A COST-BENEFIT ANALYSIS (CBA) OF CONSTRUCTION HEALTH AND SAFETY MANAGEMENT: A THEORETICAL DISCUSSION

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Research in construction health and safety has focussed on improving management strategies and policies that can effectively improve safety performance. The Health and Safety Executive (HSE) in 2005 developed on-line interactive tools for contractors to assess the cost of accidents to their organisations. Although providing good guidance, these tools developed do not provide sufficient detail to specifically assist contractors and designers in developing effective and efficient health and safety management systems. Therefore, it is considered important to develop a methodology to enable contractors to assess the true costs of accidents and the associated benefits of accident prevention as part of pre and post contract project evaluation. A framework is proposed based on an examination of economic viability of management of construction health and safety. The method developed incorporates accident cost elements, health and safety measures and benefit elements to improve decision making processes and guide contractors and designers in developing efficient and effective construction health and safety management practices.

Keywords: accidents cost, benefits, cost-benefit analysis (CBA) framework, safety measures.

INTRODUCTION

The construction industry contributes significantly to UK economy representing some 10% of the Gross Domestic Product (GDP) and employing 1.5million people (NAO, 2005). This is a significant figure, and one, which underlines the industry's real importance, as concerned with the provision of the country's essential infrastructure and 'backbone'. These essential infrastructures include: the water we drink, the roads we use, the buildings we live and work in, and are designed and produced by the construction industry. The well being of the industry is essential; its ability to compete with the best in the world market, to attract the best talent, and to have an attractive image and reputation is key (HSE, 2004).

There were 77 fatal injuries and 4,430 major injuries to construction workers in 2006/07, equivalent to a rate of 3.7 per 100 000 workers. Of the 77 deaths, 50 were employees and 27 self-employed. In 2006/07, 32% of worker fatalities across all industry occurred in construction. Based on an average of the past five years, construction fatalities account for around 30% of all worker deaths (HSE, 2007).

In the past decade, many parties in construction have become focussed in finding ways of curbing construction related injuries and fatalities (Joyce, 2001). Most of

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these interests are rooted in the escalating costs of injuries largely attributed to the rising costs of medical treatment. In order to tackle this problem, it requires a cost-benefit analysis approach to enable the stakeholders in the industry to perceive the financial benefits of proactive and efficient health and safety management. It is envisaged that a clearer understanding of the cost benefit can provide an incentive to improve construction health and safety management (Ikpe *et al.,* 2007).

The HSE in 2005 developed on-line interactive tools for contractors to assess what accidents cost to their organisations. These include: annual accident calculator; incident costs calculator and ill-health costs calculator. However, the on-line interactive tools developed by the HSE need to be modified to improve construction health and safety management. Although with a potential to provide good guidance, the tools are not detailed enough to specifically assist contractors and designers in developing effective and efficient health and safety management systems.

A cost benefit analysis (CBA) health and safety theoretical framework is presented towards providing an appropriate analytical tool to help examine key issues and capture the various benefits, safety investment, direct and indirect costs of accidents. The framework assesses the economic viability of health and safety using CBA. The framework shows different types of costs of accidents that contractors incur which can be avoided through effective health and safety management. The direct and indirect costs lead to costs of accident and have economic impact on contractors. The reductions of these costs are the expected benefits that lead to improved health and safety performance. This will help improve the quality of the decision-making process and lead towards accident reduction on construction sites.

The framework developed examines how CBA can be utilised to improve management of health and safety in the construction industry. It puts forward a positive case for using CBA to guide contractors and help improve health and safety management in the industry. The framework captures safety investments, direct and indirect costs of accidents and direct and indirect benefits of accident prevention.

COST BENEFIT ANALYSIS

CBA is defined as a methodology for valuing costs and benefits that enables broad comparisons to be made (Snell, 1997, Preez, 2004) and imposes an accounting framework that prescribes classes of benefits and costs to consider, means to measure them, and approaches for aggregating them (Pearce, 1988). It has traditionally focused on efficiency, on providing policy makers with an indication of the magnitude of net benefits associated with a particular project or policy (Moore, 1995) and is an economic technique that produces information intended to improve the quality of public policies (Kopp *et al.,* 1997).

