

# Analysis of Accidents in a Refrigerator Producing Company.

S.O. Ismaila, Ph.D.<sup>\*</sup>, S.B. Adejuyigbe, Ph.D., and O.J. Alamu, Ph.D.

Department of Mechanical Engineering, University of Agriculture, PMB 2240, Abeokuta, Nigeria.

<sup>\*</sup>E-mail: [ismailasalami@yahoo.com](mailto:ismailasalami@yahoo.com)  
Telephone: +234 8051449269

## ABSTRACT

This study analyzed accident data collected for a period of 5 years (2002-2005) from a refrigerator producing company in Nigeria. One hundred and twenty one (121) minor accidents were recorded while there were three (3) major accidents resulting in 1,245 man-hours lost and additional costs of N124, 890.00 for medical expenses.

The best safety practice was noticed in year 2005 while year 2006 had the poorest. The highest number of accidents was recorded in the production department and the major cause of the accidents was lack of knowledge of safety practices. It was concluded that the company may have to fall back on the safety policy employed in year 2005 and train new employees as well as retrain the old ones to reverse the trend of increasing accidents.

(Keywords: industrial accident, safety planning, employee injuries, safe work environment)

## INTRODUCTION

Manufacturing industries not only contribute to national income by paying taxes but also provide employment for people. There are large numbers of workers and machineries in these industries and any hindrance at any of the units may affect the profitability of the industries and reduce the taxable profits (Yusuf, 2008).

Industrial safety is a critical factor in capacity planning as accidents may result in decrease in the size, efficiency or effectiveness of labor thus decreasing the capacity of a firm's labor force with a resultant decrease in overall capacity. Organizations should ensure a safe work environment for their workers to reduce avoidable costs which include insurance premiums related

to accidents, accident treatment costs, increased labor recruitment and training.

Job and workplace design requires that the safety of employees be taken into consideration. Unsafe methods may seem cheap in the short run, but in the long run could result in higher employee turnover, lost production, lower morale, and higher indirect costs. Worker safety is morally necessary, legally essential, and economically important (Bevilacqua et al., 2008).

An accident in the workplace is the occurrence of disaster which may lead to injury to personnel including fatalities, as well as damage to property, equipment and materials, and a loss of man-hours due to unsafe acts and unsafe conditions (Akii and Ibadode, 1997). Most accidents are preventable because they are caused by people through faulty behaviors or the creation of hazardous situations. In fact, Ibadode (1997) noted that accidents were as a result of lack of control over workers, equipment, materials, and environment. Similarly, Sasou and Reason (1999) observed that management as well as physical working conditions are vital in the development of safety in a risky environment.

Oyedepo (1998) had noted that eighty-eight percent of all industrial accidents were caused by the acts of individuals. Strong (1987) opined that accidents were as result of uncontrolled environment conditions from the workplace or unsafe behavior from the workers. For accidents to occur the defense must be breached and a combination of one or more unsafe acts must exist (Hudson, 1994). Reason (1997) stated that an accident occurs if the causes of accidents pass through the defense protecting the source of danger. It is believed that all accidents or injuries have traceable causes which if controlled will prevent or reduce accidents (Adebowale, 1999). Moreover, Benach (1999) stated that industrial

accidents remain an important issue on the Spanish industrial relations agenda in 1999. They noted that between 1990 and 1997, there were about 5 million non serious industrial accidents. They also observed that there were 227,800 retirements due to industrial accidents and occupational illness with a cost of more than ESP 245 billion for social security system in addition to the medical and pharmaceutical costs.

A lot of studies describe the injuries distribution in terms of person, place or characteristics of the workplace (Siu et al., 2003; Larsson and Field, 2002; Sorock et al., 2001). The huge costs associated with industrial accidents either due to the treatment or the human agony, insurance claims as well as human lives that are lost as a result of accidents provided the need to study the causes of accidents in the industries. Therefore, this study is to analyze the reported accidents in some selected companies and establish the causes of accidents in the companies with a view to minimize them thus reducing costs as well as loss of lives.

## METHODOLOGY

The study was conducted in a manufacturing company producing refrigerators mainly for a major bottling company.

