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ESTIMATES OF COST OF ACCIDENTS IN SOME SELECTED INDUSTRIES IN SOUTHWEST NIGERIA

Enwerem, G. C.[1], Ajayeoba A. O.[2*], Raheem W. A.[3], Adebiyi K. A.[4] and Akinyemi O. O.[5]

[1]Department of Mechanical Engineering, Federal Polytechnic Ede, Ede, Osun State, Nigeria
[2,4]Department of Mechanical Engineering, Ladoke Akintola University of Technology, Ogbomoso, Oyo State, Nigeria
[3]Department of Systems Engineering, University of Lagos, Lagos, Nigeria
[5]Agricultural and Mechanical Engineering Department, Olabisi Onabanjo University, Ago-Iwoye, Nigeria
***Corresponding author: aoajayeoba@lautech.edu.ng**

ABSTRACT

The manufacturing industry is one of the most dangerous branches in light of the frequency of occupational accident. Direct and indirect losses generated by major manufacturing accidents reduce profit and cause management crises. Such losses significantly impact manufacturing business owners, workers, clients and the public. This research evaluated the effect of safety practices on operational performance of some selected manufacturing companies in Nigeria. Ten-year data were collected on yearly basis from four (4) manufacturing industries in Nigeria which are chemical, oil/gas, food/beverages, and metal/fabrication industries on annual record of accidents and annual expenditure on safety intervention programmes. The data were analyzed using existing mathematical models.
The probability of each class of accidents has highest values estimated as: 0.19, 0.52, and 0.68 for fatal, serious and minor accidents, respectively while the lowest was estimated as: 0.03, 0.2, and 0.32 for fatal, serious and minor accidents, respectively. The highest accidents cost of potential consequences of accidents were estimated as ₦94,701,700, ₦13,339,567and ₦2,969,210 for fatal, serious and minor accidents, respectively while the least accidents cost was estimated as ₦541,072, ₦1,834,120 and ₦341,562 for fatal, serious and minor accidents, respectively. However, minor and fatal accidents in metal/fabrication industry has the highest (0.68) and the least (0.03) values of probabilities of occurrence of accident, respectively, while fatal accident in oil and gas industry has the highest cost of accident estimated as ₦94,701,700 (fatal accident) which is 93.21% of the total cost of accidents in the industry.

Keywords: Accidents, Safety Interventions, safety practices and cost of accidents.

1. INTRODUCTION

Despite all established standards and legislations on safety, with sophisticated devices developed and researches carried out (Adebiyi et al, 2005); yet, a perfectly safe condition for human and property is still an illusion. The manufacturing industry remains one of the most dangerous branches in light of the frequency of occupational accident (Adebiyi et al, 2007 and Nenonen, 2011). Manufacturing is the process of adding more value to raw materials by process them into products or transforming such raw materials, purchase components or semi-finished products into finished products for sale (Misiurek and Misiurek, 2016 and Ajayeoba 2015) It is adjudged to be the third most risk sector with stakeholders besides private households and construction industry (Abdulzubair, *et al.*, 2014). Technological innovation and advancement, these days, particularly in manufacturing industries, has undeniably brands industrial professions more complex and high accidents prone, with higher operational risk consequently, made operational risks more significant than ever before (Nielsen, 2014). A very profligate stride of transformation of technology is initiated at the operative level therefore making operational risks core cause of numerous accidents (Shur, et. al., 2015) This poses threat to human life through accidents and injuries. Occupational injuries and workplace accidents remains a challenge globally (Kines *et al*., 2013) Direct and indirect losses resulting from major manufacturing accidents greatly affect the establishment's profit and cause management crises (Yaw-Yauan *et al*. 2011, Pons, 2010., Choi, 2006 and Adebiyi 2006). Accident is not only reducing productivity but besides upset cost of production (Umoh and Tobira ,2013, Gerard *et al*., 2013 and Mohamed Taufek, et. al., 2016) Consequently, many companies have been struggling to minimize the number of incidents and lost work days at the workplace. However, the relationship between business performance and occupational health and safety interventions aimed at reducing accidental injury is strongly contested. The safety expert's perception views that good health and safety practice is good for business and productivity while the industry views that Occupational Health Safety (OHS) interventions are costly and interrupt the flow of work activity and the regulations impose a non-productive investment. Unfortunately, a significant share of these costs is carried by business enterprises, with the effect of increasing their losses and reducing their profitability.

