

Organizational factors influencing serious occupational accidents

by Simo Salminen, LicSocSc, Jorma Saari, DrTech, Kaija L Saarela, DrTech, Tuula Räsänen, BSc¹

SALMINEN S, SAARI J, SAARELA KL, RÄSÄNEN T. Organizational factors influencing serious occupational accidents. *Scand J Work Environ Health* 1993;19:352-7. The aim of this article is to examine organizational factors influencing serious occupational accidents. The study was part of a larger project investigating 99 serious occupational accidents in southern Finland. A workplace analysis and an accident analysis were done at accident sites. In connection with this investigation, 73 victims, 91 foremen, and 83 co-workers were interviewed with a structured questionnaire. The results showed that the need to save time, tight schedules, and a lack of caution had a greater influence on accidents than did the foremen, co-workers, customers, professional pride, curiosity, or the wage system. Big companies had the lowest risk of serious occupational accidents. Accident risk was significantly greater for subcontractors than for main contractors.

Key terms: ergonomic accident theory, pressure of work community, size of company, subcontracting, system approach.

A worker is always a member of a larger work community. This observation is evident from the model developed by Andriessen (1). According to him, safe behavior is determined by the expectations and reactions of the foreman and co-workers and the probability of reducing accidents and workplace. After these come the attitudes of the foreman and co-workers; these attitudes are critical for safety. The difficulty with the model is the lack of individual factors, which influence the effect of group pressure (2).

In the empirical part of his study, Andriessen (1) indicated that both the foreman's and the co-workers' attitudes toward safety influenced the safety behavior of construction workers. The influence of supervisors was greater than that of colleagues (1, 3). On the basis of these studies, we can suppose that the pressure created by the work community is an important accident factor.

Nine out of 12 previous studies have shown that accident frequency is several times higher in small companies than in big ones (table 1). One study has given contradictory results (11), another showed an inverted-U relationship between company size and accident frequency (12), and a third found no difference in accident frequency between small and big factories (13). According to these results, we can assume that accident risk in larger companies is lower than in smaller ones.

Especially in the construction industry, a considerable part of the work is done by subcontractors. The status of subcontractors and their workers is marginal at construction sites because the main contractor is primarily interested in the safety of his own workers (14). Subcontractors and their workers are assumed to take care of safety themselves. There is a boundary (15) between the workers of the main company and the subcontractors. It had been assumed that subcontractors and their workers have a greater accident risk than the workers of a main contractor.

As far as we know, there is only one study (16) on the effects of subcontracting on accident risk. At the rather special Thames Barrier construction site, the accident risk of subcontracting workers was lower than that of the workers of the main contractor. This finding can be explained by the obvious underreporting of accidents by the subcontractors. The accident frequency of major accidents (requiring over 3 d of sick leave) was lower for subcontractors in the two first years, but in the third year the situation was the opposite. In the third year a group of new subcontractors came to the construction site. At the same time the accident frequency increased significantly. Generally, the results of this study on the risks of subcontracting were contradictory.

The objective of our study was to examine organizational factors influencing serious occupational accidents. Organizational factors are those structural factors in the work community which either directly or indirectly influence the occurrence of accidents. The pressure of the work community, the size of the company, and subcontracting are examples of organizational factors.

¹ Institute of Occupational Health, Department of Occupational Safety, Vantaa, Finland.

Material and methods

The data presented in this article come from a larger study (17) investigating 99 serious occupational accidents in all economic branches in southern Finland during 1 September 1988—31 December 1989. Twelve women and 90 men were injured in these accidents. Sixteen of the victims were young workers under 25 years of age, 68 were middle-aged workers, and 18 were older than 50 years. In three accidents two persons were injured at the same time.

The occupational safety legislation of Finland requires that the employer of victims of serious occupational accidents report such accidents to the safety inspection authorities. We received our information about accidents from the local safety authorities. Thereafter we called the company involved in the accident. Participation in the study was voluntary, but only two companies refused. In these cases legal action was in progress.

