agent with the engineer's representative (ER), (2) weekly co-ordination meeting with the ER and site agent, (3) weekly overall tidying up and cleaning of the site. Monthly Cycle consists of Site Safety Committee and Site Safety Management Committee meeting.

The success of SSC necessitates the participation of the contractors, the workers and the Engineer's representative and his site supervisory staff. With the full implementation of SSC, we can see a safer construction site (Highways Department 2002). Nevertheless, as workers on site have irregular working time, safety officers in Hong Kong do admit that there is difficulty in implementation of SSC. While it is difficult to find space to do exercises on small construction sites; it is also uneasy to call up all the workers to do exercises in the morning where the site is too large: workers are unwilling to spend time to gather in the morning at a place where it is far away from the place he or she works (Li 2006).

4.2.7 Performance Assessment Scoring System (PASS)

In 1991, PASS was firstly introduced in Hong Kong. It aims at providing an objective means to measure contractors' performance according to predefined standards and serves as an instrument for comparing relative performance of individual contractors on a fair and consistent basis (Housing Authority 1996). PASS assessments are carried out through site inspection, desk-top assessments and documentation verified by relevant Project Team members and PASS Assessment Team. The assessments comprise: Works Assessment (Structural and architectural work assessment) and General Assessment (Management Input, Programme and progress, environmental and other obligations and Safety assessment). The Safety Assessment includes four factors: HASAS Score for Safety and Health Management System, HASAS Score for Implementation of the Safety and Health Plan, General Site Safety and Block Related Safety (Hong Kong Housing Authority 2003).

As elements are randomly selected by computer and location spots are pre-defined, the assessment approach used by PASS gives a fair way of performance approach. Contactors generally have the same opinion that the PASS can improve safety. Nevertheless, PASS does not promote everyone's involvement within an organization. And higher tendering chances for those contractors with a higher score in PASS may not lead to better performance. Finally, even the PASS provides a feedback mechanism for contractors to improve their performance, there is no specific development plan to assist or ensure that contractors improve their performance (Chun 2001).

4.2.8 Pay for Safety Schemes (PFSS)

PFSS was introduced in Hong Kong in 1996. It primarily aims at accident reduction in competitive tendering system. It runs in line with Independent Safety Audit Scheme. It includes a fixed sum under "site safety section" in the Bills of Quantities. Safety items usually include safety officer appointment, site safety meeting, safety plan and safety training. These items will then be priced based on total payment to the contractor. It costs approximately 2 % of the estimated contract sum (Fong 2000).

4.2.9 Safety Education (SE), Safety Training (ST) and Safety Promotion (SP)

Implementation of safety and health programmes on construction projects requires a well-educated workforce that has knowledge in safety requirements. Formal training could have major impact on students' performance. Nevertheless, safety class's regulatory nature is "boring". The need for construction safety education is now a consensus issue among the construction educators and the industry for its contribution towards the reduction of accidents. (Banik 2000). Most of the safety officers agree that safety promotion which includes poster, game store, cash award can induce the workers' incentive to work safely (Li 2006).

4.3 Research Method and Results

A total of 120 questionnaires were sent by mail to construction companies selected from the Builders' Directory in 2006. 28 questionnaires were collected over 2 months. Participants were asked about (1) Total number of accidents of the company over the past year (2) Total number of workers per month on average within the past year (3) Whether they have implemented the 9 construction safety measures (ISAS, OHSAS 18001, SSSPS, PASS, PFSS, TQM bases SMS, BBS, SSC, SE, ST, SP) on site (Li 2006).

As shown in the following figure, no company has implemented TQM or BBS based safety management system. All the companies have provided Safety training as it is required in the Laws of Hong Kong. More than half of the respondents reported that they have implemented ISAS (Fig. 4.1).

The authors then run the regression of accident rates for each of the construction companies on safety measures. Dummy variable of 0 means that the company has not implemented that kind of safety measure whereas 1 confirms the implementation of the safety measure (Table 4.1).

ISAS, OHSAS and SP have negative and significant relationship with accident rate which indicate the three safety measures can effectively reduce the probability of accidents. SSSPS, PFSS and SE have negative and insignificant results. SSC has a positive but insignificant relation with accident rates.

PFSS might not be able to reduce accident rate because it is originally designed to punish those contractors which have not performed well on safety, nearly all the contractors can get 100 % sum of money for safety issues. ISAS and OHSAS are the only tools which can reduce construction accidents. They have two common characteristics: they all look at the safety issues from a wider perspective and include an item "safety planning" which recognizes possible hazards on site

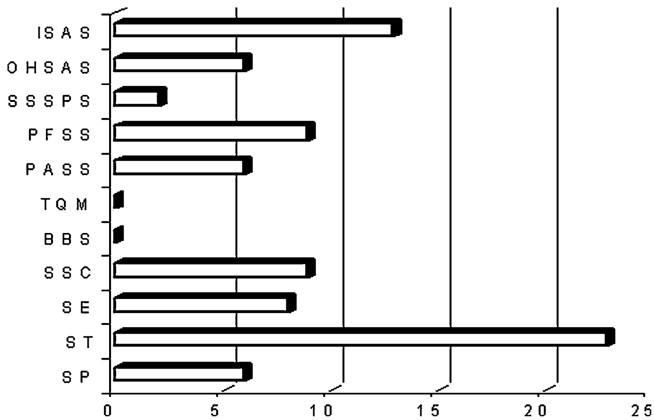

Fig. 4.1 Number of companies implements different kinds of construction safety measurescon-struction safety measures

Table 4.1 Relationship between safety measures and accident rates (Li 2006)

	Unstandardized coefficients		Standardized coefficients	T	Sig.
	B	Std. error	Beta		
Constant	60.806	9.765		6.227	0.000
ISAS	−16.273	5.552	−0.345	−2.931	0.009
OHSAS	−28.675	8.165	−0.606	−3.512	0.003
SSSPS	−2.101	9.131	−0.024	−0.230	0.821
PFSS	−5.757	5.275	−0.122	−1.091	0.290
SSC	0.008	7.080	0.000	0.001	0.999
SE	−2.928	7.156	−0.059	−0.409	0.688
ST	−13.765	9.584	−0.211	−1.436	0.169
SP	−25.040	6.534	−0.517	−3.832	0.001
Dependent variable: ACCI					

before work starts. On the other hand, Safety promotion, education, training and SSC's target are workers on site. SSC cannot effectively reduce the accident rates, and this might be due to the fact that workers in Hong Kong enter the site at different time slots or even different entries; there is difficulty in pre-work safety exercises and meeting before work start. Interviewees also complain that the content of safety training and education are not specific to the job. Safety promotion, such as cash award, can motivate the workers to work safely.

4.4 Conclusion

Construction safety measures are designed originally to reduce the chance of accidents on sites. Nevertheless, as different sites have different site characteristics, such as site area and different work groups have their own culture, safety officers need to make adjustment accordingly. When contractors and clients compromise on which type of construction safety measures, other considerations are also important.

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Chapter 5
Senior and Junior Construction Personnel's Point of View on Construction Safety

5.1 Introduction

Questionnaires provide basic information on the causes of accidents and factors influencing safety motivation. However, closed-question surveys may force a particular response and do not always allow for additional comments (Somekh and Lewin 2005). They may not reflect the complete views and opinion of the respondents. Interviews provide a chance for respondents to explain and enrich their answers. Information collected from interviews can also strengthen the validity of the questionnaires.

5.2 Objectives of Interviews

In view of the diverse and sometimes contradicting views on causes of construction accidents as noted in Chap. 1 and the diverse views on effectiveness of safety measures, 5 anonymous construction workers, 8 middle managerial staff, safety officers and the client were invited to participate in the interviews to find out their view points on causes of construction accidents.

1. Dr. Ho is an assistant safety and environmental protection manager in one of the largest contractors.
2. Mr. Wong is a foreman for one of the largest contractors in Hong Kong
3. Mr. Lam and Mr. Sin are safety managers in one of the largest contractors.
4. Mr. Chong a safety officer in a small contractor.
5. Mr. Yeung is a former safety advisor of a government department.
6. Mr. Li is a safety manager for a joint venture contracting firm.
7. Mr. Yung is a senior quantity surveyor in a government department.
8. Mr. Fan and Mr. Lam are safety officers in one of the largest contractors.

There are seven objectives in the interviews

1. To gain a broad understanding on the causes of accidents and factors influencing safety motivation.

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2. To determine the costs of accidents on Hong Kong construction sites and the costs of various safety measures.
3. To effectively reduce/eliminate the root causes of accidents.
4. To effectively enhance safety motivation.
5. To determine the pros and cons of various safety measures.
6. To identify factors affecting the effectiveness of safety measures.
7. To make recommendations to improve the effectiveness of safety measures.

5.3 Causes of Construction Accidents

5.3.1 Foreman's and Workers' Points of View: Human Factor

Most of the interviewees who are currently working on site agree that human factors are one of the root causes of accidents. Workers' negligence, carelessness, inadequate knowledge, and other human factors greatly increase the likelihood of accidents. All workers agree that human error is the major root cause of accidents.

5.3.2 Middle Management Point of View: Poor Management

Middle managerial staff hold different points of view on the root causes of accidents. Though they admit that accidents are partly due to human mistakes, site management is considered as the major factor. Mr. Chong, a safety officer for a contractor, points out that most accidents can be prevented if there is good safety management. Mr. Yung, a senior quantity surveyor for a government department, concludes that the underlying cause of accident is poor management on site: poor site management led to poor site programme on site. They increase the pressure on workers. They take shortcuts and accidents happen. Another common problem on construction sites in Hong Kong is poor time management. Although there may be only a few workers on site sometimes, at other times there might be 200 workers. Mr. Yung points out that in some cases, workers were are testing electrical wires while painters paint the walls nearby. Such poor site management of site activities increases the number of site accidents.

5.3.3 Client's Point of View: Lack of Site Safety Supervision

From the client's point of view, site safety inspection is the most important way to prevent accidents. Mr. Yeung, former safety advisor in the government, states that accidents usually happen at the time when the work is nearly finished and the site safety supervision is reduced. In one of the cases occurred in 2004 in Sha Tin, the project had nearly come to an end and there were only about 10 workers on site, with no site supervision. Unfortunately, three of the site staff were hit by lightning while in a shelter. Two men died, and a woman was hurt.

5.3.4 Other Causes of Accidents

Mr. Li points out that poor communication, design defects and work complexity are other major causes of accidents.

5.3.5 People at Different Levels View Accident Causes Differently

Based on the interviews, the authors find that people in different positions at work hold different views on the root causes of construction accidents. From the employer's point of view, accidents mainly result from a lack of safety investigation. From the middle management point of view, the main cause of accidents is poor management. However, from a worker's point of view, the major cause of accidents is human error. If the safety management system used is chosen by the employer and implemented by middle management, the workers have a higher chance of being involved in accidents. These different view points cast doubt on the effectiveness of safety measures chosen by the senior and middle management staff in accident causes reduction.

5.4 Safety Motivation

5.4.1 Contractor's Motivation for Working Safely

From company's point of view, tendering opportunity is of the utmost importance. If the chance of winning a bid is lower because of a poor safety record, the company will devote more resources to safety.

5.4.2 Middle Management's Motivation for Working Safely

From a middle management point of view, intrinsic factors generally override extrinsic factors. Mr. Yung thinks that people are motivated to work safely because they can foresee the result of not working safely. Though the working team's culture might affect their safety behaviors, most of the interviewees do not agree that penalties, awards, safety promotion, or other factors can motivate them.

5.4.3 Workers' and Foremen's Motivation for Working Safely

However, from workers' and foremen's point of view, a cash award is the best motivation for ensuring safety. They agree that some workers do unsafe work on site. In light of this, both workers and foremen suggest that penalties are also a good measure for increasing safety awareness.

5.5 Costs of Accidents/Possible Benefits of Safety Measures

All the safety officers agree that the compensation costs can be insurmountable if accidents happen. Mr. Lam, the safety manager of a contractor, mentions that the replacement costs of the injured workers can be very high when the worker's job is so specialized that one cannot easily find somebody to replace him. Second, there are also time costs. The costs will be a lot higher when the accident is fatal: a safety officer has to submit a report on the accident investigation and suggest ways of improvement. Work related to the accident must be stopped until a satisfactory report is produced. If the work is on the critical path, the subsequent delay can also lead to the deduction of liquidated damages. Third, though the insurance companies will pay for part or all of the employee compensation, losses and expenses incurred in accidents, the accident record will lead to a higher insurance premium. Fourth, the company's reputation will be affected, which in turn will directly affect its tendering opportunities.

As a safety manager, Mr. Ho mentions that the contractors need to bear the responsibility for fatal accidents since 2003. In serious cases, a panel can stop both public and private contractors from submitting bids for a certain period of time. Though large scale companies can still survive, small companies might be forced to shut down because of these accidents. If the safety measures can effectively reduce the probability of accidents, the above costs of accidents will be saved and become the benefits of safety measures.

5.6 Effectiveness of Various Safety Measures

5.6.1 Independent Safety Audit System (ISAS)

Since 1996, auditors are required to conduct audits on site every three months. Nevertheless, in actual practice, the contractor normally provides three auditors' backgrounds and usually chooses one out of the three. According to Mr. Li, under Independent Safety Audit System (ISAS), the client's resident engineer chooses three auditors from a list of available auditors. Then, the list of auditors is sent to the contractor. Because the auditor should not have conflict of interests with the contractor, the auditor can act as an objective evaluator to check for safety problems. To meet the requirements of the auditor, safety planning, safety training and promotion are required. The necessary measures include documentation, purchasing personal protective equipment and holding toolbox talks. Most accidents are the result of human error. Mr. Sin, safety manager of a contractor, comments that ISAS limits the causes of accidents through an auditor's constant supervision. Additionally, when a company implements toolbox talks, it can increase workers' safety awareness and knowledge. Mr. Li further points out that ISAS can increase a contractor's safety awareness and provide more site safety inspection to prevent any adverse reports. However, Mr. Sin disagrees as the penalty is designed to penalize the company rather than those workers with bad safety records, ISAS might not provide good motivation for workers to work safely. Mr. Ho also comments that from the contractor's perspective, asking their own officers to do something related to safety is not an easy task. By means of an external auditor, the problem of motivation can be minimized. Nevertheless, Mr. Yeung mentions that in cases where the internal safety score is less than 70 % for a particular question, there will be an adverse report. Therefore, this safety system can effectively increase the motivation for providing adequate and sufficient equipment and training.

5.6.1.1 Pros and Cons of ISAS

Mr. Li, a safety manager of a joint venture firm, points out that the content of audits is not very clear and leaves room for the auditor to interpret the requirements of safety. Further, different auditors have different interpretations. Take for instance, the question about adequate lighting: the word 'adequate' is quite subjective. Similar problems can be found in the question about whether the site has been effectively screened. Mr. Ho agrees and said he had an experience in which a safety auditor gave 0 marks to both the site safety and environmental committee items. He thought that his company met the requirement of the ISAS but scored 0 because of the terminology of the question. Though he successfully appealed the score, the 0 marks caused much trouble. Besides, the attitude of the safety advisor and site staff affects the success of ISAS.

Generally speaking, most of the interviewees agree that ISAS can effectively reduce the accident rate on most sites through the presence of an external auditor. Moreover, requesting the workers to do something extra is difficult, and the presence of an external auditor allows a safety officer to impose safety measures. However, Mr. Yeung, the former safety advisor of a government department, points out that there are still some exceptional cases where the site accident rate remains very high and some fatal accidents occur after ISAS is implemented.

5.6.2 Occupational Health and Safety Audit System 18001

According to Mr. Lam, safety officer of a contractor, OHSAS 18001 is a European standard that mainly works through risk management. Companies usually implement ISO 9001[1] and ISO 14001[2] before they implement OHSAS 18001. Mr. Lam comments that OHSAS 18001 is similar to BS 8800, which stresses the importance of plan-do-check-act. The safety officer usually refers to these method statements to do the risk assessment. He will estimate the likelihood rating and consequences. The two figures obtained are then multiplied to calculate the risk problem (Tables 5.1, 5.2, 5.3).

If the degree of risk is 15–20, the safety officer needs to review the work procedure immediately, use appropriate safety measures to reduce the risk to a low level. Supervision by a competent person is also required. If the degree of risk falls in the range of 5–14, the safety officer needs to review the work procedure within a reasonable time. He needs to formulate safety measures to reduce the risk to a low level. If the degree of risk is within the range of 1–4, workers need to follow in-house safety rules and statutory requirements. Nevertheless, if the control measures are unable to reduce the risk to a low level, the method statement shall be reviewed by the engineer. There should be re-assessment of risks according to the revised method statement and procedures.

The major expenditure of OHSAS includes the cost of setting up the system, documentation, the time cost of the safety officer for estimation of risks, documentation, etc. Though the initial setup cost is high, the marginal cost for each of the additional workers is negligible. OHSAS involves an initial estimate of risks so that suitable training and education can be provided before the work begins, so as to increase the workers' safety knowledge. Mr. Ho points out that the accident rate decreases as OHSAS builds up a framework. Mr. Lam comments that although the effectiveness of OHSAS cannot be recognised in the short term, it is a useful tool in building up the safety culture in the long term. If all the sites in Hong Kong implement OHSAS, the safety culture can be consolidated. He adds that when planning is good, the safety management will be improved. As the OHSAS safety

[1] ISO 9001 generates an integrated management system (IMS).

[2] ISO 14001 concerns environmental policy.

Table 5.1 Likelihood rating

Probability	Probability level	Likelihood rating	Prob. Value	Description	Individual failure mode
	A	5	10-1	Frequent	Likely to occur frequently
	B	4	10-2	Probable	Will occur several times in the life of an item
	C	3	10-3	Occasional	Likely to occur some time in life of an item
	D	2	10-4	Remote	Unlikely but possible to occur some in life
	E	1	10-5	Improbable	So unlikely that occurrence may not be experienced

Table 5.2 Consequences

Probability	Category	Consequence	Degree	Description
	A	5	10-1	Functional failure of part of machine or process—no potential injury
	B	4	10-2	Failure will probably occur without major damage to system or serious injury
	C	3	10-3	Major damage to system and/or serious injury
	D	2	10-4	Failure causes complete system loss and/or potential or fatal injury

Table 5.3 Likelihood rate

5				High Risk
4				
3				
2				
1	Low risk			
	1	2	3	4

officer needs to calculate an initial estimate of risks and provides safety advice before risky work begins, workers might become more knowledgeable about safety issues and concepts. Thus, the safety motivation of workers is enhanced.

Though most of the interviewees agree that OHSAS can improve safety performance by planning beforehand, Mr. Lam points out that because consequences and probabilities rely on past experiences, the prediction is subjective. Unlike the implementation of OHSAS 18001 in a factory, where the work is standardised and the potential hazards can be analysed by previous statistics, site conditions vary at each site. The characteristics of a site affect workers' behaviour. In addition, the mobility of workers between sites is very high. In the light of a tight construction schedule, the risk assessment appears to be paper work without any practical use. Take for instance, a worker completes procedure A, but the safety officer has not yet completed the risk assessment. In such case, no related courses or other safety programmes can be provided beforehand.

5.6.3 Pay for Safety System (PFSS)

In the past, when there was no monetary reward pay for safety, contractors did not invest in safety. Only the prices of materials and labour were included in Bills of Quantities (also known as BQ, contractors in Hong Kong are paid according to the items listed in BQ, it usually includes materials, labour costs etc.). Unlike the other safety measures, the main contractors are paid for their contributions to safety in a PFSS. Nowadays, BQ includes payment for safety measures in the public sector. Contractors need to spend money to implement safety plans, organise toolbox talks, and adopt other safety measures. They can pass these costs on to their clients. Administrative and time costs of the scheme are also incurred. Safety training and education costs included in the Bills of Quantity act as a driver for contractors to equip workers with adequate safety knowledge so as to reduce the frequency of accidents. Nevertheless, PFSS is not common in the private sector.

From the contractor's point of view, because the client gives money to the contractor for implementing safety measures, the contractor will implement more safety measures. Mr. Yeung agrees that PFSS is cost effective because otherwise the contractor will not invest in safety. Mr. Lam thinks that the inclusion of a safety item can increase the safety awareness and therefore reduce the accident rate. Mr. Ho thinks that resources such as money are required to implement some safety measures. PFSS allocates money to safety inspections and provides contractors with motivation and incentives to ensure safety.

The clients' points of views, however, are divergent. Mr. Yung thinks that PFSS are only indirect methods of accident rate reduction. According to his observation, nearly all the contractors receive 100 % contract sum. This is probably because most of the contractors successfully bidding the task from the government are large companies where the accident rates are lower. Mr. Yeung, however, thinks that if there was no PFSS, contractors would not devote money to safety. This omission may be evidence that the contractors did not invest in safety measures. If contractors do not act according to the contractual requirement, contractors get no money for the PFSS item. Site walks accompanied by the site staff and safety officer can reveal if a contractor has not acted according to PFSS requirements.

5.6.3.1 Pros and Cons of PFSS

Most of the interviewees agree that they do not invest much in safety if there is no PFSS. This statement is supported by most of the contractors in private sectors who do not implement PFSS. However, Mr. Li argues about the requirement of 70 % attendance for morning exercises as an example, since such requirement is nearly impossible to achieve for a large site. Moreover, only the main contractor receives money for safety from clients. The sub-contractors do not receive money for this. Their incentive to provide safety measures is low.