For example, Occupational Safety and Health Administration (OSHA) estimated that businesses spend $170 billion a year on costs associated with occupational injuries and illnesses; expenditures that come straight out of company profits. ((www.osha.gov)). In its 2007 workplace safety index, liberty mutual also estimated that employers paid almost $1 billion per week for direct workers' compensation costs for the most disabling workplace injuries and illnesses. Injuries and illnesses increase

workers' compensation and retraining costs, absenteeism, and faulty product. Therefore, as an employer or self-employed person, awareness of the costs of accidents and information about the type/frequency/location etc. of their occurrence can be of considerable value in improving health and safety management. This approach of estimating potential and actual losses highlights a feature that the successful safety programme should address, and that is the difference between day-to-day risk and the effect of a potential catastrophe.

2. METHODOLOGY

Baseline measures included safety observations, questionnaires, interviews and documentation (vetting of records) were employed to obtain data from forty manufacturing industries in south western Nigeria. The companies were classified into four based on the nature of their operation as chemical, oil and gas, food/beverage and metal and fabrication. Data on accident records, budgets and other model parameters were collected over a ten-year period (2005-2014). The manufacturing accident cost estimation model developed by Adebiyi and Ajayeoba (2012) was adopted.

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2.1 Theoretical Consideration of the Accident Cost Estimation Model

The resultant effects of accidents are basis for developing most accidents estimating models. Though various estimates have been made for the cost of industrial accidents in strictly monetary terms, but there are still some hidden accident costs (Charles-Owaba and Adebiyi, 2001). The problem of appropriately quantifying human life is the major problem of costing accident and as such no yet generally accepted model for this. Thus, it depends on the situation and circumstances. The existing accidents cost estimating models employ deterministic approach. But the occurrence of accident is probabilistic in nature and also the associated costs. Therefore, in the model developed by Adebiyi and Ajayeoba, (2011), the probability of occurrence of accidents and costs of accident consequences are considered using equations 1 – 8y.

The unit Cost of Accident Class i (C_i) may be given as:

$$C_i = f(\rho_{ai}, P_c) \quad 1$$

Using dimensional consistency,

$$C_i = \rho_{ai} * P_c \quad 2$$

However,

$$P_c = f(H_i, E_{qi}, E_{ci}) \quad 3$$

Applying dimensional consistency,

$$P_c = \rho_{ai} * (H_i + E_{qi} + E_{ci}) \quad 4$$

But,

$$H_i = f\gamma z \quad 5$$

While,

$$E_{qi} = f\left[\frac{(1+t)^{L-T}}{(1+t)^{L-T}-1}\right]N + MHR\theta \quad 6$$

Also,

$$E_{ci} = Q_i + \beta_i\alpha \quad 7$$

Substituting equations 4, 5, 6 and 7 in equation 2, we have:

$$C_i = \rho_{ai}\left[f\left[\gamma z + N\left[\frac{(1+t)^{L-T}}{(1+t)^{L-T}-1}\right]\right] + MHR\theta + Q_i + \beta_i\alpha\right] \quad 8$$

Where:

ρ_{ai}= Probability of occurrence of accident class i(Dimensionless)

H_i= Human severity cost for accident class i (N)

γ = Establishment average annual salary (N /year)

z = Establishment maximum allowable service year (year)

f_i= Degree of severity (Dimensionless)

L = Service life of the equipment involved in the accident (Year)

t = Interest rate

N = Acquisition cost of damaged equipment (N)

MHR = Machine Hour Rate (N/T)

Θ_i= Period of idleness of equipment due to accident i(T)

Q_i= Value of goods/materials damaged in accident class i (N)

B_i= Total production down time due to accident class i

α = Establishment's overall hourly cost of production (N /T).

