
This item was submitted to [Loughborough's Research Repository](#) by the author.
Items in Figshare are protected by copyright, with all rights reserved, unless otherwise indicated.

The quality of accident and health data in the construction industry: interviews with senior managers

PLEASE CITE THE PUBLISHED VERSION

<http://dx.doi.org/10.1080/014461999371691>

PUBLISHER

© E & FN Spon (Taylor and Francis)

VERSION

AM (Accepted Manuscript)

PUBLISHER STATEMENT

This work is made available according to the conditions of the Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International (CC BY-NC-ND 4.0) licence. Full details of this licence are available at: <https://creativecommons.org/licenses/by-nc-nd/4.0/>

LICENCE

CC BY-NC-ND 4.0

REPOSITORY RECORD

Gyi, Diane E., Alistair G.F. Gibb, and Roger Haslam. 2019. "The Quality of Accident and Health Data in the Construction Industry: Interviews with Senior Managers". figshare. <https://hdl.handle.net/2134/15856>.

Gyi DE, Gibb AGF and Haslam RA (1999). The quality of accident and health data in the construction industry: interviews with senior managers. *Construction Management and Economics*, **17**, 197-204.

The quality of accident and health data in the construction industry: Interviews with senior managers

DIANE E. GYI (MSc PhD MErgS)

ALISTAIR G. F. GIBB (BSc CEng MICE MCIQB)

ROGER A. HASLAM (BSc PhD FErgS) *

Department of Civil and Building Engineering, Loughborough University, Leicestershire, LE11 3TU.

** Department of Human Sciences, Loughborough University.*

Keywords: construction, health, safety, interviews, accident data.

Correspondence sent to:-

Dr Diane E. Gyi

Loughborough Design School

Loughborough University

Leicestershire

LE11 3TU

d.e.gyi@lboro.ac.uk

Abstract

Despite recent changes in legislation and advances towards an integrated project-wide approach, health and safety management in the construction industry is still a major problem, having a substantial cost to business, society and individuals. A prerequisite to improving the situation and developing an effective management strategy is monitoring, providing a detailed understanding of the effectiveness of different approaches to intervention. This paper describes a feasibility study, using in-depth interviews with senior managers to explore the quality of accident and health data, of nine large, high profile companies from the engineering construction sector. The interview dialogue comprised a series of questions and issues to be explored on the organisations accident reporting systems (e.g. what is reported, analyses performed, computerisation), unsafe act and near miss auditing (e.g. definition, validity), failure type indicators (e.g. auditing, quantification), and safety culture indicators (e.g. commitment, health). Whilst safety was a priority for companies, health (i.e. medicals and monitoring systems) had not been given the same consideration, especially with regard to subcontracted labour. This study shows that the validity of accident statistics as a measure of safety remains a limitation and that there is a requirement for a consistent and integrated approach to the measurement of health and safety performance.

Introduction

Many publications conclude that construction has more accidents of greater severity than any other industrial sector and is responsible for a significant proportion of occupational illness (Drever, 1995 and HSC, 1996). Surveys commissioned by the Health and Safety Executive (HSE) indicate compliance with RIDDOR (HSE, 1996a) for accident reporting is less than 40% (Drever, 1995) and that there is also substantial under-reporting of occupational disease (HSC, 1995a). Thus, the published statistics are the tip of the iceberg. In addition, it has been argued the

health and safety performance of construction in the UK compares poorly with other European countries (Davey Smith et al, 1990). Construction accidents also affect project programme and completion dates (CII, 1995). In a report by the HSE (1993), the costs of accidents on one case study construction site were estimated to be 8.5% of the project tender price, although it is not possible to establish how representative this site is of the industry.

In recent years a concerted effort has been made to improve the construction industry's poor performance on health and safety. The HSE has identified that a lack of effective management action causes 75% of fatal accidents (HSE, 1988). Legislation has made explicit reference to the need to manage health and safety risks throughout the project (HSC, 1995b). The profile of health and safety management has been raised by the development of project-wide management systems (Gibb, 1996a).

Unfortunately, Snashall (1990) highlighted that modes of reporting accidents vary in construction both between companies and within companies such that the interpretation of statistics is not easy. There is even difficulty in the definition of a construction worker (as opposed to any worker in the construction industry e.g. office worker). Reliance of the industry on subcontracted workers exacerbates these problems. Smith (1989) advocated that statistics should be used more often by safety managers to aid the identification of causal factors and direct the placement of resources. Hinze and Gambatese (1996) also concluded that clear and complete accident data is a requisite to the understanding of the causal factors or common trends behind accidents. However, in practice it is suspected that conclusions are rarely drawn from accident statistics which are often just briefly viewed and then filed (Kletz, 1990).