1. Machine Section: This section had 11 workers involved in notching, blanking, shearing and punching of metal sheets based on the drawings of the part in question.
2. Welding Section: The section with 10 workers undertook all the welding jobs using spot, arc, and oxy-acetylene welding techniques in respect of the inner and outer cabinets of the refrigerator.
3. Washing Section: The welded and pre-assembled cabinets were sent to the pre-treatment plant for washing and oven drying to remove dirt or oil and prepare the surface for painting. The section had 4 workers and complained of inadequate manpower. This was evident as there were some cabinets on queue in this section.
4. Spraying: The washed and pre-assembled cabinets were sent into the painting section for powder coating. The section had 5 sprayers.

5. Foaming Section: This section was concerned with preparing the cabinets for foaming and injecting foam Chemicals into the cabinet and allowed to cure for between 5 and 7 minutes. There were 6 workers in this section and some cabinets to be prepared were on queue due to inadequate manpower.
6. Screen Printing: The section is concerned with branding the refrigerator. There were only 4 workers in this section.
7. Final Assembly: Good screened cabinets were sent to the final assembly section where already prepared cooling system, evaporator cover, fluorescent fittings and tube , plastic logo of the company, suction line cover, stabilizer unit, glass door, front grid, harness plate, overload and relay were all fitted. The section had 12 workers.
8. Unit (Cooling Preparation): Unit section had 10 workers concerned with cutting of copper pipe, testing for leakage using nitrogen, brazing of the copper pipe to compressor, evaporator and condenser. They were also saddled with the responsibility of vacuuming, charging (refrigerant gas).
9. Electrical Harness: The section with 10 workers was in charge of cutting required lengths of various sizes of electrical cables, fixing thermostat, fan motor and so on.
10. Door Assembly: In this section, aluminum profiles were cut into lengths and holes at required distances drilled on them. They also fitted magnetic gasket, sheet glass and door handle. The section had 4 workers.
11. Quality Control Section: The section with 4 workers certified the products okay for onward transfer to the warehouse/customers after necessary tests had been carried out on them.
12. Packing Section: This was where certified refrigerators were properly cleaned and fitted with okay label, shelves as well as drip tray. The products were then packaged into carton and tied with polyflex strap. The section had 8 workers.

Records of past accidents from 2002 to 2006 were obtained from the clinic of the company. Such data included the cost of treatment of

accident victims, number of hours lost, number of employees, and the type of accidents. For ease of reference the accidents were categorized mainly into minor and major injuries. Also, one hundred and twenty-one questionnaires containing relevant information were administered on the workers of the company.

While some of the following were obtained from the information provided by the company, some were calculated:

(i) Total Number of Hours Worked (M)

This is the total number of hours worked by the employees of the company. It was evaluated as the number of hours the company was in the operation throughout the year. It was determined from the records of the companies as they worked 8hours daily and 6 days in a week and was assumed constant for each of the year considered.

(ii) Total Number of Major Accidents (LT)

These were the major accidents that required the workers to be absent from work for more than three days.

(iii) Total Number of Minor Accidents (MA)

These were the accidents that keep the workers away from work for less than three days.

(iv) Total Number of Hours Lost (L)

This was the total number of production time lost due to accidents and thus kept the employee away from work.

(v) Accident Severity Rate (ASR)

$$ASR = \frac{\text{Total Number of Man-Hours lost per year}}{\text{Total Number of Man-Hours worked per year}} \times 10^6$$

$$= \frac{L}{M} \times 10^6$$

(vi) Accident Frequency Rate (AFR)

AFR=

$$\frac{\text{Total Number Major Acc.} + \text{Total Number Minor Acc.}}{\text{Total Number of Man-Hour Worked Per Year}} \times 10^6$$

$$= \frac{LT + MA}{M} \times 10^6$$

(vii) Cost Man-Hour Ratio (CMR)

$$CMR = \frac{\text{Total Cost of treatment for Accident Victims per Year}}{\text{Total Number of Hours per Year}}$$

$$= \frac{C}{M}$$

(viii) Accident Prone Rate (APR)

APR=

$$\frac{\text{Number of Workers involved in Accidents over the Period}}{\text{Total Number of Workers in the Establishment}}$$

Also, correlation analysis was conducted between the degree of injury and effect of accident.

