Noise Sensitivity as a Factor Influencing Hearing Loss among Power Loom Industry Workers in Salem

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Abstract

Increased noise level with the technological advancement becomes a serious problem in the power loom industry and it has become a crucial occupational hazard to its workers. The power loom industry the work of the machines produces noise that can cause irreversible damage to workers hearing. The purpose of this research is to determine the prevalence of power loom workers in Salem city, the economic factors, may influence the noise induced hearing loss. This study is based on the application of statistical techniques to the empirical data of the hearing symptoms in power loom industry.

Key Words: Hearing loss, Power loom industry, Pareto Model, Estimation

Introduction:

India is a country of villages and about 80 per cent of the people live in them. The income levels are low and about half the population lives below the poverty line. With the advent of technological development, many high speed machines invade the industry with no exception to the power loom industry. The machines and devices used in power loom factory are highly diverse in its nature and most of them emit high noise levels due to frequent operation of noise generating components such as pneumatic elements and other fast moving mechanical components. The operational speed of power loom machines are highly increased and heralded high productivity as well as efficiency. However, parallel to technological and economical progress, ever increasing occupational noise problem reached to an alarming level with the incident of undesirable consequences and adverse health effects to its workers. The maximum noise level of some textile machines has reached 95 decibels. When a number of machines are placed in a room, cumulative noise level is reached to hazardous level where noise control becomes absolutely essential.

DEFINITION: SOUND AND NOISE

Sound is characterized by:

- ❖ Vibration
  - Frequency (**Hz**)
  - Intensity (Pa or **dB**)
    - Decibel scale logarithmic
    - Begins at threshold of hearing
- ❖ Periodicity
- ❖ Duration

"Noise is an unwanted or objectionable sound"

In homogeneous poor communities living under fairly uniform socio-economic and environmental conditions, considerable variation is observed in the health and nutrition status of power loom industry. At one end of the spectrum, a very small number of people exhibit only minimal growth retardation; at the other end some people suffer from extreme forms of hearing loss in power loom industry; and in between are large numbers of people with various degrees of growth retardation in Salem city.

ESTIMATE OF GINI'S CONCENTRATION RATIO

Gini's concentration ratio:

Dispersion in the urban size distribution is measured by using coefficient of variation relative mean deviation and Gini's concentration ratio. Gini's concentration ratio is an ideal measure for studying the variation in the noise sensitivity as a factor influencing hearing loss among power loom industry workers distribution. A method of developing Gini's concentration ratio is described with pareto and Exponential models.

Pareto Model:

The hearing loss of the person x is assumed to follow Pareto distribution f(x,a) is described as

$$f(x,a) = \frac{ax^*}{x^{a+1}} \qquad a > 0, x > x^*$$

Where, x^* is the threshold hearing loss. Parameters a and x^* are estimated by using the method of maximum likelihood (Rao.C.R. 1973).

The likelihood function of the Pareto distribution is

$$L(a:x) = \prod_{i=0}^{n} \frac{ax^{*a}}{x^{a+1}}$$

$$L(a:x) = \prod_{i=0}^{n} \frac{a^n (x^{*a})^n}{x^{a+1}}$$

$$\log L(a:x) = n \log a + na \log x^* - \sum_{i=1}^{n} (a+1) \log x$$

Differentiating this with respect to a,

$$\frac{\partial \log L(a:x)}{\partial a} = \frac{n}{a} + n \log x^* - \sum_{i=0}^{n} \log x$$

$$\frac{\partial \log L(a:x)}{\partial a} = 0 \Rightarrow n \log x^* - \sum_{i=0}^{n} \log x = -\frac{n}{a}$$

$$\sum_{i=0}^{n} \log x - n \log x^* = \frac{n}{a}$$

$$\frac{\sum_i \log x}{n} - n \log x^* = \frac{1}{a}$$

$$x^* = \frac{Min}{i \le 1}(x_i)$$

The expressions for p and q are obtained as follows,

$$p_x = F_X(x) \;\; = \int_{x^*}^{x} \frac{ax^{*a}}{t^{a+1}} dt$$

$$p_x = 1 - \left({x^*}/{x} \right)^a$$

$$q_x = \int_{x^*}^{x} t\, f(t,a)dt \Big/ \int_{x^*}^{\infty} t\, f(t,a)dt = l_1/l_2$$

Where, $l_1 = \int_{x^*}^{x} t\, f(t,a)dt$

$$= \int_{x^*}^{x} \frac{a x^{*a}}{t^{a+1}} dt$$

$$= \left(\frac{a}{a-1}\right) x^* \left[\left(\frac{x^*}{x}\right)^{a-1} - 1 \right]$$

Where,

$$l_2 = \int_{x^*}^{\infty} t\, f(t,a)dt = \int_{x^*}^{\infty} \frac{a x^{*a}}{t^{a+1}} dt = \left(\frac{a}{a-1}\right)(-x^*)$$

$$q_x = l_1/l_2$$

$$= \left\{ \left(\frac{a}{a-1}\right) x^* \left[\left(\frac{x^*}{x}\right)^{a-1} - 1 \right] \right\} \Big/ \left\{ \left(\frac{a}{a-1}\right)(-x^*) \right\}$$

$$= 1 - \left(\frac{x^*}{x}\right)^{a-1}$$

The function $q = f(p)$ has been obtained by using (1) and (2)

$$1 - p_x = \left(\frac{x^*}{x}\right)^a$$

$$\left(\frac{x^*}{x}\right) = (1 - p_x)^{1/a}$$

$$1 - q_x = \left(\frac{x^*}{x}\right)^{a-1}$$

$$\left(\frac{x^*}{x}\right) = (1 - q_x)^{\frac{1}{a}-1}$$

$$(3) = (4) \Rightarrow (1 - q_x)^{\frac{1}{a}-1} = (1 - p_x)^{1/a}$$

$$(1-q_x) = (1-p_x)^{a-1/a}$$

Since the hearing loss of the distribution is known, $q = f(p)$ is obtained by eliminating x. (i.e.)