With regard to health, there is wide agreement that adequate medical surveillance is not generally available and that work-related health problems are not identified in their early stages. In a survey of 63 line and senior managers Falconer and Hoel (1996) found that there was a clear perception of their role in injury prevention, but less clarity of the manager's role in the prevention of ill health. Health itself is a complex issue; long term strategies are required; cost benefits are not immediate and are consequently difficult to demonstrate; exposure to health risks can be multiple with changes in the nature and level of such; it has a low profile; and

there is a lack of health personnel within the construction industry (Dong, 1992). Because of the long term, disabling nature of many occupational illnesses, the financial burden is often borne by families and the State. Construction organisations, in turn, are affected by compensation claims and higher than necessary insurance premiums, as well as risks associated with a work force which may not always be fit for the job.

Whilst the scale of the health and safety problem in the construction industry is known, there is only limited objective evidence regarding causal factors in accidents and exposure patterns for illness. In particular, human factors issues and the effectiveness of different approaches to intervention are both poorly understood. A prerequisite to this understanding is thorough monitoring. Other potential benefits from well designed surveillance procedures include a raised profile of health and safety within organisations and enabling resources to be targeted most effectively. This paper presents the results of a case study investigation, assessing the current issues for effective health and safety monitoring in the construction industry.

Research Method

Expert interviews

The background to this work is described in Gyi et al (1996) and Gibb and Haslam (1996). A combination of document analysis and semi-structured, focused interviews were used to explore the components of company health and safety information systems. The purpose was to establish what accident and health information were collected, how it was used and its role in developing prevention strategies.

The sample

Interviewees were experienced managers with a responsibility and interest in health and safety. Although they represent nine large, high profile companies from the engineering construction sector (i.e. the construction activities of the process, power and energy industries), some of the information obtained reflects their personal experiences and knowledge. Two of the companies were clients and the other seven were major contractors in the UK: Consequently procedures might be expected to be the most thorough with this group. Access to companies was obtained through the

European Construction Institute, a pan-European and pan-construction organisation comprising clients, designers, contractors and trade associations.

Interview schedule

The two hour interviews were based on a framework suggested by Reason (1991). He identified five possible channels of communication considered to form the safety information system of a company. These are described as follows:-

Channel 1 : Accident and incident reporting systems e.g. accident report forms.

This information is most widely collected but thought to be unimportant for effective safety management. Local problems can be identified, but often there is a disappointing absence of trends in any long term analysis.

Channel 2: Unsafe act and near miss auditing e.g. near miss reports, observation, issues, validity. This can give detailed information on the nature and variety of unsafe acts associated with different tasks, however, measurement is difficult due to the large numbers occurring.

Channel 3: The precursors of unsafe acts e.g. poor workplace design, inadequate training, unsociable hours. These can cause accidents in conjunction with multiple, local unforeseen triggering conditions.

Channel 4: Failure type indicators e.g. poor housekeeping, inadequate training, ineffective communication and poor procedures. This information is obtained by regular observation, evaluation (and quantification) of system activities and can guide safety managers to develop effective and targeted control.

Channel 5: Safety culture indicators e.g. safety culture assessments, top level commitment to health and safety. This information is the basis for longer term evaluation of a company's health and safety performance.

Reason argued that it is important for managers to take regular samples of these proactive safety state indicators, in other words a company's 'vital signs'. Thus, interview questions focused on the current practice of the company with regard to 'what health and safety data are collected?' and 'how?'; their value/usefulness; ease of access to the information; analyses performed; whether subcontractors are included; and if any causal analysis is carried out. A classification of causal factors was taken from O'Reilly and Olomolaiye (1994) together with a seven point rating scale of cultural issues from Reason (1991). The interview concluded with a series

of questions relating to health issues. The interview schedule comprised a balance of 'open' and 'closed' response questions and summary of the questions and issues addressed are shown in Table 1. Copies of any relevant material such as accident forms, monthly report forms, policies, etc. were also obtained as evidence to support information obtained during the interviews.