5.6.4 Site Safety Cycle (SSC)

5.6.4.1 Implementation Costs

The major costs in SSC are administrative costs of implementation, time costs involved in site walks accompanied by safety officers, writing records, and other costs. Mr. Lam comments that SSC increases the communication with workers by mandating a morning assembly and briefing. The problem of not having enough site area for assembly can be solved by site design. Mr. Li points out that the morning assembly is a good time for the safety officer to tell the workers when there will be induction talks and other events. The morning exercise session, from Mr. Yeung's point of view, can reduce the risk of physical injury during work. Hazards can also be identified for the workers in the morning before they start to do their work. SSC is particularly useful for building work where there are only two exits. The morning assembly provides an ideal chance for the safety officer to convey safety messages. As giving workers more knowledge of safety concepts is also a safety motivation factor, SSC can enhance safety motivation. All the interviewees agree that SSC can be implemented effectively given that the construction site is small and there are a limited number of entrances. On very large sites, workers enter the site at different times and at different entrances. Mr. Li and Mr. Lam point out that there are difficulties in the implementation of an SSC in Hong Kong. Not all construction workers start their work at the same time; some might go to work early in the morning, others might come to work in the afternoon from another site. Therefore, Hong Kong workers might not be willing to attend the morning exercise session. As a safety officer, Mr. Li says that he does not have the power to persuade workers to come to the morning exercise session. This requirement, however, increases workload for the safety officers. Since the contractors can only receive the payment for SSC if there is 70 % attendance, it is not uncommon that the contractors cannot receive the SSC money.

5.6.5 Safety Training (ST)

Most of the companies in Hong Kong provide induction training. The major merit of induction training is that it can increase new workers' safety awareness. During safety training, workers are also taught about the consequences of not following the safety procedure. It aims at increasing the safety motivation. These training programmes stress the particular areas of importance for the workers. The implementation costs of ST depend on the type of job training. In most cases, experienced workers show the newcomers how to do the job. Some of the large construction sites may have safety training models which resemble real life situations for working at height, and working in a concealed area. Whereas the latter option involves a comparatively higher cost, the former option is relatively inexpensive. Since human error is one of the major causes of accidents, most of the interviewees agree that high-quality training reduces the number of accidents which relate to a lack of safety knowledge. The major drawback of ST is that it might not be useful to those who have worked on sites for many years as construction work is quite routine. For example, scaffolding works are quite similar on different sites. Besides, ST courses require a sufficient number of workers to open a class but there might be new workers on site every day. These classes might not be useful from this perspective. In spite of these, most of the interviewees agree that safety training can increase the safety awareness of workers. Mr. Yung comments that most of the workers have experience on construction sites. Induction training is helpful in reducing accident rates in specialized work, e.g., work under water. Mr. Sin thinks that workers remember the safety measures more easily if they complete ST.

5.6.6 Safety Education

All construction practitioners in Hong Kong are required to attend Green Card courses (It is the safety course designed for workers on site). Some companies might also provide education courses for their workers. The costs of implementation of Green Card training courses and safety education are mainly the costs of the instructors and the course materials. The marginal costs for each worker are very low. Mr. Sin thinks that safety education decreases the number of accidents. When workers listen carefully, they refresh their memory every two years. These courses can increase workers' safety knowledge. However, they are not very effective at reducing construction accidents because the knowledge transmitted to workers is too general. Some construction workers also admit that they do not understand and have no intention to understand the lessons. The major reason for this response is that they know the lecturer will give them tips to pass the test after the full-day lesson is completed. One of the course officers admits that workers usually receive Green Card right after the lesson.

Mr. Chong thinks that some of the safety courses provided by the contractor can be more job specific, their effectiveness depends greatly on the content of the courses. Mr. Ho points out that although the people of Hong Kong are told not to cross the road when the red light is on, many still do so. Mr. Wong, who works as a foreman, however, thinks that safety education can effectively increase the workers' safety knowledge and hence reduce human error. One must not neglect, however, the external benefits of the construction safety courses. When one worker has obtained knowledge specific to a given site, he might only understand very little of what is taught. Nevertheless, as suggested by certain synapses in the brain undergo longer lasting increases in their effectiveness when they are commonly used. A similar concept applies here: when the worker attends similar lessons again, his memory is refreshed, and the safety knowledge becomes part of long-term memory. There might be problems in arranging the safety courses if too few workers need to attend the course. The Green Card is also too easy to get. Generally speaking, interviewees think that safety knowledge can increase if the workers can pay attention during the courses.

5.6.7 Safety Promotion

Generally speaking, some companies produce their own safety posters. Competitions and games are also used for promoting safety to construction practitioners. The costs of implementation depend on which type of safety promotion is used. The Labour Department provides free posters for safety officers to use on sites. If a cash award scheme is used, the amount of the award is proportional to the contract sum. All of the interviewees agree that safety promotion can increase the incentive and awareness for working safely. It might also improve workers' knowledge about safety. Workers, foremen and safety officers agree that safety promotion by issuing cash awards to workers who perform well in safety can surely increase workers' safety awareness. They also agree that there should be penalties if the workers on site still perform badly after the award system is implemented. Mr. Yeung recalls that there was once a best foreman competition and the foremen were very enthusiastic about safety supervision and there was high safety awareness among their workers. Mr. Sin thinks that safety promotion methods such as posters can increase workers' safety awareness. Though the effectiveness of posters is uncertain, these methods are likely better than nothing. Safety awards might increase the safety awareness of both the workers and safety supervisors, provided that the award is valued by the receivers.

5.6.8 Performance Assessment Scoring Scheme

According to Mr. Yung, a senior quantity surveyor of a government department, the PASS used in the Housing Authority consists of two scores: a project score and a contractor score. The project score reflects the performance of the contractor on a particular project during the construction stage and maintenance period. The project score includes:

1. a quarterly project score during the construction stage (QPSc);
2. a project score at the completion stage (SCS); and
3. a quarterly score during the maintenance stage (QPSm).

It is clearly stated that safety accounts for 10 % of the quarterly project score. The contractor score reflects a contractor's overall performance on the project and is calculated as follows: (a × average QPSc in the last 4 quarters + b × average QPSc in the last 4 (or 5) quarters + c × average QPSm in the last 4 quarters)/(a + b + c), where a, b, c are relative weightings assigned according to QPSc, SCS and QPSm, respectively. As Housing Authority must give a score to a contractor, it employs some people who are responsible for this task. Administrative and documentation costs are involved. On the other hand, the contractor might invest more because it does not want to get bad results which might affect its tendering opportunities. As PASS can increase a contractor's tender award opportunities, it might increase the site supervision provided by the contractor. It has no direct effect of motivating workers to work safely. As those contractors with a higher score in PASS receive more tendering opportunities, contractors will pay more attention to safety performance to avoid scoring poorly. There is, however, no specific solution provided to assist contractors in improving their performance.

5.6.9 KYT

According to Mr. Sin, a safety manager of a contractor, points and calls increase workers' safety awareness (see details in case study 1). There are few costs, except the time costs of workers and the safety officer who leads and instructs the workers. Workers who have completed KYT do their work more carefully. Mr. Yeung, a former safety advisor of a government department, comments that KYT can be implemented in Japan because the Japanese obey the rules set by their superiors. However, there is some doubt concerning whether KYT can be effective in Hong Kong. The implementation problem will be similar to that described in SSC. Nevertheless, since only one site in Hong Kong uses KYT, most of the interviewees are not familiar with it.

5.6.10 Total Quality Method-Based, Behaviors Based Safety-Based and Site Safety Supervision Plan System

Among the six safety officers, managers and advisors interviewed, only two are familiar with TQM-based safety. Mr. Sin comments that some companies tried to use TQM, but most have given up. Therefore, there is no need to explain why the contractors do not implement this system. Similar problems are found in SSSPS and BBS. Most of the interviewees are also not familiar with BBS and SSSPS. The interviewees only know that SSSPS is required by the Buildings Department.

5.7 Critical Factors Affect the Effectiveness of Safety Measures

5.7.1 Support from Site Agent/Project Manager

There is a general consensus that the construction management team, project manager and site agent affect the success of implementation of safety measures. According to Mr. Yung, the attitude of the construction management team towards the safety measures is the most important factor. Mr. Chong also refers to two sites where he has worked on. One was located in Deep Water Bay (which will be discussed in the case studies), and the other was in Kowloon Tong and was completed in 2005. He commented that the two sites were similar in nature in that both were two-storey buildings. Nevertheless, whereas no accident occurred at Deep Water Bay, Kowloon Tong incurred three construction accidents and four penalties from the Labour Department regarding site safety problems in one year. The difference between the sites was the relatively poor attitude towards safety of the project manager in Kowloon Tong. The project manager refused to take any safety advice from the safety officers there and only focused on whether the project can be completed on time.

5.7.2 Attitude of Safety Team

"Safety measures may be there on sites with no one bothers to enforce. Safety officers can be there, but only to create a record to present to the Labour Department," Mr. Chong comments. Although most of the safety measures can effectively reduce the occurrence of accidents, a measure's effectiveness can be greatly affected by the people who implement it. Safety measures are only tools of safety; people's different uses of the tools lead to different safety outcomes.

5.8 Recommended Safety Measures

5.8.1 Adequate Training

Safety officers should recommend safety measures to site agents (SAs) and project managers (PMs). PMs and SAs are often the major barrier to adopt new safety measures. While the government advocates the importance of providing training and education courses to the workers, it has neglected the fact that these workers often have little education. In theory, education and training should be provided to workers who work in the front line and who suffer from higher chance of accidents than others. In reality, safety courses should also be provided to PMs, SAs and middle managers as well.

5.8.2 Workers' Views and Safety Measures Design

It is the workers who spend most of their time on site; however, managers who work offsite make the final decisions about safety matters. When asked about their reasons for choosing an SMS, most of them reply that they do so because of the following: (1) the client's needs; (2) regulations; and (3) company policy. The effectiveness of the safety measures is doubtful without consideration of the causes of accidents. To improve this situation, the clients who are not working on site every day should decide the safety contractual obligations, and the contractor's safety managers should choose the safety measures for workers on site after they listen to the needs and views of the workers.

5.9 Discussion and Conclusion

All interviewees agree that the all the safety measures mentioned above can effectively reduce the accident rate to a certain extent. Though all of the safety measures cannot reduce the occurrence of all kinds of accidents, they can reduce some causes of accidents while simultaneously enhancing the safety motivation. In view of the high costs of accidents, the total benefit of instituting a safety measure is much greater than the total cost.

These interviews yielded two interesting phenomena:

Though it is the client who determines what kinds of safety measures to include in the contract, the safety manager has the right to decide on any additional safety measures to be implemented. The client, safety manager, workers and foremen have different points of view regarding the major causes of accidents. There is some doubt, therefore, about the suitability of the safety measures implemented.

Among the professional safety officers, nearly all of them do not have a clear picture of BBS and/or TQM-based safety systems. Most of them also do not clearly understand SSSPS. This is because they have not worked for Buildings Department. It explains why some of the companies do not implement additional safety measures apart from statutory and contractual requirements. The high entry costs and information costs deter them from doing so. Even if someone in the company understands some of the latest safety measures, it is not easy to persuade others to use a new method. The high negotiation costs make the problem even worse.

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Chapter 6
Case Studies on Safety Measures Implementation

6.1 Introduction

To test the effectiveness of safety measures, one way is to conduct case study. Case study refers to an intensive research of a single individual or event. It involves an in-depth descriptive record, kept by an outside observer of an individual or group of individuals. Case study enables the researcher to obtain in-depth information from detailed descriptions of events and observed behaviors (Pattern 1980). Although the major problem of the case study lies in its breadth of study, a case study could appear to be so unique that it may affect the validity of the findings (Fellows and Liu 2003). Interviewing members at different levels within a case study enables us to look into the matter from different angles. The findings will therefore be more enlightening and complete. In this research study, multiple case studies are used instead of single case study. This is because single case study often falls prey to over generalised results or selection bias (Bennett and George 2005). The essence of this case study is to illuminate a decision or set of decisions on why the safety measures were chosen, how they were implemented and what the results were. The authors visited five construction sites and chose three cases to study safety measures on construction sites.

6.2 Objectives

Interviewees agree that all safety measures are designed to reduce accidents, but they also point out that the most important element is how the safety officer or safety manager uses these tools. Therefore, the main objectives of the case studies are:

1. To investigate how the safety measures were carried out.
2. To investigate the factors that affected the effectiveness of the safety measures.

It is therefore very critical in differentiating any extraneous interference on the target of study. The 3 cases were chosen because of their special characteristics.

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Case study 1 was chosen because the company won nearly 20 safety awards over the past 2 years. It is the winner of a company's best site safety award. It is also the first and only site in Hong Kong to implement KYT (KYT is an abbreviation of Japanese terms. K stands for hazard, Y for prediction, and T for Training). Case study 2 was chosen because 8 accidents happened over the past 12 months, and about 20 accidents have accumulated since the site was opened. Case study 3 was chosen because this is a typical private housing development with no safety measures implemented on top of the statutory requirements Table 6.1.

6.3 Case 1: Route 8 Nam Wan Tunnel and West Tsing Yi Viaduct

Figure 6.1

6.3.1 Safety Measures

Route 8 is the only site in Hong Kong that implemented KYT. It also adopted safety cycle and pay for safety on sites. Unlike other construction sites in Hong Kong, training facilities were available on site.

Table 6.1 Summary of the case studies

	Case 1	Case 2	Case 3
Nature	Tunnel, highway and two buildings	Elevated roadways	Private residence with pool
Contractor	A	B	C
KYT	✓		
OHSAS			
PASS			
ISAS		✓	
SSC	✓	✓	
Game stall and banner		✓	
PFSS	✓	✓	
Accident rate Over the past 12 months	3 (Total 5)	8 (Total 20)	0
Client	Public	Public	Private

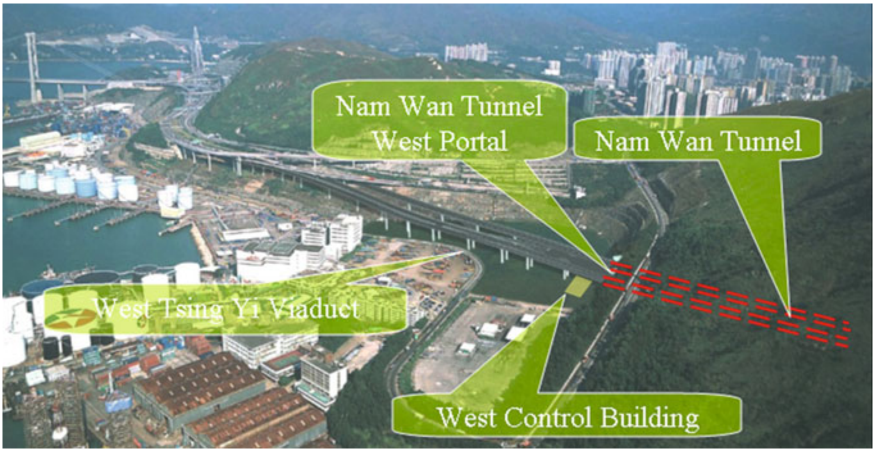

Fig. 6.1 Case 1 Route 8 Nam Wan Tunnel and West Tsing Yi Viaduct (*Source* Gammon Construction Ltd)

6.3.1.1 KYT

Because human error is one of the most important causes of accidents for frontline workers, hazard identification activities are undertaken to determine and address the sources of hazards and to increase sensitivity to hazards. Suggested time required for the hazard identification activities are shown in Table 6.2. KYT places importance on equality and the individual perspectives of working people. Hazards are identified by the safety officer and workers on site. By encouraging everybody on site to identify, and resolve safety problems and hazards on site, safety conditions can be improved. The site shows videos depicting risky behaviour, which can motivate workers to work safely.

Table 6.2 Time required for hazard identification activities

Type of work	Min
Regular work	3–5
Unusual work	10
Sudden, emergency or abnormal work	20

KYT takes place in both small and large groups. Large-group KYT aims at reminding workers of safety issues of which all workers must be aware, e.g., if it is a rainy day, all workers must be aware of the risk of slipping on wet floors Fig. 6.2.

After large-group KYT, workers are divided into small groups for small-group KYT, which involves nine steps: Figs. 6.3, 6.4 and 6.5

1. Divide workers into groups.
2. Group leader introduces the job activity.
3. Group members point out all hazards.

Fig. 6.2 Group KYT

4. Group members select the most important hazard.
5. Group members point out all counter measures.
6. Group members select the most effective counter measure.
7. Point to the counter measure.
8. Call out the counter measure.
9. Confirm at each strategic point in the task by pointing a finger at the point and naming it out loud.

Traffic safety is very important in tunnel construction as many subcontractors work inside the same tunnel. To achieve an accident-free record, drivers have to attend KYT every day to remind them to restrict their speed to less than 5 km/h. Before they enter the tunnel, they must shout 'don't speed'.

In general, the results of KYT are quite encouraging as no participant came across accidents. The three unlucky ones came from those who did not join KYT. KYT effectively reduces the likelihood of accidents. In fact, workers' concentration has a limit and cannot remain strong over a 24 hour period. Pointing and calling at essential points heighten concentration and are useful in preventing error judgments, improper operation and errors in driving. Besides, as it requires all workers to have their names written on their safety helmets, it allows them to know each other, alert one another on hazards that may be encountered and lay ground for good communication with sub-contractors. Because workers need to point to the hazard and say the safety measure required, this procedure can be deeply ingrained into the minds of workers and increase safety awareness.

6.3.1.2 Site Safety Cycle

A Site Safety Cycle is implemented at this site. It includes daily, weekly and monthly cycles Fig. 6.6.

Fig. 6.3 Small-group KYT

The daily working cycle is led by the site agent or a senior staff member. It usually lasts from 10 to 15 minutes. Workers do physical exercise together, and common safety matters are also announced. In this way, coordination among subcontractors and workers is enhanced. A brief record of the programme and name of the participants are kept Fig. 6.7.

The weekly working cycle includes a weekly safety walk with stakeholders from the contractor's safety manager, safety officer and site agent or his delegate

Fig. 6.4 Worker points at the outrigger and shouts

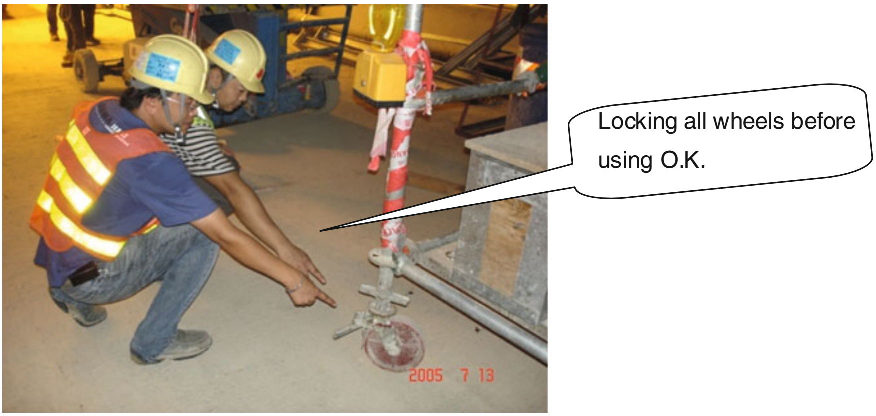

Fig. 6.5 Workers point at the wheels and shouts

and the engineer's nominated site representative to inspect the site, check the safety and health conditions by using the approved comprehensive checklist. It prompts to rectify safety deficiencies that are identified during the walk and reports the status of actions following safety meeting. The site agent or a senior staff member of the site management team of the contractor, together with the safety manager, safety officer, safety supervisor and supervisory staff of sub-contractors, attend the weekly safety coordination meeting chaired by the Engineer. Safety performance, housekeeping and tidiness of the site, and the specific areas of concern, defects and deficiencies observed in the Weekly Safety Walks, accidents and near misses that occurred on the site are discussed. After the meeting, briefing notes are prepared by the contractor and endorsed by the engineer. The weekly

Fig. 6.6 Site safety cycle

Fig. 6.7 Daily working cycle

working cycle also includes weekly cleaning and tidying up of the common areas and access routes, cleaning and/or re-conditioning of hoardings, barriers, guarding, lighting, signage and/or traffic cones, cleaning of external covers for the plant and equipment, removal of waste and debris, and other tasks to ensure that the site as a whole is clean and tidy. The process shall include, but is not limited to, all items listed as part of 'Daily Cleaning'. A complete checklist with rectification photos is submitted to registered engineer before noon on the following day. Registered engineer may carry out inspection and supervise the contractor's performance in maintaining the cleanliness and tidiness of the site.

In monthly working cycle, the engineer establishes a site safety management committee to monitor the adequacy of the safety plan to ensure its smooth implementation, and enhance communication between the engineer and the contractor on safety and health matters. Site Safety Management Committee Meetings are chaired by the engineer or his representative at monthly or more frequent intervals. During the meeting, members review the safety plan, adequacy of safety personnel, safety performance of sub-contractors, accident rates, statistics of the contractor and sub-contractors, safety and health training, safety coordination between various sub-contractors and specialists, and reports on safety audits conducted by and action plans prepared by the contractor. Members also update the safety organisation chart and propose training programmes for the following month. Any unsafe practices and conditions identified during safety inspection/audits and follow-up actions are discussed.

The SSC is successful in demonstrating that the implementation of the activities enhances the communication between site management and workers at all levels on safety and health matters. Further, it promotes workers' safety awareness and improves housekeeping and site tidiness. These elements improve safety performance/culture and prevent accidents on construction sites. As construction practitioners are required to attend the morning session, it enhances communication and coordination with other sub-contractors. The hazards that may be encountered on that day can be discussed in detail before work begins. It enhances workers' safety awareness. Workers can also receive the most updated safety information and learn more about accidents that have occurred. In addition, because all levels of construction practitioners are required to attend the morning session, good relationships with front line supervisors can be built.

6.3.1.3 Safety Training

This site provides extensive training facilities to the workers. The workers employed by both the main contractor and the subcontractors have to attend the training demonstration before working. This training demonstration eases the workers to remember the procedure of work Figs. 6.8, 6.9 and 6.10.

Since the work on this site is quite complicated, workers and foremen agree that the Safety training in these demonstrations can increase their safety awareness. After the workers have completed the training, they remember the safety procedures longer as compared to receiving the knowledge from safety education only.

