Fatal workplace accidents in outsourced operations in the manufacturing industry

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ABSTRACT

Several studies have indicated that outsourcing increases the risk of accidents and presented some explanations for this phenomenon. For example, higher accident proneness of external employees has been presented, but the common causes of accidents have not been reviewed in depth. This paper provides information about typical accidents, the contributing factors, and preventive measures of fatal occupational accidents that occurred in outsourced manufacturing tasks. This paper also compares whether these factors differ from accidents that occurred when tasks were performed in-house in the manufacturing industry. The accident analysis is based on information gathered from accident reports for fatal workplace accidents that occurred in Finland during 1999–2008. At outsourced operations in manufacturing, accidents occur most commonly when installations or work preparations are being performed. According to the reports, dangerous work practices and insufficient hazard identification most frequently contributed to accidents. In order to prevent typical accidents, e.g., occupational instructional and guidance, hazard identification, work practices, supervision, and task planning should be improved. Statistical differences between outsourced and in-house operations were also found, mainly within the contributing factors. Therefore, the safety of outsourced manufacturing operations should be considered in detail in order to prevent accidents and ensure occupational safety also when operated with other performers.

1. Introduction

1.1. Workplace accidents in the manufacturing industry

The manufacturing industry is one of the most dangerous branches in light of the frequency of occupational accidents. In 2007, the number of accidents causing more than 3 days’ absence at manufacturing companies in EU-15 countries and Norway totaled about 942,000. In the same year, 667 fatal accidents were recorded in the manufacturing industry (Eurostat, 2009c). According to Eurostat (2009a), about 4.5% of the workers employed in manufacturing businesses faced accident(s) at work in a 12-month period. These figures rank manufacturing second in the accident statistics right after construction (see Eurostat, 2009a).

In Finland during 2007, about 30,000 accidents occurred at manufacturing workplaces, of which slightly more than 14,000 caused a minimum of 4 days’ absence. Six of the accidents were fatal. Thus, about every fourth workplace accident involved employees performing manufacturing operations. During the same year, in Finnish manufacturing workplaces, the accident frequency of accidents causing at least 4 days’ absence ( workplace accidents per million work hours) was about 20, and about 43 if calculated from all reported accidents. According to the accident frequency, the manufacturing industry was the third most risky branch after construction and private households with employed persons. The number of accidents in the manufacturing industry was the same as the previous year, but the frequency decreased a little as the number of work hours increased (FAII, 2009a).

The most common working processes at the time of accidents at Finnish manufacturing workplaces in 2007 were production, manufacturing, processing (56% of the accidents). The most common modes of injuries were contact with sharp, pointed, rough, coarse material agents (23% of the accidents) and the most common injuries resulting from the accidents were wounds and superficial injuries (47% of the accidents) (FAII, 2009a).

1.2. Outsourcing in the manufacturing industry

Increased competition, globalization, and a rapidly changing operational environment have turned outsourcing into an ordinary part of companies’ operations and management. Especially manufacturing companies favor outsourcing to an increasing extent (see Eurostat, 2009b). According to the outsourcing trends, Finnish companies are some of the most eager outsourcers in Europe (Ekström, 2007; Eurostat, 2009b; Rikama, 2008). Of the Finnish companies...
operating in the manufacturing industry and employing more than 10 employees, almost two thirds outsourced some of their operations during 2000–2006 (Ali-Yrkkö, 2007). In Finnish industry, outsourcing has been most common among companies operating in the manufacture of metals, the chemical industry, and the forest industry. In these lines of business, more than 80% of the companies have outsourced some of their operations. On the contrary, food industry companies have used external providers the most seldom (fewer than every second one of the companies). Almost every studied Finnish manufacturing company that has subcontracted work to other performers has operated with domestic companies, but every sixth company has also contracted operations abroad (Ali-Yrkkö, 2007). Larger Finnish manufacturing companies (at least 100 employees) have contracted internationally to an even larger extent (Eurostat, 2009b). The share of outsourced operations has been predicted to increase at the end of the first decade of 2000 (Ekström, 2007).