Results and discussion

The interviews were recorded on audiotape and transcribed by the researcher. Procedures such as triangulation (multiple sources of data,); peer debriefing (critical discussion with peers); and member checking (allowing the sample to respond to the interview interpretations) were used to ensure research rigour (Erlandson et al, 1993).

Accident and incident reporting systems

The majority of companies collected and collated data for both their own staff and subcontractors on fatalities; over-3-day injuries (over-1-day for some companies) i.e. the individual being unable to do their normal work for more than 3 (or 1) days; minor injuries (first aid only); and near miss events or equivalent (Table 2). Sickness absence data and the figure for total days of lost time injuries were less consistently collated, agreeing with the findings of Falconer and Hoel (1996). Costing accidents, although not routinely performed was highlighted as the way forward to focus senior management's attention on prioritising health and safety. For example, one company involved project managers in a workshop to calculate the costs involved in different accident scenarios. This led to an appreciation of the financial implications of lost time, retraining etc. The response to the question of how indicative different types of data were to the level of safety performance on site is shown in Figure 1. Data which companies reported collecting routinely were ranked higher and therefore better indicators of safety performance than data which were less consistently collected i.e. costs, lost time and sickness absence. This possibly reflects the respondents limited experience using the latter data.

Managers were asked to rate various human, managerial, violation, environmental and lifestyle factors as contributory to the causation of accidents in the engineering construction industry (Table 3). The factors of 'unfamiliarity with the demands of the job', 'poor supervision' and 'no feedback from the system' were

ranked highest by the sample, followed closely by 'violations of safety rules'. It is encouraging that this group of senior managers (although small in numbers) seemed to recognise the importance of latent failures e.g. 'poor supervision' and 'no feedback' as being contributory to accident causation rather than focusing blame on the worker. Indeed, three of the major contractors were beginning to examine in depth the root causes of accidents e.g. management failures. In the recent study by Falconer and Hoel (1996), 'operator error' was seen as being the major contributory factor to accident causation by their sample of 63 line and senior managers. Reasons for this discrepancy could be that this sample was larger and included line managers who were perhaps less experienced to take a global view of accident causation factors. HSE information cited by O'Reilly and Olomolaiye (1994) indicated that for fatalities, unsafe systems of work contributed to almost half of deaths occurring from 1987-1993.

The use of statistics was limited. Frequency and incidence data were routinely calculated, but only a minority of respondents (one client and one contractor) used any other quantitative statistics, e.g. risk estimates, mean and standard deviation. All companies reported collecting frequency data, but even with this there was potential for confusion to occur. For example, the definition for one company was 'per 1,000,000 man-hours' but was 'per 100,000 man hours' for others.

All of the companies questioned the validity and usefulness of statistics.

Examples of reasons for this distrust were:-

- 1) Suspicion that figures have been manipulated. For example, the true frequency for a project can be hidden by using figures for the whole company. One third of the sample expressed serious reservations about the use/misuse of statistics and were wary of the deliberate manipulation of figures.
- 2) Inaccuracies and under-reporting of accidents and near misses. One company reported having a sophisticated computerised, accident data system with computers on site and accident pro-formas computerised on the screen, but in their experience the safety culture allowed extensive under-reporting rendering the information on the data base of little value.
- 3) Statistics are only useful to detect trends over long periods. Other measures of safety performance are urgently needed.

4) Inconsistencies between sites have the consequence where one site may report everything i.e. minor cuts etc. whereas another site may only report serious injuries. Such discrepancies have allowed the situation where safety performance (as measured by statistics) could appear worse in companies with a better and more 'open' safety culture.

In addition Kletz (1990) warns against basing safety performance decisions on data analyses which are not statistically significant. Nevertheless, the majority of these companies were using data publicly on site, in order to produce league tables of safety performance, as part of various 'safety incentive schemes' sometimes leading to donations to a charity nominated by the best contractor. At the same time they also recognised the dangers that such incentive schemes could have by encouraging under-reporting of accidents. This issue has been discussed further by Gibb (1996b).

As part of their evaluation procedure of tendering contractors, eight out of nine of the sample companies requested incidence and frequency data on all projects. One of the clients did so only on large projects. However, generally it was deemed to be a minor part of the evaluation process, for the reasons above i.e. suspicion of validity and usefulness. All of the sample reported that they had their own comprehensive pre-qualification questionnaires and assessment procedures to examine the management systems of a company with regard to safety, and these were regarded to be more informative. Information routinely requested as part of this assessment included the health and safety policy (weighted heavily on management systems), mechanisms of evaluation, procedures, responsibilities and method statements. Also, evidence of safety performance and curricula vitae (both for individual employees and the company i.e. previous contracts) were often requested and pertinent questions such as 'when were you last taken to court?' were asked. The importance of personal experience, peer-contacts experiences and 'keeping your ear to the ground' etc. was also evident from this sample.