## RESULTS AND DISCUSSION

**Table 1:** Safety Performance Characteristics.

YEAR	M	MA	LT	C	L	ASR	AFR	CMR	APR
2002	2488	15	-	6,600.00	8.5	3,416.4	6,029	2.65	0.12
2003	2488	9	1	1,800.00	100.5	40,394	4,019.3	0.72	0.08
2004	2488	6	-	1,200.00	3	1,205.8	2,411.6	0.48	0.05
2005	2488	20	-	4,000.00	10	4,019.3	8,038.6	1.61	0.17
2006	2488	71	2	111,290.00	1,122.5	451,165.6	29,340.8	44.73	0.61
<b>TOTAL</b>	<b>12,440</b>	<b>121</b>	<b>3</b>	<b>124,890.00</b>	<b>1,244.5</b>	<b>500,201.1</b>	<b>49,839.3</b>	<b>50.2</b>	<b>1.03</b>
<b>MEAN</b>	<b>2,488</b>	<b>24.2</b>	<b>1.5</b>	<b>24,978</b>	<b>248.9</b>	<b>100,040.2</b>	<b>9,968</b>	<b>10.04</b>	<b>0.21</b>

**Table Legend:**

LT-Major Accidents

ASR-Accident Severity Rate

M- Total Number of Hours Worked

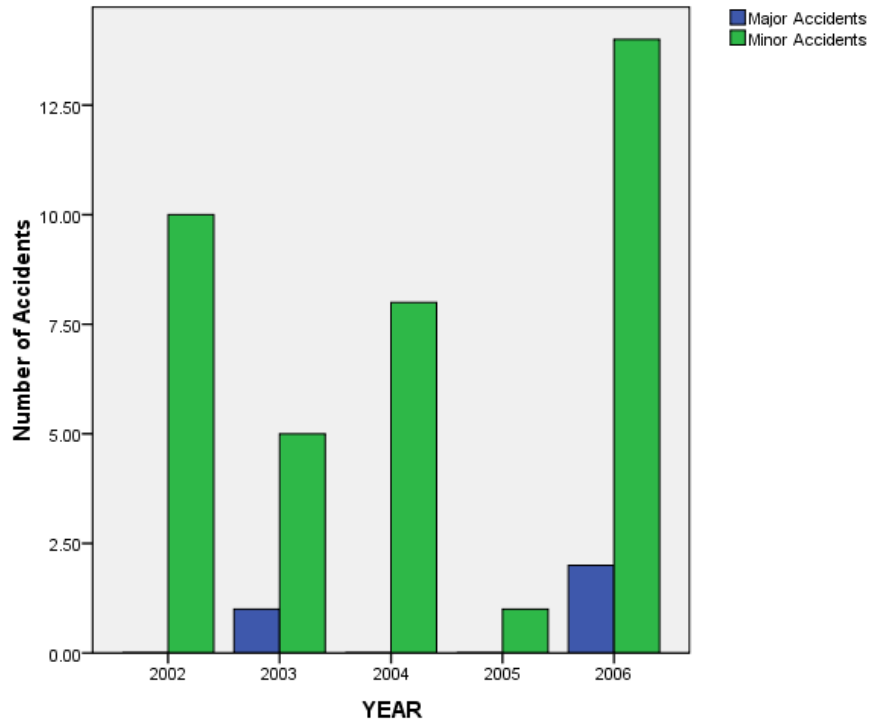
AFR-Accident Frequency Rate

CMR-Cost Man-hour Ratio

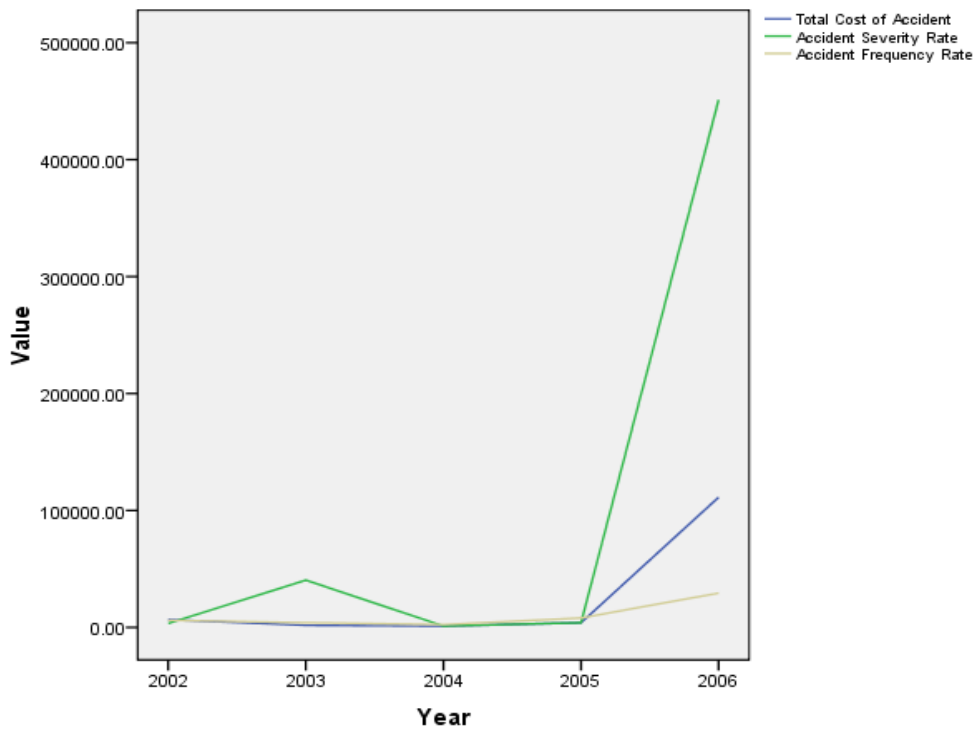
MA- Minor Accidents

C-Cost of Accidents

APR-Accident Prone Rate



**Figure 1:** Trends of Accidents from 2002 to 2006.



**Figure 2:** Trends of AFR, ASR, and C between 2002 and 2006.

**Table 2: Causes of Accidents.**

Cause of injury	Number of Respondents	Percentage
Lack of knowledge	28	23
Mechanical faults	23	19
Operators' negligence	22	18
Combination of all the factors mentioned	48	40
<b>Total</b>	<b>121</b>	<b>100</b>

**Table 3: Section with Highest Accidents.**

Section	Number of Respondents	Percentage
Production	44	36
Stores	29	24
Maintenance	24	20
Canteen	24	20
<b>Total</b>	<b>121</b>	<b>100</b>

Figure 1 shows the trends of accidents in the industry. It shows that in year 2002, the number of minor accidents was ten (10) and it went down to five (5) in year 2003 and rose to six (6) in year 2004. It went down to one (1) in year 2005 and reached all the time high of fourteen (14) in year 2006. No major accident was recorded in years 2002, 2004 and 2005, one (1) was recorded in year 2003 and two (2) were recorded in year 2006.