Finnish companies commonly outsource services supporting primary business, but the execution of core services is also sifted to service providers (see Ali-Yrkkö, 2007; Eurostat, 2009b). According to the study conducted by Ali-Yrkkö (2007), Finnish manufacturing companies with more than 10 employees have most commonly outsourced service operations (e.g., financial management, property maintenance, machine maintenance and guarding). About every second company operating in the manufacturing industry has outsourced current operations since the beginning of the 2000s. Every third manufacturing company has outsourced manufacturing operations and slightly lesser R&D operations. Service operations have been acquired almost solely from Finnish providers, but about a tenth of R&D operations and manufacturing is outsourced outside Finland (Ali-Yrkkö, 2007). Compared with other European countries, the international outsourcing statistics of Finnish large companies are somehow average from the viewpoint of operation types and the frequency of their externalization (Eurostat, 2009b).

According to Nordic outsourcing research, the most common reasons for outsourcing among Nordic companies are focusing on core operations and obtaining special knowhow. In addition, fluctuation in personnel demand, reduction of costs, and a means to change the fixed costs to variable ones were mentioned as common reasons (Ekström, 2007). The main motives for outsourcing abroad are, in addition to cost efficiency and special skills, improvement of competitiveness and access to new markets (Rikama, 2008) as well as groups' strategic decision and competitors/clients example (Eurostat, 2009b). All these factors correspond with those reported in several international studies to explain why companies outsource their operations (see Hätönen and Eriksson, 2009).

1.3. Research on effects of outsourcing on workplace accidents

In several circumstances, outsourcing has been indicated to increase the possibility of accidents and even the number of workplace injuries (e.g., Blank et al., 1995; Kochan et al., 1994; Mayhew et al., 1997; Quinlan and Mayhew, 1999; Rousseau and Libuser, 1997; Salminen, 1995). However, the magnitude of the influence is difficult to assess due to limitations in accident statistic data (Hämäläinen, 2010). Nevertheless, studies indicate that the hazardousness of multi-employer worksites is derived not just from one operator's actions but also from the other party's performance. Although most victims of shared workplace accidents worked for an external employer, accidents were usually attributable to actions by both the customers and the providers (Rantanen et al., 2007a). Several reasons for the subcontracted employees' higher accident rate have been reported. Higher accident rates have been explained to be a consequence of, e.g., subcontractors' unfamiliarity with the working conditions and practices at the worksite (Clarke, 2003), external employees' short duration of visits at the work site (Salminen, 1995), tendency of subcontractors to perform high-risk tasks (Blank et al., 1995; Kochan et al., 1994), deficiencies in external performers' safety training and experience (Kochan et al., 1994), insufficiencies in subcontractors' hazard identification (Salminen, 1995) and safety awareness (Hon et al., 2010), blurred responsibilities (Clarke, 2003), economic pressures (Quinlan and Mayhew, 2000) and poor disorganization of work processes (Quinlan and Mayhew, 2000).

Even though the effect of outsourcing on accident rates has been noticed, comprehensive and detailed research relating to the accidents has been extremely concise. Blank et al. (1995) has studied the nature of injuries and type of accidents that occurred between 1986 and 1990 in the mining industry in Sweden. According to that study, contractor employees seem to suffer from more frequent and more severe injuries than mining companies' own employees. Similar results were reported by Salminen (1995), who compared accidents that involved the main contractors and subcontractors operating in Finnish construction during 1988 and 1989. The most recent study related to the subject has studied how the fact that workplace is shared has influenced in general and in construction occupational accidents occurred between 1999 and 2004 in Finland (see Rantanen et al., 2007b). More research on the subject, especially on what kind of factors contribute to accidents, is needed in order to promote occupational safety and health at shared manufacturing workplaces.

1.4. Objectives of the article

This paper presents the results of a study conducted regarding fatal occupational accidents in outsourced services in the Finnish manufacturing industry. The aims of the paper are to

(1) study during which work tasks as well as what kind of fatal accidents occur when employees perform outsourced operations,

(2) determine the factors that contribute to the fatal workplace accidents in outsourced operations,

(3) review what kind of factors are recommended as preventive measures in the case of fatal accidents that occur in outsourced operations, and

(4) find out if contributing and corrective factors differ from those related to accidents that occurred within in-house operations.

The focus in this study is on operations carried out for a customer operating in the manufacturing industry. The operations reviewed include maintenance and repair, property maintenance, installations, cleaning, and loading/unloading in a factory area.