The safety inspection authorities (18) define all permanently disabling accidents as serious, including situations in which the possibility of a serious

accident is obvious (eg, falling from a height). Temporary injuries in which the victims were absent from work for only a short period due to injury were excluded from the data (eg, someone got something in their eyes). The mean duration of sick leave was 78 (range 0—382) workdays.

Both a workplace analysis and an accident analysis were done at the accident site with the help of eyewitnesses. A method developed especially for this study was used. In the accident analysis the researcher described the accident type according to the official Finnish classification of accident types (19). At the same time another researcher interviewed 91 foremen of victims and 83 co-workers separately with a structured questionnaire.

Later one of us (SS) interviewed 73 victims either in the hospital, at home, or after they had returned to work. Some of the interviews were done by phone. Twenty victims had died in the accidents. They constituted the greatest proportion of missing data from the interviews. In the interviews the victims, co-workers, and foremen were asked to evaluate the ef-

Table 1. Size of company and accident frequency reported in earlier investigations.

Source	Data	Accident reporting	Result
Slivnick et al (4)	Machine shops (N = 147) in the United States	Accident records of company	Significant negative correlation between company size and accident frequency
Ministry of Labour (5)	Construction companies (N = 15) in the United Kingdom	Accident records of company	Accident incidence rate in small companies (48.7) higher than in bigger companies (27.7)
Cronin (13)	Factories (N = 41) of one large company in the United Kingdom	Accident records of company	Significant relationship between factory size and accident ratio
Oi (26)	American industries (N = 5)	Data from the Bureau of Labor Statistics	Accident frequency in companies with 1—19 workers (19.67) higher than in companies with > 2500 workers (6.23)
Reigstad (11)	Industries (N = 3) in Oslo, Norway	Hospital reports, claims for insurance, police reports	Accident frequency in companies with 1—4 workers (7.09) lower than in companies with 500 workers (19.6)
Buskin & Paulozzi (6)	Construction industry in Washington state in the United States	Washington state death certificates	Significant trend towards lower mortality rates with increasing company size
Paulozzi (7)	Logging industry in Washington state in the United States	Washington state death certificates	Significant trend towards lower mortality rates with increasing company size
Hinze & Raboud (8)	Construction sites (N = 14) in Canada	Interview of safety director	Significantly lower injury frequency in larger firms
Leigh (12)	Household furniture industry in the United States	Department of Labor	Inverted-U curve between company size and injury frequency
Mendeloff & Kagey (30)	Data of the Occupational Safety and Health Administration in the United States	Fatalities reported to the Occupational Safety and Health Administration	Death rates declining with establishment size
Japan Industrial Safety and Health Association (9)	All industries in Japan	Workmen's Accident Compensation Insurance	Linear decreasing trend in accident frequency rate with increasing company size
Suruda (10)	Construction painting in the United States	Fatalities reported to the Occupational Safety and Health Administration	Risk of death significantly higher in the companies with 1—4 workers

fect of nine factors (wage system; saving of time and trouble; pressure of timetables; professional pride; influence of co-workers, foremen and customers; curiosity or desire for change; and incautiousness or carelessness) affecting accidents at the time of the accident on a five-point scale (1 = very little, 5 = very much).

For the statistical analysis, the t-test was used to make paired comparisons of different accident factors. The chi-square test was used to analyze the comparison of the accidents according to the distribution of the work force and the proportion of workers of subcontractors to that of main contractors.

Results

Factors affecting accidents

Figure 1 shows that the victims, co-workers, and foremen were consistent in their assessment of the factors influencing the accident. All of the groups assessed the influence of the saving of time and trou-

ble, the strain of timetables, and carelessness as being significantly greater than that of the wage system, professional pride, the influence of co-workers, foremen and customers, or curiosity (t-values at least 3.44, degrees of freedom (df) = 126, $P < 0.001$). In addition, the victims evaluated the strain caused by customers as greater than that of co-workers ($t = 2.01$, $df = 125$, $P < 0.05$). The co-workers thought that curiosity ($t = 2.04$, $df = 145$, $P < 0.05$) and the strain caused by customers ($t = 2.32$, $df = 141$, $P < 0.05$) influenced accidents more than they themselves. Foremen evaluated the influence of professional pride ($t = 3.85$, $df = 165$, $P < 0.001$) and the wage system ($t = 3.04$, $df = 163$, $P < 0.01$) as greater than that of themselves. They also thought that the influence of professional pride was greater than that of co-workers ($t = 2.75$, $df = 162$, $P < 0.01$).

