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Safety And Its Cost Implication In Construction Industries

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Abstract: The research paper aims to understand the technique of cost benefit analysis to determine the cost implication of the effects on human/health, safety and environment. It also emphasized on the precaution necessary to prevent avoidable accidents in the construction industries, important water development, building and road construction in Nigeria. Moreover appreciate the need for safe working environment and precaution necessary for hitch-free operation, and M-TECH analysis for optimal solution

Key Words: *Cost benefit analysis, implication, safe, health, environment, M-TECH analysis, optimal solution*

I. INTRODUCTION

In the maintenance of an environmental accident-free in the construction industries, the following cost must be in-place in the company's annual budget; health/injury, property damage and environmental harm, Chitkara (2009). Therefore, safe management is defined as a quality management system for controlling risk within the construction industries to assure the protection of its employees assets, reputation and protection of the environment risk in every sphere of human endeavour results in accident and is inherent and all pervasive, Alexandra (2008). Safety is therefore desirable and beneficial for efficient running of construction industry for risk management and cost-benefit analysis according by Matt (2008) in his crane accident and site causes fatalities. Every employer always considers a good design and construction of building infrastructure and facilities of adequate safety for a goal of production and services.

Construction industries operate with safety simply means being safe-free from danger or situation that could cause harm or injury, William (2008). It involves the employee, equipment and the work place situation where employees and equipment interact to achieve the desired objective safety in the construction industry, concerns prevention of injury to personnel and prevention of damage to equipment and environment through pollution. Employers and employees should maintain safety culture consciousness at all times while working and also show concern for the safety of their colleagues or the loss industry may incur due to damage of equipment. The slogan "Safety First" must continue to be loud, clear and a watch-word amongst all workers BLS (2008). Moreover, a good method of communicating safety messages to control accident is through personnel contacts and every worker should specifically embrace specific job he/she is performing. Also, is advisable that each worker in construction industry should know the danger-associated with the job and how to avoid accident and injury. A good safety practice in a construction company could be responsible for avoidable accident which is traceable to the carelessness of the victim or that of a colleague, UTK (2008).

II. AIMS AND OBJECTIVES

The aim of every safety management system is to ensure that the activities of the company are to plan, carry out, control and direct so that the business objective of the company are met. Also, the company to have an improvement loop in its construction following the plan to check, feedback steps of any system as to:

- determine the cost benefit analysis of the effects on health, property and environment
- minimize the cost effect using M-TECH linear programming to obtain optimal solution
- pursue the goal of no harm to employees.
- protect the environment and equipment.
- use material and energy efficiently to provide infrastructure and service.
- develop construction strategy and service consistent with the aims of sustainability.
- promote a culture in which the company employees share thus, commitment.
- encourage company working in partnership with her employees and where appropriate with company's policy
- focus safety development assistance on activities having impact and broad benefit for the company.
- play a good leading role in promoting best safety in the company.
- manage health, safety and environment matters as any other business activity

III. CAUSES OF UNSAFETINESS

Every construction industry needs a safe working environment and precaution necessary for hitch free operation. Therefore, these are numerous causes of unsafely events in its everyday activities. ‘

- nonchalant attitude of workers causes accident because of carelessness through failure to think ahead or improper steps in executing a task which could bring accident occurrence
- inadequate training of workers to carry out specific function can possibly cause accident and inability of an employer to supervise properly his employees
- wrong handling of machines and tools causes accident in the construction industry because of adequate information instruction or training on the use of equipment and machinery
- as a result of fatigue arises from working for hours without sufficient rest periods or relaxation, exposes the workers/employers to accident victims. Fatigue creates lack of coordination and the strength to perform duty responsibly
- poor knowledge of safety from the part of employer and the lack of adequate safety briefing to the employees, becomes impossible for a safety conscious work-force in the company
- use of certain medication and influences of alcohol which at work capable of affecting employees sense of safety and causes accident
- lack of maintenance culture causes unavoidable accident in any establishment. Inadequate maintenance of equipment and facilities or obsoletes, non-removal of rubbish and waste materials are unsafe and causes accident
- company without proper dressing such as wearing unsafe foot wears, from overall, floppy trousers, rings, chains, watch-straps and even uncovered long hair which tangles up are all sources of danger to serious accidents
- in-conducive working environment such as poor ventilation, high or too low temperature poor lighting, blocked hallways and emergency exists, slippery floors and falling objects in a company cause accident