2. Materials and methods

2.1. Accident reports

The data used in this study has been gathered from investigation reports of fatal workplace accidents that occurred in Finland. The Federation of Accident Insurance Institutions (FAII) and labor organizations coordinate the compilation of the reports that are drawn up after fatal accidents occur in Finnish workplaces or in corresponding conditions involving employees or entrepreneurs insured according to the Employment Accident Insurance Act. Reports are not compiled in cases where an accident has occurred in external or commuting traffic or the death was caused by an occupational disease. Reports are used to inform the workplaces where the fatalities occurred. Reports are also publicly available in Finnish via FAII's web pages (FAII, 2009b).
The accident reports have been compiled based on investigations conducted by a group of experts. The group consists of representatives from the FAII and from labor, officials’, and employers’ organizations in the line of the business in question. In addition, participants from research institutes and insurance companies may be used. The aim of the investigations is to determine what happened, why an accident occurred, and how similar accidents could be prevented. The people responsible for the accident are not investigated (FAII, 2009b).

The accident reports are about five pages long verbal descriptions but they also include a chain-of-events graph based on the Finnish accident investigation model (see Saari et al., 2001) and pictures and drawings clarifying the accident. In addition, the reports include background information on the injured party, employer and accident scene. The reports also contain the accident classification based on the ESAW-classification. The classifications indicate the victim’s age, workstation, occupation, working process, physical activity, deviation, mode of injury, branch of the injured party’s employer and company size.

The investigation system has been in place since 1985 in the case of employees and since 1998 in the case of entrepreneurs. By the end of July 2008, 811 accidents had been investigated, in which 786 employees and 39 entrepreneurs died (FAII, 2009b).

2.2. Data in focus and analyzing methods

The focus in this study is on fatal occupational accidents involving employees during the 10-year time period 1999–2008. Accident reports used to gather the data have been obtained from the FAII’s accident database. The accident reports were selected as a data source because unlike other accident statistics they include reliable information on whether the victim was employed by the customer or the service provider company and whether the accident occurred at the customer’s site or somewhere else. Furthermore, the accident reports include corrective actions recommended by the accident investigation group aimed at preventing similar accidents.

The data presented in this paper were compiled as a part of a research project at Tampere University of Technology by reviewing all the accident reports from the period under review. Accidents, that occurred when employees performed industrial operations for the manufacturing industry at the industrial site, were selected. From the selected reports, the following information was gathered:

- type of the operation (in-house or outsourced),
- operation-related factors (working process and physical activity),
- accident factors (deviation and mode of injury),
- factors contributing to the accidents,
- recommended corrective actions,
- background information (e.g., service providers’ branches, company size and age, profession and experience of the victim).

Information on the type of operation, factors contributing to the accidents, recommended corrective actions and experience of the victim were obtained from the accident descriptions. Data on the other variables were available as ESAW-codes. However, some of the accident reports did not contain information on all of these factors.

During the period under review, 274 fatal workplace accidents occurred involving employees at Finnish workplaces. Summaries were available for all of these (representing information about operation type, operation-related factors, accident factors, and some background information) and full-length reports for 262 accidents. Of these accidents, 83 (30%) corresponded to the target group: employees who died while performing manufacturing industry operations at an industrial site. The production area, factory, workshop; maintenance area, repair workshop; area used principally for storage, loading, unloading, and other similar types of work environments are considered industrial sites (ESAW codes 010–019). Of these relevant cases, 34 (41%) occurred when employees were performing outsourced operations. The cases selected were from the following lines of businesses: manufacturing industry (SIC code D), transport, storage and communication (I), construction (F), real estate, renting and business activities (K), electricity, gas and water supply (E), wholesale and retail trade (G), and other community, social, and personal service activities (O). Detailed information on the cases selected is presented in Table 1.

The data was analyzed using the statistical program SPSS 15.0. Descriptive statistics were calculated to summarize the basic features of the data. To identify dependencies between variables, the data was subjected to statistical tests (Fisher’s exact test and Mann–Whitney U-test).

3. Results

3.1. Background information

During 1999–2008, 34 fatal workplace accidents occurred at outsourced operations and 49 at in-house operations in the Finnish manufacturing industry. The annual number of accidents varied between 1 and 6 in the case of outsourced operations and between 3 and 10 for in-house operations. One accident that occurred at outsourced operations claimed three victims, but other cases involved one victim. The share of the fatal workplace accidents that occurred at outsourced operations compared with all fatal accidents in Finnish manufacturing is illustrated in Fig. 1.

