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# INDUSTRIAL ACCIDENTS IN JAPAN: AN EMPIRICAL ANALYSIS

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Industrial accidents and work-injuries have remained an important problem for study ever since the dawn of industrialization. There is practically no field left which has not looked into this growing problem of human concern. Sociologists, psychologists, business experts, insurance companies, lawyers, medical doctors and even labor economists have tried to understand from different angles the behavior of work accidents, their causes, effects, reduction and prevention.

The most widely known step taken in this direction has been through law, that is, making provision for compensation for work-injuries under the Common Law, for industrial accidents under the workman's compensation acts or under the Social Security legislations. These provisions differ from country to country, but there exist some legal provisions for compensating for the loss of industrial accidents in almost every country. The compensation is both in kind (medical services) and in cash. Most of the research on industrial accidents focus on the economic or medical aspect of the compensation laws. In other words, the economic studies pertain to test the adequacy of compensation acts by measuring the present wage losses, the future earnings along with the worker's life expectancy. In case of death, issues like the number of dependants, the length of dependancy of each dependant, and the future family expenditures are taken into account. The medical studies try to testify the accuracy of physical loss of earning capacity for each disablement, as defined under the act, the future earning capacity and to suggest new standards and policies for the long run. In short, a majority of the studies remain under the framework of the workmen's compensation acts. Important among these are by Earl F. Cheit, H. M. and A. R. Somers and Alfred M. Skolink.(1)

The other studies which have a broader scope, relate usually to the qualitative aspect of industrial accidents. In this case, psychological studies either with the environment and the worker or individual tests in the laboratory can be mentioned as examples. If direction is towards the quantitative side, most of the research is in the form of case studies based on data from sample surveys. Professor Earl F. Cheit has tried to study in his book the economic cost of work-

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(1) Cheit, Earl F., *Injury and Recovery in the Course of Employment*, John Wiley and Sons, Inc. New York, 1961; Somers Hermand and Anne R., *Workmen's Compensation*, John Wiley and Sons, Inc., New York, 1954; Skolink, Alfred M., "Trends in Workmen's Compensation: Coverage, Benefits, and Costs", *Social Security Bulletin*, Vol. 21, No. 8, August, 1958; Somers Herman M., "Confronting the Crisis in Workmen's Compensation", *Monthly Labor Review*, Vol. 82, No. 3, March 1959, pp. 252–256.

men's compensation by statistical measures but it relates to the California sample survey only. Another quantitative approach with regard to the industrial accidents has been recently through medical doctors by studying the effects of environment including air pollution, on human health, efficiency and human behavior.(2) Besides interpreting accidents from medical point of view, medical doctors have also realized the need for psychological, sociological, economic, and even engineering and operational research oriented study of all accidents. Haddon, Suchman and Klein have assembled almost all possible kinds of researches conducted on accidents in their book, "Accident Research: methods and approach".(3) In their book one gets a pretty good idea on accidents but unfortunately very few work seems to be done on industrial accidents. The book also lists some quantitative studies on work-accidents but they are only one or two in number and also are specific in their approach as described above. In short, one may state that a study of industrial accidents on a macro level is yet to be seen.

This paper is an attempt to establish a quantitative relationship between the work-accidents in manufacturing industries in Japan and some socio-economic variables. Such a relationship may help to understand some underlying factors which prevent or contribute to accidents. Hopefully then, industrial accidents might no longer be considered a subject only for the insurance companies or the workmen's compensation law but also for economists in the sense that accident prevention policies may be economically oriented.

## Model

Industrial accident rate in a manufacturing industry is assumed to be a function of (i) income, (ii) age, (iii) monthly hours worked (iv) and sex. Specifically, the functional relations is:

(1) $$A_r = a + bY + cA + dH + eS + U$$

Where $A_r$ is the industrial accident rate which defines two types of accidents. The first being the injury frequency rate per million man-hours worked, and the other is the severity rate of accidents per million man-hours worked in the manufacturing industries. $Y$ is the average monthly contract cash earnings in yen, $A$ is the average age of the workers, $H$ is the average monthly man-hours worked and $S$ is the percentage of female workers to total workers employed.

(2) Kiefer, N. C., "Accidents—a Preventable Epidemic", *Archives of Env. Health*, V. 13: 468–475, 1966; Cooper, A. G., "Carbon Monoxide", *Arch. Environ. Health*, V. 7: 524, 1963; The National Academy of Sciences, and National Academy of Engineering, "Effects of Chronic Exposure to Low Levels of Carbon Monoxide on Human Health, Behavior and Performance". U.S. *Public Health Service, Publication No. 1503*, 1966.

(3) Haddon William Jr., Edward A. Suchman and David Klein., *Accident Research: Methods and Approaches*, Harper and Row Publishers, New York, 1964.