Unsafe act and near miss auditing

The sample was divided with regard to the measurement and use of the term 'near miss'. Two companies did not use the term and considered it ambiguous. For example, a cut finger could be determined a near miss because the same event could have had more severe consequences e.g. loss of an arm. Three of the companies

used the term but admitted that there was gross under-reporting, especially apparent on the small/medium, lower profile projects. Reasons for non-reporting included the large disincentive created by the 'macho culture'; a fear of retribution and embarrassment; not wanting to reflect a poor safety performance; the paperwork; lack of trust raising fears of a hidden agenda; and also workers were not used to reporting such events. Another three companies were positive about the use of near miss auditing and had made efforts to create a high profile by use of notice boards, tool box talks, incentives, safety bulletins and a 'no blame culture'. The final company (a client), although affirmative about the need for near miss reporting, felt that despite encouragement and hard work, a high enough level of reporting of such events would take a very long time to become a reality. This company were implementing policies such as those to support a high number of visible safety advisors on site and increased training, in order to slowly encourage a positive safety culture (a pre-requisite to such changes in behaviour).

Less than half of the companies (including both client companies) used observation-based methods for unsafe act/near miss auditing (such as used by DuPont) and then it was mainly on the larger sites. In DuPont this involves formal observation by supervisors of each employee's working practices, for 1-2 hours per week (Reason, 1991). It was reinforced by all of the sample that to be effective such schemes require trust at all levels, a positive safety culture, considerable resources, training, commitment and hard work. The additional cost to the project was the main limiting factor. However, it was agreed that when such schemes work they were very effective at raising safety awareness, giving 'ownership' to the workers at risk, creating opportunities for discussion and identifying ideas for safer working practice.

Failure type indicators

All the major contractors and both client companies 'always' or 'often' carried out full safety audits and safety inspections on site, many of which were quantified. Client representatives were usually involved in these and two thirds of the sample submitted copies of audits to the client as routine. This is encouraging as many studies e.g. Liska et al (1993), Mattila et al (1994) have suggested that top level commitment and support is an essential factor in ensuring safety.

The majority of the sample considered that audits were a site/project document only, for regular monitoring and 'action', but archived following completion of a project. Consequently data were not routinely collated or analysed. It seems an omission that these large quantities of data are not utilised and explored, for example in the study by Mattila et al (1994), the level of housekeeping strongly correlated with the level of safety performance.

Safety culture indicators

Poor safety culture is now recognised as a significant factor in safety performance (Duff et al, 1994 and Dester and Blockley, 1995). Rating their own safety culture, the majority of these large companies gave safety a high priority. Terms such as 'acknowledgement of the importance of organisational and managerial factors', 'many proactive measures in place' and 'top level commitment to improving safety culture' featured in their responses. However, at the other extreme one company admitted 'keeping just one step ahead of the regulators, but showing some signs of concern about the accident trends'. It was accepted that there was no room for complacency and that hard work was still needed at all levels before there was a confident, genuine commitment to safety. In agreement with Dester and Blockley (1995), most organisations in the sample appreciated their duty to promote safety culture development in smaller companies.

Health

All of the participating companies had an alcohol and substance abuse policy or a draft ready for implementation. It was agreed that if there was suspicion of such behaviour regarding any employee, the worker would be requested to leave the site and a disciplinary procedure would commence. However, only one client and one main contractor company carried out post-accident, random and pre-hire screening for alcohol; in these cases it was a condition of employment and was thought to be accepted by workers. Others considered that enforcement of such screening would be difficult in the UK due to civil rights and industrial relations opposition. Consequently the true extent of the alcohol and substance abuse problem is not known for the UK construction industry, unlike the situation in the USA where screening has extended to include such conditions as HIV and hepatitis.