Victims performing outsourced operations were on average 43.2 years old (18–69 years). The age did not differ statistically significantly between outsourced operations even though the average age of victims in the case of in-house operations was slightly higher, 47.2 years (23–62 years). The majority (about one third) of the victims belonged to the age group of 45–54 years in both operation types. Compared with in-house operations in the group of outsourced tasks, the share of victims was greater among the under 25-year-olds and smaller among the ages 55–64.

The most common occupations of the victims in the case of outsourced operations were truck driver (21% of the victims), machine driver (15%), electrician (12%), and machine repairer (9%). Other occupations were cleaner, plate maker, machine operator, mechanic, forklift driver, welder, insulation worker, carpenter, engineering worker, and engineer. Victims were in general experienced in the work tasks they were performing at the time of the accident. Of the external employees, 73% had at least 5 years’ experience or were described as experienced in the accident reports. Less than every tenth external victim had at most only 1 year of experience. Victims performing in-house operations were competent as well, because almost 90% were considered experienced and only 3% had only a little experience. The differences between outsourced and in-house operations were not statistically significant.

Half of the provider companies for whom the victims worked employed at least 50 employees. However, the proportion of smaller companies employing nine employees at most was also remarkable (40%). In-house operations were commonly performed for large companies, because three of four companies were large (at least 50 employees), and only one tenth employed at most nine employees. The differences in the size of the victim’s employer company between outsourced and in-house operations were statistically significant ($p = 0.003$). The victims of accidents that occurred when employees were performing outsourced operations
3.2. Working process, specific physical activity, deviation, and mode of injury

3.2.1. Working process

The most common working processes executed at the time of accidents that occurred at outsourced manufacturing operations were installations and preparations (27% of the cases), maintenance and repairs (18%), and cleaning tasks (15%). The working processes performed differed notably between outsourced and in-house operations even though statistical significances were found only in the cases of production \((p = 0.044)\) and monitoring \((p = 0.019)\) that were more common in-house tasks. Detailed information on the percentages and examples of the working processes performed is presented in Appendix.

3.2.2. Specific physical activity

The majority of the victims among the outsourced operations were moving at the site while the accident occurred (41% of the cases). Other common activities were working with hand-held tools (16%) and handling objects (16%). Some slight differences in percentages between outsourced and in-house operations can be found, but those were not statistically significant. The particular percentages related to victims' activity are displayed in Appendix.

3.2.3. Deviation

Breakage, bursting, splitting, fall, or collapse of the material agent was most commonly mentioned as a deviation contributing to the accidents that occurred at outsourced manufacturing operations. In almost every third report, this factor was recorded as a deviation. Other deviations that frequently took place during a performance of outsourced tasks were slipping, stumbling, falling, or falling of persons (24% of cases) and shock, fright, violence, aggression, threat, or presence (18%). In the case of in-house operations, the most common factor was different, the loss of control of a machine, handheld tool, object, or animal. This was marked as a deviation in every fourth report discussing accidents that occurred when employees performed in-house manufacturing operations. However, the difference was not statistically significant. Detailed information on the deviation data is presented in Appendix.

3.2.4. Mode of injury

Almost every second accident report that discussed accidents that occurred at outsourced manufacturing operations mentioned injuries being caused due to trapping or crushing. In addition, horizontal or vertical impact with or against a stationary object; struck by or collision with object in motion and contact with electrical voltage, temperature, or hazardous substances were mentioned in the context of several accidents within outsourced operations. The different modes of injuries were almost as common in the case of in-house as outsourced operations, so statistical significances were not found. Comprehensive information on the percentages of modes of injuries in outsourced and in-house operations is presented in Appendix.

