Social Costs of Construction Accidents and Safety Investments in Hong Kong

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Abstract

Financial costs of a construction accident are those costs which are borne by the employer of the victim as a result of losses from the accident. Financial costs are, however, are fraction of the social costs which are borne by the society as result of loss in the economic activity in the society and for providing rescue/support services/facilities to the victim. In addition to the accident costs, there are preventive costs called as safety investments made by the contractors and the related public sector organizations. In this paper, the cost data of 406 accident cases on 87 construction projects in Hong Kong from year 2005 to 2007 have been analysed along with the accident cost and safety investment data from 23 organizations. The data for accident costs from contractors was normalized to reflect the overall society. The results show that there was a gradual increase in the safety investments as a fraction of overall construction output in Hong Kong from years 2005 to 2007 whereas social costs of accidents expressed as fraction of overall construction output gradually decreased in those years. Overall, there was an average of $1.30 decrease in the accident costs with an extra $1.00 on safety investment with respect to the previous year.

Keywords

Accidents, Construction, Costs, Hong Kong, Investments, Safety

1. Introduction

Construction site safety is a matter of life and costs. It is a matter of life because in case of accidents the life of humans is at risk. It is a matter of cost because making adequate investments on a safety programme can save the costs incurred as a result of construction accidents. The costs of construction accidents can be huge and can include the time losses due to absence from work, medical expenses; damages to finished works, idle time of equipment and plant, reduction in productivity immediately after the occurrence of accident, etc. Heinrich *et al.* (1980) were among the firsts to investigate the costs of construction accidents. Construction costs were studied in more details afterwards by Leopold and Leonard (1987), Lee (1991), Levitt and Samelson (1993) and Everett and Frank Jr. (1996). The research on costs of accidents has classified such costs in two broad categories, namely the financial costs and social costs. Tang et al. (1997) and Hinze (2000) have proposed the ways to evaluate and analyze the effect of financial costs of construction accidents on the safety performance of construction projects.

In comparison to financial costs which are the losses to the contractors, Ngai and Tang (1999) remarked that the social costs of construction accidents are the losses borne by the society. The financial costs, therefore, are a component of social costs. However, not all financial costs are social costs as some costs are just the internal transfer within a society. The social costs of construction accidents in Hong Kong have been quantified for the years between 1999 and 2005 by two studies made by Tang *et al*. (2004) and Tang *et al*. (2007). These studies explicitly calculated each element of social costs of construction accidents and the safety investments made by the Hong Kong construction industry as a whole for the corresponding years. Tang *et al*. (2004) found that from 1999 to 2001, every extra HK$1.00 invested in safety resulted on average in a reduction of HK$2.27 in social costs (US$1 = HK$7.8 approx.). The corresponding figure from Tang *et al*. (2007) for the years between 2002 and 2005 was HK$1.67. The results from both studies showed that there is a decreasing trend in the reduction of social costs of construction accidents as a result of increasing safety investments. The present study would investigate how the social costs of construction accidents respond to the social safety investments made in the years from 2005 to 2007.

2. Components of Costs of Construction Accidents

The total social cost of a construction accident can be derived from a number of contributing items. These items have been identified. The calculations of costs related to these items are described as follows:

2.1 Victim's Losses

There are three contributing items for this loss. First is the loss to the society due to the absence of victim from work as a result of injury. For example, as a result of an accident, a worker who earns HK$600 per day, remains absent for 20 days. The social cost would be the full loss of HK$12,000 (600 x 20). The financial cost to the contractor would be 80% of this amount as the maximum amount of employees' compensation to be paid according to laws in Hong Kong. Second contributing factor is the loss due to permanent disability to the victim reducing efficiency to perform work for the rest of his/her life. This is calculated up to the normal retiring age which is 65 years in Hong Kong starting from the age at the time of accident. For example, if the worker above suffered accident at the age of 54 year and was certified to be 2% permanent disable, the social cost due to disability of worker would be [600 x 365 x (65- 54) x 2/100] = HK$48,180. The third contributing factor is the sympathy money which is usually given by the contractor to the victim or his/her family after a severe accident. This is only a financial loss to the contractor and not a social cost as it represents the internal transfer within a society (Tang 2003).