As shown in Table 1 and Figure 2, year 2006 recorded the highest of all performance indicators with ASR of 451,165.6; AFR of 29,340.8; CMR of 44.73 and APR of 0.61 resulting to a loss of N 124,890.00 to the organization with more than eighty nine percent attributable to year 2006 alone.

All the one hundred and twenty one (121) respondents agreed that accidents were not caused by a specific machine. The same number (100%) also agreed that minor injuries were predominant in the establishment while eighty-six (86) respondents representing ninety percent (90%) opined that accidents were investigated by the company.

The section with the highest rate of accidents was the Production Department with thirty-six percent (36%) followed by Stores with twenty-four percent

(24%), maintenance and canteen followed with twenty (20%) each.

The main causes of accidents were lack of knowledge (23%), mechanical faults (19%), operators' negligence (18%), and a combination of all the factors mentioned (40%). This is at variance with the findings of Fall (2006) and Lind (2008) who found that the most typical fatal accidents in the industry is crushing and impact with solid or stationary objects. Lind (2008) also established that machines and devices were the major cause of severe non-fatal accidents. The effects of the accidents may include injury to worker (24%), delay in production (22%), destruction of equipment or tools (20%), cost of insurance or treatment (20%), and loss of lives (14%).

There is a significant low positive correlation as regards the degree of injury and effect of accident at 95 percent confidence level ( $r=0.331$ ,  $p=0.001$ ). From the foregoing, it is obvious that in year 2005, the company had a good safety program in place which brought about the least number of accidents. However, in year 2006 there were higher cases of number of accidents which were largely due to lack of knowledge of the workers on the production which is in agreement with the study of Bevilacqua et al. (2008) who found out that inadequate knowledge and procedures were

the immediate cause of accidents. This presupposes to mean that there were new recruitments in that year with little or no safety training.