IV. IMPORTANCE OF SAFETY

In Nigeria construction industries make significant contribution to nation economy and provide large number of employment as per the latest statistics released in October 2014 by the coordinating minister of econmy and finance, Okonji-Iweala(2014)

Among the people employed in the construction industries, in which close to 85% are unskilled labourers. The new technologies and deployment of project management strategies employed has made it possible for these industries to undertake mega projects in spite of facing number of challenges.

Also they are the fastest growing sectors in Nigeria as they record maximum number of accidents and injuries than other industries. In addition to cost of human injury and death, the accidents are unduly expensive in terms of damage of property and delays in completion of project.

Moreover the follow three vital components are affected

- Health and injury which can lead to medical treatment or death, serious injury or life threatening occupational disease, example, are amputation, major fracture, acute poisoning and fatal fraction.
- Property damage can be expensively difficult to replace or irreplaceable.
- Environmental Harm can affect many people, permanently or for a longtime at a high level.

The cost implication of safety organization, also involves, compensation hospital bills, reputation cost and replacing equipment cost.

Equipment need not to be kept till it becomes unserviceable. Therefore, in its useful life, every equipment passes through a period of most economical operation, and there is also a period when it ceases to be economical. It is at this uneconomical point of time that an equipment should be considered for replacement. The replacement time is difficult to determine as it depends upon many cost factors such as depreciation cost, investment cost, operation cost, down-time cost, obsolescence cost, inflation and new equipment purchase cost (replacement cost) Chitkara 2009.

The cost of safety in the construction industries is quoted as indirect cost which includes all cost that is attributable to a given project but cannot be identified with the performance of specific activity or a work-package in other words all costs other than direct cost are covered under indirect cost.

The employer of labour in construction industries also carry out a systematic critical appraisal of all construction hazard involving personnel, plant, services and operation method of work site. Also they ensure that the present construction safety health and environment management system fully satisfy the legal requirement, company’s written safety polices, matt (2008).

V. SAFE CONDITION

Efficient Construction Company always has a good method of communication safety message to control accident through personal contacts. Employer advises his employees on specific safely instruction and training regarding the job performance, concerning the damages associated with the job and to avoid accident and injury, UTK (2008). He initiates always safety prevention through:

- safety education which gives each sector of the company alert to their individual safety on and off the work place. It also gives safety training as a specialized form of education designed to prepare on employee specifically on how to perform his duty safely
- safety engineering, also eliminates many unsafe conditions by proper engineering technique. Eliminating unsafe conditions by mechanical revision, modification of equipment or machine and other changes. Moreover, safety guards, warming signal, safety value and special lifting devices
- safety enforcement prevents accident through safety knowledge gained by educational and engineering methods. Safety enforcement is designed for those who will not learn, understand, or comply with safety regulations and instruction except through enforcement
- safety encouragement maintains safety interest in good company keeping, reporting hazards and the likes. Employers encourage the employees in terms of bonus or contest which stimulate their safety consciousness and improve morale. Therefore, the employees frequently use their own imagination, common sense and self discipline to protect themselves
- safety psychology is science which treats the mind of every employer or employee to point where he must be aware of the fact that safety is an integral part of every activity in the company, must be psychological alert

Benefits of Adherence to Safety

The importance of industrial operation cannot be over-emphased, as the strict adherence to safe practice has the following benefits.

- increase in production and hence increase profits and results in increase in salaries and allowance
- increase in efficiency and no occurrence of accident
- longer life of equipment
- no injuries and no disabilities
- high morale of workers as there will be no fear of equipment and operation
- promotion of company's name and reputation
- workers will be happy as the experienced hands will not think of signing for another company
- company will stay in business and expand instead of folding up

Responsibility of Employer to Employee

In a construction industry executing projects at a reasonable height, falls from height continue to be biggest killer on the construction sites and it is advisable for scaffold and specify equipment to carry out from a platform with suitable edge protection, NBN (2008).

