Estimation of Air Traffic Accident Cost in Nigeria.

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ABSTRACT

This project proposes an accident cost estimation model in the aviation industry in Nigeria. The model takes into consideration the probability of accidents and the cost of the potential consequences. Potential consequences of accidents are classified as human severity, property damage, and economic implications. The three classes of accidents identified in this study were fatal, serious, and minor.

The cost of each class of accident was developed in terms of the probability of accident occurrence class i (Pai), human severity cost of the accident (Hi), degree of severity (fi), service life of the aircraft (L), interest rate (t), usage life of aircraft (T), acquisition cost of damaged aircraft (N), period of idleness of aircraft due to accident (θi), flight rate (FR), economic implication cost (Ec), and value of damaged goods (Qi).

Historical data was collected from the Federal Aviation Authority with the aid of a questionnaire and personal interviews on the occurrence and consequences of accidents between the periods of 1983 to 2007. The data collected was statically analyzed and applied to the model. The average cost of each class of accident (fatal, serious, and minor) was estimated as: fatal, ₦1,453,616,775.00; serious, ₦2,547,388.80; and minor, ₦511,928.00.

(Keywords: cost model, economic impact, airline accidents, Nigerian air travel, probability)

INTRODUCTION

The threat of air traffic accidents on our airways has called for sober refection at the local, national, and international levels. This is due to the resulting losses, of both human and material resources (ROSPA, 1999, Saari, 1999; Sacks et al., 2002 and Adebiyi et al., 2006). There can be a gross loss to the industry in terms of medical bills payable to the injured and insurance coverage also has a heavy impact in the form of compensation to victims or victims' estates. Both the airline organizations' profit and the national economy suffer from down-time and loss of lives. As a result, there is considerable national and international interest in many countries of the world in establishing agencies to monitor and manage airway safety, for example, the National Airspace Management Agency (NAMA) in Nigeria.

There has been a sizeable amount of literature on air traffic accidents in developed countries, however, empirical investigations, particularly related to air traffic accidents cost in developing countries, is extremely sparse. In Nigeria, airway safety has received little attention and the attempts made to date across the entire transportation segment have mostly centered on the highways and manufacturing industry as evidenced from Adebiyi et al. (2005), Adebiyi, (2002), Ige (1999), and Inegbenebor and Olalekan (2002).

Even at the international level, most research that has been carried out on airway safety has been concentrated on risk reduction and accident prevention with emphasis on design, maintenance. and operation of aircraft (Roelen et al., 2000, Sarac et al., 2006, Brooker, 2006, Jacobson et al., 2007, Bristow and Irving, 2007, and Shyur, 2008). However, putting a cost on air travel accidents will draw the attention of the employees, society, and the management on the need for organized safety programs.

This research provides compelling justification to search for improved methods of reducing the rate of accidents. A less obvious implication is that safety programs that have even modest effects in reducing accident risk can have enormous pay–off in terms of cost/benefit.

In the cost estimation attempts, two approaches: human capital/production losses and willingness-to-pay (WTP) are commonly being employed. Some of the more frequently employed methodologies include bottom-up, analogous, parametric techniques, and expert judgment. Recently, parametric techniques have gained popularity because they can provide shorter cycle time than other traditional techniques.

Although there are documented efforts on the estimation of air traffic accident cost, there are significant deficiencies remaining with emphasis on the structural integrity on airway safety interventions (Tally, 1995, Youdi, 2004, Groeneveld et al., 2001, and Peck and Healy, 2007), and with respect to the consideration of the probabilistic nature of accidents. The various attempts have been deterministic in nature. However, Harold and Moriarity (1999) stated that since accident occurrence is probabilistic in nature, its cost estimation model should also be.

Despite the attempts, no generally agreed upon accident cost estimating model is available (Adebiyi, 2006). Based on the author's experience, and that of all practitioners who have attempted cost estimation, it was discovered that cost estimation is a very difficult item, subject to the variability in human beings and complex systems. One noticeable difficulty is estimating the cost of life (in injury and mortality). A known fact is that the value of life cannot be adequately represented by direct cost and loss of earnings.

