

COST BENEFIT ANALYSIS OF ACCIDENT PREVENTION IN CONSTRUCTION INDUSTRY

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Abstract: Cost Benefit Analysis (CBA) is a common framework for evaluating the benefits and drawbacks associated with any particular project. The technique has the advantage that all costs and benefits are taken into account before finalizing the project. This paper mainly focuses on the safety issues in the construction site with the base of Cost Benefit Analysis. The paper reviewed the rate of accidents in the construction industry and presents a model predicting CBA of accident prevention on construction projects. A quantitative method approach was used to collect data from health and safety managers in the construction industry for the survey. A total of 29 companies were selected for questionnaire survey. A Ratio Analysis was adopted to calculate the relationship between the turnover and cost/benefit of the companies and Correlation Analysis was used to find the correlation coefficient for developing CBA model. A simple linear regression model was adopted to identify the effect of total costs of accident prevention on benefits of accident prevention. The result revealed that costs of accident prevention are significantly associated with benefits of accident prevention. All the calculations were done in Microsoft Excel.

Keywords: Cost Benefit Analysis, Ratio Analysis, Correlation Analysis, Regression Analysis

1. INTRODUCTION

The construction sector is defined as one which embraces the construction materials and products; suppliers and producers; building services manufacturers; providers and installers; contractors, sub-contractors, professionals, advisors and construction clients and those organizations that are relevant to the design, build, operation and refurbishment of buildings[1-5]. The construction industry is regarded as a hazardous and high-risk environment where workers face a greater risk of work-related fatality or injury than workers in other industries. Though the industry has been paying significantly greater attention to health and safety in recent years with the aim of

reducing accidents and injuries, it is consistently responsible for the largest number of fatal work injuries than any industry in India (HSE, 2007). The construction industry contributes significantly to Indian economy, representing some 10% of the Gross Domestic Product (GDP) and employing 1.5 million people. 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'[6-12].

1.1 SCOPE AND OBJECTIVE

The aim of the project is, to develop a CBA model of accident prevention in construction industries by investigating the costs and benefits of accident prevention in the construction industry. Site Safe is a small independent organization set up by the construction industry[13-17]. Its single job is to reduce construction injuries and deaths by taking the lead in promoting construction site safety. Construction can be a hazardous business. One of the best ways to avoid injuries and minimize costs is through good planning and coordination both before and on the job. This should start when the decision is made to go ahead with the project, and should consider all stages and parties associated with the work..

2. METHODOLOGY

The research methodology is largely quantitative. Data collection was through a survey administered to local contractors who have been involved in the construction of buildings and facilities in the District for over 10 years. The survey was sent to randomly selected company's executives of both indigenous and local construction firms. A total of executives of the local firms returned with the completed questionnaire for analysis[18-24].

Section 1: Design of Questionnaire Survey

Section 2: Data Collection through Questionnaire Survey

Section 3: Data Analysis and Calculation

Section 4: Validation of the Result

Section 5: Result and Discussion

2.1 DESIGN OF QUESTIONNAIRE SURVEY

The questionnaire survey is designed primarily to elicit information from health and safety managers and similar personnel on costs and benefits of accident prevention so that the relationship between them could be explored using appropriate statistical techniques. Steps are taken to ensure that the designed questionnaire is „respondent-friendly“. The questionnaire format includes 3 parts, which is given below

- (i) Pilot Questionnaire
- (ii) Quantitative phase (Interviews)
- (iii) Main Questionnaire Survey

2.2 SURVEY ANALYSIS

Survey is a method of collecting data from people about who they are, how they think and what they do. Literature study described survey research as a way to generalize from a sample to a population so that inferences can be made about some characteristic [25-31], attitude or behavior of the population. As with most other research, a confidence level of 95% was assumed. For 95% confidence level (i.e. significance level of $\alpha = 0.05$) $Z = 1.96$. Based on the need to find a balance between the level of precision, resources available and usefulness of the findings and confidence interval (C) of $\pm 10\%$ was also assumed for this research. When determining the sample size for a given level of accuracy the worst case percentage picking (p) should be assumed. This is given as 50% or 0.5. Based on this assumption, the sample size was computed as follows.

$$SS = \frac{1.9^2 + 0.5(1-0.5)}{0.1^2}$$

$$SS = 96.04$$

Therefore the required sample size of the questionnaire is 96.