Seven out of nine of the companies (including both client companies) undertook pre-employment medicals for their own employees (mostly white collar workers), but only one did so for their subcontractors (usually the operatives). In the case of the latter company, a site pass was not issued without a medical. With regard to ongoing health surveillance, six monitored their own employees, but only two of the companies monitored subcontractors and then only on certain large projects where there was a nurse on site. Only one major contractor had the view that because they were contracting out the work, it doesn't mean that they could ignore the responsibilities that went with it. Whilst it is recognised that there is a specific requirement for health checks with certain tasks i.e. radiation workers or crane operators, generally, there appeared to be no consistent approach to health surveillance particularly for subcontracted labour. This is important because despite the often quoted 'mobility' and 'high turnover' of subcontracted labour, the work force mostly consists of the same group of core workers, that have been in the industry for years, rotating between contractors and projects (Brown, 1996).

Generally companies admitted that they had concerns about health; managers wanted workers who were passed fit for the job. Issues raised included resourcing occupational health management in the competitive construction environment, the numbers of temporary workers, multi-contracted work, and the fear of job loss by workers. The view of the sample seemed to be that impetus was needed from elsewhere i.e. legislation, rather than from within the industry. However, pressure on the industry is increasing to consider health issues. For example Fink (1996) reports on the case of Armstrong and others versus British Coal Corporation, where the court found that British Coal had failed to investigate the condition of vibration white finger in its employees properly. Its defence for this failure of there being 'other more pressing matters in the coal industry' at the time was rejected.

In addition most operatives were thought to be unaware of their health needs such that a voluntary scheme would have limited success. Any health promotions were usually aimed at prevention and not surveillance. One major contractor expressed concerns that if the task design required the use of Personal and Protective Equipment (PPE) there was a problem, as workers often do not like wearing it, which could ultimately lead to long term health problems. Taking the example of eye protection; glasses and goggles steam up; visual field is reduced;

scaffolders bang their heads; vision quality is reduced especially if their eyesight is not already perfect; and the macho culture effects their motivation to wear it. It is important that PPE is fully evaluated for the task using ergonomics principles.

The main ill health effects of working in engineering construction were reported in the experience of the respondents to be manual handling injuries (backs); respiratory disease (asbestosis); musculoskeletal injuries e.g. vibration white finger; noise-induced hearing loss and skin problems. This suggests a good awareness of the main health risks for construction workers. In the literature (Drever, 1995), construction workers are listed among the occupational groups with significantly raised relative risks ($p < 0.01$) as follows:-

- 1) most at risk occupational group for skin disease (relative risk 2.51).
- 2) 3rd highest risk group (after coal mining and nursing), for musculoskeletal disorders of the back (2.95).
- 3) 4th highest risk group for trauma and poisoning (2.96).
- 4) 3rd highest risk group for lower respiratory disease (3.61).
- 5) 2nd highest risk group (after coal mining), for pneumoconiosis (6.47).

In addition it was considered by respondents that there was a general deterioration in the physical capacity of workers in their 40's and 50's caused by hard work under difficult conditions, often away from home. These managers were however generally optimistic that improvements in working conditions that have taken place in recent years should result in fewer claims in the future.

Concluding remarks

The case study approach adopted by this research comprising interviews with health and safety experts raises a number of issues for consideration by the construction industry. It should be emphasised that their companies represent large, engineering construction organisations where procedures might be expected to be most thorough and the situation across the wider construction industry is likely to be worse. The research must be placed in context of this. Themes for concern raised by the industry were apparent from the interviews. The main conclusions are summarised below:-

- 1) Serious under-reporting, particularly of minor injuries and near miss events, undermines the validity of accident statistics.

- 2) Although under-reporting undermines the validity of accident statistics, this is coupled with a failure to collate and undertake effective analysis of the data that are collected. Furthermore there is little to encourage a high reporting rate for accidents because this can work against a company when tendering for contracts.
- 3) Accident statistics are an indicator of safety performance but should not be the only measure of it. For example, the extent of safety investment can be an indicator of safety performance (Tang et al, 1997), including measures such as frequency of safety training courses; number of safety officers on site; the purchase of quality safety equipment; and the attendance and quality of tool box talks, and safety meetings.
- 4) Commitment and hard work are needed at all levels for a good safety culture; there is no room for complacency.
- 5) Findings from the sample indicate that little exists in terms of medicals and health monitoring. This should be a major concern for the industry and its employees. There also seemed to be limited communication between Occupational Health and Health and Safety departments with regard to the role each takes in the management of occupational health.