3.3. Contributing factors

The most common factors contributing to fatal workplace accidents in outsourced operations in manufacturing related to dangerous work practices (e.g., working in a danger zone or utilizing work methods involving a considerable possibility of errors), insufficient hazard identification (e.g., default on risk assessment or underrating the significance of identified hazards), human error (e.g., miscalculation in the workings of machinery or defective assembly) and deficiencies in instruction and guidance (e.g., introduction to work tasks or worksite neglected or carried out defectively). The first two factors were mentioned as contributors more than in every second accident report discussing accidents that occurred when employees performed outsourced operations. The latter had an influence on every third shared workplace accident. Other common factors contributing to the accidents were inadequate supervision (e.g., supervision at the worksite was ignored or supervision of compliance with instructions was inadequate), defective communication (e.g., risks of work tasks, changes in work performance, simultaneous work tasks or employees on site were not known to all parties involved), insufficient safety devices (e.g., safety devices were not provided or they were removed or switched off), and inappropriate warning signs (e.g., warning signs on machinery were defective or ambiguous or danger zones...
The most common contributing factors related to fatal workplace accidents in the Finnish manufacturing industry presented in the accident reports during 1999–2008 were not marked. These factors were listed as accident contributors in every fourth outsource-related accident report. Several other factors were also mentioned in the accident reports studied.

When the contributing factors related to accidents that occurred in outsourced operations were compared to those that took place in-house, several statistically significant differences were found. Inappropriate warning signs ($p = 0.003$) and inadequate flow of information ($p = 0.012$) were mentioned more commonly in the accidents reports discussing outsourced operations than in reports related to in-house operations. On the other hand, machine malfunction was considered contributing to accidents more rarely in the outsourced cases than in the in-house ones ($p = 0.018$). In addition, differences that can be considered as indicative emerged within insufficient hazard identification, instruction, and guidance and safety devices. From these, safety device insufficiencies were more common among the accidents that occurred in-house operations. Two other factors were mentioned more commonly in the reports that considered outsourced operations. The list of the contributing factors mentioned at least in every tenth report discussing outsourcing operations, their frequency, and the differences from in-house operations are illustrated in Fig. 2.

3.4. Recommended corrective actions

The reports discussing accidents that occurred during the execution of outsourced operations in the manufacturing industry recommended several actions to prevent similar accidents. Most commonly, reports brought out the importance of proper occupational instruction and guidance (e.g., introduction to safe work methods, performance in abnormal situations and proper use of tools and safety devices given to all employees regardless of the employer) as well as sufficient hazard identification (e.g., systematic identification of hazards and execution of corrective actions related to established work practices, abnormal situations and different work phases). Occupational instruction and guidance were mentioned as a recommended corrective action on more than 80% of the reports related to outsourced tasks. In the case of hazard identification, the proportion was only 10% smaller. The next common recommended preventive factors were the utilization of safe work practices (e.g., execution of work phases in correct order, verifying that the installation is dead and avoidance of danger zones), sufficient supervision (e.g., supervision of compliance with safe work practices, interference with faults, ensuring possibility to perform tasks safely), task planning (e.g., planning of proper execution order of work phases, working in fault situations, and execution of simultaneous, short-term and short notice work tasks), consideration of safety issues in machine design (e.g., by taking into account safety aspects, different work tasks, and operation conditions), compliance with rules and instructions (e.g., to follow work orders, utilize given safety devices, and operate according to safety regulations), sufficient safety devices (e.g., flash barriers, backup beepers, and safety rails that are installed and utilized appropriately), appropriate warning signs (e.g., excavations’ sealing-off line markings, valves’ setting markings, and switchboards’ voltage signs), and written work instructions (e.g., for work tasks performed rarely, requiring notable recalling and performed by inexperienced employee). These factors were mentioned at least in every third report but even in every two of the three reports relating to outsourced tasks. In addition, several other actions were recommended as preventive measures among outsourced operations in the Finnish manufacturing industry. Factors that are mentioned at least in every tenth outsourced-related report are presented in Fig. 3.

The recommended corrective actions were more or less the same in the reports discussing outsourced and in-house operations. Differences were found merely in the case of two factors, and additionally, these differences can be considered only indicative. Indicative differences emerged in the case of occupational instruction and guidance and task planning. Both measures were mentioned more frequently in the reports reviewing accidents that occurred at outsourced operations than in the reports of in-house operations.

4. Discussion

4.1. Evaluation of the data

The data used in this study consists of 83 accident cases; about 40% of these cases occurred at outsourced operations. The size of the data is only moderate, but even so, it covers all fatal workplace accidents that occurred during the period under review involving Finnish employees working in the manufacturing industry.