2.2 Victim's Inefficiency after Resuming Work

It is the estimate of the loss due to inefficiency of the injured worker after resuming work. This is a social cost to the society as well as the financial cost to the contractor. It takes into account the effect of the absence from work and the permanent disability. It is calculated by: Daily wage x (day loss x 1/20 + % disability) For example, if a worker who earns HK$600/day is absent from work for 20 days, and is certified by a doctor to be of 2% permanent disability, then the loss due to inefficiency is calculated by: HK$600 x (20 x 1/20 + 2) = HK$1,800 The formula is based on the assumption that the severity of 1% disability is equivalent to an injury resulting in a loss of 20 working days and has been explained in Tang *et al*. (2007).

2.3 Costs of Medical Expenses and Hospitalizations

The social costs of medical expenses include the costs incurred by the Hong Kong SAR Government (or more exactly the Hong Kong Hospital Authority). A contractor pays a nominal amount of money for the victim employee as expenses for treatment in public hospitals, which is heavily subsidized. For example, in 2007, the financial cost (cost to the contractor who pays for the victim) of staying 1 day in

a public hospital was HK$100, but the social cost (actual cost borne by society) was HK$3,480/day. Table 1 shows the social costs of hospitalization and its related services (information obtained from the Hong Kong Hospital Authority).

Table 1: Actual Costs for the Medical Services of the Hong Kong Hospital Authority

	Cost (HK$)		
	2005	2006	2007
Accident and Emergency per attendance	720	700	730
Hospitalization (In patient) per day	3,280	3,290	3,480
General out-patient per attendance	250	260	270

2.4 Costs Due to Fines and Legal Expenses

These consist of solicitor fees, other legal expenses and fines imposed by court. Solicitor fees are both financial costs and social costs whereas a fine imposed by court is an internal transfer of money within the society, so it is a financial cost to the contractor but not a social cost to the society.

2.5 Costs Due to Loss of Time of Other Employees

This cost is both financial and social, because it is not only borne by the contractor but also by the society. When an accident occurs, other employees will assist the victim and carry out works like accident investigation, accident reporting, mitigating/preventing further damages, cleaning up the mess, and so on. It is assumed that 0.05 day will be spent by the site agent, 0.05 day by the site engineer, 0.25 day by the site foreman and a total of 1 day by other labourers. These figures are arrived at after consulting experienced site staff.

2.6 Costs Due to Damage to Plant/Equipment and Material/Finished Work

All these costs are both financial and social. They are financial costs because contractors need to bear these costs. They are social costs because they are real losses to society.

2.7 Costs Due to Idle Machinery or Equipment

Contractors need to bear the cost of idle machinery and equipment when workers temporarily stop work due to accidents. The costs are both financial and social. The formula for estimating such costs is: (Contract sum x 20%) x 2% / (No. of working days). This formula was explained in Tang *et al*. (1997).

2.8 Costs Due to Other Items

These costs refer to any other costs which have not been mentioned above but have been incurred by the contractor and/or society. Whether or not this item belongs to social costs depends on the nature of the losses and must be considered on individual basis.

2.9 Costs Due to Lost Time of Relatives/Friends

Loss of time of the victim's relatives and friends is also a social cost of an accident. They need to spend time in taking care of the victim. For those relatives and friends who are full-time employees, they may also have to take time off from their work, resulting in a reduction of overall productivity of the society. The formula used to quantify the working time lost by working relatives and friends, after consulting with experienced social workers, is: Daily wage x (day loss + % disability x 20) The daily wage of relatives and friends is taken as the same as the victim because it is considered they are likely coming from the same class of people from the society. The factor 20 is based on the assumption that

the severity of 1% disability is equivalent to an injury resulting in a loss of 20 working days. For example, if a worker who earns HK$600 a day was absent from work for 10 days and was certified to be 2% permanently disabled, then the social cost due to the lost time of relatives will be: HK$600 x (10 + 2 x 20) = HK$30,000

2.10 Costs Incurred by Public Organizations

When construction accidents occur, the following public organizations need to provide assistance, and the costs incurred are social costs. The names of these organizations are as follows:

(1) Hong Kong Police Force   (4) Social Welfare Department
(2) Fire Services Department   (5) Legal Aid Department
(3) Labour Department   (6) The Courts

Questionnaires were sent to these organizations to acquire cost data for years 2005, 2006 and 2007.