Though the company normally investigates the causes of accidents, it seems that the results of the investigation are not made known to the workers and such had little or no effect to guide against future occurrences. It may therefore be essential for the management of the company to put in place a safety program that was used in year 2004 which probably may include safety training programs for the workers.

## CONCLUSIONS

From the study, safety performance of the company examined in this case study is on the decline as all safety performance indicators were very high in year 2006. The highest cases of accidents were recorded in production department of the company while the main cause of accident was lack of knowledge of safety procedures. To reverse the present situations, the company should train the new workers in its employment and retrain their old workers on safety procedure.

## REFERENCES

1. Adebowale, I.O. 1999. "Safety Programme Performance Evaluation: The Case with a Manufacturing Firm". M.Sc. Thesis, Department of Industrial and Production Engineering University of Ibadan, Ibadan, Nigeria.
2. Benach, J., Benavides, F.G., and S. Jarque. 1999. "The Impact of Industrial Accidents". European Industrial Relations. Observatory On-line. Accessed on April, 18,2008.
3. Bevilacqua, M., Ciarapica, F.E., and G. Giacchetta. 2008. "Industrial and Occupational Ergonomics in the Petrochemical Process Industry: A Regression Trees Approach". *Accident Analysis and Prevention*. 40:1468-1479.
4. Hudson, P.T. 1994. "Diagnosis and Target Setting in Drilling and Engineering Operation". *A Journal of Society of Petroleum Engineers*. January: 22-31.
5. Ibadode, A.O.A. 1997. *Introduction to Manufacturing Technology*. Ambik Press: Benin City, Nigeria.

6. Larsson, T.J., and B. Field. 2002. "The Distribution of Occupational Injury Risk in the State of Victoria". *Safety Science*. 40: 419.
7. Lind, S. 2008. "Types and Sources of Fatal and Severe Non-Fatal Accidents in Industrial Maintenance". *International Journal of Industrial Ergonomics*. 38:927-933.
8. Oyedepo, A.M. 1998. "Industrial Safety Measures and Their Applications to Nigerian Firm". B.Sc. Project, Department of Industrial and Production Engineering, University of Ibadan, Ibadan, Nigeria.
9. Reason, J. 1997. *Managing the Risks of Organizational Accidents*. Ashgate Publishing Ltd.: London, UK.
10. Sasou, K. and J. Reason. 1999. "Team Errors: Definition and Taxonomy". *Reliability Engineering and System Safety*. 65(1):1-9.
11. Siu, O., D.R. Phillips, and T. Leung. 2003. "Age Differences in Safety Attitudes and Safety Performance in Hong Kong Construction Workers". *Journal of Safety Research*. 34:199-205.
12. Sorock, G.S., D.A. Lombardi, T.K. Courtney, J.P. Cotnam, and M.A. Mittleman. 2001. "Epidemiology of Occupational Acute Traumatic Hand Injuries: A Literature Review". *Safety Science*. 38:241.
13. Strong, M.E. 1987. *Human Factors in Occupational Injury Evaluation and Control*. Handbook of Human Factors. John Wiley and Sons Inc.: New York.
14. Yusuf, T.A. 2008. "Investigation of Causes of Accidents in Manufacturing Industries". B.Sc. Project, Department of Mechanical Engineering, University of Agriculture, Abeokuta, Nigeria.

## ABOUT THE AUTHORS

**S.O. Ismaila, Ph.D.** is a lecturer in the Department of Mechanical Engineering in the College of Engineering, University of Agriculture, Abeokuta. His research interests include Ergonomics, Operations Research, and Environmental Engineering.

**S.B. Adejuyigbe, Ph.D.** is a Professor in the Department of Mechanical Engineering, University of Agriculture, Abeokuta. His research interests include Computer Aided Design and Manufacturing as well as Ergonomics.

**J.O. Alamu, Ph.D.** the current Head of Department of Mechanical Engineering,

University of Agriculture, Abeokuta. He holds a Ph.D. in Mechanical Engineering. His research interests are in renewable energy and materials science and engineering.

#### **SUGGESTED CITATION**

Ismaila, S.O., S.B. Adejuyigbe, and O.J. Alamu. 2009. "Analysis of Accidents in a Refrigerator Producing Company". *Pacific Journal of Science and Technology*. 10(2):255-261.