Fig. 6.8 Working at height training demonstration

6.3.1.4 Pay for Safety

Bill no. 14 in Bills of Quantities of this construction project states clearly the safety measure items that will be paid. It includes the site safety plan, weekly site walk, Site Safety Cycle, and other items. Since the main contractor receives a sum of money for providing the Site Safety Cycle, safety promotion and training to workers, contractors will have the motivation to provide safety measures to workers. However, sub-contractors and sub-sub-contractors do not receive money for providing safety measures. They therefore have less incentive to provide safety measures to their employees.

6.3.1.5 Area Management

To facilitate safety management on such a large site, the site is divided into 4 areas. There is one person responsible for each area. This makes it clear who is responsible for site safety problems Figs. 6.11 and 6.12.

6.3.1.6 Green Measures

Green plants are planted on the site. Psychologically speaking, green plants help relax the nerves. They are a good measure to lessen the stressful behaviours that cause accidents Fig. 6.13.

Fig. 6.9 Climbing at height demonstration

6.3.2 Comments on Overall Effectiveness of Safety Measures

This was the only site that required the authors to wear both a safety helmet and a reflective vest. The authors visited this site twice and discovered that safety awareness is quite good on this site. All workers wear a safety helmet, and all visitors are required to wear a reflective vest. Safety measures have the common flaw of requiring contractors to invest a significant amount of money. Implementation of KYT, however, requires a negligible sum of money to reduce careless behaviour during a risky job and raise the safety motivation of workers. All of these potentially save substantial money spent on accidents. The morning session

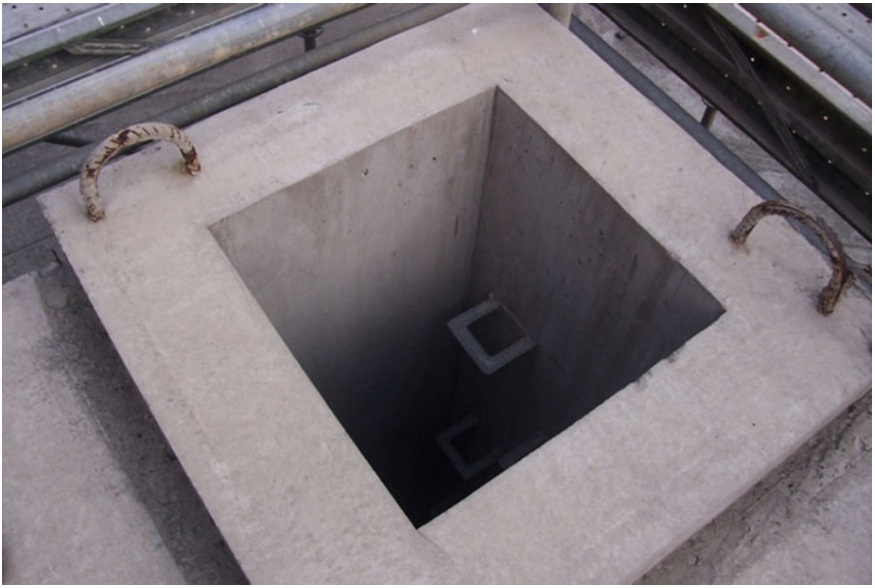

Fig. 6.10 Demonstration for working in a manhole

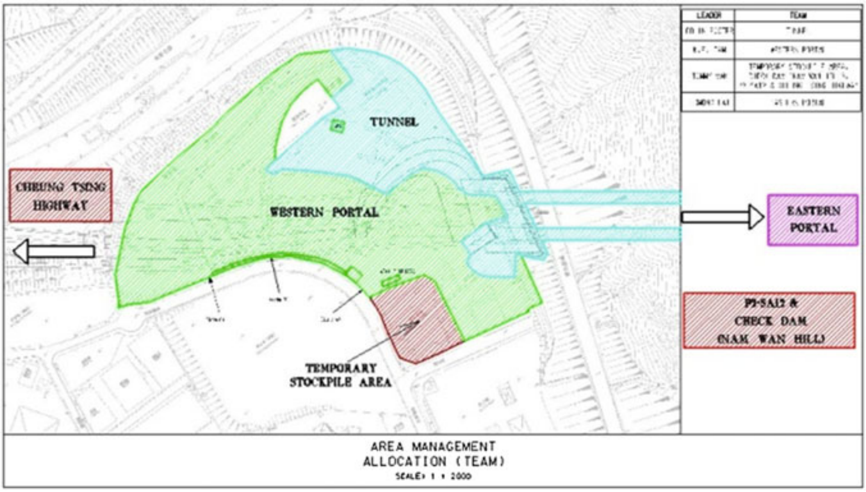

Fig. 6.11 Area management allocation

in SSC enhances the safety communication between workers and the site's safety officer. The only problem of implementing SSC and KYT is that the participation rate might not be very high. There are many side entries where workers can enter the site and work without visiting the area where KYT and SSC take place. On this

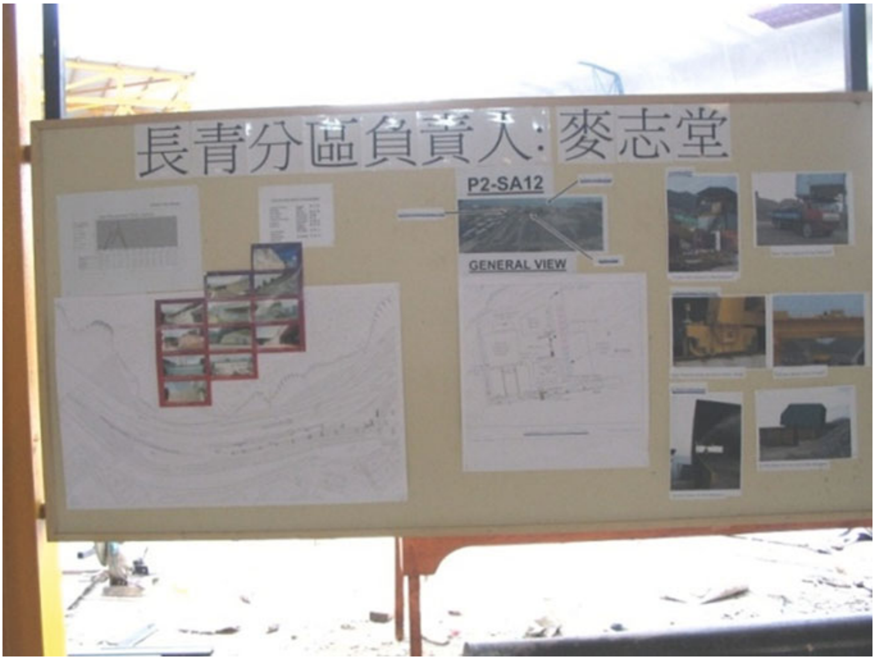

Fig. 6.12 Area management example

Fig. 6.13 Green plants on site

site, PFSS creates the incentive for the main contractor to provide safety measures; however, as the safety manager mentions, the subcontractors think that it is unfair for them that they need to follow the instructions of the main contractor but receive no incentive to provide adequate safety measures to workers.

6.4 Case Study 2: Shatin New Road T3

Fig. 6.14 Shatin new road T3

6.4.1 Site Safety Cycle

The site implemented Site Safety Cycle which is the same as Case 1. However, there are some problems in the implementation. Take for instance, the requirement of 70 % attendance at morning exercise is difficult to achieve. The major reasons for the difficulty are threefold: first, Hong Kong workers tend not to obey the rules as there are no penalties for not attending. Second, because the site is very large, there are many site entrances, and the location of morning exercises may not be located on the way to one's workplace. Third, workers' hours on the site differ, and some may arrive at the site in the afternoon Fig. 6.15.

6.4.2 Safety Promotion

There is a large safety banner marked 'SAFETY FIRST' located just opposite the site office. As the site area is very large, many workers might not even see the banner. Therefore, there is some doubt as to its effectiveness. A game day was held at the beginning of the construction work. Though it might have been a good reminder to work safely at the beginning of the project, the construction work has lasted 4 years; it is doubtful that the effects of this measure have persisted.

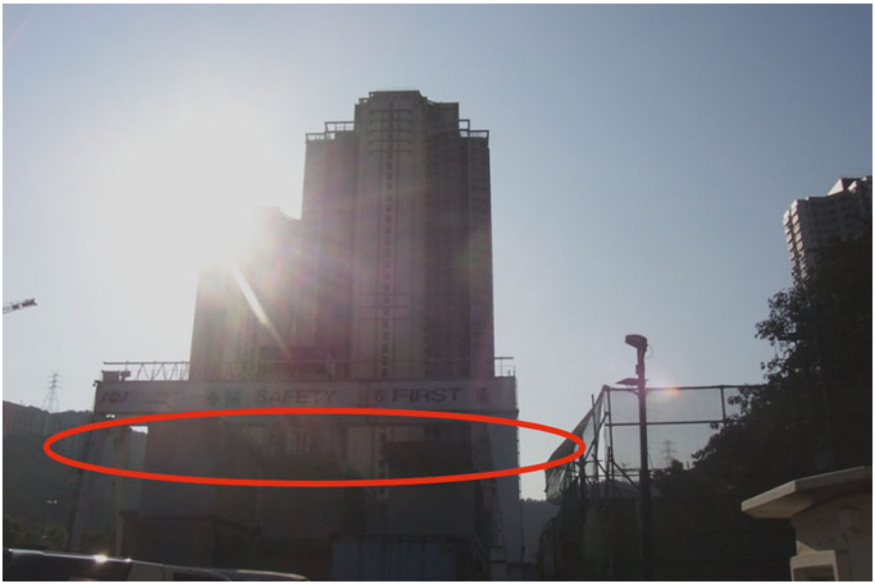

Fig. 6.15 Safety banner

6.4.3 Comments on Overall Effectiveness of Safety Measures

The authors spent some time walking around the site. Although this site has implemented the largest number of safety measures, the safety awareness among workers was very low. After 5 minutes of walking around the site, the author saw a worker who was not wearing his safety helmet. The safety manager had to remind him to do so. In addition, a worker jumped from a high level to the ground. When the safety manager reminded him to use the ladder provided, he responded that his action was correct! The high accident rate is another indicator of the poor safety awareness of the workers. This finding conveys an important message: no matter how good the safety systems are and how many site safety measures have been implemented, the safety situation cannot be improved if the measures are implemented poorly. Safety measures are only tools that help safety officers in enhancing safety awareness; how the safety officers make use of the tools makes a difference.

6.5 Case 3: Private Residence in Deep Bay

In Hong Kong, many private construction companies employ only minimal safety measures, with no additional safety measures on top of the requirements in Factories Industrial Undertakings Ordinance FIU(O) Cap 59.

Induction training is provided to site workers, and project safety plan training is provided to subcontractors' safety representatives. Induction and specific training are also offered for workers of different grades by the experienced workers at the site. However, because the site is small, there is no demonstration model. This kind of training is also common at construction sites in Hong Kong. Safety inspection visits are held periodically to identify hazardous areas. As the law requires only one part-time safety officer, the safety officer is responsible for inspecting both this site and another site in Kowloon Tong. Only free safety posters taken from the Labour Department are posted on site.

This case is a typical case of a private client. The client generally only pays for the materials and labour, and safety is not the client's primary concern. Though no accident has happened at this site, safety awareness is not very high among workers. One worker was observed not wearing a safety helmet Fig. 6.16.

Fig. 6.16 Case study 3

Why do the site owners or contractors choose not to use other safety measures on top of the legal requirements? Are safety measures useless on small sites? From a safety officer's point of view, a safety management system is useless for a site like this small site. In addition to the time and resources required to implement safety measures such as OHSAS, there is also doubt about the effectiveness of these safety management systems. Without enough support from the client, the safety officer can report the adoption of safety measures in black and white, but nothing is likely to be done in reality to improve workers' safety. Unless the client pays for safety measures, small companies as such do not want to invest.

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Chapter 7
Using Web 2.0 to Share the Knowledge of Construction Safety as a Public Good in Nature Among Researchers: The Fable of Economic Animals

7.1 Introduction

Site safety has always been considered as a tough nut to crack problem in many different places around the globe. It costs many deaths and injures over the past ten years (Poon et al. 2008). Construction safety researchers in different parts of the world are working hard to provide viable solutions. Some of them put the lens on the causes of accidents, (Atkinson et al. 2005), others focus on safety education (Sang et al. 2006; Wojcik et al. 2003), accident compensation (Dement and Lipscomb 1999; Ledwith 2004; Saram and Tang 2005) and safety regulations (Thomas 1998). In other high risk industries, such as mining (Hingston 2001) and road (Siggerud 2007; Zou et al. 2008), researchers have studied the safety knowledge sharing but few research has mentioned construction safety knowledge sharing with the help of Web 2.0 (Table 7.1).

The birth of World Wide Web (WWW) has changed people's knowledge sharing methods. In Silicon Valley, some construction websites provide platforms to share construction knowledge since early 2000. DPR, a Silicon Valley based contractor which has earned approximately $1 billion revenue every year, adopts Autodesk Buzzsaw as online workspace, enables building teams to store and share project drawings and documents in a central location (Autodesk 2010). On the other hand, general public can receive information from construction forums (ConstructionWork 2010). Similarly, people who are interested in safety can share or receive knowledge from Blogs (Ensafe Planning Solutions 2010) and forums (AbsoluteAstronomy.com 2010).

7.2 Riding the Wave of Web 2.0

Characterized by double click, traditional read-only Web 1.0 was designed by Hypertext Text Markup Language. The evolution from Web 1.0–2.0 can be described as a change from a static to a more fascinating dynamic concept. Online

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Table 7.1 Average number of deaths and accidents (Poon et al. 2008)

Years	Japan	South Korea	Singapore	Taiwan	Hong Kong	United Kingdom
1997–2001 (Average number of accidents per 1,000 workers)	6.4	6.7	7.4	11.1	187.6	12.6
1997–2001 (Average number of deaths per 10,000 workers)	1.6	3.1	2.7	2.3	5.2	0.47
2002–2006 (Average number of accidents per 1,000 workers)	6[a]	8.2[a]	7.7[a]	12.9[a]	67.6	9.7[b]
2002–2006 (Average number of deaths per 10,000 workers)	1.66	3	1.7	1.7	3.4	0.35
1997–2006 (Average number of accidents per 1,000 workers)	6.2[a]	7.5[a]	7.6[a]	12[a]	127.6	11.2[b]
1997–2006 (Average number of deaths per 10,000 workers)	1.63	3.1	2.2	2	4.3	0.41

[a] Data used up to 2005
[b] Based on data supplied in 2002

users will not only read, but also insert their own web content in the era of Web 2.0 by using simple tools on the internet. Moreover, the whole process of web design has been simplified: understanding Hypertext Text Markup Language is no longer a prerequisite for web content writers. Decentralization of the web content authority also implies that more collaboration among construction safety researchers has become possible in our virtual world (Parakh 2006). Although skeptics have criticized the risks associated with the Web 2.0 (Jason 2008), the impact of Web 2.0 is enormous: it has changed:

1. The learning paradigm (Carl et al. 2008; Christine et al. 2009; Emory 2007; Henk 2008; Julia 2008; Maness 2006; McLean et al. 2007);
2. Librarianship (Myhill et al. 2009; Stephen 2008) and
3. Communication method (Goodfellow and Graham 2007).

Although there are some deficiencies in using Web 2.0 tools (Pera and Ng 2009; Thelwall and Hasler 2007), Blog, Really Simple Syndication (RSS), Folksonomy, Wikis etc. provide low cost, convenient methods for sharing construction safety knowledge. Online discussion communities have now become a popular platform for conversations and interaction across a broad range of contexts and topics (Bateman et al. 2011). The social network communities, such as LinkedIn and Facebook, usually embrace more than one of the aforementioned Web 2.0 tools to provide more flexible ways of knowledge sharing. While LinkedIn, Facebook, Yahoo! Group contain research communities online which are not designed specially for academic researchers, there are more and more social networks designed solely for researchers' uses, such as 2Collab, Be2Camp and MyNetReseach etc. They do not only provide information such as call for papers or grants, but also provide knowledge on paper and thesis writing (Table 7.2).

Table 7.2 Summary of Web 2.0 tools

Web 2.0 tool	What are they?	Merits	Shortcomings
Blogs	Blogs are informal online journal which reflects the author's personal thoughts (McLean et al. 2007)	1. Easy to retrieve (McLean et al. 2007), 2. Rapid publication is allowed (McLean et al. 2007) as content can be updated and disseminated easily (Goodfellow and Graham 2007) 3. No proprietary software has to be installed; specialist computer skills are not required (Goodfellow and Graham 2007)	1. Lack of editorial governance and the associated security (Maness 2006).Therefore, blogs carry little authority and most of the contents are crass, trivial and opinionated (Thelwall and Hasler 2007)
Wikis	Wikis are open web-pages (McLean et al. 2007), rely on server-side processing capabilities to convert the paragraphs of words into HTML. The central idea of wiki is a tool which aims at achieving the goal of collaborative authoring (Tredinnick 2006), registered users can publish, amend and change the content (Maness 2006).	1. Some websites provide costless and easy way of building wiki website (Myhill et al. 2009) 2. The interaction among users simulates face-to-face discussion among scholars (Maness 2006). 3. A perpetuity record of people's conversations become valuable pool of resources (Maness 2006) 4. Provisions of both synchronous and asynchronous audio and video collaborations (Maness 2006) in wiki increases the flexibility in knowledge sharing	1. The lack of peer review services prompt to problem of reliability (Maness 2006). Nevertheless, the openness feature can eliminate "unfit" resources by other wiki users (McLean et al. 2007). 2. Consensus "cataloguing" is still in the early stages, and there are concerns over sus tainability of some promising tools (McLean et al. 2007)
Social network	communities	Social networks, e.g., enable messaging, blogging, streaming media, tagging and so on. (Maness 2006)	1. This method is on-going and multidirectional (Myhill et al. 2009) 2. Asynchronously communication is allowed (Maness 2006)

(continued)

Table 7.2 (continued)

Web 2.0 tool	What are they?	Merits	Shortcomings
Folksonomy	A collaborative categorization of content by allowing users to assign "tags" on specific items (McLean, et al. 2007). While users use tagging in Flickr for tagging pictures, they use this for tagging books in LibraryThing (Maness 2006)	1. With an increase in the number of journal publishers with RSS feeds, persistent search of new paper is allowed by an "alert" sent from cyberspace (McLean et al. 2007)	1. A willing and capable community is needed to tag the content correctly (Cosh et al. 2008) 2. Tagging is only suitable for collections of content but not individual articles (Cosh et al. 2008)
Really simple syndication (RSS)	RSS, has always been regarded as the plumbing of the web. It enables users to syndicate and republish in the internet (Maness 2006)	1. Tagging allows users to add and change the data in the web, eases the process of lateral searching (Maness 2006)	1. Due to the large number of new articles in individual RSS feeds, users need to further organize and locate information, and related articles of interest (Pera and Ng, 2009)

7.3 A Bird's Eye View on Construction Safety Knowledge

According to Margit and Frey (2000), knowledge is fundamentally related to human action. It arises from observations incidental on other activities or deliberate seeking by knowledge seekers (Arrow 1971). After absorption by the members in our societies, level of understanding on particular knowledge is shown by acts of these participants (Dulaimi 2007).

Construction safety knowledge in Web 2.0 is one of the many examples of public goods in the eyes of economists. First, it is indivisible in the sense that a person's consumption does not reduce the amount available to the others. Second, it is non-excludable. It is difficult or impossible (in case of open source) to exclude individuals from gaining benefit from the good. Because of the non-excludable characteristic, there is temptation for internet users to free-ride on the works of others, enjoying a public good without contributing anything (Kollock 1999). Nevertheless, if everybody free rides, everybody will keep what he knows in mind, everybody suffers. Therefore, provision of public goods poses one major challenge—the issue of motivation—getting people to contribute in spite of the free-ride temptation (Kollock 1999).

7.4 Knowledge Sharing under the Lens of Economists

Neo-institutional economists recognize that the society we live in has been turning gradually into a "knowledge society". Any organization that deals with a changing environment not only needs to process information efficiently, it also creates knowledge (Nonaka 1994). "Knowledge" by definition is a high-value form of information that is ready to apply to decisions and actions (Davenport et al. 1998). An interesting characteristic of knowledge lies on fact that its value grows when it is shared (Cabrera and Cabrera 2002). It increases at the rate at which the individuals are willing to share their insights with others (Jarvenpaa and Staples 2000). The process of knowledge sharing involves codifying, modifying and refining ideas based on past experience, which is different from but related to communication (Tredinnick 2006). Previous research on knowledge sharing based on economic theories focuses on intra firm knowledge sharing, e.g. (D'Aspremonta et al. 1998), and inter firm knowledge sharing (Aoki 1986; Foss and Pedersen 2004). Others focus on individuals' choice on knowledge sharing. Ford (2005) comments that an individual's perceived value of knowledge may affect his or her decision to share. Constant et. al. (1994) argues that people share their expertise because it permits self-expression and generates personal benefits to knowledge provider. Granovetter (2004) concedes that shared ideas tend to be more easily enforced in a dense social network. Nevertheless, a host of research challenges concerning construction safety knowledge sharing based on economics theories have been ignored.

7.5 Resistance to Use Web 2.0 as Tools for Knowledge Sharing

Resistance to change or the so-called inertia does not only exist in the world of physics. We might not want to change our living environment, working environment or our dishes for dinner even if new choices are available. Organizations may find it hard to motivate their employees to share their knowledge (Cabrera and Cabrera 2002). Similarly, not many researchers are willing to change their method of knowledge sharing though they know there is a more effective and less costly substitute. Because of cognitive rigidity, only one-third of major technological changes in organizations succeed (Gray 2002). Ever since the era of Bernoulli, economists have shown that individuals tend to display risk aversion behaviors and risk aversion has become the explanation for many phenomenon in economic world. A risk averser, by definition, is unwilling to take a bet that is actuarially fair (Arrow 1971). Technological change such as Web 2.0 in our daily lives has brought many advantages to us on the one hand, but introduces risk on the other hand. That risk can be viewed as a kind of unknown or low transparency. We may trust the construction safety knowledge providers who provide their valuable knowledge. Nevertheless, we may not trust the web server or the website owners who hold all the sources of information which include password, usernames, etc. Moreover, when information is subtle, nuanced and difficult to verify, people find it hard to trust impersonal sources (Granovetter 2004) which may not be correct (Cosh et al. 2008). They prefer to rely on people they know instead (Granovetter 2004). This explains why participation rate in some of the construction safety knowledge sharing websites is low, e.g. AbsoluteAstronomy.com (2010).