Effect of company size

We have compared the distribution of serious occupational accidents to the distribution of both the work

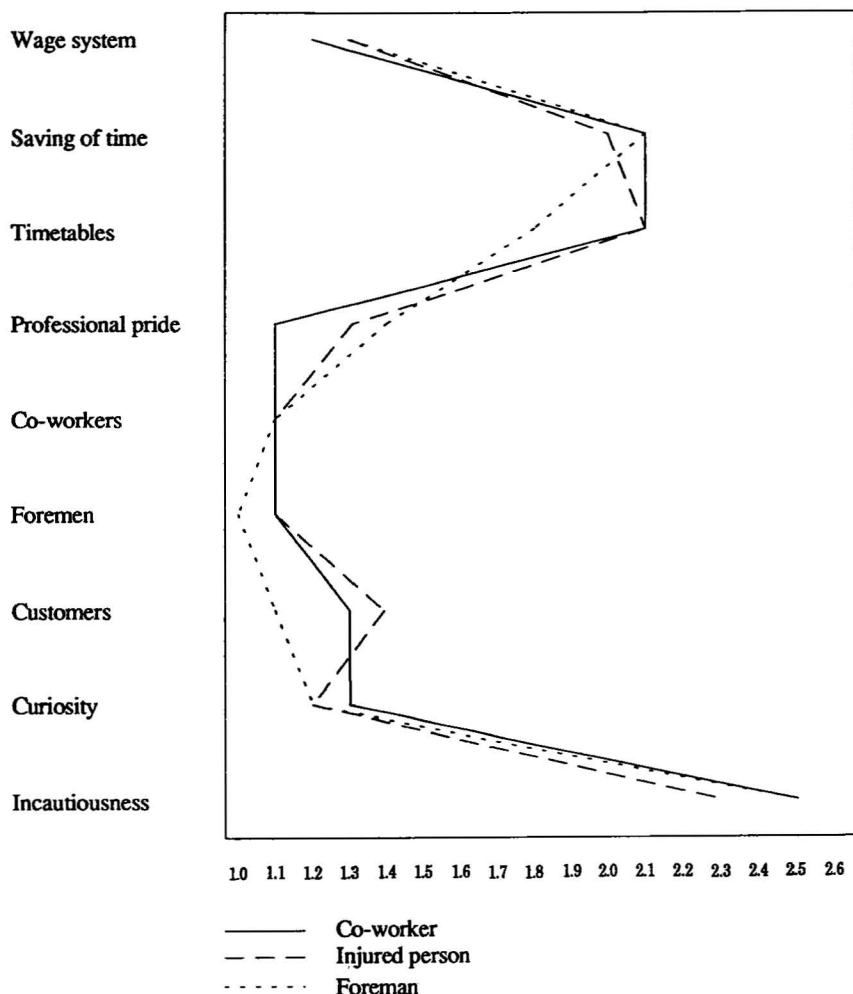


Figure 1. Factors influencing accidents evaluated by the victims and their co-workers and foremen.

force (20) and all occupational accidents (19) during the time of the study (table 2). The accident risk was highest in the construction industry, in which accidents happened four to six times more often than its proportion of the work force. The accident proportion of manufacturing and transportation was two times higher than their proportions of the work force. The accident risk was lowest in the services and trade industries.

Figure 2 compares the distribution of the number of workers in the accident companies to that of all Finnish companies and all industrial companies (20). It shows that the proportion of large companies (over 500 workers) in serious accidents is smaller than their proportion of all workers ($\chi^2 = 20.05$, $df = 1$, $P < 0.001$) and of industrial workers ($\chi^2 = 36.32$, $df = 1$, $P < 0.001$). The accident proportion of companies with 10–200 workers was, however, greater than their proportion of industrial workers ($\chi^2 = 11.94$, $df = 1$, $P < 0.001$) and of workers in all economic branches ($\chi^2 = 7.91$, $df = 1$, $P < 0.01$). The situation with companies with fewer than 10 workers depended on the comparison population. If we had used only the industrial workers as a comparison group, the accident risk in these companies would have been higher than in larger companies ($\chi^2 = 4.72$, $df = 1$, $P < 0.05$). If we had used workers in all eco-

nomical branches, the difference between the small and large companies would have no longer been statistically significant ($\chi^2 = 0.04$, $df = 1$).