Assuming 50% response rate is $96/0.5 = 192$. Based on this a total of 200 companies were selected randomly.

3.1 DATA ANALYSIS

Data Analysis involved the ratio analysis, correlation and regression analysis on quantitative data.

3.1.1 Ratio Analysis

Ratio is defined as a relatively crude diagnostic tool which can help managers and investors identify the strengths and weakness of a company. Ratio analysis is used to check the probability and efficiency of business and also the liquidity. In Ratio Analysis, mean[32-37], median and standard deviation values were calculated. For accuracy of the result the median values are used as the measure of central tendency. These median values are summarized in Table 1.

Table: 3.1Median values of Companies

Company Name	T/C Ratio (Median)
Small	43.75
Medium	51.21
Large	164.65

It can be inferred from these results that small companies spend relatively little higher proportions of their turnover in total on accident prevention than medium and large companies. It is indicated that large companies spend more on health and safety measures than medium and small companies.

3.2 BENEFIT OF ACCIDENT PREVENTION

The benefits comprise of total benefit to companies. From the literature review , it was revealed that companies need to be convinced of the business benefit for investing in health and safety management and also assurance that there is a pay back in financial terms as well as employee satisfaction. The awareness of the financial benefits of accident prevention is necessary[38-42], that it will encourage some decision makers to develop more efficient and practical health and safety management in their

companies. This study elicited information on benefits of accident prevention through questionnaire survey.

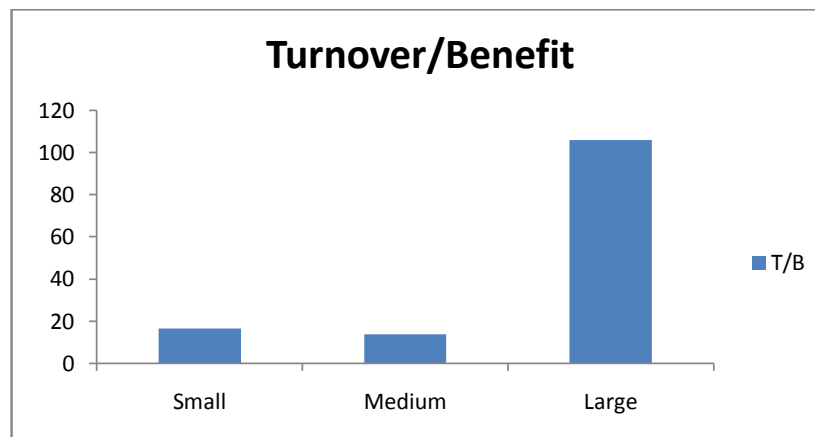


Fig: 3.2 Comparative result of Benefits of Accident Prevention

3.3 COMPARISON OF TOTAL COST AND BENEFIT OF ACCIDENT PREVENTION

The total costs and total benefits are compared across different categories of companies taking turnover into account using BCR. BCR is the Benefit Cost Ratio is defined as the ratio of the present value of the benefits relative to the present value of the costs[43-45]. The medium values are taken for measure of central tendency. The medium values of total cost of accident prevention and total benefit of accident prevention are summarized in table 2.