7.6 The Nature of Motivation

Knowledge depreciates when it becomes obsolete (Yang 2007), however, its public good in nature decreases people's incentive in engaging in any construction safety knowledge sharing activity by Web 2.0. It is necessary to understand people's motives. The decision of not to contribute mainly springs from two sources—the desire to free ride, or being afraid of wasting efforts on not so good returns (Kollock 1999). Previous research suggests a number of dilemmas in knowledge sharing within a network setting. The first dilemma is how to motivate people to participate in the process of knowledge sharing with others (Dyer and Nobeoka 2000). Previous studies have shown that people are motivated by various different types of factors (Ryan and Deci 2000). While Wiki learning and podcasting are appealing to digital natives, what motivates construction safety researchers to share their knowledge remains unclear. The following sections shed light on economics ones, based on intrinsic and extrinsic theories.

7.7 Intrinsic Motivation

One is said to be motivated intrinsically when one receives no apparent reward except the activity itself (Frey and Jegen 2000). Intrinsic motivation is often viewed as self sustained as it is valued on its own sake. It can be directed to the activity's flow, to a self-defined goal, or the responsibility of norms (Osterloh et al. 2002). Most of the intrinsic motivation theorists agree that mastery goals promote intrinsic motivation by encouraging task involvement, fostering perceptions of challenge, supporting self-determination and generating excitement, whereas performance goals motivate individuals by instilling threat, exerting anxiety and pressure. Generally speaking, both performance and mastery goals focus on competence attainment. These approaches aim at facilitating optimal task engagement. Within performance or mastery orientation, individuals perceive achievement as a challenge which generates excitement, encourages cognitive investment, facilitates concentration and task absorption, and orients the individual toward the presence of success-relevant and mastery-relevant information (Elliot and Harackiewicz 1996). Intrinsic motivation can be a self-defined goal or personal and social identities obligations. Behavioral view of organization often emphasizes intrinsic motivation. Intrinsic motivation lowers transaction cost within the company, raises trust and social capital (Margit and Frey 2000; Osterloh and Frey 2000).

As intrinsic theories focus on the activity itself which motivates people to share knowledge, a study on game theoretical behavior which focuses on people's decisions under different situations become necessary. Generally speaking, there are four features which are shared by both game theories and construction safety knowledge sharing.

1. Knowledge sharing requires the presence of at least two persons, i.e., the presence of at least two or more players
2. Each of the players can choose to share knowledge or withhold knowledge, and this decision is mutually exclusive
3. Similar to all the other economic theories, players are assumed to be rational. Knowledge owners are also rational
4. People's decisions to share or not are based on the return or playoffs in the language of game theorists (Chua 2003).

7.7.1 Game Theory and Construction Safety Knowledge Sharing

Construction agents interact strategically in many ways when they face the choice of whether or not to share the knowledge. The corresponding playoff under game theories are A, B, C, D as shown in Table 7.4 (A, B, C, D are numbers assigned arbitrarily). For example, if player A chooses to share his knowledge but player B chooses to withhold knowledge, the playoffs will be "B" for player A, "C" for Player B as shown in the shaded boxes of Table 7.4. Alternatively, when both decide to withhold safety knowledge; playoff will be "A" for player A and "D" for player B as shown in lower right hand boxes with underline in Table 7.3.

Table 7.3 Playoff matrix of knowledge sharing game

		Player B	
		Share knowledge	Withhold knowledge
Player A	Share knowledge	A, A	B, C
	Withhold knowledge	C, B	A, D

Table 7.4 Prisoners' dilemma construction safety knowledge sharing game

		Player B	
		Share knowledge	Withhold knowledge
Player A	Share knowledge	6, 6	2, 8
	Withhold knowledge	8, 2	3, 3

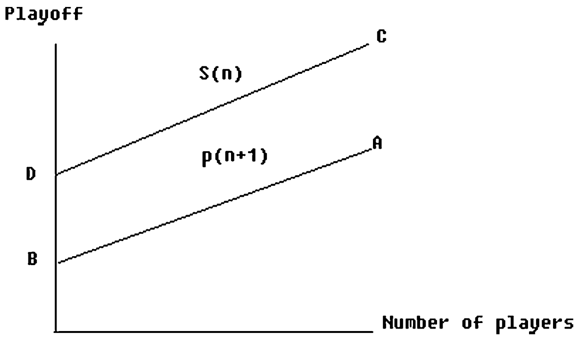

Fig. 7.1 N-persons' prisoners dilemma game (Dixit and Skeath 1999)

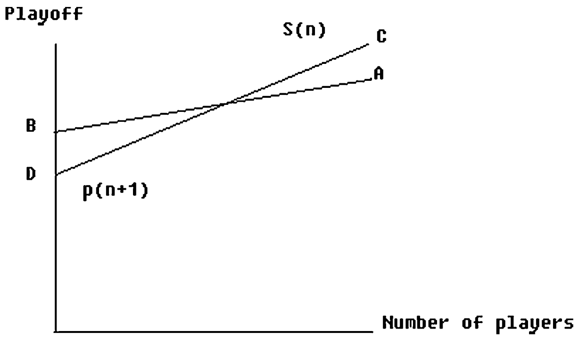

Fig. 7.2 N-persons' Chicken's game (Dixit and Skeath 1999)

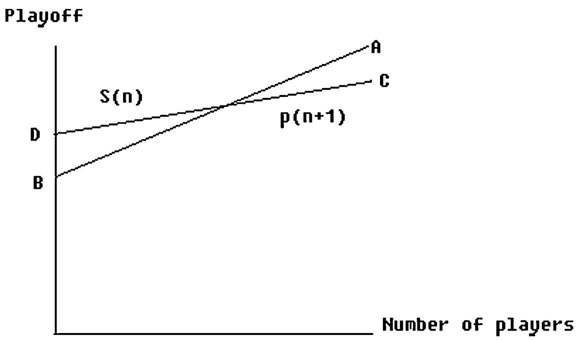

Fig. 7.3 N-persons' assurance game (Dixit and Skeath 1999)

7.7.2 Prisoners' Dilemma of Construction Safety Knowledge Sharing

Prisoner's dilemma originated from two prisoners in a crime who were questioned in two separate rooms. Typical payoffs of both players display $C > A > D > B$ (Table 7.4). Corporate is a dominant strategy (Varian 2005), and sharing knowledge at the same time is the only way to maximize benefit (Chua 2003).

In a N-persons game which simulates the real environment of knowledge sharing, payoff for each player depends on the acts among the pool of players. Suppose that there are N people altogether, each knowledge sharer receives payoff $p(n)$ and each shirker receives payoff $s(n)$. According to Dixit and Skeath (1999), a person will choose to share knowledge if and only if $\mathrm{p}(n + 1) > \mathrm{s}(n)$. In case of prisoners' dilemma where $s(n) > p(n + 1)$ no matter how many people are using Web 2.0 as tool of knowledge sharing, the new comer chooses to shirk. (Fig. 7.1)

7.7.3 Chicken Game of Construction Safety Knowledge Sharing

Chicken game is characterized by the payoff $C > A,\ B > D$, both of the players maximize by choosing different strategies from the other (Chua 2003). In a N-persons game of chicken, however, the best strategy will depend on the number of knowledge sharers in Web 2.0. When there are few participants, the new comers will be more willing to share their knowledge, up to the intersection point of line AB and CD (Fig. 7.2, Table 7.5).

7.7.4 Assurance Game of Construction Safety Knowledge Sharing

If $A > C, A > D\ and\ D > B$, this is an assurance game where no dominant strategy exists for individual players (Chua 2003). In a N-persons game of assurance, however, there is a dominant strategy which is just the opposite of that in multi-persons chicken games (Fig. 7.3, Table 7.6).

The above illustrate how the players within the knowledge sharing activity react under different situations and show that the players in the activity themselves are the major determining factors in making the decisions on whether or not to share the knowledge. There are two major problems associated with intrinsic motivation. First, the outcome is more uncertain than extrinsic motivation. Therefore, traditionally people prefer to implement reward and command policy. Second, intrinsic motivation can lead to an undesirable outcome. For example, the adaptation of not choosing the same strategy in game of chicken implies that one out of two players in our simplified model withholds knowledge in his hand. History also shows that some terrible crimes are the product of intrinsic motivation. Some negative intrinsic motivation factors such as the desire to dominate, jealousy, retaliation, are not less motivated than the positive ones, e.g. self-sacrifice, delicacy, and love. To reduce undesirable intrinsic motivation factors, some people contend that external interventions via carrots and sticks are necessary. Nevertheless, there are some conditions where intrinsic motivation outperforms the extrinsic ones. Some

Table 7.5 Chicken's construction safety knowledge sharing game

		Player B	
		Share knowledge	Withhold knowledge
Player A	Share knowledge	5, 5	3, 8
	Withhold knowledge	8, 3	1, 1

Table 7.6 Assurance construction safety knowledge sharing game

		Player B	
		Share knowledge	Withhold knowledge
Player A	Share knowledge	8, 8	1, 5
	Withhold knowledge	5, 1	3, 3

researchers suggest that intrinsic motivation usually enhances tacit knowledge transfer when extrinsic motivation fails. It also helps overcome the so-called multiple task problems where goals to be set are unclear. Finally, intrinsic motivation is needed for tasks where creativity is needed. In stark contrast, however, extrinsically motivated people tend to produce typecast repeated work (Margit and Frey 2000).

7.8 Extrinsic Motivation

A central tenet of economics is that people respond to incentives (Benabou and Tirole 2003). People are extrinsically motivated if their needs are satisfied indirectly via pecuniary compensation, e.g., workers are given US$10 when they share construction safety knowledge on Facebook or the possible prospect of promotion (Cabrera and Cabrera 2002). Motivators as such do not provide direct utility but serves to acquire desired goods and services only (Margit and Frey 2000), Such view coincides perfectly with Reinforcement theory supporters (Davidsom and Griffin 2006).

Nevertheless, extrinsic motivators like monetary reward may not always produce desirable effect as they might distract people's attention from work process to the goal of getting a reward. Optimal bonus can be zero or even negative (Benabou and Tirole 2003). A famous literary case comes from the whitewashed fence under the scene in the Adventure of Tom Sawyer, Mark Twain comments "in order to make a man or a boy desire a thing, it is only necessary to make the thing difficult to obtain" (Twain 1977).

7.9 A Battle Between Intrinsic and Extrinsic Motivators

We all know a simple mathematics equation that one plus one equals to two. It is also natural to concur on the idea that a larger amount of virtual money reward plus intrinsic motivators will produce higher performance than either one of them. Nevertheless, empirical evidence on motivation often disproves this rudimentary idea. When people introduce extrinsic motivators, it usually fails because of crowding out effect. The concept of crowding out has been applied widely to provide explanation for failure in government policies. Simply taking a look at papers with more than 200 citations these days, quite a couple of them shed light on the crowding out effect on government expenditure which crowd out the private investment (Aschauer 1985; Barro 1989; Cutler and Gruber 1996; Fischer 1993; Kingma 1989). To our disappointment, while a substantial body of literature indicate that extrinsic motivation conflicts with intrinsic motivation (Benabou and Tirole 2003), few or even no authors have used this to provide vivid explanation for those construction safety knowledge sharing motivation cases failure.

Under some conditions, the use of the price system undermines intrinsic motivation, i.e., crowding-out effect (Margit and Frey 2000). For the purpose of economics analysis, the so-called "hidden cost of reward" can be summarized in two respects:

1. All interventions outside the individual himself, i.e., both positive rewards and regulations along with those negative sanctions, may affect intrinsic motivation;
2. External interventions may crowd in/out intrinsic motivation (Frey and Jegen 2000).

Besides, where the intrinsic and extrinsic motivation can clearly be separated under symmetric information, agent and principle under asymmetric information cannot. When the agent is not sure about the principle's ability, intrinsic motivation drops with the level of the bonus. A reward can be a good positive reinforcement in short term only, but it usually decreases in the future (Benabou and Tirole 2003).

Because of the aforementioned reasons, previous study performed by Fehr et. al. (1997) has confirmed the possibility of a crowding-out on intrinsic motivation which turns out to become a reciprocal behavior. Based on Frey and Jegen's (2000) model, graphical representation of crowd out effect on knowledge sharing is illustrated in the following figure. Suppose S is original traditional supply curve and researchers are willing to share "A" amount of construction safety knowledge by Web 2.0. Based merely on the relative price effect, an increase in external reward form O to R increases people's activity on knowledge sharing from A to A'. Unfortunately, the crowding-out effect leads to a shift in supply curve leftwards to S'. Hence, raising the reward from O to R leads to a decrease in people's online activity by Web 2.0. The final results of such "motivator" lead to point C instead of B (Frey and Jegen 2000) (Fig. 7.4).

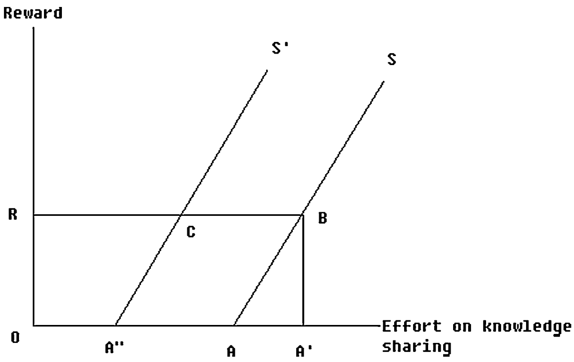

Fig. 7.4 Crowding out effect (Frey and Jegen 2000)

7.10 Conclusion

The revolution of Web 2.0 in the internet introduces a new channel for construction safety researchers to share their knowledge. It also brings in the question of motivation and resistance in doing so. Openness and transparency are important factors in the success of Web 2.0 construction safety knowledge sharing (Eysenbach 2008). Besides, web site owners have to understand the extrinsic and intrinsic motivation of safety researchers, e.g. their perceived payoff of knowledge sharing.

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Chapter 8
Future Motivation in Construction Safety Knowledge Sharing by Means of Information Technology

8.1 Introduction

Coupled with poor workforce safety behaviours and attitudes, outdoor communication and operations, changes in design, complex equipment and tools on site, workers' safety is a complex issue (Choudhry and Fang 2008). A series of initiatives which include legislation, law enforcement, and safety training effectively reduce the number of industrial fatalities in the construction industry to 60.6 accident per 1,000 workers in 2007 in Hong Kong; the third lowest figure ever recorded. Nevertheless, construction accident rates still rank 2nd among all the four major industrial activities in Hong Kong (Hong Kong Labour Department 2007). Ways to lower the high accident rates on sites are still a can of worms among construction safety managers and officers across the board (Fig. 8.1).

8.2 Construction Safety Knowledge Sharing by IT

Many safety officers blame low education levels of workers as barriers in sharing safety knowledge by means of Information Technology (IT). Many of our predecessors were not well educated in the old days. Hardly could we imagine an illiterate construction worker knows how to operate IT or read safety instructions. Yet, with the introduction of 9 years compulsory schooling in Hong Kong since 1978 (Cheung et al. 2004), education level of the majority has raised. People who have attained an education level below primary school have decreased from 6.9 % in 2002 to 5.5 % in 2007 (Education Bureau 2007). Starting from school year 2008–2009, the HKSAR offers 12 year free education. It is expected that the education level of all the local born will raise in the future, so as our construction workers (HKSAR 2007). Furthermore, IT has become part of the curriculum since kindergarten; many of the kids know IT well before they start their high school education. While number of computer users has soared over the years, knowledge sharing with the help of information technology is very limited. This chapter aims to study possible motivation in sharing construction safety knowledge inter and intra construction

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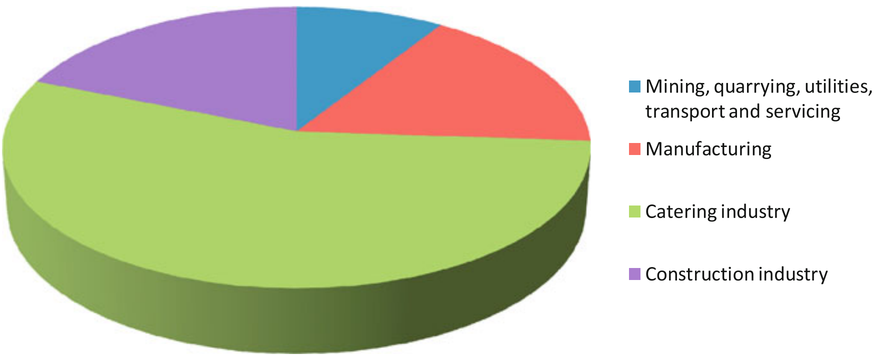

Fig. 8.1 Accident rates in four major industries and Source: (Hong Kong Labour Department 2007)

organizations. With the help of improved software, it is foreseeable that there will be more and greater variety tools in knowledge sharing. At the present day, knowledge sharing initiatives with the help of IT are among private individuals only. Construction companies, which include those large contractors, only provide face-to-face safety lessons to their new employees and every 3 years afterwards. Limited visual aids, e.g. video and DVD, are used in the lessons. IT is seldom used for knowledge sharing between safety officers and workers.

8.3 Costs of Construction Accidents

Time and costs are the major concern for both clients and contractors. Accidents, however, are one of the factors which leads to increase in time and costs in construction projects. Contractors and/or clients may need to pay compensation to the workers if they are responsible. Table 8.1 illustrates some of the examples that the contractors and/or clients need to pay for the accidents in 2005–2006.

Apart from the costs shown in the table, there are also high indirect costs of construction accidents. Direct costs of accidents are relatively small when compared with the indirect costs. Numerous indirect costs which include loss of time for investigating the reasons for the injuries, reporting to the Labour Department and mass media etc. (Saram et al. 2005). Having an accident not only reduces earnings, but also brings sufferings and grief. To employers, occurrence of an accident will lower staff morale and bring a negative impact on their companies' image which ultimately affects tendering opportunity (Li and Man 2006). The following Tables 8.2, 8.3 show material damages and non-material damages of the compensation which the clients need to pay for the accidents and illustrates the estimated lost of time as a result of a construction accident.

The need to re-arrange the work and conduct investigation after an accident always leads to longer time to complete the whole project. Assume an accident

Table 8.1 Costs of compensation paid by contractors and/or clients decided by court (Li and Man 2006)

Case no	Nature of the case	Results	Compensation (Hong Kong Dollar)
[2006] HKEC 312	A worker struck on head by oxyacetylene cylinders	Death	$ 1,605,000.00
[2006] HKEC 1531	A worker struck by a falling metal tube, and had his head injured	Occasional headaches, neck plain and dizziness	$ 219,003.00
[2005] HKEC 607	A worker fell from height	Recurrent dizziness	$ 1,945,057.80
[2005] HKEC 2182	A worker fell from height	Lost certain mobility of his right wrist	$ 21,606.00
[2005] HKEC 2156	A worker fell from height	Fractures in left knee, right ankle and thighbone	$ 2,387,435.40
[2005] HKEC 2156	A worker fell from a 3 m height of a retaining wall	Fractures on right knee	$ 2,387,435.40
[2005] HKEC 1972	An assistant site supervisor struck on the back of his head by iron pipe	Depression	$ 1,491,528.00
[2005] HKEC 1493	A worker's fingers were crushed against the wall by pipe	Fingers were crushed	$ 25,049.00

Table 8.2 Direct and indirect costs of construction accidents (Saram et al. 2005)

Non-fatal accident cases	Fatal accident cases
Material including temporary works damages	Material including temporary works damages
Loss of earnings	Loss of dependency
Loss of earning capacity	Loss of wealth accumulation
Loss of personal property	Loss of earnings to the immediate family members
Medical expenses	Loss of personal property
Miscellaneous expenses	Funeral expenses
	Loss of services
Non-material damages	Non-material damages
Pain, suffering and loss of amenities	Bereavement
Loss of society	

involving injury to a worker, total number of hours can be as much as 44.26 hours. For instance, assume a victim earns $20 per hour, it then leads to a lost of $885.2 to the society. Moreover, contractors are also at risk from being barred from tendering

Table 8.3 Time lost in construction accidents (Li and Man 2006)

Relevant parties	Hours lost	Items of hours lost
Injured worker	3.7	On the day of injury
	8	Lost subsequent to the day of injury
Transporting the worker	3	On the day of injury
	3	Vehicle time and mileage
Crew costs	12	A crew of 5 to 4
Workers idled by watching	5	Other workers' time
Damaged materials	2	Repair the damage
	2	Restore work conditions
Replacement worker	0.06	Lost productivity
Supervisory time	2.7	Assist injured worker
	1.5	Investigate the accident
	1.3	Complete the report

for public works projects because of poor safety performance. In 2005, a total of 11 contractors were barred from tendering for public work (Li and Man 2006).

8.4 Causes of Construction Accidents

Low education level of construction practitioners (Cheng et al. 2004), poor and inadequate communication error, lack of training, sub-contracting etc. are some of the factors which lead to accidents and temporary works failures (Li and Man 2006). The Health and Safety Executives in U.K. concluded that human behavior is a contributing factor in approximately 80 % of the accidents. Many studies revealed that the majority of accidents and resulting injuries are attributed to unsafe work practices of the workers rather than unsafe working conditions (Choudhry and Fang 2008). New workers often become victim of accidents because they do not have the knowledge about potential hazards and problems on site (Choudhry and Fang 2008). "Don't know" is one of the significant factors responsible for unsafe workers' behavior on sites. It provides an explanation to 38 % of all construction "over-3-day injuries" (Edwards and Holt 2008). Usually, near misses or incidents make workers realize the significance of safety practices on site. Some people, therefore, advocate the importance to share these near misses more effectively among the workers (Choudhry and Fang 2008).