The original theoretical basis for CBA, as a technique of economic evaluation for public investment was laid in the 1930s when the US corps of engineers devised a methodology to justify dam projects to the congress. Since the 1930s CBA has been a popular tool for evaluating public sector projects and is one of the oldest techniques that were developed in the USA to assess the implications of alternative water resources schemes, its application rapidly expanded to a variety of public sector activities in all parts of the world (Preez, 2004). In addition, CBA is commonly used in transportation planning and resources development (Carley, 1987). Its framework was also further developed in the late 1960s and early 1970s as a technique for project evaluation that could be used across economies (Harberger and Jenkins, 2002). CBA

has also gained wide usage in Asia, and particularly in USA. CBA has also been used effectively to preserve environment or health in the USA through the Environmental Protection Agency. CBA has been introduced in the context of agricultural projects, in the health context, water supply and electricity or gas and transport (Snell, 1997). This concept offers the potential to be applied to construction health and safety management.

APPLICATION OF CBA

In recent years, most research efforts in construction health and safety have focussed on improving health and safety management, practices and policies towards improved safety performance. In order to reduce and eventually eliminate construction accidents, researchers have explored techniques implemented by different construction parties to realise 'zero-injury objective' (Hinze and Huang, 2006). However, considerably fewer efforts have focussed on the application of CBA to construction health and safety management. CBA studies have the potential to show that investing in health and safety management can offer a good return on investment (Ikpe *et al.,* 2006).

Everatt et al (1996) examined the total cost of accidents in the USA and employed the use of a quantitative method and defined costs to consist of direct costs (insurance premium, legal fee etc.) and indirect costs (transportation of injured worker to the hospital, wages paid for time not work, overtime costs, cost of replacement worker, cost of repair/clean up or replace damage from the accidents, cost of investigation). The results showed that the total costs of accidents rose from 7.9% to 15.0% of the total cost of project. Even though this study provides the total costs of accidents it fails to consider the benefits meaning that, it is not possible to tell if these costs are excessive.

Tang *et al.,* (2004) examined the costs of safety incurred by building contractors on sites in Hong Kong using a mathematical model by dividing the total equivalent day loss by the total man-hour. Tang et al (2004) employed quantitative methods and defined costs of site accidents include loss due to the injured person, loss due to medical expenses, and loss of time of other employees to attend to accident victim, equipment or plant loss, loss due to damaged material or finished work. The costs also include investment in the salary of personnel employed to monitor safety and investment in the purchasing of equipment such as safety boots, goggles, helmets, first aid facilities and other equipment that has to do with the provision of safety on site, and the cost of training and promotion. Promotion includes the printing of pamphlets and posters, the production of safety advertising boards and banners, and the organisation of safety campaigns.

The results showed that the optimal safety investment was found to be approximately 0.6% of the contract sum and the total costs to contractor (accident loss + safety investment) was found to be 0.82% of the contract sum. While this study provides the costs of accidents in relation to the financial losses of contractors it fails to consider the economic benefits and therefore, it is not possible to tell if the cost outweighs the benefit. Based on their findings the authors recommended that a safety investment greater than 0.6% would result in intangible benefits, such as greater peace of mind of workers, better reputation of the company, greater job satisfaction which they admitted were not considered in the mathematical model but are valuable assets to contractors.

Oxenburg and Marlow (2005) examined the direct costs of injury and hidden costs (cost of overtime, training, supervision, labour turnover, waste and rework, loss production, reduced productivity) in the construction industry. They employed qualitative and quantitative approaches (mixed method) and used a cost benefit analysis model to assess the total costs of employment and the losses due to injury in workplace. The results showed that by using analytical tools, the effectiveness of an intervention might be estimated prior to its introduction. This study provides the costs of accidents but fails to consider the benefit of accidents prevention. It is not possible to tell if these costs are excessive.

HSE (2005) developed on-line interactive tools for contractors to assess the cost of accidents to their organisations These costs as identified by HSE are: lost time; sick pay; damage or loss of product and raw materials; repairs to plant and equipment; extra wages, overtime working and temporary labour; production delays; investigation time; fines; loss of contracts; legal costs; and loss of business reputation; sickness absence; overtime payments; lost production; missed deadlines; cost of recruiting and retraining of staff. The systems focussed solely on what accidents could cost organisations. However, while this tool provides useful guidance it is not sufficiently detailed to specifically assist contractors and designers in developing effective and efficient health and safety management systems. In addition, it refers to cost estimates of accidents but does not take into account what are the actual costs and the benefits of accident avoidance. In addition the extent to which these tools have been utilised in the construction industry to realise the intended aims and objectives are still vague.

Although, these efforts discussed above may be useful in their various applications and may also have contributed to reduction in construction accidents they fail to identify and examine the actual benefits of accident prevention in the industry. It is against this background that a CBA approach is conceived as a means of complementing current efforts. CBA can help determine if the expected reduction in accidents and financial losses due to accidents exceed the costs.