$a$ is a constant, $b, c, d$ and $e$ are measures of marginal accident frequency and severity rates with respect to $Y$, $A$, $H$ and $S$ respectively, and $U$ is a random error term. *A priori* one would expect $Y$ and $S$ to have negative signs and $A$ and $H$ to have positive relationship. This expectation is merely based on common sense and results obtained for the United States and India.* Higher income may serve as an incentive which may help one to be careful on one's job and consequently one is likely to be involved in lesser accidents. Regarding sex, it has been pointed out by a number of studies that women workers are generally more careful and cautious on their jobs than their male counterparts and this may be one of the factors for their involving in lesser number of accidents. Furthermore, women are generally not employed on such jobs which are hazardous in nature and involve greater risk and this can also be one of the reasons for less accidents. As regards age, one may say that with growing age one may not be able to concentrate on the job that well as a young person; but, this argument can be easily inverted by saying that young blood may involve the possibilities of greater haste, carelessness and hence greater accidents. So one does not know in what fashion the age variable may be related with industrial accidents unless tested statistically. With regard to the hours of work, one may argue that after a certain point with increasing hours, the fatigue builds up which may result in lessening the efficiency and thus creating more accidents.

It is important to point out that there have been some earlier studies which indicate the similar line of thoughts although the scope of the studies are not necessarily the manufacturing industry. One such study is by Gordon[4] which relates primarily to home accidents. It indicates that the quality of housing as judged by the amount of income or rental paid, do strongly influence the frequency of home accidents. Another study by the National Safety Council[5] indicates that shorter working hours have helped to cut industrial fatigue which is often a factor for on-the-job accidents. Age factor seemed to make no difference in the accident incidence rates but this study referred to agricultural accidents only.[6]

It is therefore obvious that on the basis of these studies, one is unable to pinpoint exactly those factors which contribute to the frequency and severity of industrial accidents to the extent that one can evolve a policy for accident prevention. However, this paper is an attempt to relate empirically some of the socio-economic factors to industrial accidents in the manufacturing industries in Japan.

* Koshals, R. K. and M, V. Shukla; "Industrial Accidents in the United States—A Macro Approach," *Indian Journal of Industrial Relations*, V. T, No. 3, pp. 393–402, 1972. Koshals, M. and R.K.; "A Macro Analysis of Industrial Injuries—Some Indian Experience," *Accident Analysis & Prevention* V. 4 pp. 135–139, 1972.

(4) *Ibid.*, P. 25, Originally from Gordon John E., "The Epidemology of Accidents", *American Journal of Public Health*, V. 39: 504–515, 1949.

(5) *Ibid.*, P. 32; Orginally from National Safety Council, *Accident Facts—1957 edition.*

(6) King H. F., "An Age Analysis of Some Agricultural Accidents," *Occupational Psychology*, 29: 4: 245–253, October 1955.

## Data

Data for this study pertains to the year 1967 for 17 manufacturing industries in Japan. These industries are listed in Appendix I. Data was collected from the *Japan Statistical Year Book, 1968*. The data for the number of women workers was obtained from the Bureau of Statistics.

## Empirical Results

Using the data for 1967 and applying multiple regression, the following results are obtained:

$$(2) \qquad F_r = -20.0824 - \underset{(6.49)}{0.7459Y} + \underset{(5.73)}{1.1166A} + \underset{(2.22)}{0.1305H} - \underset{(4.37)}{0.2545S}$$

$$R^2 = 0.9314 \qquad F\text{-Ratio} = 40.70^{**}$$

$$(3) \qquad S_r = -3.6006 - \underset{(1.40)}{0.0344Y} - \underset{(2.97)}{0.1235A} + \underset{(0.77)}{0.0096H} - \underset{(0.94)}{0.0117S}$$

$$R^2 = 0.6755 \qquad F\text{-Ratio} = 6.25$$

Where $F_r$ is the frequency rate of industrial accidents per million man-hours worked and $S_r$ is the severity rate per million man-hours worked. The figures in parentheses below the coefficients are their $t$-values. $R^2$ denotes the coefficients of determination. $F$-Ratio is to test the overall fit. *A* 5 percent level of significance for the $R^2$ is denoted by * and a 1 percent level of significance is denoted by **.

Statistically, the results of equations (2) and (3) are impressive and the signs of the coefficients are consistent with the assumptions made earlier. Equation (2) explains 93 percent of the variations in the frequency rate of accidents and equation (3), about 68 percent of the severity rate of accidents in Japan.

According to both the equations, the coefficients of income have a negative sign. This makes sense because income is taken to be a proxy for education and experience. So the higher the income, the higher is expected to the level of education and the length of training. This implies that the probability of accident rates in such cases is hoped to be less because with the application of one's education and training, one may become more cautious and try not to neglect safety rules. One may also state that persons with higher income may be more interested in their work than those with income on the lowest level and interest in work may contribute in lessening the number of accidents. According to equation (2), a hundred yen increase in the average monthly contract cash earnings, would reduce the frequency rate of accidents by about 75 per million man-hours worked and the severity rate by only three per million man hours worked. But an increase of the *average age* of the workers by one year, would increase the frequency rate by about 1.12 and the severity rate by 0.12. Similarly, increase in the average monthly hours worked by one would increase the frequency rate by 0.01. An increase in the percentage of number of women workers by one would on the other hand, imply a reduction in the frequency rate of accidents by about 0.25 and the severity rate by 0.01. It appears that for policy purposes, income, percentage of women workers and monthly hours worked are important variables. However, it is not possible to just increase the income levels unless productivity also advances. On the other hand government could easily control the daily or monthly number of hours worked and the percentage of women in the labor force.