3. Safety Investments by Contractors

Contractors invest money in order to prevent the occurrence of accidents. Questionnaires were sent to the contractors for providing the amount of safety investment on the contract along with the information about the contract sum, duration and the number of accidents for the contract. In this study, data were obtained from 87 projects. There were altogether 406 accidents in these 87 projects. Figure 1 shows the distribution of the contract values and the number of accidents for these 87 projects.
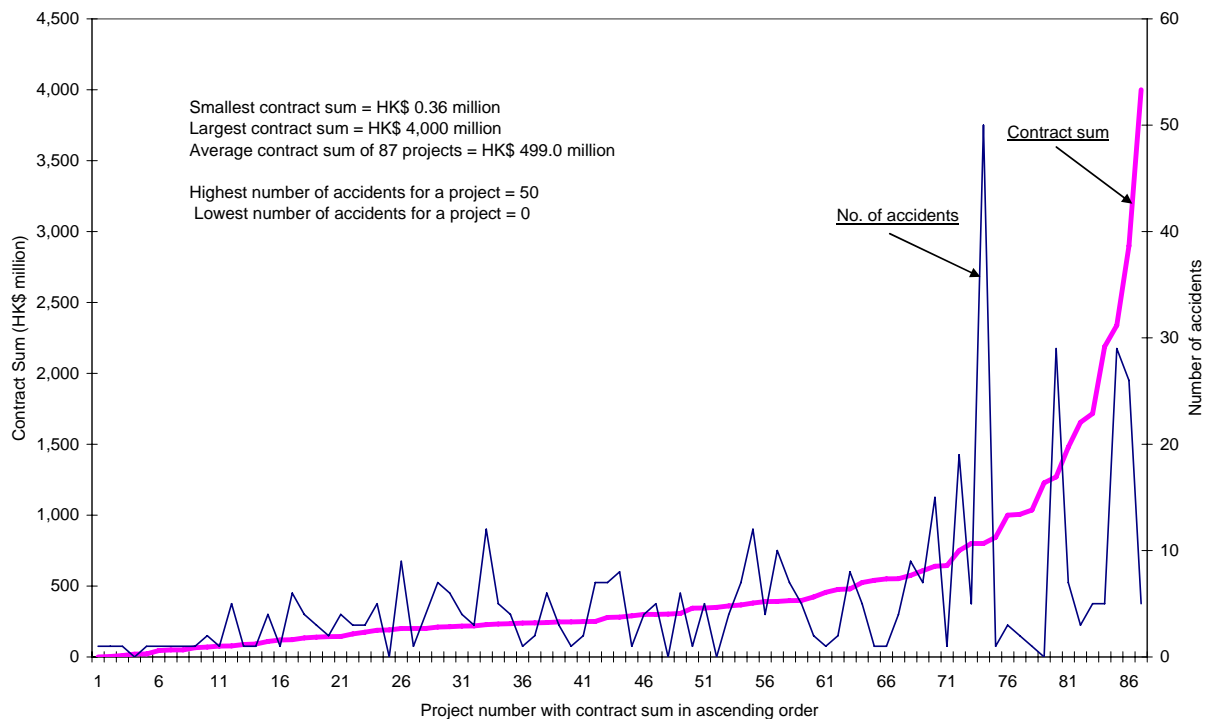
The 87 projects mentioned above were carried out in Hong Kong from 2005 up to 2007. In analyzing the data, the method of distributing the contract sums into the three time periods can be illustrated by an example. If a project had a contract sum of HK$300 million and lasted for 30 months, of which six months fell in 2005, twelve months in 2006 and twelve months in 2007, then the contract sum falling in year 2005 is given by: HK$300 million x 6/30 = HK$60 million and those falling in each of years 2006 and 2007, are: HK$300 million x 12/30 = HK$120 million. For accident costs, the costs of the accidents were distributed to the year in which the accident occurred. For safety investments made by contractors, the distribution methodology is the same as that used for contract sum distribution. Table 2 shows the safety investment made by contractors for these 87 contracts for the years 2005, 2006 and 2007.