THE CBA CONSTRUCTION HEALTH AND SAFETY THEORETICAL FRAMEWORK

Figure 1 presents the CBA theoretical framework designed to help examine key issues and capture various benefits, safety investment, and direct and indirect costs of accidents. The framework shows different types of costs of accidents that contractor's incur in the construction industry which can be avoided through effective health and safety management. These costs have economic impact on contractors. The reductions of these costs are the expected benefits that lead to improved health and safety performance which relies heavily on the ability to quantify the costs and benefits of accident prevention. The costs are grouped into two as cost related to safety (expenses invested directly by contractors to prevent accidents) and cost of accidents. Its rigorous implementation will help lead to improvement of production and productivity, work motivation, personal relationship in the worksite, and improvement of corporate image of the organisation and consequently reduces the rate of accidents.

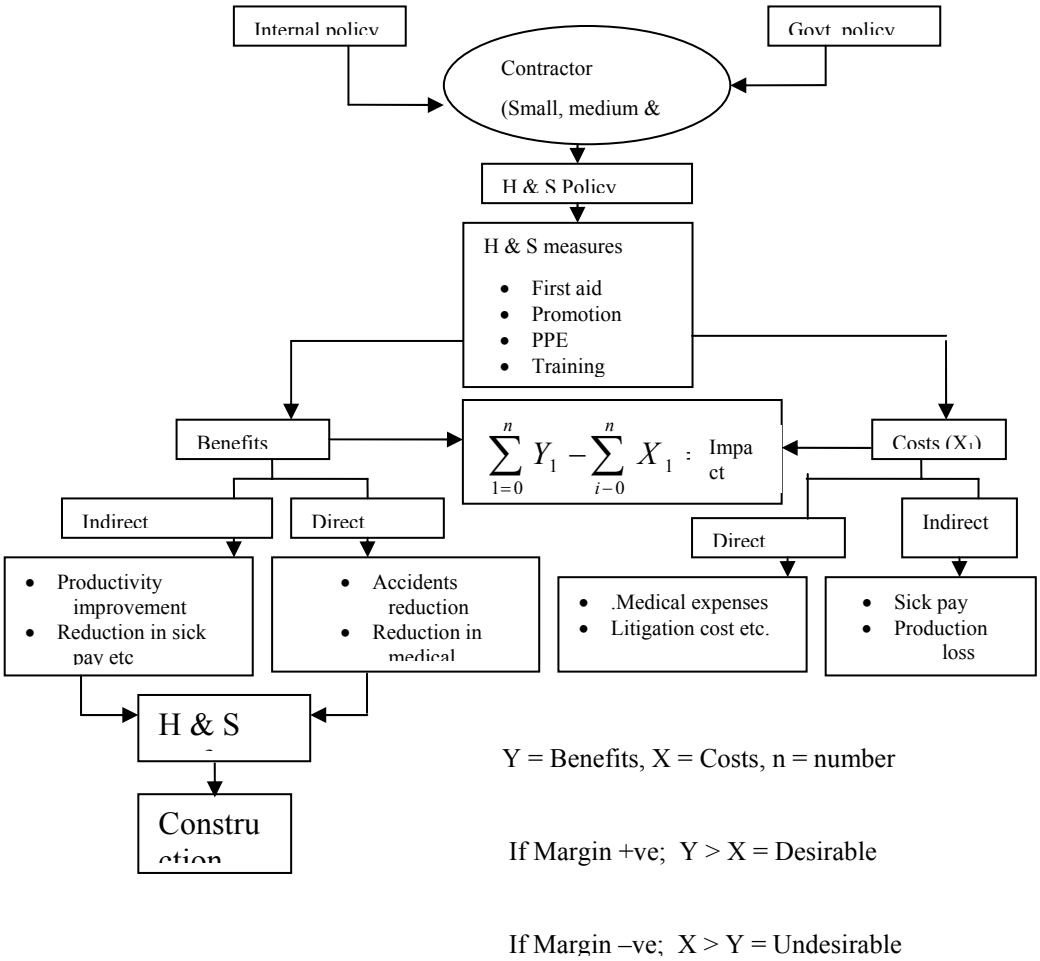

Figure 1: CBA Construction Health and Safety Framework

COSTS

Accidents in the construction industry represent a substantial ongoing cost to the employers, workers and society (Haslam, et al 2004). The costs of accidents incurred by contractors on account of accidents are divided into three sections. The first is the 'cost of construction health and safety measures' i.e. expenses invested directly by contractors in safety measures to prevent accidents. The second is 'direct costs' this is cost caused by accidents arising from the occurrence of accidents despite the fact that safety measures were in place. The third is the 'indirect costs' of accidents. All these costs contribute to the overall monetary costs of accidents.