This analysis suggests that not only greater working hours are harmful from the point of the increase in the frequency rates of industrial accidents but also indicates that the theory of overtime work is fallacious.(7) In other words, the attitude of the workers for working for greater overtime hours in order to earn more and the hope of the employers for greater production through overtime hours is a deceptive concept. For policy purposes, the government can definitely control the increasing hours in work by first reducing the maximum overtime hours and then setting a limit for total hours of work. This analysis seems inconsistent with the recent demand of the auto workers in the United States by the General Motor Workers' Union for a reduction in the work week from 5 to 4 days and without increase in the existing average hours. Further analysis is needed to have insight into the problem and to see how far the production changes by shifting to four days of work week.

At this point it is important to note that the frequency rates are the ratios of the number of persons killed and injured in accidents to the total man-hours worked and the severity rate is the ratio of the number of days lost to the total man-hours worked.(8) Although both types of accidents are important when policies aiming at accident prevention or reduction are being considered but from the definitions given above, the frequency rates seem to be more important from the human wealth point of view. In addition to the loss of many skilled hands which means greater indirect costs in terms of hiring new workers and additional costs in terms of compensation to those injured or to the dependants of those decreased (workers). So policies aiming at higher income, greater education and training for workers, lesser number of hours of work, employing younger workers and more women workers would not only mean a reduction in the frequency rate of accidents but also a contribution towards greater production and less indirect costs. As the age and income variables are also significant for reducing the severity rates of accidents, policies for higher income and recruitment of younger workers (as mentioned above), would also mean a further reduction in the man-days lost as well.

(7) Bureau of Statistics, Office of the Prime Minister, *Japan Statistical Yearbook, 1968,* Tokyo, Japan.

(8) *Ibid.*, p. 613, Table 409 B.

## CONCLUSIONS

Our analysis suggests that an increase in the average monthly contract cash earnings of the Japanese workers would reduce the industrial accident frequency and the severity rates. An increase in the age of the workers would also increase the frequency and severity rates of industrial accidents. On the other hand, an increase in the average monthly-hours worked, would increase the frequency rate only. An increase in the percentage of number of women workers would reduce the frequency and the severity rates.

For prevention of industrial accidents in the Japan manufacturing industry, policies aiming at an increase in earnings (which indirectly implies improving education and training of the workers), greater recruitment of younger workers, lesser hours of work, and employment of greater number of women workers would prove helpful.

A final point to note may be that in this analysis, we have taken only four variables out of the many which may affect the frequency and the severity rates of industrial accidents.[8] Air pollution levels may be one such variable. As Lester B. Lave and Eugene P. Seskin[10] state that the relatively low levels of carbon monoxide can affect the central nervous system sufficiently to reduce work efficiency and increase accident rates. Many other studies[11] in this regard, relate the same results. However, in the absence of accurate data for air pollution levels or data for any one of the existing pollutants like carbon monoxide in the air for different industries, it is difficult at this point to say in concrete terms as to how many accidents can be prevented through the improvement of air pollution. A further study in this direction is needed.

## APPENDIX I

*List of industries included under the manufacturing Industry—*

1. Food and kindred products
*2. Tobacco
3. Textiles
4. Apparel and related products
5. Lumber and wood products

(9) A few of the other variables for which data was available in addition to these four, were tried but the results were not significant. These were the duration of service and the union membership. But there may be many other variables which may prove significant which can be known only if data is available for them.

(10) Lave, Lester B. and Eugene B. Seskin, "Air Pollution and Human Health," *Science*, Vol. 169, No. 3947, August 21, 1970, p. 731.

(11) Shulte, J. H. *Archives of Environmental Health.*, Vol. 7, 1963, p. 524; Cooper A. G., "Carbon Monoxide," *U.S. Public Health Service, Publication* No. 1503, 1966; National Academy of Sciences and National Academy of Engineering, "Effects of Chronic Exposure to Low Levels of Carbon Monoxide on Human Health, Behavior and Performance," Washington, D.C., 1969.

6. Furniture and fixtures
7. Paper and allied products
8. Publishing, printing and allied industries
9. Chemicals and allied products
10. Petroleum and coal products
11. Rubber products
*12. Leather and leather products
13. Ceramic, stone and clay products
14. Iron and steel
*15. Non-ferrous metal products
16. Fabricated metal products
17. Machinery excluding electrical
18. Electrical machinery
19. Transport equipments
20. Precision instruments
*21. Ordnance and others
*22. Transport and communication
*23. Electricity, gas and water

* These industries were excluded because some of the values were not available.