Acknowledgements

We would like to thank the following companies for their co-operation with this research: AMEC Process and Energy Ltd, Bechtel Limited, British Gas plc (Engineering Projects), Fluor Daniel Inc., GEC Alsthom Engineering Systems, Laing Industrial Engineering and Construction, National Power, Nuclear Electric, Siemens plc and Stone and Webster Engineering Limited.

References

- Brown, P. (1996) Total integration of the safety professional into the project management team. In L.M. Alves Dias and R. Coble (eds) *Proceedings of the First International Conference of CIB Working Commission W99, 137-143*, Lisbon, Portugal, 4-7 September. A.A. Balkema Publishers: Rotterdam.
- Construction Industry Institute (CII) (1995) *Construction safety zero accidents, the cost of worker injury*. Austin, Texas: CII.

- Davey Smith, G., Egger, M. and Blane, D. (1990) Safety and health in the construction industry. *British Medical Journal*, **301**, 932.
- Dester, W.S. and Blockley, D.I. (1995) Safety - behaviour and culture in construction. *Engineering Construction and Architectural Management*, **2**, 17-26.
- Dong, W. (1992) A mortality study of workers in the British construction industry, 1975-1987. *PhD Thesis*, London School of Hygiene and Tropical Medicine.
- Drever, F. (1995) *Occupational Health: Decennial Supplement*. London: HMSO.
- Duff, A.R., Robertson, I.T., Phillips, R.A. and Cooper, M.D. (1994) Improving safety by the modification of behaviour. *Construction Management and Economics*, **12**, 67-78.
- Erlandson, D.A., Harris, E.L., Skipper, B.L. and Allen, S.D. (1993) *Doing Naturalistic Enquiry. A Guide to Methods*. London: Sage Publications.
- Falconer, L. and Hoel, H. (1996) The perceptions of line and senior managers in relation to occupational health issues. *Occupational Medicine*, **46**, 151-156.
- Fink, S. (1996) Law in action: The presumption of knowledge. *The Safety and Health Practitioner*, July 1996, 38-.
- Gibb, A.G.F. (1996a) Implementation of a project management safety manual. In L.M. Alves Dias and R. Coble (eds) *Proceedings of the First International Conference of CIB Working Commission W99, 3-10*, Lisbon, Portugal, 4-7 September. A.A. Balkema Publishers: Rotterdam.
- Gibb, A.G.F. (1996b) Safety motivation: Evaluation of incentive schemes. In L.M. Alves Dias and R. Coble (eds) *Proceedings of the First International Conference of CIB Working Commission W99, 405-415*, Lisbon, Portugal, 4-7 September. A.A. Balkema Publishers: Rotterdam.
- Gibb, A.G.F. and Haslam, R. (1996) Causes of accidents and priorities for intervention. In L.M. Alves Dias and R. Coble (eds) *Proceedings of the First International Conference of CIB Working Commission W99, 237-241*, Lisbon, Portugal, 4-7 September. A.A. Balkema Publishers: Rotterdam.
- Gyi, D.E., Gibb, A.G.F. and Haslam, R. (1996) A methodology to investigate the causes of accidents in the construction industry. *Proceedings of the ARCOM 12th Annual Conference, 11-16*, Sheffield Hallam University, 11-13th September.

- Health and Safety Commission (HSC) (1995a) *Health and Safety Statistics 1994/1995*. Sudbury, Suffolk: HSE Books.
- Health and Safety Commission (HSC) (1995b) *Designing for health and safety in construction: A guide for designers on the Construction, Design and Management Regulations 1994*. Sudbury, Suffolk: HSE Books.
- Health and Safety Commission (HSC) (1996) *Health and Safety Statistics 1995/96*. HMSO: Sudbury, Suffolk.
- Health and Safety Executive (HSE) (1988) *Blackspot construction: a study of five years fatal accidents in the building and civil engineering industries*. London: HMSO.
- Health and Safety Executive (HSE) (1993) *The costs of accidents at work*. London: HMSO.
- Health and Safety Executive (HSE) (1996a) *A guide to the Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995*. Sudbury, Suffolk: HSE Books.
- Hinze, J.W. and Gambatese J.A., (1996) Using injury statistics to develop accident prevention programs. In L.M. Alves Dias and R. Coble (eds) *Proceedings of the First International Conference of CIB Working Commission W99*, Lisbon, Portugal, 4-7 September. A.A. Balkema Publishers: Rotterdam.
- Kletz, T.A. (1990) *Critical aspects of safety and loss prevention*, 9. London: Butterworth & Co (Publishers) Ltd.
- Liska, R.W., Goodloe, D. and Sen, R. (1993) *Zero Accident Techniques*. Clemson, South Carolina: Clemson University.
- Mattila, M., Rantanen, E. and Hyttinen, M. (1994) The quality of work environment, supervision and safety in building construction. *Safety Science*, **17**, 257-268.
- O'Reilly, M.G. and Olomolaiye, P.O. (1994) Human factors and construction accidents: A UK survey. In *Proceedings of the Fourth conference on Safety and Well-being at Work*, Centre for Hazard and Risk Management, Loughborough University, November 1994, 108-115.
- Reason, J. (1991) Too little and too late: a commentary on accident and incident reporting systems. In T.W. van der Schaaf, D.A. Lucas and A.R. Hale (eds),