Health and safety measures

This refers to costs related to the following: first aid; machinery/equipment; personal protective equipment; safety training; investigation; accident prevention and recurrence; hiring of temporary worker; recruitment and replacement of competent workers (HSE, 2006, Tang, *et al.,* 2004, Oxenburg and Marlow, 2005, Everatt *et al.,* 1996). These investments are primarily undertaken by contractors to improve health and safety management in the construction industry to benefit worker, employer and society. Many construction industry accidents and financial losses can be directly attributable to these preventative measures. The performance of the health and safety affects the reduction of costs of accidents (Tang *et al.,* 2004, Evarett *et al.,* 1996, Mossink, 2002) as well as better production and improvement of the overall image of the industry.

Direct Costs

Direct cost is defined as those actual costs that can be directly attributable to injuries and fatalities (Tang *et al.,* 2004). It refers to expenditure on insurance; damage to buildings and equipments or vehicles; damage to the product; cost of health or expenditure on medical care; cost of investigation; legal costs; death; permanent disability; worker illness; losses of current production; pains as well as discomfort associated with accidents (Everatt *et al.,* 1996, HSE, 2006, Oxenburg and Marlow, 2005, Tang *et al.,* 2004 and Mossink, 2002).

Indirect Costs

Indirect costs refer to costs that may not be covered by insurance and are the less tangible costs (Ferret and Hughes, 2007) that result from accident. They are classified by HSE as those costs incurred by the diversion of time to deal with the consequences of an accident, which also can affect productivity and these, include: cleaning up; hire costs of temporary equipment; waste disposal; temporary labour; costs of advising and consulting experts; lost time, sick pay, overtime working and temporary labour; and; loss of business reputation (Everatt *et al.,* 1996, HSE, 2006, Oxenburg and Marlow, 2005, Tang *et al.,* 2004 and Mossink, 2002).

Effects of accident costs

As demonstrated above, accidents in the construction industry have great consequences not only on the employers but also on the workers, co-workers, families and the society. Construction work is intrinsically hazardous, but inadequate task planning, poor safety training, lack of safety incentives, insufficient incident investigation and poor safety management- play a major role in this poor level of safety within construction (Lee and Halpine, 2003). Figure 2 below illustrates the effect of accident costs. The costs of accidents in the industry has a significant effect on not only in the industry but the worker and the society as further illustrated in fig. 2 below

Effects of accident costs

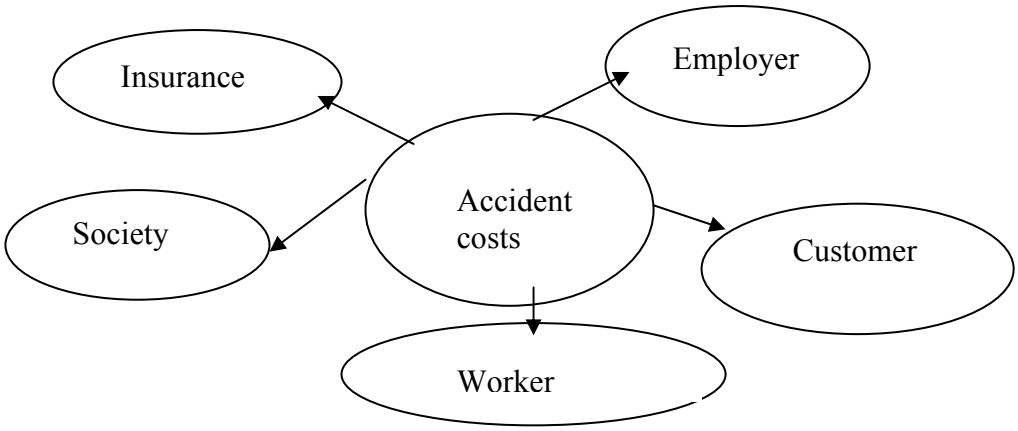

Figure 2: Source: HSE 2005

Accidents at work and injuries represent a considerable economic burden to employees, employers and to society as a whole (Mossink, 2002). Accidents in the industry represent a substantial ongoing cost to the employers, workers and society (Egan, 1998). Reducing these costs will be beneficial to workers, employers and society in terms of avoiding death, permanent disability and other minor accidents as well as substantial costs saving (Ferret and Hughes, 2007). Accident prevention in the

construction industry is not just a matter of setting up a list of rules and making safety inspections, although both of these have their place. What is required is a system for managing health and safety which meets the needs of the business and complies with the law (Holt, 2001).