8.5 Knowledge and Knowledge Sharing

Knowledge is a mix of framed values, contextual information, experience and expert insight that provides a framework for accessing and integrating new knowledge, skills and information. This knowledge is absorbed by members within organizations. Their understanding of the knowledge is then demonstrated by members' actions and processes (Dulaimi 2007). Generally speaking, there are two types of knowledge: tacit and explicit. Tacit knowledge is acquired via imitation and practices. On the other hand, explicit knowledge is usually diffused throughout an organization in the form of rules and guidelines and expressed in codified forms. Within an organization, knowledge is stored in the form of common organizational practices (Lin and Lee 2004).

Unlike air particles which can flow around freely, knowledge is tied to a subject who knows it well. Someone who has the ability to acquire and share knowledge is necessary (Hendriks 1999). Knowledge sharing generally refers to the process where individuals iteratively refine an idea or thought in the light of experiences. The idea is then modified step by step or rejected progressively (Chua 2003). Knowledge sharing can also be regarded as something which is different from but related to communication. It can also be referred to those other than but related to information distribution. Reconstruction is required to learn something from someone else or to share his or her knowledge (Hendriks 1999). Knowledge can be shared by means of face-to-face interaction and synchronous and unsychronous communication via electronic respiratory. Organizations use various methods to boost knowledge sharing, e.g., introducing incentive schemes for knowledge sharing. Ford, for instance, holds a talk about the importance of knowledge sharing and organizes some relevant events (Chua 2003).

Knowledge sharing assumes there are at least two parties; one is the knowledge owner while the other is the knowledge receiver. The one who owns the knowledge should purposely and eagerly communicate his knowledge in form of acts, speech, writing and so on. On the contrary, prospective knowledge receivers have to observe these knowledge expressions, listen, read etc. The process of knowledge sharing consists of two processes: first, 'knowledge owners' do an act of 'externalization'. This process of externalization can be in vast different forms; one of the very common and traditional ways is explaining the concept in a lecture, tutorial class or codifying it in an intelligent knowledge system. It also includes any action performed based on this knowledge. Knowledge externalization can also be an unconscious act; i.e., an act which does not originally target at sharing knowledge. Take for an example, we can learn by observing somebody operate a machine, even if this person is not aware that he is being watched. In most of the times, knowledge sharing, however, has difficulty in motivating the knowledge owners to externalize their knowledge in one or various ways. Apart from that, knowledge sharing assumes an act of 'internalization' by those knowledge receivers, by reading books, learning by practices etc. Some barriers, namely, culture, language, social distance, differences in mental or conceptual frames, space and time may cause distortion in the internalization of externalized knowledge (Fig. 8.2).

Knowledge sharing is a basic element for individuals in organizations to learn. "People" and "technology" are the two major key elements in achieving the goal of effective knowledge sharing tactic. Knowledge sharing consists of three layers: infrastructure, formal rules and infoculture. The first layer, infrastructure, refers to those hardware or software. Knowledge infrastructure can also be interpreted as the

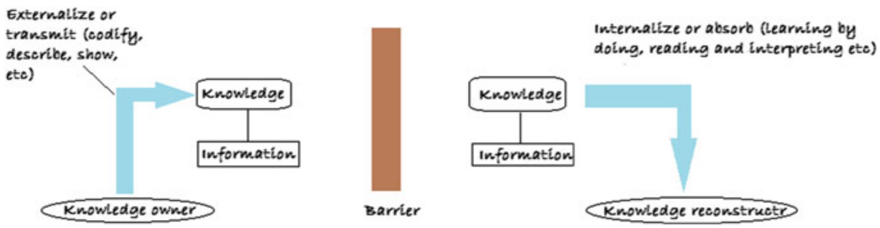

Fig. 8.2 Simplified model of knowledge sharing (Hendriks 1999)

knowledge architecture in its physical system. It refers to possible methods which improve knowledge transmission and storage (Dulaimi 2007). Previous research on knowledge management has shown that information technology is often an important knowledge sharing facilitator, knowledge respiratory, internet, intranet, blogs are very good examples. Researchers and practitioners have noted that the success of knowledge sharing activities essentially rely on top tier managers to promote knowledge sharing. Furthermore, several indispensable factors have to be considered to ensure a successful knowledge sharing tactic, for example, it must also go with organization planned targets (Lin and Lee 2004). The second layer, "infostructure", represents the formal rules and regulations which govern the knowledge exchange between the various stakeholders within the network. Knowledge Infostructure are the set of practices which the employees of the companies adopt for exchanging knowledge based on the existing knowledge infrastructure, i.e. the first layer of knowledge sharing. The third layer, infoculture, represents the background knowledge set in social relations adjoining the processes of work groups. An open and trusting culture is a significant factor for knowledge sharing in any organisation. To ensure smooth knowledge sharing within an organisation, a climate of trust in organizations is necessary (Dulaimi 2007).

As knowledge sharing happens whenever an individual is agreeable to give a helping hand to the others and learn from others, knowledge sharing allows individuals to learn in the company and to assimilate the knowledge for application in a practical way. Therefore, knowledge sharing and organizational learning are closely connected. The process of knowing, thinking, learning and sharing factors have a reciprocity relationship. On top of that, people within an organization can establish their mutual understanding via sharing their views, thinking, information and knowledge. Knowledge exchange among folks allows stakeholders to improve their capability and produce new knowledge communally. By sharing with and transferring to others, value of knowledge appreciates. Redundant intermediary channels might lead to incomplete knowledge transfer as quality of knowledge may be distorted, or become less accurate. Organizational members' misunderstanding, ignorance or/and failure to convey the original concept or idea can affect the overall organizational performance. This incomplete knowledge transfer would lead to knowledge decrease ultimately. Knowledge depreciation usually happens when:

1. The newly emerged goods and services make the originally old knowledge obsolete;
2. Workers leave their post before transferring their knowledge;
3. Sharing is only put into practice for certain individuals or selectively shared to some individuals (Te Yang 2007).
4. In the light of this, rapid knowledge sharing method is necessary. Traditional face-to-face safety knowledge sharing method seems not being able to provide the way for this. Information technology, however, meets the requirement of fast knowledge transfer.

8.6 Paradigm Shift in Knowledge Sharing

In recent years, technological breakthrough and globalization have changed the methods, hardware and software which share knowledge. Generally speaking, there are several key elements identified in our new era:

1. Knowledge and digital economy;
2. Virtual;
3. Internetworked;
4. Disinter mediated;
5. Convergent;
6. Innovative;
7. Immediate;
8. Global (Mak 2001).

Major alterations in our work environment include:

1. From conventional semiconductor to computer chip technology;
2. From analogue to digital;
3. From manual to server computing;
4. From traditional footpath to information superhighway;
5. From disintegrated text, data and image in documents to multimedia;
6. From proprietary to open systems;
7. From hand-craft to object computing;
8. From graphical user interface to virtual reality and multimedia user interface (Mak 2001).

The popularity of World Wide Web (WWW) and Internet have affected all walks of life. Industries are evaluating how to gain benefit with them (Doherty 1997). Organizations and corporations, especially those medium to large size, have been and are taking advantages of these paradigm shifts in technology. Government bureaus, broadcasting industry, educational organizations (from pre-school to universities) and even food and beverages companies are moving towards this digital era. The current application of information technology in the construction industry is, however, similar to other industries-piecemeal. Contractors invest in IT mainly to attain the goal of manpower and cost savings, increase efficiency and get more business (Mak 2001). Their uses are mainly focused on daily communication (e.g. bosses send emails to their employees notifying the daily tasks), administration (e.g. transmission of data files) and construction drawings (e.g. AutoCAD drawing).

On construction sites in Hong Kong, construction workforce usually learn safety knowledge from toolbox talks and morning Site Safety Cycles (Choudhry and Fang 2008). The major ways in sharing safety knowledge among construction workers are by means of face-to-face interaction. Although IT is gaining its popularity, knowledge sharing by means of IT is limited. Face-to-face safety meetings, toolbox talks and morning assembly on-site Green Card training, worker registration training, and on-site induction training remain the major sources of safety knowledge (Choudhry and Fang 2008).

8.7 Possible Key Enabling/Emerging Technologies in Sharing Construction Safety Knowledge with the Help of IT

Overcoming geographical constraints, increasing velocity of information transfer and improving task performance are some of the very good examples to show the merits or market information technology to construction companies' seniors, persuading staff to use the "newly" developed tools in sharing the safety knowledge. While many of them can tell the existence of intranet to share information or knowledge and some researchers even equate promoting knowledge sharing with intranet, the potential of IT in supporting knowledge sharing goes beyond intranet usage (Hendriks 1999). Some individuals have already started to share their safety knowledge via Web-based communities, blog, virtual lessons and even online games. Although construction companies in Hong Kong seldom use these methods in knowledge sharing with employees, these examples can provide much insight for safety officers.

8.7.1 Professional Web-Based Communities

Professional web-based communities are developing as an important means of assembling, systematizing and distributing knowledge within an organization. Within these communities, individuals can bring together their own "pieces of knowledge" to fabricate a "pool of knowledge" (Obonyo and Wu 2008). Pooling of knowledge and experiences among group members can provide more options in problem solving (Choudhry and Fang 2008). Web-based sharing knowledge can be treated as a kind of social practice which requires participants to actively engage in the process of creating, communicating and refining knowledge. By way of this medium, people often can build up their social networks with similar interests. In the construction industry, social networking can be used to reinforce communication among safety officers and workers intra and inter organizations. To build up a good social network site for sharing knowledge, or sharing safety knowledge in our case, a user friendly publishing and sharing information platform is necessary (Obonyo and Wu 2008). Thanks to web servers such as Youtube, video production can be as simple as a mobile phone or camera with video taking function, a video can be uploaded within 5 minutes' time. Safety messages can be conveyed easily by means of easy sharing tools. Another merit of web-based communities is, while production of video tape is usually limited by geographical location: a safety VHS tape produced in Hong Kong can usually be distributed to workers in Hong Kong only, but videos uploaded to communities such as Facebook or Youtube can be viewed by people from all over the world. There are currently four community groups in Facebook about construction safety and three groups about occupational safety. Group creators and members of the group can share some videos and photos about safety, discuss on discussion boards and post the most up-dated information under "wall post" (Tables 8.4, 8.5).

However, as there are no restrictions on the quality of data which can be posted on web, accuracy of data depends on the one who posts the information, the creators of these communities and the mechanisms of information distribution. Furthermore, the success of information and knowledge sharing depends heavily on "interactivity" (Obonyo and Wu 2008), many of these groups on web "die" eventually because the members become inactive as time goes by. With the popularity of web-based community, more web-based communities similar to Facebook will be set up, and free videos and education materials can be obtainable readily on web.

Table 8.4 Construction safety groups in Facebook (Facebook 2008)

Construction safety related group	Origin	Contents	Open group
Construction safety	Turkey	Basic information, video, wall post, photos	Y
Construction jobs—health and safety	London	Basic information, recent news	Y
Construction safety officers/first aid attendants	Vancouver	Basic information, video, wall post, photos, Discussion board, posted items	Y
Health and safety in construction. Help Lauren with her Uni work!	Unknown	Basic information, contact	N

Table 8.5 Occupation safety groups in Facebook (Facebook 2008)

Occupational safety group	Origin	Contents	Open group
Occupational health and safety management group	Turkey and Los Angeles	Basic information, contact, photos, videos, discussion board, posted items	Y
Occupational health and safety	Unknown	Basic information, photos, videos, discussion board, notes, mini-feed	Y
Stargazer safety kit	U.S.	Basic information, discussion board	Y

8.7.2 Intranet

Nowadays, nearly all medium to large size companies have established their own intranets. Many of these are established to inform or notify staff of the companies' policies, new rules, or even companies' annual dinners etc. Intranets can also be used to upload or download information from and to the central databases. This allows members of organizations to share the information rapidly. In order to gain an advantage from Intranet as a device for knowledge sharing, it is crucial for the information to be more dynamic than static. Moreover, companies have to avoid problems such as deficient information content. In spite of the merits and advantages provided by intranets, intranet practitioners often hold the view that intranet does not meet their expectations (Ingirige and Sexton 2007). In the future, it is likely that there will be more safety information circulated around construction workers on-site, as there are more and more mobile phones to provide mail box services to mobile owners.

8.7.3 Online Safety Games

Computer or video games which require players to play through computer network and internet are online games. Gone are the text-based role playing games, computer games designers nowadays usually design games made up of a virtual world simulating real life environment and science fiction settings (Weibel et al. 2007). Since players can play by themselves or with the other game players and make conversation with others online concurrently, these games have attracted much players (Weibel et al. 2007). More than 400,000 people play Everquest and around 2000 gamers play the game at the same time at every time slot. In Hong Kong, playing online games has become youngsters and teenagers' 'homework'. According to a research study, 48.9 % of the youngsters claim that they play computer games every day from one to four hours. 63.2 % consider themselves as computer game addicts. Although more than 60 % of those who play computer games are teenagers between 13 and 15 years old now (Chen 2007), they will become pillars of our society and part of the workforce on sites. While people nowadays mainly focus on negative impacts of online games on adolescent playing, for example, the effects of playing aggressive games and addiction (Griffiths et al. 2004), provided that we can make good use of computer games in conveying safety messages, we can successfully turn what we regard as "bad" into "good". Besides, another major characteristic of computer games is that, it can be a good method to promote brand names. Nike, for example, provides online games as one of the methods in marketing its products as well as collecting information of players online (Spero and Stone 2004). Though it is does not necessary for safety games providers to collect information of the players' online, games providers of online safety games can also be a very good channel in posting their advertisements. Besides, with the help of simple tools such as C++, DarkBASIC Professional, JAVA etc., games writing can be done by many people with certain level of computer knowledge. While it is uncommon for games providers in Hong Kong to provide safety education games, it is foreseeable that there will be more safety games written in Chinese in the future for teaching the practitioners in a more interactive and interesting manner.

8.7.4 Virtual Classrooms

Given the widespread use of the Internet and the boom in website design, it is predictable that web-based lessons in HTML will become one of the major media in online learning. With the help of operating systems (e.g. LINUX Redhat), web servers (e.g. Apache), system databases (e.g. MySQL) and programming knowledge (e.g. JAVA and PHP) (Sun et al. 2008), virtual lessons of construction safety can become a reality.

As part of mandatory requirements in the regulations in Hong Kong, all contractors need to provide safety education to their employees. Face-to-face construction safety lessons are one of the most common methods to covey the safety knowledge. As the cost of finding suitable candidate is to teach the safety course is high, these lessons can only be carried out at certain periods of time. Another problem is that, these construction companies need to spare some space to hold these courses. In view of high labour costs and limited space on construction sites, safety lessons cannot be held so frequently. Besides, some work on sites are so special and unique that general safety courses cannot meet the need of these workers.

Distance learning, from this perspective, provides a good solution to the problems aforementioned. Besides, learning companions can also form some Internet-based interactive learning groups. The emergence of these virtual lessons help switch the traditional classroom into global learning group. On top of the aforementioned merit, there are three potential educational advantages: (1) unlimited learners at the same time, (2) asynchronous learning and (3) the application of global resources, course instructors or even learners can upload any new information to the website at

Table 8.6 Local and overseas private companies which provide services on safety training

Company	Source of information	Originality	Face-to-face safety course	Multimedia/online safety course	Games
The workplace safety store	The workplace safety store (2008)	Texas, US	X	X	
Safety video direct	Safety Video Direct (2007)	Alabama, US		X	X
National safety compliance	National Safety Compliance (2008)	Washington, US		X	X
Pure safety	Pure Safety (2008)	Hilliald, US		X	
Compliance consultant	Compliance Consultant (2008)	Georgia, US	X		
Omni safety	Omni safety (2008)	Not mentioned	X		
KHK management consultants limited	KHK Management Consultants Limited (2008)	Hong Kong	X		
Hong Kong human resources limited	Hong Kong Human Resources Limited (2008)	Hong Kong	X	X	
Hong Kong safety training centre	Hong Kong Safety training Centre (2008)	Hong Kong	X		
The Hong Kong safety training association	The Hong Kong safety training Association (2008)	Hong Kong	X		
Industrial technology consultant limited	Industrial Technology Consultant Limited (2008)	Hong Kong	X		

any time and in any place (Sun et al. 2008). The Table 8.6 shows some of the private companies which provide multimedia/online courses. Most of the safety training course providers in Hong Kong provide face-to-face training only. Few or even none of them provide distance learning programmes. In some of the developed countries, such as US, multimedia and virtual learning is very common. As some of the workers in Hong Kong only work for a few days in a week, it is highly unlikely that they will be able to have some specific courses for them. These virtual lessons can provide them with up-to-date knowledge. Besides, it is also possible that they can re-read the course again if needed.

8.7.5 Blog

Blog, a new term which only appears in these few years, can hardly be found its meaning in traditional dictionary. It generally refers to a shared on-line journal where people can post diary entries about their personal experiences and hobbies (The free dictionary 2008). Young people always write their blogs to share their thinking and viewpoints on blog websites such as Xanga, Yahoo, MSN Space etc. Some of the young academic researchers also write their own blogs to share their academic research on web. Other blog writers can choose to subscribe others' blog timesentry and read it via email, e.g. Blog of KK (KK 2008). Writing and posting a blog message can be completed within a very short time. Yet, readers from all over the world can get access to the information simply by clicking into the website. Blog subscribers can also leave comments and ask the blog owners questions. There are already some private individuals who share their knowledge on safety on blogs. Similar concepts can be applied in some construction companies for informing their employees about safety courses, toolbox talks etc.

8.8 Who Moved My Cheese? The Major Barriers to Resist Change

It is the nature of human beings to resist change. The extent of resistance differs from people to people (Davis and Songer 2008). By the time the new wave of information technology comes, construction practitioners or even the high level managerial people resist or refuse to bring about any changes to their current system. Although more and more people attain the basic knowledge of information technology, including those who are in pre-school education and primary school, application of IT on construction safety knowledge or information transmission is limited. There are many reasons why people resist change. These include inertia, misunderstanding, fear of poor outcome and failure. In view of resistance to change, some authors suggest various solutions to overcome these, e.g. education, coercion, political support, manipulation and discussion.

8.9 Traditional Motivation Theories

Motivation refers to encouragement, direction and pushiness behavior. Motivation theory has a root on Adam Smith's basic postulation that all humans are selfish and are trying to do the work subject to the constraints they face (Li and Man 2006). The diagram below sheds light on the importance of motivation factors in knowledge sharing by means of information technology (Fig. 8.3).

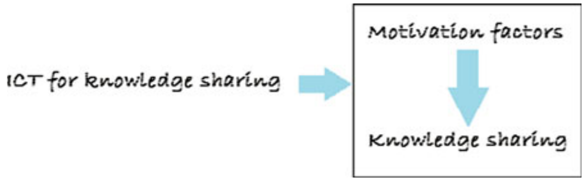

Fig. 8.3 Motivation in knowledge sharing by means of information technology (Hendriks 1999)

8.9.1 Theory X

Based on the rudimentary assumption that men are not self-motivated, Douglas McGregor's Theory X suggest that men have to be directed, forced and threatened with penalty for achieving certain organizational objectives (Li and Poon 2007). McGregor points out two distinctive assumptions made by the manager on human behavior by Theory X and Theory Y. Nevertheless, some researchers concede that minimal supervision is sufficient to ensure the organization members do what they should do (Morden 1995). Subject to regulations, human beings can exercise discretion (Cooper and Phillips 1997; Morden 1995), punishment and fines are peripheral means to achieve goals set by organizations only (Stroh 2005). Moreover, some authors opine that disciplinary actions tend to be ineffective because of delay or its mild nature (Peters 1991).

In the light of Theory X, the major motivation in adopting IT for safety knowledge comes from the high penalty in accidents. Fixed costs, e.g., purchasing safety games and interactive training costs, are very low when compared with the high compensation costs paid by the contractors and possible ban of tendering which leads to wind up of the companies and workers' loss of jobs. This is also one of the reasons why some innovative safety management systems, such as Zero Accident Activities (KYT), Site Safety Cycle etc. are imported from Japan.

8.9.2 Theory Y

In stark contrast, however, Theory Y represents another polar hypothesis about human behavior. Followers of Theory Y trust men and have confidence that they are responsible. Provided a suitable working environment, workers can reach the goal set by the companies. Theory Y followers consider human beings need to work and be treated like precious members in the society (Kock 2005). Trust is the fundamental requirement for communication, open and communal learning. Trustful human relationship also helps generate a strong cooperative power within the company (Rogers 1995) so as to establish an IT knowledge sharing platform.

Nevertheless, Theory X and y represent two completely different scenarios which neither of them represent the real situation well, it is more likely to find an amalgamation of the two (Li and Man 2006).

8.9.3 Reinforcement Theory

Psychologist Skinner contends that human behaviors are directly related to the results of their acts. By applying reinforcement, people's behaviors will change (Courtland et al. 1993). Monetary incentives, such as cash allowance, increase in salary and non-monetary incentives such as being named "Achiever of the Week", can motivate or positively reinforce employees to do good work (Davidsom and Griffin 2006). By offering pleasant consequences, positive reinforcement can motivate people to do the work. Usually, there are too few winners in any incentive programme, distrust and corruption among members of organization can lead to much greater concern. Moreover, monetary incentives can be costly and useful in short term only. It is quite often that they do not encourage long-term improvements (Li and Man 2006). Successful positive reinforcement strategy, therefore, can also motivate safety officers or workers with computer knowledge to share their safety knowledge by means of IT.

Sometimes, employees will do work in one way because they know that if they do in another way, they will have negative consequences. In this way, their behaviors are reinforced by avoidance learning (Courtland et al. 1993). Negative reinforcement, however, can offset positive punishment reinforcement. Sometimes, positive values of co-workers are so great which lead the workers to accept punishment instead (Schermerhoen et al. 2003). In order to achieve some of the companies' objectives and implement new innovative policies, newly implemented policies are usually associated with penalties for those violators.