In this study, a probabilistic air traffic accident cost estimation model is proposed with a view of estimating the cost of each class of accidents to justify the need for safety intervention and for evaluating the financial implication of air traffic accidents on the national economy.

THE DEVELOPMENT OF THE COST ESTIMATION MODEL

The resultant effects of accident occurrence are injury, damage, loss, and emotional consequences to the initiators and survivors of accidents (Barber and Donovan, 1988). Also, Adebiyi and Ajayeoba (2006) reported that the cost of potential consequences of accidents may be categorized into human severity; property damages; and opportunity cost. The latter was adopted in this study.

Human Severity

The cost of human severity varies with respect to the classes of accidents (i.e., fatal, serious, and minor). The major problem is how to place a cost on human life. According to Phelps (1999) the cost of life is estimated as the sum of average gross national product, average court penalties, and insurance compensation. This approach address the average economic worth of a citizen regardless of age or status. Mathematically, human severity may be denoted by:

$$H_i = f_i \lfloor YZ \rfloor \qquad \textbf{(1)}$$

where,

f_i = Degree of severity

Y = Establishment Average annual Salary (₦/year)

Z = Establishment maximum allowable service year

Damages

This reflects the economic implication cost of damages and losses (equipment and goods) resulting from accidents. It may be mathematically expressed as:

$$A_{ci} = f\left[\frac{(1+t)^{L-T}}{(1+t)^{L-T}-1}\right]N + Q_i \qquad \textbf{(2)}$$

L = Service life of the aircraft involve in the accident

t = economic rate

T = Usage life of aircraft

N = Acquisition cost of damaged aircraft (N)

i = counter of class of accidents

The Penalty Cost

This is the opportunity cost of not using the aircraft as a result of an accident. It may be expressed as:

$$A_{ci} = R\theta_i \quad \textbf{(3)}$$

R = Flight Rate (N/Hr)

θi = Period of idleness of aircraft due to accident i (Hrs)

i = counter of class of accidents

However, the occurrence of an accident is probabilistic in nature, so the associated cost should be as well (Harold and Moriarity, 1999). Therefore, to estimate the actual cost of an accident, the probability of occurrence and the associated cost of accident consequences are important. Thus, the probability of each class of accidents may be mathematically given as:

$$\rho_i = \frac{\text{Number of each class of accidents}}{\text{Total number of accidents}} \quad \textbf{(4)}$$

Therefore, combining equations 1, 2, 3, and 4, the cost of accident class i (Ci) could be obtained as follows:

$$C_i = \rho_i \left[\left[f_i \left[Y_i Z_i \right] + N \left[\frac{1+T^{L-t}}{1+T^{L-t}-1} \right] + R\theta_i + Qi \right] \right] \quad \textbf{(5)}$$

THE MODEL APPLICATION

Data was collected through the use of a questionnaire and personal interviews from the Federal Aviation Authority of Nigeria (FAAN), Airline Operators, and some insurance houses in Lagos State. Information was collected on:

- Numbers of accidents and classes of accidents.
- Establishment average annual salary (Y).
- Service life of the aircraft involved in the accident (L).
- Usage life of aircraft, (T).
- Acquisition cost of the damaged aircraft (₦).
- Flight rate (R).
- Period of idleness of aircraft due to accident class (θ_i).
- Establishment maximum allowable service year (z).

The number of accidents that occurred from 1983 to 2007 obtained from Federal Aviation Authority (FAA) is presented in Table 1.

Table 1: Air Traffic Accidents Occurrence (1983 – 2007).

Year	Fatal	Serious	Minor
1983	1	4	-
1984	-	7	-
1985	1	4	-
1986	2	3	-
1987	-	5	-
1988	3	8	1
1989	1	6	1
1990	-	7	1
1991	4	5	-
1992	1	8	-
1993	-	3	-
1994	3	4	-
1995	4	1	5
1996	2	3	-
1997	2	1	-
1998	2	7	-
1999	1	4	-
2000	1	4	-
2001	2	5	-
2002	2	2	-
2003	1	6	-
2004	2	4	2
2005	3	10	1
2006	1	6	1
2007	-	1	-
Total	**39**	**118**	**12**

ESTIMATION OF MODEL PARAMETER

The probability of occurrence of accident class i was estimated from expression (4) and Table 1 while the estimates of other model parameters are presented in Table 2.