Moreover, when selecting equipment to be used, it is wise to think about the type of job, how long it will last and where it should be done, and consider of working platform for a properly erected Mobil scaffold or working platform, DL (2002). For the employer to achieve reasonable result he must ensure that:

- all work at height is properly planned and organized
- all work at height takes account of weather condition that could endanger health and safety
- employees involved in work at height are trained and competent
- the place where work at height is done is safe
- equipment for work at height is appropriately inspected
- the risk from fragile surface are properly controlled
- the risk from falling object are properly controlled.

VI. METHODOLOGY

The technique of cost benefit analysis is a long standing approach to making decision about, safety; human health, property and environment, which the economists use in performing mathematically, précising way of determining the protection of environment, Ackerman and Heinzerling (2002). Cost benefit analysis seeks to translate all relevant consideration in monetary terms and is used to monetize, compensation cost, irreplaceable cost and protection/prevention cost which are included in the company's annual budget cost benefit analysis has an advantage of environmentally protective regulation in translating lives, health, and the natural environment into monetary terms and the discounting of harms, human health and the environment in the future.

Considering the System Analysis (operation research) in the annual budget of a company where the average costs of effects on each family that may be affected through the construction work are ₦3,000,000 for healthy/injury, ₦4,000,000 for property damage and ₦5,000,000 for environmental harm. As the company agrees to compensate individual family, incur irreplaceable cost and protection/prevention cost: ₦2,000,000 for health/injury ₦2,000,000 for property damage and ₦4,000,000 for environmental harm [compensation cost] and must be greater than or equal to ₦30,000,000. More so ₦4,000,000 for health/injury, ₦2,000,000 for property damage and ₦2,000,000 for environmental harm [irreplaceable cost] which must be greater or equal to N35,000,000, and finally N3,000,000 for health/injury, N4,000,000 for property damage and N5,000,000 for environmental harm [protection/ prevention cost] and must be greater than or equal to N40,000,000

The objective of the analysis is to minimize the cost effect on health/injury, property damage and environmental harm by obtaining optimal solution.

The Decision variables are:

X_1 = Health/injury

X_2 = Property Damage

X_3 = Environmental Harm

Constraints are

Compensation: $X_1 + X_2 + X_3$

Irreplaceable: $X_1 + X_2 + X_3$

Protection/Prevention: $X_1 + X_2 + X_3$

Therefore Minimizing

Minimize $\not{Z} = 3x_1 + 4x_2 + 5x_3$

Subject to: $2x_1 + 2x_2 + 4x_3 \geq 30$

$4x_1 + 2x_2 + 2x_3 \geq 35$

$3x_1 + 4x_2 + 5x_3 \geq 40$

$X_1 + X_2 + X_3 \geq 0$

VII. ANALYSIS

Using M-Tech analysis

Minimize $\not{Z} = 3x_1 + 4x_2 + 5x_3$

Subject to: $2x_1 + 2x_2 + 4x_3 \geq 30$

$4x_1 + 2x_2 + 2x_3 \geq 35$

$3x_1 + 4x_2 + 5x_3 \geq 40$

$X_1 , X_2 , X_3 \geq 0$

Min $\not{Z} = 3x_1 + 4x_2 + 5x_3 + MR_x + MR_x + MR_x$

Sub to

$2x_1 + 2x_2 + 4x_3 – Sx_4 + Rx_7 = 30$

$4x_1 + 2x_2 + 2x_x – Sx_5 + Rx_8 = 35$

$3x_1 + 4x_2 + 5x_3 – Sx_6 + Rx_9 = 40$

X_j's≥0, S_j's≥0, R_j's≥0

Iteration 1

C_j	3	4	5	0	0	0	M	M	M	
Basic	X_1	X_2	X_3	S_{x4}	S_{x5}	S_{x6}	R_{x7}	R_{x8}	R_{x9}	Solution
Z(min)	897	996	1095	-100	-100	-100	0	0	0	10500
R_{x7}	2	2	4	-1	0	0	1	0	0	30
R_{x8}	4	2	2	0	-1	0	0	1	0	35
R_{x9}	3	4	5	0	0	-1	0	0	1	40