8.9.4 Hierarchy of Needs Theory

According to Maslow's theory, men are motivated by five classes of needs:

1. Physiological (e.g. shelter, hunger, sex thirst and other bodily needs),
2. Safety (e.g. security, protection from emotional and physical harm),
3. Social (e.g. belongingness acceptance, affection and friendship),
4. Esteem (e.g. internal esteem factors, for instance, self-respect, autonomy, and achievement; and external esteem factors, for instance, recognition, status, and attention),
5. Self-actualization (e.g. the drive to become what one is capable of becoming; includes growth, achieving one's potential, and self-fulfillment) (Kim 2008).

Although needs theory has been heavily criticized, for instance, (1) its strict assumption on hierarchy of needs, (2) failure to explain how behavior can be affected within the hierarchy, (3) its weak empirical foundation, it still proves its value at the present moment. Maslow's theory indicates that motivation for knowledge work comes from his three highest hierarchical levels. Needs theory

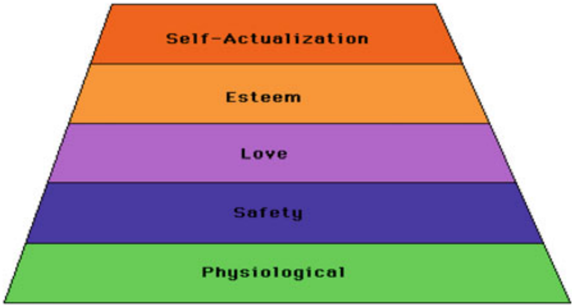

Fig. 8.4 Maslow's needs theory (Kim 2008)

implies that knowledge owners do not have the motivation to share what they know by information technology because such action will not lead them to earn more money or improve their relationships with their colleagues. Their motivation, however, mainly comes from their want to attain self-actualization (Hendriks 1999) (Fig. 8.4).

8.9.5 Herzberg's Two-Factor Theory

Two-factor theory is based on two different groups of factors: motivation and hygiene. Hygiene factors motivate people firstly in a negative way. Generally, they do not motivate people when they are present, however, absence of them will lead to dissatisfaction and decreased motivation. These factors include salary, working conditions, status and interpersonal relations. On the other hand, presence of motivation factors lead to an increase both in motivation and satisfaction. These include challenge of work, promotion opportunities, sense of achievement, job recognition, sense of responsibility and operational autonomy (Hendriks 1999). We almost turn to motivation factors automatically, instead of hygiene factors when we intend to look for the reasons why people want to share knowledge by means of information technology. Bonuses (either in monetary or non-monetary terms) or penalties, for example, may lead to a rise in the use of knowledge sharing by information technology. Yet they are not likely to lead to increased motivation for knowledge sharing by IT. When hygiene factors are absent, knowledge sharing by means of information technology may be frustrated. Yet it is not very likely that they will lead to a rise in sharing knowledge motivation. The six factors identified as motivators by Herzberg also appear to be elements which trigger knowledge sharing by information technology, such as blog, intranet, web-based communities etc.

8.10 Foreseen Industrial Impacts and Conclusion

High accident rates in construction industry are often regarded as a hard nut to crack. While there are more and more people who know information technology well, application on sharing safety knowledge is limited in Hong Kong's construction industry. Sharing knowledge by this method can increase the interactivity of the knowledge assimilation process and make the whole process livelier. Moreover, with the help of information technology, it can share the safety knowledge among construction practitioners from all over the world in a faster way. To motivate construction practitioners to share their safety knowledge by means of IT, Theory X and Y, reinforcement, two-factors theory and needs' theory have been examined and are summarised in Table 8.7. With better understanding of motivation theories, companies know better how to implement a successful knowledge sharing platform with the help of IT. It is expected that the construction accident rates will further decrease (Table 8.8).

Table 8.7 The possible causes and strategies in resistance to change (Dent and Goldberg 1999)

Causes of resistance					
Surprise	X				
Inertia	X				
Misunderstanding	X	X	X	X	
Emotional side effects	X	X	X	X	
Lack of trust	X	X	X	X	
Fear of failure	X				X
Personal conflicts	X	X	X	X	
Poor training	X				
Threat to job status or security	X	X	X	X	X
Workgroup breakup	X	X	X	X	
Fear of poor outcome					X
Faults of change					X
Uncertainty		X	X	X	
Strategies for overcoming					
Education	X	X	X	X	
Participation	X	X	X	X	X
Facilitation	X	X	X	X	
Negotiation	X	X	X	X	X
Manipulation	X	X	X	X	X
Coercion	X	X	X	X	
Discussion					X
Financial benefits					X
Political support					X

Table 8.8 Comparison and contrast different theories in achieving the goal of motivating members of organizations in sharing safety knowledge by means of IT

Can the following theory motivate members of the companies to share their safety knowledge by IT?	Theory X	Theory Y	Reinforcement theory (+)	Reinforcement theory (−)	Hierarchy of needs	Two-factor theory
Punishment	Yes	No	No	Yes	No	No
Trust	Yes*	Yes	Yes	Yes*	No	No
Salary	Yes*	No	Yes	Yes*	Yes	No
Status	Yes*	No	Yes	Yes*	No	No
Interpersonal relationships	Yes*	No	Yes	Yes*	Yes	No
Challenge of work	Yes*	No	Yes	Yes*	No	Yes
Promotional opportunities	Yes*	No	Yes	Yes*	No	Yes
Achievement	Yes*	No	Yes	Yes*	No	Yes
Recognition of Job done	Yes*	No	Yes	Yes*	No	Yes
Sense of responsibility	Yes*	No	Yes	Yes*	No	Yes
Desire for operational autonomy	Yes*	No	Yes	Yes*	No	Yes
Self-actualization	Yes*	No	Yes	Yes*	Yes	No

Note Theory X and positive reinforcement theories with "*"indicate that people are motivated because they are afraid of *lower* achievement, salary etc

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Chapter 9
Demand for Construction Safety

9.1 A Global Review on Construction Accidents

The unique characteristics in construction industry such as dynamic environment, change in composition of crews, materials, equipment, challenging work environment and culture make it one of the most high risk industries and is a leading contributor of fatalities at work (Solís-Carcaño and Arcudia-Abad 2012, forthcoming; Gilkey et al. 2012, forthcoming; Tam and Fung 2012, forthcoming). Tam and Fung (2012, forthcoming) report that around 1.2 million people died of work related diseases and accidents annually and 120 million people became ill or have been injured (Sacks et al. 2009) and incurred a huge economic cost (Cortés et al. 2012). In the United Kingdom, construction and manufacturing industries dominated the number of fatal accidents from 1995 to 2000. The construction industry alone represented over 40 % of the total number of fatalities reported among the four industry sectors and was consistently reported as the first or second worst offender for reported fatal injuries (Edwards and Nicholas 2002). In Australia, the construction industry experienced 37 fatalities, i.e., 5.6 fatalities per 100,000 employees, which was more than double the average for all the industries (2.4 fatalities per 100,000 employees) in 2007–2008 (Zou 2011). In Singapore, construction is also one of the most high risk occupations (the industry accounted for 29 % of the total workers' expenditures, but accounted for 40 % of worksite accidents) (Imriyas et al. 2007). Apart from the abovementioned developed countries, developing countries share similar safety problems on sites. In Ghana, the Labour Department reports 56 out of 1,120 construction accidents were fatal. This figure is higher than International Labour Organization's estimates for developing countries. All these imply the construction industry has a highly conducive environment for human and monetary loss occurrences (Garrett and Teizer 2009) and no doubt that workplace safety indicators such as accident severity rate, fatality rate, injury rate, accident frequency rate as well as the workers and their family members' pain and suffering often provide important information on demand for safety measures (Ling et al. 2009).

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9.2 Direct Costs in Construction Accidents

Direct costs of accidents include monetary compensation for the companies, the financial loss for the country's health care and injured workers' loss of working capacity. The European Agency for Safety and Health at Work estimates that 4.6 million of accidents happen each year in the EU. They result in 146 million loss in working hours. This amount is roughly equal to around 2.6–3.8 % of the EU Gross National Product (GNP) every year (Rikhardsson 2006).

In Denmark, the Danish companies have to pay full wages for the first 14 days after an accident according to the National Law. After 2 weeks' time, the Danish social security system takes over but the rates are usually lower than the wages of employees. Other countries such as the UK and the US do not have the same social security regulations, which implies that either the company has to pay an insurance company to have them covered or carries the costs itself (Rikhardsson 2006). Therefore, the total uninsured losses from day to day accidents ranged from twice to 36 times the total insurance premiums in a year. On average, for every £1 recovered from insurance, a company has to pay £10 in the UK (HSE 1999). In Australia, the construction industry hired 961,300 people from 2007 to 2008 (around 9 % of the Australian workforce), incurred 14,409 claims for compensation leading to an incidence claim rate of 22 claims per 1,000 employees, and this is 50 % more than the average claim among all the other industries (14 claims per 1,000 employees) (Zou 2011).

In Singapore, the law states that the provision of adequate workers' compensation insurance (WCI) cover is mandatory in contract of service (a 'worker' refers to a person engaged in non-manual work whose average monthly earnings do not exceed SG$1,600, or manual labour regardless of how much he/she earns per month). The significance of the WCI expenditure in construction is overwhelming. Hence, insurance companies which issue the WCI have to bear significant financial risks. Many insurers in Singapore suffer from detrimental loss ratio. Some even give up issuing the WCI (Imriyas et al. 2007). Around $1,150,000 per fatality and 460,000 disabling injuries roughly cost $15.64 billion. Injuries account for 7.9–15 % of the cost of newly constructed nonresidential projects. Because of the high costs, they cripple many of the entrant firms. It also significantly affects the Gross Domestic Product in turn (Hallowell 2011). In Ghana, although 10 % of the reported accident claims were settled, the total amount was $150,000 which was quite expensive as compared with the income of the country (Kheni et al. 2010).

9.3 Indirect Costs in Construction Accidents

Dating back to the 1920s, Herbert Heinrich documented that the costs of occupational accidents in American companies were substantial with many hidden costs that are neglected by the senior management staff. In general, costs that were not covered by insurance were termed indirect or hidden costs. They include sick leave pay, the production setbacks, non-productive time of colleagues, administrative costs, fines and investments in extra safety measures and replacement hiring costs. Factors affecting the costs of occupational accidents include length of absence and type of accident, wage structure and policies (a large portion of the total accident costs in each company is often sick pay during absence), industries' work characteristics, number and types of accidents, injured workers' position and wage, local labour agreements and structure of the social security system. Many researchers hold the view that if these costs become explicit, managers will be motivated to take health and safety issues into account in their decision making (Rikhardsson 2006).

9.4 The Relationship Between Indirect and Direct Costs in Construction Accidents

The ratio between direct and indirect costs can be represented by iceberg metaphor where the larger hidden part of the iceberg represented the indirect costs. The ratio between these costs depends on factors such as company size, accident type, industry, accident frequency, etc. In general, the ratio of insured and non-insured costs due to work related ill-health is a 1:3.3 ratio, i.e. for every dollar covered by insurance, 3.3 dollars are not covered (Rikhardsson 2006). A research study conducted by the United Kingdom Occupational Health Authorities shows different ratios ranging from 1:1 to 1:11. It generally depends on factors including the company size, type of accident and industry (Rikhardsson 2006). Heinrich estimates that the ratio of indirect to direct costs would be higher than 4–1. Direct costs refer to money paid by the insurance companies to the injured workmen for medical and wage compensation If we include the overhead, i.e., the difference between money paid by the insurance company and total insurance premium in direct costs, the ratio will become to 2–1 (Laufer 1987). The construction industry accounts for a disproportionately high injury rate. In 2002, it is estimated that the indirect and direct costs of fatal and nonfatal construction injuries totalled $13 billion. Nevertheless, the industry continues to have the largest number of fatalities record and in 2009 accounted for nearly one fifth of all workplace deaths from all industries (Hallowell and Calhoun 2011).

9.5 Conclusion

There are huge direct and indirect costs as well as pain, sufferings and grief of both the workers and their family members should an accident happen. In contrast, there are numerous benefits in improving construction safety conditions on sites, in terms of efficiency, competitiveness, disputes, conflicts and profitability with reduction in delays (Choudhry 2012, forthcoming). Preventing occupational accidents should therefore make good economic sense for society as well as being good business practice for companies (Rikhardsson 2006).

Statistics should be used more often by safety managers to identify causal factors and direct the placement of resources and understanding of the trends behind accidents (Gyi et al. 1999). For example, Danish Patient Safety Database was developed on the basis of the Danish Act on Patient Safety (Zhou et al. 2012, forthcoming).

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Chapter 10
Workers' Compensation for Non-fatal Construction Accidents: Review of Court Cases in Hong Kong

10.1 Introduction

Persistently high accident rates on site have caught the attention of many researchers and construction practitioners in Hong Kong (Siebert and Wei 1998). Accidents replay on sites thousand times each year, and buzz on accident prevention is boring but inescapable. As compared with other places in Asia, such as Japan, South Korea, Taiwan and Singapore, Hong Kong accident rates on site stand the highest among all. Muttering our astonishment, number of accidents per thousand employees is one-digit more in Hong Kong than others (Poon et al. 2008). Frazzled safety officials have taken a crack at overturning the situation by legal regulations, such as Occupational Safety and Health Regulation and Construction Sites (Safety) Regulations. To restore the victims position (Ashworth 1986) and punish those ill-performed contractors, Employees' Compensation Ordinance was enacted in 1953 (Poon et al. 2008). Legislation as such established an ex ante "contract" between workers and employers where the employers promise to pay a specified amount for all accidents arising in course of employment. Workers' compensation also shifts the liability of workplace accidents from negligence liability to a form of shared strict liability (Fishback and Kantor 1998). While millions of money have been spent by nerve racking contractors on construction accident compensation, limited research has been done on the compensation cases. This chapter provides some fundamental and useful information about the cases in District Court and High Court. It presents the total compensation spent by contractors each year. An estimation on percentage of compensation spent on (a) Pain Suffering and Loss of Amenities (PSLA), (b) loss of earnings, (c) loss of earning capacity, (d) special damages, and (e) future treatment costs. Victims were awarded huge sums of compensation (HK$1.5 million) by (a) workers' trade of work, (b) parts of bodies injured, (c) mechanism of injuries.

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10.2 Liability of Contractors on Workers' Safety under Common Law

In Hong Kong, it is widely accepted that 'judge made law' results from former court cases decided by judges in Hong Kong, UK and other common law jurisdictions. As questions of contractors' and subcontractors' duties on safety issues have employment law dimensions, a brief outline of the applicable legal principles is necessary. As early as 1950, Lord Oaksey had already provided his view on employer's duty in Winter v Cardiff Rural District Council: employers have to supply the employees with adequate directions as to the system of work or mode of operation and adequate plant. If the time system or mode of operation is highly dangerous, complicated or involves a number of men performing different functions or prolonged, it is naturally a matter for the employers to take the responsibilities of deciding what system shall be adopted. This view is confirmed in one of the recent court cases in Hong Kong, the learned judge held that "(f)irst, an employer owes to his employee a duty to exercise reasonable care to ensure that the system of work provided for him is a safe one. Secondly, the provision of a safe system of work has two aspects: (a) the devising of such a system and (b) the operation of it" Li Moon Chai v Leung Shu Man (2008). This view is also reaffirmed by other judges in Liu Wai Leung v. Asia Construction Co Ltd (2008).

In deciding the risk precautions, it is of the view that the employer should provide different degrees of protection on case by case basis "…Where one employment happens to be more dangerous than another, a greater degree of care must be taken, but where the employer cannot eliminate the risk of danger, it is required to take reasonable precautions to reduce the risk as far as possible…" Nguyen Van Vinh v Cheung Ying Construction Engineering Ltd (2008). However, this does not mean that an employer is required to remove every risk which might confront its employee. As the Lord Oaksey commented in Winter v. Cardiff Rural District Council (1950), "but this does not mean that an employer must decide on every detail of the system of work or mode of operation. There is a sphere in which the employer must exercise his discretion and there are other spheres in which foremen and workmen must exercise theirs…. On the other hand, where the operation is simple and the decision how it shall be done has to be taken frequently, it is natural that it should be left to the foreman or workmen on the spot".

Whilst the immediate employer of the employee is liable for the safety, Morris v. Breaveglen (1993) ruled that the principal contractor cannot escape his liability. In that case, the victim sustained injury while working under the employment of one employer, as he had been instructed to work under the directions of employees of a second employer. The general employers argued that they should not be liable for the injuries as they were not exercising direct control over the plaintiff. Nevertheless, judges invalidated such contention. In Rainfield Design and Associates Ltd v. Siu Chi Moon (2000), judges share similar view "[t]he purpose of the Regulations was clearly to provide for the safety of workman and the primary responsibility for this must rest with the contractor responsible for the site. Even where a subcontractor had a contractual duty to provide plant and equipment, the contractor responsible for the site would not be relieved from its duty under the Regulations". Common law rules as such, however, were severely limited by common law defenses available to the employer, on employees' contributory negligence. If proved, it is possible to completely bar an employee's recovery.

10.3 Various Legislation in Relation to Construction Accident Compensation in Hong Kong

In response to work-related deaths and injuries, three major pieces of legislation have been enacted and implemented. The Factories and Industrial Undertakings Ordinance in 1980 laid down the general duties of employers at work. Its subsidiary regulation, Construction Sites (Safety) Regulations Chapter 59I, was written clearly to provide the safety of workmen and the primary responsibility for this must rest with contractors. Contractors have to ensure suitable and adequate safe access to and egress from every place of work where the construction work is being carried out [Regulation 38AA(2)]. They should also provide workers employed on sites with safety helmets [regulation 48(1)(1)]. Where workers are employed on sites, contractors responsible for the sites should take such precautions as are necessary to prevent any workers from being struck by any falling materials or objects at work [Regulation 49(1)(1)].

Previous research shows that most of the accidents in Hong Kong involves falling from height, striking by objects etc. (Poon et al. 2008). Specifically, it has also stated the responsibilities of contractors for different nature of work on sites, e.g., they also have to identify, rectify against all hazardous conditions, safeguard any person working at a height on the construction site (Regulation 38A) and to prevent any person from falling from height by taking adequate steps [regulation 38B(1)]. Any contractor or workman engaged in construction work who does anything likely to endanger himself without reasonable cause or others shall be guilty of an offence and liable on conviction to a fine of HK$50,000 (Regulation 69).

Another piece of legislation, Occupational Safety and Health Regulation, Chapter 509A, stipulates that every employer must ensure the safety and health at work of all the employer's employees. It has provided several requirements on safety system, safety place of work and manual handling operations, for example:

The person-in-charge of a workplace has to ensure that plant is not installed or kept unless the plant is safe and without risks to those who use the plant [Sect. 3(1)].

He/she needs to ensure (a) the dangerous parts of plant installed or kept are effectively guarded; and (b) in particular when any dangerous part of the plant is in motion, the guard relating to that part is kept in place [Sect. 4(1)(1)].

The person responsible for a workplace must ensure that an effective means for draining the workplace is installed and maintained at the workplace if (a) an activity carried out at the workplace makes the floor of the workplace wet; and (b) the wetness can be eradicated by means of a drainage system (Sect. 14).

The person responsible for a workplace must ensure that employees employed at the workplace who undertake manual handling operations which may create safety risks are provided with relevant and comprehensible information (Sect. 29).

Although Hong Kong has a rather short history in safety and health regulations, history concerning workers' compensation ordinances in Hong Kong can be traced back to 1950. To protect the workers' welfare, Employees' Compensation Ordinance Chap. 282, Sect. 7 was enacted in 1953 (Poon et al. 2008). It states clearly the amount of compensation in cases of permanent total incapacity due to work according to age of the employees. It has three categories:

1. Employees who are under the age of 40, he or she will be compensated with HK $344,000 or 96 months of earnings whichever is higher [Sect. 7(1)(a)];
2. Employees who are over 40 years of age but under 56 years of age at the time of the accident are eligible to receive HK$344,000 or 72 months of earnings whichever is higher [Sect. 7(1)(b)];
3. Employees who are 56 or above are entitled to receive HK$344,000 or 48 months earning whichever is higher [Sect. 7(1)(c)].

These do not, however, mean no restrictions on the amount of monthly earnings in calculating compensation. In fact, the aforementioned monthly earnings are subject to a maximum of HK$21,000 for estimating compensation. Settlement of claims between employers and employees can be done by various ways which include but not limited to direct payment or settlement, settlement by court or certificate. Under this ordinance, an employer must also process valid insurance to cover his liabilities for the work injuries of his employees (Labour Department 2008b). It sounds easy to understand terms within the ordinance, "[r]egrettably, this ordinance had its origin in English statutes drafted nearly a century ago but which has since incorporated both English and local amendments, is by no means easy to follow. This is particularly regrettable when the purpose of the legislation is to provide for payment of compensation to injured employees, a class covering a wide spectrum of the community with various educational backgrounds" Lau Suet Fung v. Future Engineering Company Ltd (2003). This might provide one of the reasons why arguments over level of compensation arise and some of which end up in court.

10.4 Research Method

Descriptive statistical analysis of 101 workers' compensation court cases due to accidents on construction sites while doing construction work was carried out. All of them arose between 1st January 2004 and 13th November 2008 in District and High Courts. Despite some unknown variables within the Hong Kong law report, it represents the best source of information available concerning nonfatal construction injuries court cases currently available. For simplicity, definition of construction site is adopted from Construction Site (Safety) Regulations as "… a place where construction work is undertaken and also any area in the immediate vicinity of any such place which is used for the storage of materials or plant used or intended to be used for the purpose of the construction work…" And for the meaning of "construction work", one can also turn to the Factories and Industrial Undertakings Ordinance, Chap. 59, under Sect. 2, it says "'construction work' means the construction, erection, installation, reconstruction, repair, maintenance… renewal, removal, alteration, improvement, dismantling, or demolition of any structure or works specified in the Third Schedule…".