![Fig. 2](image-url). The most common contributing factors related to fatal workplace accidents in the Finnish manufacturing industry presented in the accident reports during 1999–2008.)
However, due to the small number of data, all possible differences in variables between accidents that occurred at outsourced and at in-house operations may not have come up with the statistical tests used. By reviewing the presented results, it is still possible to get a clear picture of the nature of the fatal accidents. Another noteworthy issue is that the accident reports used as a source of the data are mainly qualitative descriptions of the accident cases that occurred in the Finnish manufacturing industry. The operation-related factors and accident factors, which are working process, physical activity, deviation and mode of injury, as well as the victim's profession and a branch and the size of the victim's employer company, are presented in the reports according to the ESAW codes. All other information included in the data has been gathered from the description and categorized by the researchers performing the study. In order to ensure appropriate data collection, only those factors mentioned unambiguously in the descriptions are endorsed to the data. No further interpretations are made in order to avoid misunderstandings and to ensure uniform processing of the accident reports. Third, the accident reports compiled about fatal workplace accidents are made based on an accident investigation carried out by a case-specific group of experts. The differences in the investigator groups and the investigation processes may cause variation in the aspects presented in the accident reports. From the scientific point of view, variation in the reports makes the gathering of comprehensive and congruent information from all the accident reports at least burdensome and complicated but in some cases even impossible. However, relatively quality data was obtained with an extensively careful dissection of the reports.

The focus in this paper has been only on fatal workplace accidents, because such data about non-fatal occupational accidents that occurred in Finland that includes information about the employer status is not available. Thus, the most comprehensive occupational accident database does not include information that can be used to define whether the work task performed at the time of the accident was outsourced or not. However, it could be assumed that the results obtained by studying fatal accidents can be also widened to the non-fatal accident context. In light of a study discussing fatal and severe non-fatal accidents in maintenance, the accident types and accident sources of severe and fatal accidents are quite similar. The clearest difference between these two accident categories is that the machines and devices are emphasized as an accident source in the case of severe non-fatal accidents. Otherwise, the accident information is relatively uniform regardless of the severity of the accident (see Lind, 2008). By taking into account the facts that maintenance tasks are one of the most commonly outsourced industrial operations and that the types and sources of maintenance accidents presented in Lind's (2008) study discussing only those accidents that occurred in the Finnish employer worksite in the manufacturing industry.

When compared with European statistics, the accident factors reported in this paper describe typical accidents that occur in the manufacturing industry rather well (see European Commission, 2009), although some variation exists between different countries. Due to similar safety management problems encountered in multi-employer worksites in different countries, the contributing factors to accidents and the recommended corrective actions in particular reported in this paper are relevant to the safety of every multi-employer worksite in the manufacturing industry.

4.2. Review of the results

4.2.1. Accident trend

Compared with all fatal accidents in the manufacturing industry, the proportion of accidents that occurred at outsourced operations
seems to have risen during the period of review. However, the number of accidents in outsourced operations remained at about the same level during the same time span. Thus, the number of accidents that occurred when employees performed in-house operations has notably decreased. The most probable reason for the upward trend of the accident proportion within outsourced operations is the expansion of outsourcing during the past decade. Unfortunately, no specific data about the extent of the use of external service providers was available. Thus, within this study, it cannot be found whether the increase of the accident proportion among outsourced manufacturing operations and the steady level in accident numbers differing from the development within the in-house tasks can be explained totally by the increased outsourcing numbers or whether the growth originates partially from the development of poorer safety that in the group of in-house operations.

4.2.2. Working processes

Even though the differences in working processes between outsourced and in-house operations were statistically significant only in the case of production and monitoring, the differences in the proportion of setting up, maintenance, and cleaning were also remarkable. Production and monitoring were more common in-house processes and the latter more frequent among outsourced operations. This reflects the companies’ current tendency to focus on their core operations and outsource the operations supporting core functions. The differences in the executed working processes between outsourced and in-house operations may have some kind of influence on other variables reviewed. For example, it is clear that some of the differences between outsourced and in-house operations in the proportions of the specific physical activity, deviation, and mode of injury can be explained by the different working processes. Thus, it is also probable that working processes may have an effect on the factors contributing the accidents. However, most of the contributing factors relate to the organizational and human factors that are not very task specific. Therefore, it could be assumed that the working process’s influence is not that significant from the perspective of the utilization of the results. However, the assumptions and the magnitude of the possible influence cannot be checked due to the limited number of data.