Iteration 2

Basic	X_1	X_2	X_3	S_{x4}	S_{x5}	S_{x6}	R_{x7}	R_{x8}	R_{x9}	Solution
Z(min)	349.5	248.5	0	173.75	-100	-100	-275.75	0	0	2257.5
X_3	0.5	0.5	1	-0.25	0	0	0.25	0	0	7.5
R_{x8}	3.00	1.00	0	0.5	-1.0	0	0.5	1	0	20
R_{x9}	0.50	1.50	0	1.25	0	-1	-1.25	0	1	2.50

Iteration 3

Basic	X_1	X_2	X_3	S_{x4}	S_{x5}	S_{x6}	R_{x7}	R_{x8}	R_{x9}	Solution
Z(min)	0	-800	0	-700	-100	599	600	0	-699	540
X_3	0	-1	1	-1.5	0	599	60	0	-699	5
R_{x8}	0	-8.00	0	-7.0	-1	6	7	1	6	5
X_1	1	3	0	2.5	0	-2.00	-2.5	0	2	5

Iteration 4

Basic	X_1	X_2	X_3	S_{x4}	S_{x5}	S_{x6}	R_{x7}	R_{x8}	R_{x9}	Solution
Z(min)	0	-1.33	0	-1.77	-0.17	0	-98.83	-99.83	-100	40.83
X_3	0	0.33	1	-0.33	0.17	0	0.33	-0.17	0	4.17
R_{x7}	0	-1.33	0	-0.17	-0.17	1	1.77	0.17	-1	0.83
X_1	1	0.33	0	0.17	-0.33	0	-0.17	0.33	0	6.63

Iteration 5

Basic	X_1	X_2	X_3	S_{x4}	S_{x5}	S_{x6}	R_{x7}	R_{x8}	R_{x9}	Solution
Z(min)	0	-1.33	0	-1.77	-0.17	0	-98.83	-99.83	-100	40.83
X_3	0	0.33	1	-0.33	0.17	0	0.33	-0.17	0	4.17
R_{x7}	0	-1.33	0	-0.17	-0.17	1	1.77	0.17	-1	0.83
X_1	1	0.33	0	0.17	-0.33	0	-0.17	0.33	0	6.63

The values of $X_1 = 6.63$, $X_2 = 0$, $X_3 = 4.17$
Min ₹ $\Rightarrow 3_{x1} + 4_{x2} + 5_{x3}$
$= 3(6.67) + 4(0) + 5(4.17) = 40.83$
$20.01 + 0 + 20.85 = 40.87$
Minimize ₹ = N40.87m

VIII. CONCLUSION

In Nigeria, the recommended construction policy has not practically remarkably improved as some construction projects are prone and exposed to errors and risk, thereby increasing the rate of accidents and injuries at work place.

In most cases lack of concern for safety always creates room for accidents and it is very necessary for employees to develop the right attitudes towards safety and ensure that they do not endanger their own lives by operating without concern for safety precaution.

Therefore right attitude towards safety prevents employer and employees from experiencing the painful consequence of accident events, requiring complex control or severe consequences of risky and most dangerous level, considering qualitative and quantitative risk assessment technique and cost-benefit analysis through M-TECH analysis leading to optimal solution

Finally, from the above M-TECH analysis, at the 5^{th} interaction the solution becomes optimal with the values of the objective being ₦40.83 million, the company needs ₦20.86m for environmental harm cost while N20m for health/injury and does not need to compensate property damage since it is not in the solution which indicates no contribution to the minimization cost to the protect.

Recommendation

Employer commitment to health, safety and environment should be paramount to the establishment of the company to earn the confidence of employees and stakeholders, and for the employees to be diligent at work.

A good safety environment contributes to sustainable productions, therefore the employer must be committed to the following:

- employer and employees should have a systematic approach to health, safety and environment management designed to ensure compliance with the safety laws and to achieve continuous performance improvement
- employer should set targets for improvement and measure, appraises and reports performance
- employer is required to manage, health safety and environment in line with the safety laws
- employer is required to cooperate with the employees under the operational control to apply the safety laws and uses its influence to promote it in the company
- employer should include, health, safety and environment performance in the appraisal of all the employees and rewards accordingly.

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