BENEFITS OF EFFECTIVE HEALTH AND SAFETY MANAGEMENT

Benefits are the sum of the maximum amounts that people would be willing to pay to gain outcomes that they view as desirable. It refers to reduction of fatalities, major injuries and ill health cost and also reduction in financial losses due to accidents, improved production and improved image of construction industry through prevention of accidents occurrence (Tang *et al.,* 2004, Mossink, 2002 and HSE, 2006). Cost benefits are perceived to offer both direct and indirect implications to construction health and safety (Shearn, 2003).

Direct benefits

The direct benefits of health and safety management involve costs savings (HSE, 2006). Additional savings beyond the costs of accident include the saving of time, expenditure on medical care and the possible reduction in the costs of accidents as a result of improvement. The direct benefits include: reducing insurance premiums; reducing litigation costs; reducing sick costs; improving production and productivity rates and lowering accident rates reducing material damage (HSE, 2006).

Indirect benefits

The indirect benefits include reducing absenteeism; improving corporate images, improved job satisfaction, reducing sick pay, lost time, overtime working and clean. The benefits stemming from the improvement of health and safety in the construction industry are likely to accrue to contractors and society. This could be regarded as the main reasons why improving health and safety in the construction industry is worthwhile. The use of CBA to calculate maximum benefits is of fundamental importance to the construction industry. One method of calculating the benefits of reducing accident is that of estimating the current costs that will be averted if the accident is reduced (Mishan, 1982). A reduction in costs of accidents can be directly translated into a benefit for contractors (Ikpe *et al.,* 2007). In the construction industry, clients need better value from their projects and construction companies need reasonable profits to assure their long term future (Egan, 1998). Contractors need to be convinced of the business benefits for investing in health and safety management and also assurance that there is a pay back in financial terms as well as employee satisfaction.

Measuring Costs and Benefits

In order to achieve a reduction of accidents in the construction industry measurement of costs and benefits is required. In measuring costs and benefits, two concepts of cost are important in CBA and these are financial costs and resources costs (Carley, 1987). Financial costs are the monetary values of actual goods and services used in carrying out a particular policy, conducting a programme or delivering a service e.g. costs of material, manpower, facilities, information and other overhead cost which often have market values and are easily expressed in monetary terms. Resources costs on the hand involve opportunity forgone and refer to the benefit which might have been gained had the resources been employed in their next best alternative use in the lack of

this benefit in a project cost (Carley, 1987). In the case of measuring fatality, problems may arise of putting value on human life as well as the cost of injuries. However, they can be expressed in monetary terms. In the context of this framework, they are stated as the direct and indirect costs of accident. Costs and benefits could be measured and weighed up against each other in order to generate criteria for decision making.

Methods used in CBA measurement

Some methodologies used in CBA include: The net present value (NPV) method considers all future cost benefit flows (Bjornstad, 2006). This method yields one value that is easily interpreted. If the value is positive, the project yields benefits that exceed its costs. If the value is negative, costs exceed benefits. The internal rate of return (IRR) is another method which is based on the assumption that the cost benefits flows are reinvested at the internal rate of return. The method requires the compounding of all positive cost benefit flows to the last period of the project life period, at a given rate. If the projects like construction health and safety are to be examined, IRR may yield results that are inconsistent with a ranking based on the NPV method

Another method is the willingness to pay (WTP). The WTP for improved health is a function of the productivity improvement (Morris and Willcocks, 1996). It is based on the assumption that it is reasonable for people to pay to avoid accident than to obtain improved conditions (Kopp *et al.,* 1997). It represents the maximum amount of money that individual is willing to pay in exchange for an improvement in circumstances or consumer surplus brought about by a policy (Layard and Glaister, 1994). In order to tackle the cost of accidents and to improve production in the construction industry, the willingness to pay approach could be used to acquire the benefits or to avoid the costs. Generally, to tackle this health and safety problem, it requires a CBA approach to enable the stakeholders in the industry to perceive the financial benefits of proactive and efficient health and safety management (Ikpe *et al.,* 2007).

CONCLUSIONS

The CBA framework suggests strategies for the management of health and safety at a much-reduced cost. The decision maker can thus evaluate the outcomes of each strategy and make decisions in a more structured manner. This will encourage contractors to consider the savings they would make rather than looking only at the costs when making decisions about expenditure on measures to reduce accidents. The CBA framework if adopted will allow decision makers to identify potential improvement and measure the difference between gains and losses. Reducing the costs of accidents will produce significant benefits such as fewer fatalities and injuries and less property damage; and better health and safety and improved productivity for construction.

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