We continued the analysis by examining the differences between small (<10 workers), middle-sized (10–499 workers), and large companies (≥ 500 workers). Table 3 shows that there were different

Table 2. Occurrence of occupational accidents by industry during the period under study.

Industry	Work force (N = 2 319 527) (%)	All accidents (N = 105 986) (%)	Serious accidents (N = 102) (%)
Agriculture and forestry	9	4	0
Mining and quarrying	0	0	0
Manufacturing	22	41	41
Energy and water supply	1	1	0
Construction	6	21	34
Trade, restaurants and hotels	15	10	2
Transport and communication	7	8	17
Financing and insurance	8	4	4
Services	29	11	2
Other	3	0	0

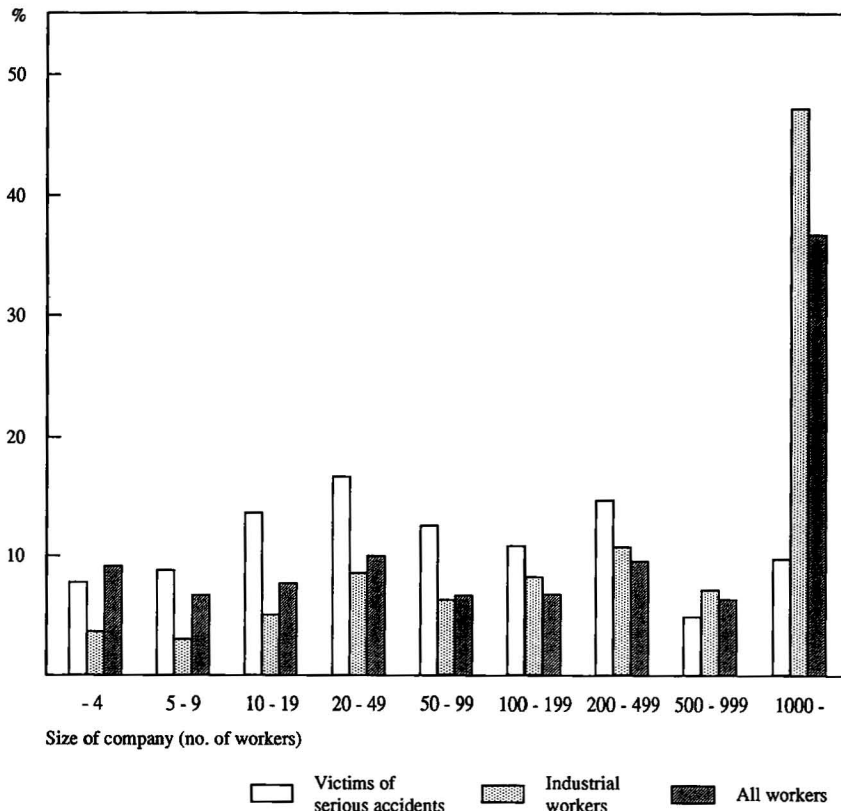


Figure 2. Distribution of accidents according to size of company.

Table 3. Accident type according to size of company.

Accident type	Size of company ^a		
	Small (N = 17) (%)	Middle-sized (N = 70) (%)	Large (N = 15) (%)
Falling from a height	12	30	13
A machine cuts or presses	71	14	80
Other	17	56	7

^a Small: < 10 workers, middle-sized: 10–499 workers, large: ≥ 500 workers.

Table 4. Accident frequency by type of contractor.