4. Safety Investments made by Public Organizations

Apart from organizations which incur cost in case of construction accidents there are a number of public organizations in Hong Kong which invest money for the prevention of accidents. The names of these organizations are as follows:

(1) Architectural Service Department	(11) Hong Kong and China Gas Company
(2) Buildings Department	(12) Hong Kong Housing Authority
(3) Civil Engineering & Development Department	(13) Industrial Centre, the Hong Kong Polytechnic University
(4) Construction Industry Training Board	(14) Labour Department
(5) Drainage Services Department	(15) Occupational Safety and Health Council
(6) Electrical and Mechanical Services Department	(16) MTR Corporation
(7) Hong Kong Electric Company	(17) Student Financial Assistance Agency
(8) CLP Power Hong Kong	(18) Vocational Training council
(9) Fire Services Department	(19) Water supplies Department
(10) Highways Department	

Questionnaires were sent to these organizations for providing their input as safety investment in Hong Kong's construction projects. The completed questionnaires gave the authors the necessary data for evaluating the total construction safety investment in Hong Kong for years 2005 to 2007.

Smallest contract sum = HK$ 0.36 million
Largest contract sum = HK$ 4,000 million
Average contract sum of 87 projects = HK$ 499.0 million

Highest number of accidents for a project = 50
Lowest number of accidents for a project = 0

Figure 1: Distribution of Contract Values and Number of Accidents

Table 2: Total Safety Investments made by the Contractors of the 87 Projects

	Year 2005	Year 2006	Year 2007
Total safety investments made by the 87 projects (HK$1,000)	64,100	82,892	74,724

5. Data Analysis

After all the above information was collected, the data was analyzed. The total contract sums of the 87 contracts, split over three years (2005, 2006, and 2007) are shown in Table 3. These represent

14.86%, 23.39% and 22.72% of the total construction outputs in Hong Kong in the years 2005, 2006 and 2007 respectively (Hong Kong Census and Statistics Department, 2008).

Table 3: Total Yearly Contract Sum of 87 projects against Yearly Construction Output

	Year 2005	Year 2006	Year 2007
Total contract sum of 87 projects (HK$ million)	8,283	10,711	9,655
Total construction output in Hong Kong (HK$ million)	55,743	45,785	42,497
Percentage representing total construction output	14.86%	23.39%	22.72%

Social costs due to medical expenses and contractors' losses and the losses of victims and relative/friends for these 87 projects are shown in Table 4 for the respective years.

Table 4: Total Social Costs of 87 projects

	Year 2005	Year 2006	Year 2007
Total number of accidents occurred	91	167	148
Total number of hospitalizations	28	27	22
Total number of hospitalization days	272	181	170
Social cost due to hospitalization incurred by the Government (HK1,000)	912	614	608
Social cost due to medical expenses (non-hospitalized) paid by the contractor (HK$1,000)	214	380	195
Social cost due to losses of victims - corresponding to Section 2.1 (HK$1,000)	27,558	22,491	14,399
Social cost due to losses of relatives – corresponding to Section 2.9 (HK$1,000)	13,508	17,439	12,304
Social cost due to contractor's losses - corresponding to Section 2.2, 2.4 to 2.8 (HK$1,000)	1,023	1,643	1,522
Total social cost incurred in 87 projects (HK$1,000)	43,215	42,566	29,029

Table 5: Yearly Social Costs Incurred by the Six Public Organizations

	Year 2005	Year 2006	Year 2007
Yearly social costs incurred by the six public organizations (HK$1,000) – see Section 2.10	20,304	20,001	18,675