i = Counter of class of accidents

T= Total no of years considered

G = Number of identified class of accidents

1 = Fatal, 2 = Serious, 3 = Minor

2.2 The model Application

The model was applied to estimate the cost of accident in manufacturing industries in Nigeria. Data were collected from four (4) different type of manufacturing industries in Nigeria. The data include the accident occurrence and other model parameters. As a matter of fact, a single factor rarely causes an accident. Accident occurrence involves combination of two or more

contributory factors and also the cost of potential consequences. The data on Table 1 were the values collated from the surveys

3. RESULTS AND DISCUSSION

The consequential effects of accidents may be categorized into human severity, property damaged and economic implication. The estimates of the model parameters are presented in Table 1. The probability of each class of accidents has highest values estimated as: 0.19, 0.52, and 0.68 for fatal, serious and minor accidents, respectively while the lowest was estimated as: 0.03, 0.2, and 0.32 for fatal, serious and minor accidents, respectively. This reflects that minor accidents have greatest probability of occurrence while fatal accidents have the least. However, metal and fabrication industries among the four listed have the highest and the least values of probability of occurrence of accident. Also, from Table 2, the highest accidents cost of

Results

Table 1: Manufacturing Accidents Unit Cost Estimation Model Parameters

PARAMETERS		Chemical Industry	Oil and Gas	Food and Beverages	Metal and Fabrication	Average
Establishment average annual salary(N/year)		1,320,000	9,000,000	1,200,000	N8,700,000	3,840,000.00
Establishment maximum Allowable Service year (year)		16	35	15	35	25.25
Service life of the equipment involved in the accident (year)		15	30	9	20	18.50
Interest rate		10	10	10	10	10.00
Usage Life of Equipment		9	24	7	12	13.00
Acquisition cost of damaged equip(N)		1,000,000	10,000,000	900,000	20,000,000	7,975,000.00
Machine Hour Rate (N/T)		50,000	300,000	60,000	432.23	102,608.06
Establishment's overall hourly cost of production (N/T)		500,000	3,000,000	600,000	50,000	1,037,500.00
Total production down time due to accident:	Fatal	16	16	12	12	14.00
	Serious	6	5	4	6	5.25
	Minor	3	4	2	3	3.00
Valve of goods/materials damaged in accident :	Fatal	8,000,000	4,800,000	7,200,000	2,000,000	5,500,000
	Serious	3,000,000	1,500,000	2,400,000	750,000	1,912,500
	Minor	1,500,000	1,200,000	1,200,000	100,000	1,000,000
Period of idleness of equip due to accident:	Fatal	10	10	12	14	11.50
	Serious	8	7	6	4	6.25
	Minor	3	2	4	0.5	2.38
Degree of severity	Fatal	0.9	0.72	0.9	0.96	0.87
	Serious	0.09	0.27	0.07	0.039	0.12
	Minor	0.01	0.01	0.03	0.001	0.01
Probability of Occurrence of Accident:						
Fatal		0.12	0.19	0.16	0.03	0.12
	Serious	0.26	0.2	0.52	0.29	0.32
	Minor	0.62	0.61	0.32	0.68	0.56

Table 2: Cost Estimation

Class of Accident	Chemical Industry (₦)	Oil and Gas (₦)	Food and Beverages (₦)	Manufacturing (₦)	Average (₦)
Fatal	541,072	94,701,700	921,271	29,617,953	18,183,096
Serious	575,103	3,933,980	1,834,120	13,339,567	3,143,489
Minor	1,300,870	2,969,210	341,562	853,503	1,366,286

potential consequences of accidents were estimated as ₦94,701,700, ₦13,339,567and ₦2,969,210 for fatal, serious and minor accidents, respectively while the least accidents cost was estimated as ₦541,072, ₦1,834,120 and ₦341,562 for fatal, serious and minor accidents, respectively. This showed that the fatal accidents have the greatest economic cost implication while the minor has the least. Thus, fatal accident in oil and gas industry has the highest cost of accident estimated as ₦94,701,700 which is 93.21% of the total cost of accidents in the industry while minor accident in food and beverages industry has the least cost of accident estimated as ₦341,562 which is 11.03% of the total cost of accidents in the industry.

CONCLUSION

In this study, the cost estimation model was formulated and applied to the data collected from the four different types of manufacturing industries. Therefore, it could be concluded that the fatal accident has the highest contribution to adversity, hence, has the highest cost of accident estimated, while minor accident has highest probability of occurrence.

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