10.5 Results

10.5.1 Age

Previous research has diverse views on which age group is more accident prone. While some authors concede that young workers have a higher chance of accidents due to lack of experience, others argue that accident rate among older workers is not lower than that of younger ones (Li 2006). This research reveals that majority of the serious injuries come from the age group (47–56) which accounts for 30 among the 101 court cases, age groups 27–36 and 17–26 mark for 18 and 15 cases respectively. There were 7 cases falling under the age group 57–67 only. Nevertheless, the percentage of court cases over construction employees by age group is highest in age group 17–26 as noted in the following Table 10.1.

In a study conducted in Denver by Lowery et. al. (2000), workers who build elevators and conduits, install glass, metal, or steel were at particularly high risk of injury. A glance of the following Table shows that general labourer/casual workers ranked highest, with a total of 26 cases, followed by electrical technicians,

Table 10.1 Number of court cases within each age group

Age group	Number of employees in construction sector by age group (2004–2007) (Census and Statistics Department 2009)	Number of court cases (2004–2008)	Percentage of court cases over construction employees by age group (10–3)
17–26	111.8	7	6.26
27–36	245.1	30	0.12
37–46	342.4	13	3.8
47–56	308.8	18	5.83
57 and above	61.4	15	0.24
Unknown	N/A	7	N/A
Total	1,070.4	101	0.052

Table 10.2 Number of non-fatal accidents from 2004–2008 analyzed by type of work performed

Type of work	Number of court cases (2004–2008)	Number of injured cases (2004–2007) (Labour Department 2008a)	Percentage of court cases over injured cases
Steel bender/form worker	7	570	1.23
Scaffolder	7	302	2.32
Plumber	3	523	0.57
Carpenter	11	491	2.24
Electrical technician	11	1,559	0.71
General labourer/ causal worker	26	N/A	N/A
Decorator/ painter/ plasterer	11	678	1.62
Other	26	N/A	N/A

painters/decorators/plasterers, and carpenters, each of them accounted for 11 cases. A glimpse of the Table, however, reviews that of the percentages of litigation over injured cases, scaffolders ranked highest, followed by carpenters, each of them accounted for more than 2 % (Table 10.2).

10.5.2 Mechanism of Injury

Previous study of Dement and Lipscomb (1999) revealed that the highest rates for compensation cases involving medical costs were observed for being struck by an object, lifting/movement and falls from height. In Japan, South Korea, Taiwan and Singapore, the most common type of construction deaths happened on sites was falling from height (Poon et al. 2008). In Hong Kong between 1997 and 2008, approximately one-fifth of the construction accidents on site were ‘striking against or struck by moving objects’, ‘injured whilst carrying’ and ‘fell on the same level’ (Labour Department 2008a). Nevertheless, the highest rates of injury involved litigation were falling from height (37) and being hit by falling objects (32). Generally speaking, there is an upward trend in being hit by falling objects. Being hit by objects reflects poor housekeeping on sites, one of the major causes of accidents on sites as indicated in research by Li (2006) and Atkinson et al. (2005) (Table 10.3).

10.5.3 Parts of Bodies Injured

In a study conducted by Dement and Lipscomb (1999), compensation claim incidences were highest for back/shoulders, fingers, and leg/knee. In Hong Kong, claimants have to supply their medical assessment reports for compensation

Table 10.3 Categorization of construction injuries in Hong Kong litigation in 2004–2008

Years	Hit by falling object	Fell from height	Trapped in/between objects	Hit by moving objects	Slipped and fell	Struck by objects	Others	Total number of non-fatal accidents
2008	12	11	1	1	0	4	0	29
2007	7	6	2	0	0	0	1	16
2006	6	6	1	1	1	3	1	19
2005	6	9	0	1	3	4	0	23
2004	1	5	1	4	2	0	1	14
Total	32	37	5	7	6	11	3	101

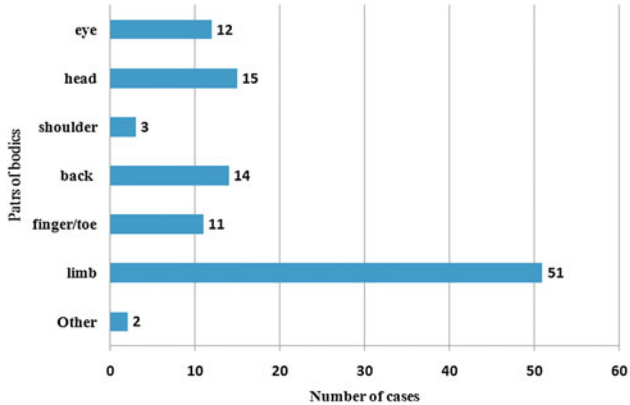

Fig. 10.1 Parts of body injured among the 101 court cases in 2004–2008

purposes. Doctors fill in the form which indicates which part of the bodies the claimants suffer and the corresponding percentage of body impairment. There are also guidelines in Hospital Authority concerning impairment assessment on different parts of body injuries, e.g., injuries on thumb induce greater body impairment than index finger. As shown in Fig. 10 1, mechanism of injury was highest for limbs (51), accounting for half of the cases. The other common injuries are head (15), back (14), eye (12) and fingers or toes (11).

10.5.4 Compensation Awarded in 2004–2008

The total compensation awarded for a victim would be the sum of all items of compensation for damages decided by the judge. The primary aim of compensation is to provide remedy to the victim as close as possible to the status had the accident not happened. As a matter of fact, victims might not be awarded compensation under each and every sub-category of damages (Saram and Tang 2005).

After deciding the whole sum of money to be compensated, the judge would decide the percentage of liability which was borne by the contractors and/or subcontractors. Had there been no prior agreement on the percentage of each defendant's liability on construction injuries, court also decides the percentage each party should pay, e.g., Ho Ho Ming v. Tse Po Wah and Others (2008), Pang Dai Shing v. Ho Shun Ching and others (2007). Although there is no consensus on how heavy the accident compensation should be, the learned judge in Hutchinson v. London and North Eastern Railway Co (1942) stated that "The real incentive for the observance by employers of their statutory duties… is the possibility of heavy claims for damages. Such legislation would be nugatory if, in every case, employers could disregard the statute, and allege that… the plaintiff could see the danger and, therefore, ought to have ceased working, which in many cases might mean dismissal, or to have taken some extra precaution which was not taken".

Compensation may be awarded under the following headings:

1. Pain Suffering and Loss of Amenities (PSLA): these compensate for injury which leaves victims disabilities which tarnish general activities and satisfaction of lives, but allow reasonable mobility to victims, for instance, bad fractures which lead to recurrent pain, Lee Ting Lam v. Leung Kam Ming (1980). In order to consider the amount to be awarded under this heading, judges will also consider the victim's habit such as sport activities, family lives and background.
2. Loss of pre-trial earnings: this encompasses monthly earnings from the date of accident to end of sick leave, Wong Hak Man v. Harvest Engineering Development Ltd and Chun Wo Building Construction Limited (2008).
3. Post trial loss of earnings: this encompasses the earnings lost after trial, generally speaking, it takes into consideration the plaintiff's age on the day of hearing and the possible maximum age which the victim is still able to work, Siu Leong Ching v. Professional Scaffolding Engineering Co Ltd and Another and Tong (2004).
4. Future medical treatment: this encompasses future inpatient treatment, Wong Chun Lam v. Tai On Civil Engineering Ltd (2008).
5. Special damages: these encompasses hospital and other medical charges, such as expenses on tonic food, travelling, bonesetters, Chinese Herbalists, treatment in mainland hospital, medical accessories, Lin Chiu Lung v. ILE Company Limited (2005), Wong Hak Man v. Harvest Engineering Development and Chun Wo Building Construction Limited (2008).
6. Loss of earnings capacity: victims would only be compensated under this heading of claim only if the plaintiff's injuries leave residual disabilities, leading them to disadvantages in labor market, Wong Chun Lam v. Tai On Civil Engineering Ltd (2008).

Apart from the aforementioned items, judges might award the plaintiffs under the item such as loss of society, retirement benefit etc. Panel of judges might also deduct a sum of money which had been received by victims and their

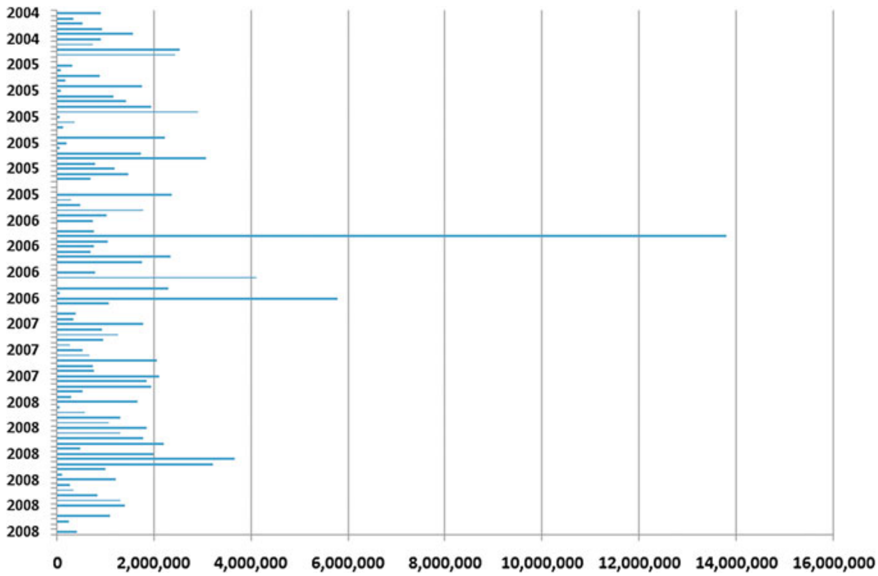

Fig. 10.2 Total amount of compensation of cases in 2004–2008

corresponding responsibilities for their negligence. In a few cases, judges might choose to award the victims according to employees' compensation under ECO, Sect. 9, 10 and 10A instead, e.g. Chu Yee Man v. Chuen Kee Construction Co Ltd (2008). The Figure above illustrates the amount of total compensation for cases in chronological order (Fig. 10.2).

The following Table illustrates the total amount of compensation each year and its detailed breakdown. Total compensation was highest in 2006 which gave an amount of HK$39,643,353 and lowest in 2004 which was HK$10,997,637. Loss of earnings (which includes pre and post trial loss of earnings and loss of MPF) accounts for the largest head of compensation, followed by Pain Suffering and Loss of Amenities. Among the 101 cases, the highest sum of compensation was HK$13,800,000. The victim was a site casual worker, aged 31 at the time of the accident. He suffered from injuries in his spine, fracture of limbs and ribs and a laceration over the left eye. Four victims were not compensated for any money. One of them failed to satisfy all the necessary criteria which would give the court the power to rule on his claim. The other one also failed because there was no evidence that the plaintiff was assigned to do the alleged work by the contractor. Failing to file the report in timely manner and mention of the injury during medical examinations were reasons for zero compensation (Table 10.4).

In terms of heavy compensation, a previous study in the United States revealed that the five costliest occupational injuries in construction industries were miscellaneous special trade contractors, followed by plumbing, heating, and air-conditioning and electrical workers (Waehrera et. al. 2007). Of these 101 cases in Hong Kong, 29 victims received compensation of more than HK$1.5 million

Table 10.4 Total compensation awarded in 2004–2008

Years	Total number of non-fatal accidents	Total PSLA ('000)	Total loss of earnings ('000)	Total loss of earning capacity ('000)	Total special damages ('000)	Total future treatment ('000)	Total deductions from ECC and victims' faults ('000)	Total sum of compensation ('000)
2008	29	6,779	26,964	267	610	584	4,005	32,443
2007	16	3,400	13,980	950	530	279	890	15,937
2006	19	7,260	20,234	875	1,378	2,669	7,640	39,643
2005	23	6,085	24,645	2,404	506	382	7,771	25,725
2004	14	2,940	11,283	431	211	116	5,174	10,998

(a line is drawn on HK$1.5 million as this represents a large sum of compensation and sufficient amount of cases to give readers a generalized picture). While general laborers marked the highest number of cases, less than one-fourth of them were awarded compensation which exceeded HK$1.5 million. Four out of seven steel bender/form workers who filed court cases have received compensation greater than HK$1.5 million. Further details of different trades of workers' compensation can be found in Figs. 10.3 and 10.4.

When we look at parts of bodies injured, head injured victims have the highest chance to be compensated with a larger sum of money. Among all the head injured cases, 47 % of them were awarded more than HK$1.5 million. Eye and shoulder injured victims cases ranked second.

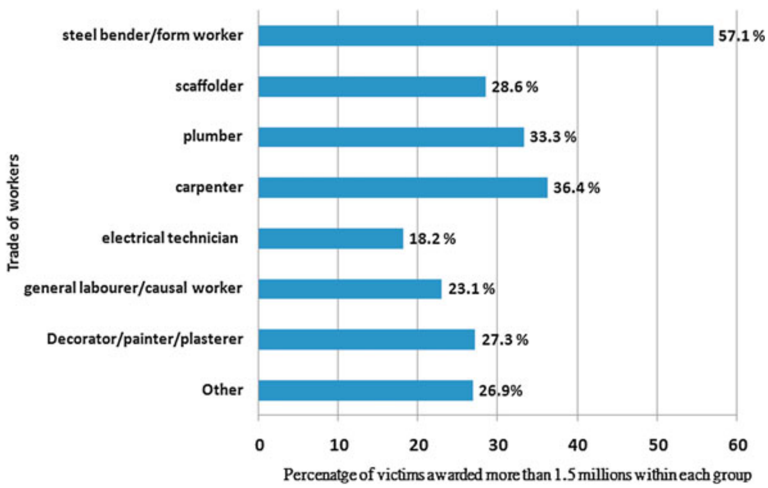

Fig. 10.3 Percentage of victims awarded more than HK$1.5 million within each group

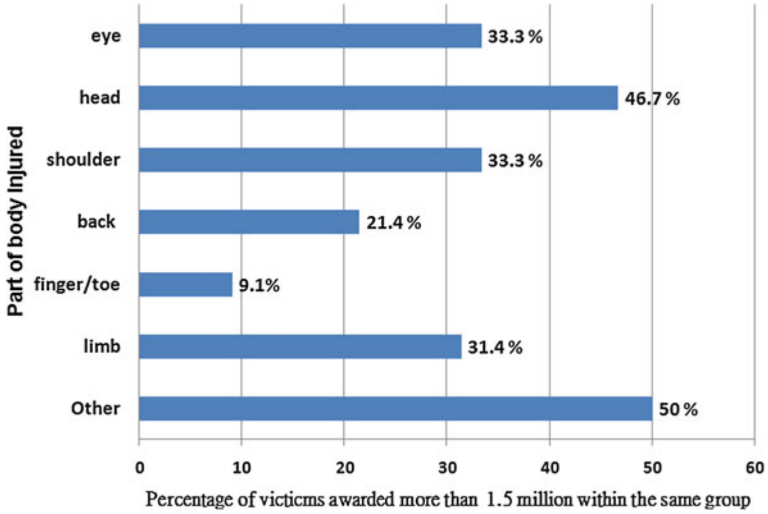

Fig. 10.4 Percentage of workers' compensation greater than HK$1.5 million analysed by parts of bodies injured

The results generally reflect that seriousness of the injury has great impact when the judges decide on level of compensation. With regard to the mechanism of injury, approximately 54.5 % of the injured who were struck by objects were awarded compensation above HK$1.5 million. Meanwhile, around one-third of Slip and fall received such a high level of compensation (Fig. 10.5).

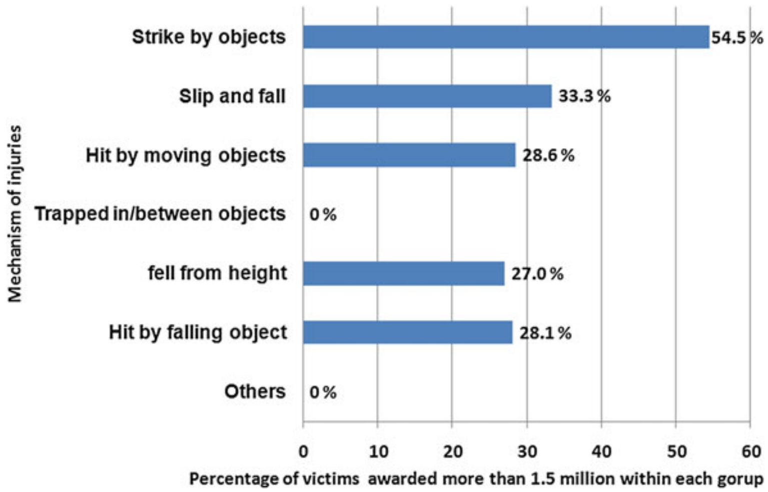

Fig. 10.5 Percentage of victims awarded more than HK$1.5 million categories by mechanism of injury

10.6 Conclusion

Obedience to law is not taken for granted (Becker 1968). One of the justifications for imposing heavy sums of compensation is to prevent further similar offences. Huge sums of compensation churned out profit of these companies every year. Neither would the injured persons and their family members feel better. Year 2006 alone cost nearly HK$40 million as compensation decided by court, not to mention those which have already been spent before hearing. It has been said that judges decide the amount of compensation based on the seriousness of the accidents. Little wonder that head injuries cases have a higher chance to receive larger sums of money as compensation. Surprisingly, steel benders tap into the trade of workers which was the group with greatest opportunity to be awarded huge compensation but not the largest pool of cases among all trades of workers. After all, this study does not only provide useful information to contractors on preparing safety measures to different ages and trades of workers, it also provides comprehensive information to insurance companies when they provide services to their clients.

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Chapter 11
Construction Accident Compensation in the United Kingdom

11.1 The Rationale for Construction Accident Compensation

In many countries, accident compensation not only relieves workers' financial burden after accidents, but also becomes the major tools to deter the irresponsible or negligent behavior of contractors and employers on construction safety. Further, where death has occurred, serious punishment of the corporation achieves a sense of justice for the deceased's relatives. For those followers in the law of manslaughter, the rationale for safety regulation is that a corporate employer should consider its employees' safety in the same manner as an employer who is an individual or partnership. Employees ought to receive comparable protection and benefits whatever the form of their employer. On top of that, where death has occurred corporations are punished primarily to increase worker safety by seeking to effect a change in corporate practices and operations to prevent future deaths (Pritchard 1997).

11.2 History of Legal Development in the UK Workers' Compensation

The United Kingdom's legal system developed slowly before the industrial revolution. Its development had a close relationship with 6 kings: Alfred the Great (849–899 AD) in Britain drew up the Doom Book; Edward the Confessor (1003–1066 AD) introduced judges; William the Conqueror (1027–1087 AD) established higher courts and initiated legal precedent; King Henry II (1133–1189 AD) introduced trial by jury; King John (1166–1216 AD) began the process of establishing the rights of freemen; King Edward I (1239–1307 AD) established the legal system that is still used in the United Kingdom (Winder 2009). Generally speaking, workers at that time were vulnerable with limited channels to seek for accidents happened at work. It was the Dark Ages of workers' compensation in the UK.

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Later, Industrial Revolution swept across Europe from the eighteenth to nineteenth century, it changed the way of how people worked. The introduction of inanimate power and machines replaced the men's power, new methods replaced the old ones, and greater division of labor not only fastened the pace of economic development but also increased industrial injury. As a result, they drew more attention on workers' health and safety as well as workers' compensation (Winder 2009). By early 1800s, an early version of employers' liability was introduced with focus on 3 major aspects:

1. Vicarious liability: an employment relationship has to be established where an employer is vicariously liable for the breaches of contract of employees and torts;
2. Volenti non fit injuria: there is no negligence if a person voluntarily assumes the risk of injury;
3. Contributory negligence: an employer is not liable for any negligence towards an injured worker where an injury was at least partially due to worker negligence.

Therefore, one can conclude that injured workers had few options in seeking for compensation at that time. Many of them could only rely on charity funds which were obtained from the community or employers. Suing their employers for negligence under the contract of employment and common law was a time-consuming and costly process. Hiring a lawyer also posed heavy burden to poor employees. Even worse, judges often tried to avoid any bad precedents which might lead to a flood of claims later on. Therefore, the chance to obtain any compensation greatly depended on the subjective decisions made by the judges. Besides, until the 1930s, "employer's charter" incorporated the principles of the voluntary assumption of risk and contributory negligence was used as a defense against employee claims of negligence. The servant or employee was assumed to have accepted all kinds of the ordinary risks during work under this line of reasoning. In view of all these, it was not easy for workers to seek for compensation successfully. Yet, the court case in 1837 overturned this obviously unreasonable and unfair theory. A servant sued his master for work-related injuries where the employer lost the case. It marked the milestone in the United Kingdom work safety as it was the first time where the principle of common employment was introduced—a limitation to the principle of vicarious liability. The humanitarian movements became committed to develop an organised labour movement, winning the right to vote from workers. Every time when the sympathetic parliamentarians had been elected, legislation which would redress the problems of common employment would be sought. The UK Employers' Liability Act was established in 1880s to provide workers with rights to receive compensation and remedies from employers. Nevertheless, it limited application to manual laborers and to injuries in situations with damages a maximum of three years earnings (Winder 2009).

11.3 Modern Common Law Principle in Accident Compensation

In 1932, Lord Atkin's judgment established the general principle of liability for negligent behavior: "You must take reasonable care to avoid acts or omissions which you can reasonably foresee would be likely to injure your neighbor". First, the employer is responsible to an employee for an accident caused by the negligence of any other employee acting within the scope of his authority (Smith v. Baker). One of the important issues in negligence lies in the "but for test", i.e., will the accident happen "but for" the defendant's negligence (Steele 2010). If the injury occurs without the defendants' negligence, negligence is not a necessary cause of the damage to the accidents (Fig. 11.1).