Near Miss Reporting as a Safety Tool, 9-26. Oxford: Butterworth-Heinemann Ltd.

Smith, T.A. (1989) Why you should put your safety program under statistical control. *Professional Safety*, April: 31-37.

Snashall, D. (1990) Safety and health in the construction industry. *British Medical Journal*, **301**, 563-564.

Tang, S.L., Lee, H.K. and Wong, K. (1997) Safety cost of optimisation of building projects in Hong Kong. *Construction Management and Economics*, **15**, 177-186.

Table 1. Summary of questions and issues discussed during interviews.

	Questions and Issues
Accident and incident reporting systems	What project data are collected (for employees and contract staff)? Are these data collated centrally? The ease of extracting specifics from the data e.g. by month, by age of worker, by injury type? The validity of data with regard to safety performance? Analyses performed? Computerisation? Causal factor analysis? Causation factors?
Unsafe act and near miss auditing	Definition of the term near miss? Opinions regarding the term? Ensuring validity? The ease of extracting specifics regarding near miss data e.g. by month, age of worker? Observation-based schemes and simulation-based schemes to aid identification of near misses?
Failure type indicators	Full safety audits? Quantification techniques? Informal meetings, safety checks? Inclusion of contractors? Client involvement? Use of audit data e.g. collation, quantitative analysis.
Health and safety culture indicators	Rating safety culture? Alcohol and substance abuse procedures and policies? Alcohol screening (post-accident, random, pre-hire)? Pre-employment medicals? Health surveillance? Inclusion of contractors? Main ill-health effects of engineering construction?

Table 2. The accident and incident data routinely collected by the companies.

Data collected	Major contractors (n=7)		Clients (n=2)	
	company personnel	subcontracted personnel	company personnel	contractor personnel
Fatalities	7	7	2	2
Over-1 or 3-day injuries	7	6	2	2
Minor injuries	7	6	2	2
Non-injury accidents	7	6	2	2
Near miss events	7	6	2	2
Sickness absence (general)	6	4	2	1
Total lost time (days)	6	5	1	1
Cost of accident (*direct)	4	4	1	1
Cost of accident (*indirect)	2	2	0	0

direct - e.g. sick pay, damage to equipment/buildings, liability.

indirect - e.g. training replacement staff, investigation costs, loss of corporate image.

Table 3. Factors considered contributory to the causation of accidents. The scale is 1 (not at all) to 5 (to a very large degree).

	mean rank (median)
The demands of the job are not familiar (e.g. inexperienced operators)	3.78 (4)
Poor supervision	3.78 (4)
No feedback from the system (disciplinary procedures re violations, safety performance)	3.67 (4)
Violations of safety rules	3.56 (3)
Failure to recognise danger or carelessness on the part of the employees,	3.44 (3)
Hostile environment (e.g. weather, noise, dust, toxic materials)	3.33 (3)
Lack of training (e.g. equipment use, hazards)	3.22 (3)
Time shortage ('cutting corners')	3.11 (3)
Health (e.g. injuries, illness)	2.78 (3)
Tiredness (after physical effort)	2.78 (3)
Poor tools/equipment (e.g. difficulties using, old, worn out)	2.56 (3)
PPE deficiency (not provided, poor quality)	2.56 (3)
Alcohol abuse (hangovers, over the limit)	2.44 (2)
Information overload (too many procedures, too complicated, difficult to implement)	2.44 (2)
Monotony and boredom (due to a dull routine without variation in the task)	2.44 (2)
Substance abuse (e.g. drugs)	2.11 (2)

Figure 1. Respondents ranking of different data types with regard to providing an indication of site safety performance (1=low, 5=high).