Employer	Construction workers (%)	Victims of serious accidents (N = 34) (%)
Main contractor	59	32
Subcontractor	41	68

types of accidents in the different-sized companies ($\chi^2 = 37.21$, $df = 4$, $P < 0.001$). Typical accidents in small and large companies were cuts and other injury from being pressed by moving parts of machines. In the middle-sized companies falls from heights were typical accidents. The differences were not explained by differences in economic branches because, in both the manufacturing and construction industries, 21% of the serious accidents were falls and 29% were cuts caused by moving parts of machines.

Subcontracting

In all, 34 of the accidents in the study happened in the construction industry, and 23 of the construction victims were under the service of a subcontractor. On the average, 41% of the workers worked for a subcontractor at Finnish construction sites (21). If we assume that the same proportion of workers is employed by subcontractors in the accident sites as in the construction industry in general, we can make the comparison presented in table 4. It can be seen that the accident risk of subcontractor workers was higher than that of main contractor workers ($\chi^2 = 9.98$, $df = 1$, $P < 0.01$). Subcontracting increased the accident risk one and a half times.

Discussion

Our first assumption about the influence of the pressure of the work community on accidents was not confirmed. All parties of the accidents consistently stated that other factors influenced the accident in question more than did the work community. This finding can partly be explained by the victims' desire to protect their foremen and co-workers from the responsibility and blame related to the accident.

The people involved in the accidents tended to have the same general attributions towards accident causation. This observation is not congruent with that of a Swedish study (22) which showed large differences between the view of accident risks on the part of accident victims, their fellow-workers, safety delegates, and safety managers. These differences between the studies can be explained by the different questionnaire techniques (forced alternatives versus open questions). On the other hand, studies based on the defensive attribution hypothesis (23) have usually stressed the differences between the parties of an accident in responsibility attributions (24, 25). This contradiction can be explained by the tendency to avoid one's own responsibility for an accident even though the interviewed people assessed the important accident factors in the same way.

In agreement with our second assumption, the accident risk of workers in the large companies was smaller than that in the small and middle-sized companies. Although this phenomenon has not yet been explained, it has been suggested that the lower accident frequency for larger companies is due to lower labor turnover rates, a greater number of employees in safer office tasks, or the hiring of fewer young men, who tend to take more risks (26). In this study it was not possible to examine these factors.

One obvious explanation would be that large companies have better material and intellectual resources for the promotion of work safety. This explanation was not, however, confirmed because the average number of safety measures after the accident was almost the same in the large companies (0.8) as in the small and middle-sized companies (0.7). Some of the measures were stipulated by the safety authorities, and this stipulation reduced the variety between companies.

Another explanation would be the information system for accidents. We obtained the information about the accidents from the safety authorities. The companies were obligated by law to report all serious accidents to the safety authorities, but they did not report all accidents (27–29). It is probable that small companies did not report their accidents as often as middle-sized and large companies (30).

The different occupational insurance systems for large and small industrial companies in Finland would be a third explanation. The large companies have individual insurance fees based on their own accident rates. The small and middle-sized companies have different risk categories, and the insurance fees of the company depend on the accident rates of all companies in the individual category. It is more profitable for large companies to use money for accident prevention than it is for small and middle-sized companies.

In agreement with our third assumption, the accident risk of workers employed by subcontractors was higher than that of the workers for main contractors. This assumption can be explained by the system ap-

proach, which considers accidents as a consequence of dysfunctioning in the actions of the organization (15). The accident frequency was higher in the boundary areas between the main contractors and the subcontractors.

Of course, the short visits of subcontractors' workers to one construction site is an important reason for increased accident risk. A subcontractors' workers do not become familiar with the conditions at the site. Previous studies have shown that experience in the work task is more important to occupational safety than experience in the profession or in the company (31–33). In addition, the exchange of information between the main contractors and the subcontractors might be poor, and this situation, according to the ergonomic accident theory (34, 35), would increase accident risk.

This study had two main problems. The first was that the collected sample was rather small. Comparisons among work forces showed that the data on serious accidents were concentrated in industries traditionally labeled as dangerous. The second problem was the lack of a reference group. Because the accidents in the study represented all industries, it was impossible in practice to form a reference group consisting of nonaccident workers. However, the existence of a reference group can help only in the interpretation of the results based on the first hypothesis on the importance of the work community as an accident factor.

Acknowledgments

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