4.2.3. Contributing factors

In the case of accidents that occurred at outsourced operations, inappropriate warning signs, insufficient hazard identification, deficiencies in instruction and guidance, inadequate flow of information, and insufficient task planning were emphasized as contributing factors more commonly than at in-house operations. An explanation for this is that ensuring the adequacy of these issues is considered difficult when working at work sites operated by other performers (Nenonen, 2009). The complexity of managing the factors in question may relate to the problems in the service providers’ own safety management but as well as to unworkable arrangements and cooperation between partners. According to the literature, e.g., weaknesses in external companies’ hazard awareness may spring from hazard identifications external companies made unsystematically (see Trethewy et al., 2003) or equally from host companies’ poor communications of hazard identification results (see Mynttinen, 2006). From the viewpoint of instruction and guidance, insufficiencies may result because host companies have not considered that external employees are not as aware of and experienced with common practices and procedures as the host’s own employees (see Clarke, 2003). On the other hand, the flow of information may be inadequate, e.g., due to unclear procedures causing breaks in the information flow or workers’ obliviousness about what information should be shared with partners (see Kuitunen et al., 1999). Furthermore, problems in task planning may arise because the task should be executed at short notice or at a work site that is not familiar to the performer (Lind and Nenonen, 2008). In addition, providers’ poor commitment in managing safety at customers’ site (see Holmes et al., 1999), limited resources available for safety management (see Lin and Mills, 2001), and long supply chains with confusing relations (see Loomsøre et al., 2003) may cause insufficiencies in the factors contributing to the accidents.

The contributing factors of the accidents that took place when employees performed in-house operations differed from those that occurred in outsourced operations were insufficient safety devices and machine malfunction. These two factors seem to relate closely to each other. In-house operations include more machine failure removals made by machinists than outsourced tasks. Removal of machine malfunction, especially if the failures are recurrent, may lead to bypassing or out-taking of safety devices in order to quicken the execution of the tasks.

4.2.4. Recommended corrective actions

The only significant differences in the recommended corrective actions between outsourced and in-house operations were found in occupational instruction and guidance and task planning. This may partially be a consequence of the way the accident reports are compiled. Many reports recommend along with the case-specific corrective actions more universally applicable measures. These universal actions may not relate just directly to the identified primary contributing factors but are measures that affect more generally safety performance and prevention of accidents. Because of this reporting style, several corrective actions are mentioned in every report, and thus, some of the recommendations presented in the reports may be somewhat similar.

4.2.5. Exploiting the results of this study

According to the results presented in this paper, even though most of the contributing factors between outsourced and in-house manufacturing operations are similar, several differences in the frequency of the contributing factors exist. From these results can be drawn a conclusion that mainly similar measures to manage safety in outsourced operations can be utilized than in in-house ones. However, when employees operate at another company’s site, the focus in safety management and accident prevention should be directed at the contributing factors most common to the outsourced operations. Also noteworthy is the transition from the execution of manufacturing operations in-house to acquiring these operations from external companies. This also shifts the hazards and possible accidents to the service-providing companies. However, the responsibility of managing the safety cannot be off-loaded merely to providers but should be done with the cooperation of all performers operating on the site in order to ensure the safety of the employees of the service-providing companies and other employees operating at the shared workplace.

5. Conclusions

This article discussed fatal workplace accidents that occurred in the Finnish manufacturing industry during 1999–2008. The purpose of this review was to identify what kinds of accidents occur when employees performed outsourced manufacturing operations and study the factors contributing to these accidents. In addition, the purpose was to compare accidents that occurred at outsourced operations with those that took place at in-house operations. The study was carried out by analyzing accident reports made based on accident investigations executed by a group of experts. According to the analysis of the accident reports of the Finnish manufacturing workplaces, every year several accidents claim the lives of the employees working for the service providers or the
main companies. About 40% of these accidents occur when employees perform outsourced operations. The largest share of the fatal workplace accidents involves middle-aged employees who are experienced in the tasks they are performing at the time of the accident.