These are estimated from the data obtained from available reports of accidents gotten from FAAN and Airline operators. The accuracy of the values was enhanced by taking the averages of the data for available operating years.

Using these parameters, the cost of each class of accident is estimated from equation (5) as shown in Table 3.

Table 2: Estimate of Model Parameters.

Parameters	Estimates
Y	₦ 5,750,000. 00
Z	35 YEARS
L	31 YEARS
T	22 YEARS
T	10%
N	₦ 3,500,000,000.00
θ_1	—
θ_2	14 DAYS
θ_3	3 DAYS
R	₦ 56,000.00
f_1	1
f_2	0.003
f_3	0
Q_1	₦ 4,500,000.00
Q_2	₦ 2,000,000.00
Q_3	₦ 500,000.00
ρ_1	0.2308
ρ_2	0.6982
ρ_3	0.0710

Table 3: The Cost Estimate of Each Class of Accident.

	Fatal ₦	Serious ₦	Minor ₦
Hi	201,250,000.00	603,750.00	0
ACi	1,247,866,775.00	784,000.00	168,000.00
ECi	4,500,000.00	2,000,000.00	500,000.00
Ci	1,453,616,775.00	2,547,388.80	511,928.00

RESULTS AND DISCUSSIONS

The model comprises eleven elements that are linked together by linear and polynomial functions. These are Aircraft's service life $(L)_1$, probability of accident (ρ_i), aircraft acquisition cost (N), degree of seventy (θ), severity rate (f), flight rate (R); average annual salary in aviation (Y), maxim service years (Z), period of idleness of aircraft (θi), materials loss (Qi), and types of accidents (i). The model classified the consequences of accidents reported in the literature into human severity, damages, and penalties. Contrary to previous attempts, the proposed model provides a real cost estimate of air traffic accidents that helps the individual, airline operators, private ownership management, and government to know the true nature of consequences of accidents and to put it into proper perspective.

The Cost Estimates

The cost estimates obtained through this model are:

Fatal ₦ 1,453,616,775.00
Serious ₦ 2,547,388.00
Minor ₦ 511,928.00

The critical analysis of the estimates revealed that property damaged accounted for 68% of the cost in fatal accidents while opportunity cost is prominent in both serious and minor accidents accounting for 50% and 80% of the costs, respectively. The human severity factor has a contribution of 20% in fatal and about 70% in both serious and minor accidents. However, in manufacturing and road traffic accidents, the human severity factor had major contributions to each class of accidents. These are indications of the difficulty in placing value on human life, thereby supporting the 1999 (Harald and Moriarity) statement that estimating the cost of accidents depends greatly on location and circumstances.

Although fatal accidents have the greatest economic implication, serious accidents have the highest frequency of occurrence. A total of 169 accidents were recorded in the 25 years period of 1983 to 2007. The statistical analyses revealed that an incidence of 7 accidents per year. Also, the most prominently occurring accidents fall within the serious category, 118 (69.82%);

followed by fatal accidents, 39 (23.08%); and minor accidents 12 (7.1%). The pattern of these results is in agreement with Adebiyi et al. (2007) but converse to the results obtained in both road traffic and manufacturing accident data where the commonest accidents are in the minor class. The information from the model application will be useful for advising management on the magnitude and the cost of consequences for accidents of different types and the benefits of preventive strategies.

CONCLUSIONS

In this study, a cost estimation model was formulated and applied to the data collected from the Federal Aviation Authority in Nigeria. Although the inflationary effect was not taken into consideration, notwithstanding, the application estimated the costs of fatal, serious, and minor accidents as: ₦1,453,616,775.00, ₦2,547,388.00 and ₦511,928.00, respectively. Based on this, it could be concluded that fatal accidents have the greatest contribution to adversity, while serious accidents have the greatest probability of occurrence in the Nigeria aviation industry.

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