The total social costs borne by the six public organizations are shown in Table 5. The total safety investments made by the nineteen public organizations are shown in Table 6. The individual cost incurred and safety investment made by each organization is supposed to be confidential and is not shown for their privacy. The total social costs shown in Table 4 and the total safety investments shown in Table 2 have to be proportioned to the yearly values by using the percentages they are representing as shown in Table 3. Then the values in Tables 5 and 6 have to be added to these overall yearly values respectively. The calculations of yearly social costs of accidents and yearly social safety investments are shown in Tables 7 and 8 respectively. The overall social costs and the overall safety investments for year 2005, 2006, and 2007 have to be expressed as the percentages of total

construction output in the respective years. These are shown in Table 9. Table 10 shows the differences of these percentages between 2005 & 2006 and 2006 & 2007. These values, the reduction in social costs divided by the increase in social safety investment for 2005 versus 2006, and 2006 versus 2007 respectively, can be calculated. The mean value shown in Table 10 is 1.30. This means that for every extra $1.00 of safety investments made during 2005 to 2007, a reduction of $1.30 in social costs of construction accidents was achieved in Hong Kong.

Table 6: Total Social Safety Investments made by the 19 Public Organizations

	Year 2005	Year 2006	Year 2007
Yearly social safety investments made by the 19 public organizations (HK$1,000)	212,196	214,749	231,477

Table 7: Calculation of Overall Yearly Social Costs

	Year 2005	Year 2006	Year 2007
Yearly social cost excluding those incurred by the six public organizations (HK$1,000)	43,215 /0.1486 =290,838	42,566 /0.2339 =181,954	29,029 /0.2272 =127,767
Yearly social costs incurred by six public organizations (HK$1,000)	20,304	20,001	18,675
Overall yearly social costs (HK1,000)	311,142	201,956	146,442

Table 8: Calculation of Overall Yearly Social Safety Investments

	Year 2005	Year 2006	Year 2007
Yearly social safety investments excluding those incurred by the 19 public organizations (HK$1,000)	64,100 /0.1486 =431,395	82,892 /0.2339 =354,330	74,724 /0.2272 = 328,885
Yearly social safety investments made by the 19 public organizations (HK$1,000)	212,196	214,749	231,477
Overall yearly social safety investments (HK1,000)	643,592	569,079	560,362

Table 9: Overall Social Costs and Safety Investments as Percentage of Total Construction Output

	Year 2005	Year 2006	Year 2007
Total construction output in Hong Kong (HK$ million)	55,743	45,785	42,497
Overall yearly social costs (HK$1,000)	311,142	201,956	146,442
Overall yearly social costs as percentage of total construction output (%)	0.5582	0.4411	0.3446
Overall yearly social safety investments (HK$1,000)	643,592	569,079	560,362
Overall yearly social safety investments as percentage of total construction output (%)	1.1546	1.2429	1.3186

Table 10: Reduction of Social Costs as Result of One Extra HK Dollar Increase of Safety Investments

	Year 2005 vs. Year 2006	Year 2006 vs. Year 2007
Reduction in overall social costs (% of total construction output)	0.5582 – 0.4411 =0.1171	0.4411 – 0.3446 =0.0965
Increase in overall social safety investments (% of total construction output)	1.2429 – 1.1546 =0.0884	1.3186 – 1.2429 =0.0757
Reduction in social cost divided by increase in safety investment	0.1171 / 0.0884 =1.3249	0.0965 / 0.0757 =1.2756
Mean Value	(1.3249+1.2756)/2 = 1.30	

6. Conclusion and Recommendation

It can be seen from the results that for every extra $1.00 of safety investments, the reductions of social costs were $1.32 for 2005 versus 2006, and $1.27 for 2006 versus 2007. The mean value was $1.30. These figures can be called as "social cost reduction to safety investment increment ratio". It is found that there was a decreasing trend for this ratio from 2005 to 2007. However, this trend cannot continue forever. According to the "law of diminishing returns" of economics theory, a time in the future may come when every extra $1.00 of safety investments will result in $1.00 of reduction of social costs. If this happens, the "optimum point" will be reached. This value should be considered as the minimum safety investment required in a construction project, considering the lives of people that are at risk. Therefore, it is recommended that the Hong Kong SAR Government should keep track of the development of safety investments made and the social costs incurred in the years ahead. These data can be used as a reference for the Government's policy decision.

7. Acknowledgements

8. References

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