In the second doctrine, common employment states that the abovementioned general principle does not apply when the accident occurs due to the negligence of a fellow-employee at work, i.e., the employee has to bear the risks arising from the negligence of an employee selected with due care by the employer (Bartonshill Coal Co. v. Reid; Johnson v. Lindsay and Co.). The third, in the case of employment involving risks, the rule applies only when the maxim volenti non fit injuria can fairly be invoked. In such employment, there is a duty on the employer to take reasonable care and to use reasonable skills to provide and maintain proper machinery, plant, appliances, and works; select properly skilled persons to manage and superintend the business; and finally, provide a proper system of work. In fact, many of the modern court cases held that it was contrary to all probability to assert or to assume that the employee contracted on the basis that he was aware of risks

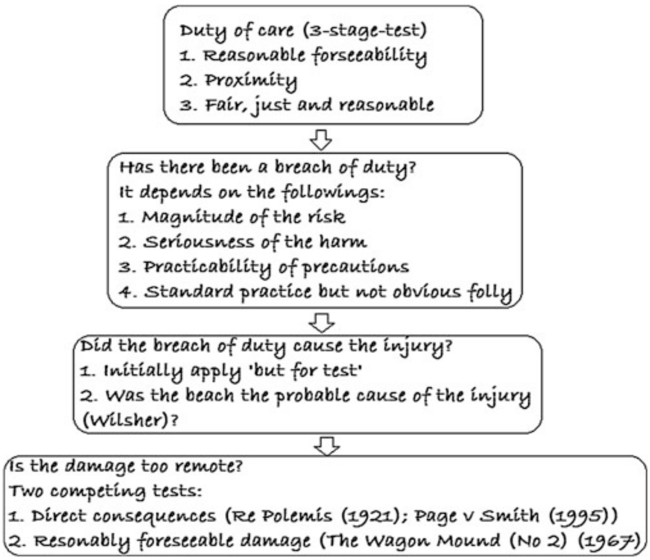

Fig. 11.1 Stage of test for negligence (Fung 2003)

in respect of these matters or that he impliedly agreed to take the risks upon himself.

11.3.1 Psychiatric Injury in Common Law

The duty of care for psychiatric injury lies on the fact that the contractor/employer is under the duty to take reasonable care for the plaintiff's physical safety. The criteria for psychiatric injury compensation are:

1. In case of nervous shock, it is necessary to distinguish between primary victim (the one who suffer from physical injury) and secondary victim (victim who sees the primary victim suffer and suffer from psychiatric injury afterwards).
2. In secondary victims' claims, the law insists on certain control mechanisms so as to limit the number of potential claimants. The proximity test refers to the closeness to time and space. It limits the number of secondary victims to those with close ties of love and affection only. And the plaintiff has to witness the accident or its immediate aftermath himself. Being told about the death of the beloved ones is insufficient.
3. It is legitimate to use hindsight to apply the test of reasonable foreseeability in case of secondary victims.
4. Whether the defendant can reasonably foresee his conduct will expose the plaintiff to the risk of injury. If yes, the duty of care will be established (Glofcheski 2009; Srivastava and Tennekone 2005).

11.3.2 Is a Warning Sufficient to Relieve the Employers from Legal Responsibility?

In Sword v. Cameron, the First Division of the Court of Session found that a master was liable in damages to a quarryman in the course of his employment who was injured by the firing of a blast before he reached a place of shelter. In such cases, the employer may protect himself either by making provision for due notice being given or by removing the source of danger. Nevertheless, should he adopt the first course, he is still liable if the injury is caused by the failure to give a warning due to the employer or his superintendent's negligence.

11.4 UK's Legislation

Apart from common law, statues also play an important role in UK work compensation. The Construction (Health, Safety and Welfare) Regulations 1996 (The National Archives 2012) Sect. 5 (1) states that there shall be suitable and sufficient safe access to and egress from every place of work and to any other place provided for the use of any person while at work, access and egress shall be risks free. Section 6 (1) states that sufficient and suitable steps shall be taken to prevent any persons from falling by providing working platform, guard-rail, barrier, toe-board or similar means of protection.

> Regulation 44 (2) reads as "where any electrically charged overhead cable or apparatus is liable to be a source of danger to persons employed during the course of any operations or works to which these regulations apply, whether from the operation of a lifting appliance or otherwise, all practicable precautions shall be taken to prevent such danger either by the provision of adequate and suitable placed barriers or otherwise".

Furthermore, it also states that warning signs are not sufficient to relieve the construction site owner's liability from accidents. 2(4)(a) of the Occupiers' Liability Act states that "[where damage is caused to a visitor by a danger of which he had been warned by the occupier, the warning is not to be treated without more as absolving the occupier from liability, unless in all the circumstances it was enough to enable the visitor to be reasonably safe".

11.5 Research Method

To know more about the accident compensation, the keyword construction and accidents and tort was used in BAILII database. There were 507 documents found as of the date on 14 May 2011 and valid cases were displayed in the last Table of this chapter. The current research identifies "construction site" and "construction work" according to The National Archives (2012). "Construction site" refers to any place where the principal work activity being carried out is construction work and "construction work" means the carrying out of any civil engineering, engineering construction work or building and includes any of the following:

1. The construction, conversion, de-commissioning, demolition or dismantling of a structure, alteration, commissioning, repair, renovation, upkeep, redecoration or maintenance work;
2. The preparation for an intended structure which includes site exploration, clearance, investigation (excludes site survey), laying or installing the structure's foundations;
3. The disassembly or assembly of pre-fabricated elements to form a structure;
4. The removal of a structure (or a part) or extraction of mineral resources;

5. The commissioning, maintenance, removal or repair of electrical, mechanical, compressed air, gas, telecommunications, hydraulic, computer or similar services which are normally fixed within or a structure but excludes the extraction or the exploration of mineral resources or activities preparatory thereto carried at a place where such extraction or exploration is carried out.

11.6 Results

The court case reports show that the amount of compensation ranging from £2,000 with interest to £1,050,000. Many of these cases took more than 5 years to come to final decision of compensation which is quite time consuming. The court case reports provide some important criteria in determining whether a victim can obtain monetary compensation under common law.

11.6.1 Damages have to be Foreseeable

In the court case Simmons (Respondent) v. British Steel plc (Appellants) Scotland, the judges stated that the employer was liable for damages that were reasonably foreseeable "…[w]hile a defender is not liable for damage that was not reasonably foreseeable, it does not follow that he is liable for all damage that was reasonably foreseeable: depending on the circumstances, the defender may not be liable for damage caused by a novus actus interveniens or unreasonable conduct on the part of the pursuer, even if it was reasonably foreseeable… if the pursuer's injury is of a kind that was foreseeable, the defender is liable, even if the damage is greater in extent than was foreseeable or it was caused in a way that could not have been foreseen...".

11.6.2 Reasonableness

Based on the example of ground condition, the judge in Michael Moon and Paul James Garrett and Ors 2006 explained the nature of reasonableness "[t]he unevenness of the ground was a slightly contributory factor to the fall, but the ground was not so uneven so as to found any liability in negligence and/or breach of statutory duty by virtue of its unevenness. A polished surface cannot be expected on a building site. Some degree of unevenness of ground must be present on building sites, and indeed the unevenness to be observed in the photographs can hardly be such as to give rise to liability for any tripping or slipping, based on a reasonable condition test for a building site". The lengthy judgment also stated that “e]ach case of this kind depends on its own particular facts, to which the broad principle of reasonable care must be applied with common sense. The task of finding the facts and applying the principle to them is eminently a matter for the court of first instance”.

11.6.3 Psychiatric Injury

In some cases, psychiatric injury can be identified as an action for damages in Young v. Charles Church (Southern) Ltd 1997. The courts, however, have to distinguish physical and mental injury as their different characteristics make it inevitable that different considerations apply with regard to the evidence which proves that injury has occurred, and how it was caused.

11.6.4 Proximity

For the claim of damages for negligence to succeed, the plaintiff has to establish a legal relationship between himself and the defendant on the basis of proximity (Young v. Charles Church (Southern) Ltd).

11.6.5 Time is of Essence

Time is also an important concern as to whether damages can be recovered. The Judge in Simmons (Respondent) v. British Steel plc (Appellants) Scotland, pinpointed that “the exacerbation of the pursuer’s skin condition and the onset of his depressive illness occurred too long after the accident for it to be the ‘direct’ cause of these developments”.

11.6.6 Volenti Non Fit Injuria

Can “Volenti non fit injuria” be applied as an employer’s excuse from liability ? In Joseph Smith (Pauper) v. Charles Baker and Sons (1891), the plaintiff was working at a drill and some workmen were cutting and taking stones out of it near him. The stone slipped and fell from the crane upon the plaintiff and did him serious injury. Although they moved for a nonsuit, “on the ground that the case ought not to have been allowed to go to the jury, the plaintiff having admitted that he knew of the risk and voluntarily incurred it”. The judge refused the motion and entered judgment for the plaintiff for £100.

11.6.7 Degree of Responsibility

As "[a]ccidents are not as per definition by chance but are usually caused by avoidable human errors of judgment, with usually no single cause, but rather a combination of reasons resulting in the ultimate event" (Michael Moon and Paul James Garrett and Ors 2006), in deciding the level of compensation, judges usually consider not just the immediate party who is liable for the accident but also the plaintiffs themselves and other stakeholders who may be liable for the accident. For example, the judge in Mark George Chinery v. Engineering With Excellence Ltd and Ors Mr Chinery found that the employers were 70 % responsible and the second defendants were 30 % responsible but the third defendants were not liable. It also ruled that a substantial amount of compensation would be deducted in this case as the plaintiff had contributory negligence. For other cases, please refer to Joseph Smith (Pauper) v. Charles Baker and Sons.

11.6.8 Deceit

In some cases, the plaintiff cannot recover the loss of earnings because of exacerbation of the health condition after accidents, e.g. Simmons (Respondent) v. British Steel plc (Appellants) Scotland. The judge in Timothy v. Hewison and- (1) Meridian Shipping Pte, (2) Coflexip Stena Offshore Ltd, (3) Flex Installer Offshore Ltd even warned that the dishonesty of the plaintiff could be charged according to S.16 of the Theft Act.

11.7 Conclusion

Accident compensation aims at relieving the financial needs of the workers after accidents and motivating the corporations to improve the safety policies in the future. When judges decide the amount of compensation, the major considerations include the foreseeability of the damages, reasonableness, proximity, reliability of the plaintiff etc. Summary of the court cases can be found in the following Table 11.1.

Table 11.1 Summary of all the construction accident compensation court cases in UK

UK	Year of accident	Year of case heard	Causes of the injury and results	Compensation	Reasons
Ferguson (A.P.) Appelants v. Welsh and others (respondents)	1976	1987	On 16 July 1976, when Mr. Ferguson was engaged in demolition work in a building, he sustained an accident which resulted in a broken back, leaving him paralysed from the waist downwards	£150,000	The Welsh brothers were liable in damages to Mr. Ferguson as their employees. The system adopted by the Welsh brothers for demolition of the building breach of various regulations which include the Construction (General Provisions) Regulations 1961 (S.I. 1961, No. 1580) and the Construction (Working Places) Regulations 1966 (S.I. 1966, No. 94) and was highly dangerous
Simmons (Respondent) v. British Steel plc (Appellants) Scotland	1996	2004	On 13 May 1996, the pursuer sustained injuries in the course of his employment as a burner at Clyde Bridge Steel Works, Cambuslang. He tripped, fell from the burning table and struck his head on a metal stanchion. He shaked, dazed and a swelling on the right side of his head was developed. This was accompanied by disturbance to his eyesight, headaches, suppuration from his right ear and a severe depressive illness. He was unable to return to work since the accident	£3,000, with interest	The exacerbation of the pursuer's skin condition and the onset of his depressive illness happened too long after the accident for it to be the direct cause of these developments

(continued)

Table 11.1 (continued)

UK	Year of accident	Year of case heard	Causes of the injury and results	Compensation	Reasons
Timothy v. Hewison and-(1) Meridian Shipping Pte, (2) Coflexip Stena Offshore Ltd, (3) Flex Installer Offshore Ltd	1995	2002	On 21 December 1995, a crane operator suffered from serious injuries after an accident happened. He was unable to work for 15 months but returned to work in the spring of 1997. He *misrepresented* his medical condition and resumed working in the same capacity as before without telling his employers about his epilepsy after the accident. For a long time before the accident, the plaintiff already suffered from idiopathic epilepsy without defined underlying cause. The doctors agreed that had the accident not taken place, there would be 20 % likely that he would not sustained a serious maxillo-facial injury and a head injury when he suffered from an epileptic seizure while he was asleep; and there would be 80 % chance that he would remain fit free for the remainder of his life	£0	The appellant should not be able to recover the loss of earnings because of these reasons: (1) the appellant must prove that but for the accident he would have continued to work in that capacity to recover the loss of earnings, (2) as the plaintiff continues to work in that capacity he would have to deceive his future employers by a false representation that he did not suffer from epilepsy and by failing to inform them that he was able to avoid epileptic seizures only by taking anti-convulsants; (3) He would thus commit the criminal offence of obtaining a monetary advantage by deception, i.e. the opportunity to receive the earnings (the loss of that he is claiming) which is contrary to Sect. 16 of the Theft Act 1968

(continued)

Table 11.1 (continued)

UK	Year of accident	Year of case heard	Causes of the injury and results	Compensation	Reasons
Young v. Charles Church (Southern) Ltd	1989	1997	The plaintiff claims damage for psychiatric illness that he has suffered since 25 May 1989. The accident occurred at his place of work where his workmate besides him was electrocuted and killed. Andrew Cook, the plaintiff's colleague and scaffolder got electric shock later knocked down another men with a mark on his arm. The plaintiff got nervous shock after witnessnessed Mr Cook's accident	£0	The plaintiff should not be able to recover from any loss. The basis of the decision rest in Alcock v Chief Constable of South Yorkshire where the shock is caused by fear of injury to others but not to the plaintiff himself, the test of proximity is not simply reasonable foreseeability: there must be a sufficiently close tie of love and affection between the victim and the plaintiff
Michael Moon and Paul James Garrett and Ors	2001	2006	Mr Moon was employed as a delivery driver by C H Kendal and Sons. On 10th October 2001, when he was delivering 3.5 pallets of heavy concrete blocks to Mr Garrett, some blocks fell off the lorry. The fall caused Mr Moon to lose his balance, rolled into a pit and suffered from a serious back injury	NA	The judge Lambert found that Mr Garrett was liable but dismissed the claim against Mr Moon's employers. Mr Garrett should pay the costs of Mr Moon and himself as he was aware that the pit posed some danger. He had purchased and erected a warning fence which was inadequate

(continued)

Table 11.1 (continued)

UK	Year of accident	Year of case heard	Causes of the injury and results	Compensation	Reasons
Mark George Chinery v. Engineering With Excellence Ltd and Ors	1995	2002	On 7th July 1995, Mr Chinery was working as an employee of Engineering with Excellence Limited, the first defendant appellant as a lagger. suffered severe injury which resulted in paraplegia when he fell from the seventh floor 700 mm circular capped ventilation duct. The first defendants were sub-contractors to Balfour Kilpatrick. Their work included carrying out insulation work to the newly installed chilled water pipe work. The second defendants, Balfour Kilpatrick Limited, were sub-contractors to Laing for the public health and mechanical works. Having suffered from severe injuries he could not to give exact details of how it happened. The court held that he should receive £1,050,000 as damages against the three defendants	£1,050,000	After considering contributory negligence on the plaintiff's. part, Mr Chinery's employers were 70 % responsible and the second defendants were 30 % responsible but the third defendants were not liable. The Deputy Judge held that the third ones were not obliged to carry out further and more expensive work than they had been authorized to do. Mr Rae failed to ensure that no trap existed which could have avoided the accident. He did not give sufficient risk consideration to the lightweight cover to the duct in a confined space when he knew other persons were going to have to work in the area. It was the second defendants' responsibility to instruct the third ones to remove the duct, the extent to be removed as well as the method of capping

(continued)

Table 11.1 (continued)

UK	Year of accident	Year of case heard	Causes of the injury and results	Compensation	Reasons
Timonthy Hewsion v. Meridian Shipping Pte (2) Coflexip Stena Offshore Ltd (3) Flex Installer Offsore Ltd	1995	2002	The appellant suffered from serious personal injuries while he was employed by the first respondents as an AB/crane operator on the cable-laying vessel which was owned by the third respondents and chartered to the second respondents on 21 December 1995. The appellant sustained a serious maxillo-facial and a head injury. He suffered from an epileptic seizure when he was asleep which was obviously caused by the accident. He thereafter remained off work for 15 months but returned to work again with the first respondent in the spring of 1997. It was about the time when he filled in the medical questionnaire. He misrepresented his medical condition and resumed his work in the same capacity as before but he did not tell his employers about his epilepsy after the accident	£0	The appeal was dismissed: (1) to recover loss of earnings the appellant must prove that but for the accident he would have continued to work in that capacity; (2) to be able to continue to work in capacity he would have to deceive his future employers by failing to inform them that he was able to avoid epileptic seizures by taking anti-convulsants only and by falsely representing that he did not suffer from epilepsy and; (3) he committed the criminal offence of obtaining a monetary advantage by deception, took the opportunity to make the earnings, which is contrary to Sect. 16 of the Theft Act 1968. The appellant is not entitled to recover the loss of earnings claimed (Hunter v. Butler). He should not be permitted to claim because ex turpe causa non oritur damnum

(continued)

Table 11.1 (continued)

UK	Year of accident	Year of case heard	Causes of the injury and results	Compensation	Reasons
Joseph Smith (Pauper) v. Charles Baker and Sons	1891	1888	The plaintiff was employed in working at a drill while two other workmen struck with a hammer at the drill, a stone slipped from the crane and fell upon the plaintiff leading to serious injury	£100	As the plaintiff knew the possibility of such an accident, three affirmed the fault on the part of the respondents. One of them, however, negatived contributory negligence. Another assumed the risk should be borne by the appellant. The sixth assessed damages at £100. The judge entered judgment for the plaintiff for £100

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Chapter 12
Job Burnout and Safety Performance in the Hong Kong Construction Industry

12.1 Burnout and Safety

Many researchers have investigated the effect of burnout. It has been suggested as a major reaction produced by job stress (Lee and Ashford 1993; Cordes and Dougherty 1993) and the result when an individual is exposed to constant and routine stress over a prolonged period of time (Westman and Eden 1997). Maslach et al. (1996) defined burnout phenomenon as a syndrome of emotional exhaustion, cynicism and reduced personal accomplishment.

Emotional exhaustion refers to feelings of depleted emotional resources and a lack of energy. Cynicism incorporates a cynical attitude involving an exaggerated distancing from work. Diminished personal accomplishment means a situation in which employees tend to evaluate themselves negatively and become dissatisfied with their accomplishments at work (Yip 2007). Yip (2007) investigated the phenomenon of job burnout in the Hong Kong construction industry. 33 and 17 % of participants experienced severe burnout in emotional exhaustion and cynicism respectively.

Burnout is often associated with mental and physical disorders such as distress, anxiety, headaches and sleep disturbances (Maslach et al. 2001; Tang 2001; Gunn 2004). Individuals suffering from burnout would produce work of lower quality and are often involved with making mistakes at work (Smith 1999). Thus, occupational stress may lead to workplace accidents.

For decades site safety has received a lot of attention and effort, yet not entirely satisfactory in the Hong Kong construction industry. Significant progress has been made but improvement rate has reached another plateau in recent years. A study funded by the Construction Industry Institute has confirmed that most safety measures are effective and mature organizations have better performance (Rowlinson et al. 2009). Prescription by the Government and the Authority, and self-regulation by the organizations were effective to improve safety but it appears that the existing plateau one can only break through by a change in culture. Indeed safety has now become one of the most important priorities of the stakeholders in the local industry.

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The presence of job burnout phenomenon could be accountable for the high accident rate in the Hong Kong construction industry. Lagarade et al. (2004) has discovered the positive correlation between high level of emotional exhaustion and accident causation. Research has found that the coping strategy, adopted by individuals, is likely to have a moderating effect on the relationship between job burnout and safety performance.

A study was undertaken at The University of Hong Kong (Poon et al. 2012) to explore whether or not there is an interaction between job burnout and safety performance, including the identification of possible coping strategies in reducing workplace accidents.

12.2 Findings

A total of thirty senior construction personnel such as site agent, senior construction manager, safety manager etc. took part in interviews on the investigation between the job burnout effect on safety performance.

The findings from the interviews showed that the effect of burnout on safety performance is mixed and complex. Many construction personnel lost their ability in hazard identification, supervision, problem solving and decision making. They also felt a loss of concentration and sight of risky areas, and were less motivated to contribute. The above effects will directly affect safety performance. Other interviewees felt that safety performance was a group phenomenon and individual burnout would have no effect on safety performance. Although productivity could be lowered by the reduced personal accomplishment aspect but the project safety should be affected.

In between the two ends, burnout effect on safety performance can be moderated through mediation. The individual’s degree of direct involvement in safety provision and the quality of the workers and work processes would have different impact on safety performance. A high reliability system is likely to compensate the individual lapses. On the other hand, a low reliability work system with poor quality workforce and processes compound the burnout effect and aggravate the poor safety conditions.

A number of mediators which can have negative or positive modification to the burnout effect have been suggested. Negative impact such as under-evaluation of the contribution from safety personnel, the mechanistic application of safety management system, and rivalry and political manoeuvring should be avoided. Leadership, good team interaction and working relationship, quality of workforce, and organizational culture should be promoted as far as possible.

It has been found that individual reactions to job burnout are quite different. The experience of reduced personal accomplishment, due to inequality in pay with new recruits, can eventually lead to quitting the present post. The positive steps such as a flexible and adaptable approach to deal with the burnout effects with satisfaction have also been recorded.

12.3 Summary

Different reactions have been found in experiencing job burnout by construction personnel in Hong Kong. The burnout effect can have direct or no effect on safety performance depending on the level of involvement of staff and reliability of the work system. Positive mediators are leadership, good working relationship and organizational culture. However, under-evaluation of the contribution from safety personnel, mechanistic application of the safety management system, and rivalry and political manoeuvring will aggravate the safety situations. A positive attitude will have the greatest influence on diluting the burnout effect.

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