$$q = 1-(1-p_x)^{a-1/a}; \qquad 0 \le p \le 1$$

The graph of the function $q = f(p)$ is Lorenz curve representing the variation in the hearing loss. Gini's concentration ratio is stated as

$$p = \frac{\text{Area between the lorenz curve and the line of equal distribution}}{\text{Total area under diagonal}}$$

$p = 1 - 2A$ Where, A is the area under the Lorenz curve.

$$A = \int_0^1 F(p)dp = \int_0^1 \left[1-(1-p)^{(a-1)/a}\right] dp$$

$$= \int_0^1 \left[1-(1-p)^{(a-1)/a}\right] dp$$

$$= \frac{a-1}{2a-1}$$

$$p = 1 - \frac{2(a-1)}{(2a-1)} = \frac{1}{(2a-1)}$$

Gini's concentration for noise sensitivity as a factor influencing hearing loss among power loom industry workers using pareto model is estimated

$$\hat{p} = \frac{1}{(2\hat{a}-1)}$$

ESTIMATE OF GINI'S CONCENTRATION RATIO:

Pareto Model:

Table No. 1 : Distribution of noise induced w.r.to hearing loss (January 2019)

Noise Induced Hearing Loss	No. of Persons
1.00-2.00	5
2.00-2.50	6
2.50-3.00	42
3.00-3.25	31

3.25-3.50	5
3.50-4.00	11
Total	100

The parameter of the pareto model are estimated using the information given in the Table No. 1. Further Gini's concentration ratio has been estimated using the estimates of the $\hat{a}$ of pareto model. Computations of such estimates are presented in Table No.2

Table No. 2 : Estimate of the parameter using Pareto Model (January 2019)

Noise Induced Hearing Loss	Mid x_i	No. of Persons f_i	Log x_i	f_i log x_i
1.00-2.00	1.500	5	0.1761	0.8805
2.00-2.50	2.250	6	0.3522	2.1132
2.50-3.00	2.750	42	0.4393	18.4506
3.00-3.25	3.125	31	0.4948	15.3388
3.25-3.50	3.375	5	0.5282	2.641
3.50-4.00	3.750	11	0.5740	6.314
Total		100	2.5646	45.7381

$$\hat{a} = \left[\frac{\sum f_i \log x_i}{\sum f_i} - \log x^* \right]^{-1}$$

$$x^* = \underset{i \leq 1}{\text{Min}}(x_i)$$

$$x^* = 1.500$$

$$\log x^* = 0.1761$$

$$\hat{a} = \left[\frac{45.7381}{100} - 0.1761\right]^{-1}$$

$$\hat{a} = 3.555$$

Gini's concentration ratio in Pareto model is

$$\hat{p} = \frac{1}{(2\hat{a}-1)}$$

$$= \frac{1}{[(2\times 3.555)-1]}$$

$$\hat{p} = 0.1636$$

Table No. 3 : Estimate of the parameter using Pareto model (February 2019)

Noise Induced Hearing Loss	Mid x_i	No. of Persons	log x_i	f_i log x_i
1.00-2.00	1.500	1	0.1761	0.1761
2.00-2.50	2.250	1	0.3522	0.3522
2.50-3.00	2.750	27	0.4393	11.8611
3.00-3.25	3.125	31	0.4948	15.3388
3.25-3.50	3.375	23	0.5282	12.1486
3.50-4.00	3.750	17	0.5740	9.758
Total		100	2.5646	49.6347

$$\hat{a} = \left[\frac{\sum f_i \log x_i}{\sum f_i} - \log x^* \right]^{-1}$$

$$x^* = \underset{i \le 1}{\text{Min}}(x_i)$$

$$x^* = 1.500$$

$$\log x^* = 0.1761$$

$$\hat{a} = \left[\frac{49.6347}{100} - 0.1761\right]^{-1}$$

$$\hat{a} = 3.1230$$

Gini's concentration ratio in pareto model is

$$\hat{p} = \frac{1}{(2\hat{a}-1)}$$

$$= \frac{1}{[(2\times 3.1230)-1]}$$

$$\hat{p} = 0.1906$$

Months	Estimates of parameters (Pareto model)	
	$\hat{a}$	$\hat{p}$
January	3.555	0.1636
February	3.123	0.1906

Gini's concentration ratio is gradually increases over the span of 2 months, though the noise induced hearing loss are 1.500. The increasing tendencies of concentration of noise induced hearing loss in Salem, have been observed empirically.

CONCLUSIONS:

The noise level inside a covering plant of a power loom industry was experimentally measured and developed a noise propagation pattern. Since the noise level was well above the action level of noise exposure, quality of the noise was analyzed in order to design a noise control system. A mathematical model is developed to predict the noise distribution and the model is validated with the noise data gathered according to the standards. An economically viable acoustic ceiling was designed to control noise and carries out a pilot implementation in order to prove the effectiveness of the recommended noise control method experimentally. This study is the first of its kind in rural area in Salem.

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