Table: 3.2 Comparison of Total Cost and Total Benefit of Accident Prevention

Company	T/Y _{total cost}	T/Y _{total benefit}	C/B	B/C(%)
Small	43.75	16.72	2.61	38.21
Medium	51.21	14.00	3.65	27.33
Large	164.65	105.85	1.55	64.28

From the values shown in Table2, it can be seen that total benefit of accident prevention outweigh cost of accident prevention by ratio 3:1 ,65% benefit gain to 39%

benefit loss. This means that it benefit companies three times more financially to prevent accidents. This findings provides support for null hypothesis which stated that the benefit of accident prevention will outweigh the costs of accident prevention. The alternative hypothesis claimed that the cost will outweigh the benefit is rejected. There s enough evidence from the static to accept the null hypothesis that benefit of accident prevention outweigh the cost.

3.4 CORRELATION ANALYSIS

Correlation analysis is a means of measuring the strength or „closeness“ of the relationship between two variables (Fleming & Nellis, 1994). Correlation indicates both the strength and the direction of the relationship between a pair of variables and is a very common statistic tool in construction research.

Table: 3.3 Correlation Analysis Matrix

	Total Benefits	Total Preventive Cost
Total Benefits	1	0.903
Total Preventive Cost	0.903	1

From Table 4 the Pearson's correlation coefficient, $R = 0.903$, it reveals a positive value, strong and highly significant association between the total benefits of accident prevention and the total costs of accident prevention. This means that as the costs of accident prevention increases, there is a corresponding increment in the level of benefits accruing from accident prevention. There is a positive relationship between cost of accident prevention and benefits of accident prevention ie, the higher cost of accident prevention, the higher the benefit of prevention[46-50].

3.5 DEVELOPMENT OF COST BENEFIT ANALYSIS

A model is a mathematical abstraction that is an analogy of events in the real world (Motulsky, 1995). It is written as an equation that defines a value that will predict (Y) from one or more variables (X).). Simple linear regression was adopted to explore the

relationship between costs and benefits of accident prevention. It was anticipated that the results of the linear regression model would reveal how well costs of accident prevention predict the benefits. Regression analysis is usually concerned with the derivation of an equation which defines a best-fitting regression line .

Table: 3.4 Model Summaries

Regression Statistics	
R	0.902
R^2	0.813
Adjusted R^2	0.806
Standard Error	35.24
Observations	28

Table 5 shows that 81% ($R^2 = 0.813$) of the proportion of variations in the benefits of accident prevention is explained by the variable costs of accident prevention. Here the Adjusted R^2 is 0.806 implying that the model explains 81% of the variations in the benefits of accident prevention within the population leaving 19% unexplained. The coefficient analysis of regression modeling as shown in Table 6.

Table: 3.5 Coefficient Analysis

Model	Unstandardised Coefficients		Standardised Coefficients	t	Sig.	95% Confidence Interval for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
Coefficient	10.102	1.12	0.687	5.916	0.001	4.342	8.966
Total Preventive Cost	2.000	0.182		10.643	0.000	10.64	2.306

From Table 5, the model signifying the influence of cost of accident prevention on benefits of accident prevention to companies could be expressed as follows :

$$\text{Total Benefits of Prevention} = 10.102 + 2.000 \text{ Total Costs of Prevention}$$

The above equation shows the unique monetary contribution that the costs of accident prevention make to the benefits of accident prevention[49-50]. The unstandardized coefficient provides the relative measure of extra benefits from accident prevention.

4. RESULT AND CONCLUSION

In this study it was found that the correlation analysis that costs of accident prevention are positively and significantly related to benefits of accident prevention. The result of the regression shows that benefit of accident prevention is positively influenced by costs of accident prevention. This finding further reinforced the notion that costs of accident prevention are related to benefits of accident prevention as indicated above. This notion which was encapsulated in the hypothesis, which stated that the more contractors spend on accident prevention the greater the benefits they will derive is, however, supported by the results of the correlation and regression analysis of costs of accident prevention to benefits of accident prevention. The regression analysis shows that the more contractors spend on accident prevention the greater benefits they derived. These results imply that further expenditure on costs of accident prevention will produce greater benefits of accident prevention.

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