The most common working processes in the case of fatal accidents that occurred at outsourced operations were installations and preparations as well as maintenance and repairs. The most common specific physical activity, deviation and mode of injury were movement, breakage, and impact against a stationary object, respectively. When outsourced operations were compared with in-house tasks, some differences in the shares among the studied variables were found. However, these differences were statistically significant only in the case of a couple working processes.

The most common factors and deficiencies that were mentioned in the accident reports as contributing to the accidents that occurred at outsourced operations were dangerous work practice, insufficient hazard identification, human error, and deficiencies in instruction and guidance. These contributing factors differed between outsourced and in-house operations in several cases. However, the recommended corrective actions in the reports were very similar.

The analysis discussed in this paper has yielded previously quite shortly reviewed information related to the factors influencing the fatal accidents at outsourced operations in the manufacturing industry. Results of the analysis presented in the paper can be used among others in risk assessment, accident prevention, and orientation of safety measures at shared workplaces in the manufacturing industry. The results gathered during the analysis presented in this paper are also examined in a research project executed at the Department of Industrial Management at the Tampere University of Technology. During the project, an operational model of safety management for service providers operating in the manufacturing industry was developed. With the support of the practical information and tools of the model, industrial providers can enhance safety when operating with customer companies.

Appendix A

Accident-related variable proportions of fatal workplace accidents at outsourced and in-house operations in the manufacturing industry in Finland during 1999–2008.

<table>
<thead>
<tr>
<th>Variable (ESAW-code)</th>
<th>Examples of variables presented in the accident reports</th>
<th>Outsourced operations (%)</th>
<th>In-house operations (%)</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Working process</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Production, manufacturing, processing (11)</td>
<td>Working in a production line, manufacturing of products, and removal of a process malfunction</td>
<td>3 (n = 33)</td>
<td>18 (n = 49)</td>
<td><strong>&quot;</strong></td>
</tr>
<tr>
<td>Storing (12)</td>
<td>Load of a cargo and transfer of supplies at a store</td>
<td>6</td>
<td>6</td>
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<tr>
<td>Remodeling, repairing, extending, building maintenance (24)</td>
<td>Repair of a valve</td>
<td>3</td>
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<tr>
<td>Setting up, preparation, installation, mounting, disassembling, dismantling (51)</td>
<td>Unloading of a cargo, installation of lights, and assembly of scaffolding</td>
<td>27</td>
<td>20</td>
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</tr>
<tr>
<td>Maintenance, repair, tuning, adjustment (52)</td>
<td>Repair of a loader, fault correction of process equipment, and survey of electrical connections</td>
<td>18</td>
<td>6</td>
<td></td>
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<tr>
<td>Cleaning working areas, machines (53)</td>
<td>Cleaning of a production area, a pipeline, and a conveyor</td>
<td>15</td>
<td>4</td>
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<tr>
<td>Waste management, disposal, waste treatment of all kinds (54)</td>
<td>Discharging of a silo, loading of a garbage truck, and transferring waste to a waste container</td>
<td>6</td>
<td>2</td>
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<tr>
<td>Monitoring, inspection of manufacturing procedures, working areas, means of transport, equipment (55)</td>
<td>Oil level survey, inspection of a production line operation, and visit to a production area</td>
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<td>16</td>
<td><strong>&quot;</strong></td>
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<tr>
<td>Other auxiliary activity (59)</td>
<td>Adjustment of a crane cable and removal of a pipe blockage</td>
<td>6</td>
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<tr>
<td>Movement (61)</td>
<td>Moving between work sites and the transfer of a forklift</td>
<td>12</td>
<td>12</td>
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<tr>
<td>Other working processes (99)</td>
<td>Lifting of a container and inspection of a process operation</td>
<td>3</td>
<td>2</td>
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<tr>
<td><strong>Specific physical activity</strong></td>
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<tr>
<td>Operating machine (10)</td>
<td>Usage of a band saw, a baking chamber, and a grinding machine</td>
<td>9 (n = 32)</td>
<td>9 (n = 46)</td>
<td></td>
</tr>
<tr>
<td>Working with hand-held tools (20)</td>
<td>Usage of a pressure washer, a torque wrench, and a vacuum cleaner</td>
<td>16</td>
<td>15</td>
<td></td>
</tr>
</tbody>
</table>

(continued on next page)
References


