Superior safety performance

OSH personnel and safety performance in construction

Dr Iain Cameron, Dr Billy Hare and Dr Roy Duff
Glasgow Caledonian University

research report

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OSH personnel and safety performance in construction

Report submitted to the IOSH Research Committee

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Abstract

What makes organisations superior safety performers? The 'Triple Ace Triangle' theory suggests that superior safety performers require:

- management commitment and leadership
- worker engagement
- access to competent occupational safety and health (OSH) advice.

This study investigated the relationship between competent OSH personnel and OSH performance in construction. The study design included collecting data via a questionnaire and the Contractors Health and Safety Assessment Scheme (CHAS) database. In total, data from 101 contractors were used. OSH personnel were measured in terms of quantity and quality. The quality measure was based on experience and qualifications, using a representative salary. OSH performance was measured using the accident frequency rate (AFR). The OSH investment and OSH performance data were skewed, which prevented the use of parametric tests, so Spearman's rho, Mann-Whitney and Kruskal-Wallis tests were used. Exponential curves for 'OSH investment' and 'cost of accidents' were produced for cost–benefit calculations.

An association was observed between investment in OSH personnel and OSH performance ($r = 0.25$, $p = 0.011$). The optimum OSH investment was found to be 0.1 per cent of turnover, resulting in 0.03 per cent accident costs. Organisations with statistically significant differences in AFR were:

- those with internal OSH personnel (lower AFR) and those who only used external consultants
- those affiliated to an OSH professional body or organisation or with OSH personnel who were members of an OSH professional body (lower AFR) and those with no such affiliations
- those with OSH personnel who provide training, vet sub-contractors, have environmental responsibilities or have greater authority (lower AFR) and those who do not
- those with highly trained line managers (lower AFR) and those with less well-trained line managers.

The optimum OSH investment figure of 0.1 per cent of turnover should be treated as a minimum. Investment in competent internal OSH personnel should be considered for construction organisations with at least £4 million turnover. External consultants should be seen only as a supplement rather than a replacement. However, increasing numbers of OSH personnel indefinitely will not reduce accidents to zero; investment in OSH management will obviously need to be spent elsewhere. The OSH function can be more effective if OSH personnel also participate in training and vetting sub-contractors, if their remit includes environmental responsibilities and if they have increased authority.

This study addressed one leg of the proposed 'Triple Ace Triangle' theory. A further study is recommended, which encompasses all three legs, including management leadership and worker engagement. The latter might also identify effective methods of engaging migrant workers.

Executive summary

Introduction

The question of what makes certain organisations superior safety performers remains, largely, an unanswered one. The 'Triple Ace Triangle' theory suggests that organisations with superior OSH performance require three components:

- management commitment and leadership
- worker engagement
- access to OSH advice.

The aim of this study was to address the third component by investigating the relationship between the provision and application of competent OSH personnel and OSH performance in construction organisations. The underlying assumption – that greater investment in OSH personnel is associated with improved OSH performance – is central to most literature on OSH performance but, strangely, is not mentioned by the Health and Safety Executive (HSE) in its 'excellence model'. The objectives of the study were to:

- develop appropriate assessments of OSH personnel provision
- select appropriate measures of organisational OSH performance
- investigate and quantify any association between these two measures
- translate this association into a cost–benefit relationship
- investigate, classify and evaluate the organisational structures in which OSH personnel operate, including any association with OSH performance.

Methods

The study design included collecting data via a questionnaire survey and from the Contractors Health and Safety Assessment Scheme (CHAS) database. Data from a total of 101 contractors were used for analysis. These contracting organisations employed a total of 660 OSH personnel (internal and/or external) and over 200,000 site workers, including subcontactors.

OSH personnel were measured in terms of quantity and quality. The quantity measure was 1 unit per full-time OSH practitioner, including a fractional count for part-time staff. A notional fraction of 0.1 was used for external consultants. This was based on an estimate of the actual time spent by consultants working for construction organisations.

The quality measure was based on the experience and qualifications of OSH practitioners. Average salaries in relation to experience and qualifications were developed from existing survey data to establish a representative salary incorporating both elements. A three-by-three matrix with a salary representing each combination was the result. The quality measure was normalised by presenting it as a percentage of turnover.

OSH performance was measured using the accident frequency rate (AFR) for one full year. Subcontractor numbers were included, but office staff were excluded for increased accuracy. The calculation was thus:

$$\frac{\text{number of reportable accidents}}{\text{average number employed}} \times 100{,}000$$

The OSH investment and OSH performance data were skewed. This was expected, rather than being the result of poor sampling. However, it also prevented the use of parametric tests, which are considered more powerful than non-parametric tests. Nevertheless, parametric tests may have led to misleading results. Spearman's rho was used to test OSH investment with OSH performance using a 5 per cent level of significance. Organisational factors were tested by comparing mean AFR. Comparisons of two means were performed using the Mann-Whitney test. Comparisons of three or more means were performed using the Kruskal-Wallis test, with *post hoc* Mann-Whitney tests and Bonferroni adjustment for significance.

A cost–benefit relationship was developed with two elements – a cost for OSH investment and a cost for accidents:

- investment in OSH personnel was already calculated as a representative salary, being a percentage of turnover
- accident costs, based on HSE research, were used for 'major' and 'over-three-day' accidents. These were multiplied by the number of accidents experienced by each organisation before being converted to a percentage of turnover.

Exponential curves for each element were produced using regression. Combining the values for each produced a third curve which was then used to obtain an optimal measure of OSH investment.

All the data were entered into Microsoft Excel to calculate organisational measures of OSH investment and OSH performance, before being transferred to a software package called Statistical Package for the Social Sciences (SPSS). SPSS was then used to perform the statistical tests described above.

Findings

A significant positive correlation was observed between investment in OSH personnel and OSH performance ($r = 0.25$, $p = 0.011$). The OSH investment and accident cost curves, produced for the cost–benefit analysis, had a coefficient of correlation of 0.26 and 0.60 respectively. The optimum OSH investment was found to be 0.1 per cent of turnover, resulting in 0.03 per cent accident costs.

The following organisational factors were found to be significant (where m = mean):

- Organisations with internal OSH personnel had a lower AFR (m: 1,274) than those that used only external consultants (m: 3,168). This difference was found to be statistically significant.
- Use of external consultants was concentrated among smaller organisations in the sample (turnover less than £25 million). The difference in AFR was reduced when small organisations were compared. However, a third category, 'internal and external', was ranked with the lowest AFR for these smaller organisations. Therefore, smaller organisations (under £25 million turnover) that employ a mixture of internal OSH staff and an external consultant tended to perform best.
- Organisations affiliated to an OSH professional body or organisation or with OSH personnel who were members of an OSH professional body had a lower AFR (m: 1,420) than those with none (m: 2,622). This difference was found to be statistically significant.
- Organisations with OSH personnel that train their own staff in OSH had a lower AFR (m: 1,313) than those that did not (m: 1,973). This difference was found to be statistically significant.
- Organisations with OSH personnel who vet (or assess) subcontractors had a lower AFR (m: 1,301) than those that did not (m: 3,106). This difference was found to be statistically significant.
- Organisations with OSH personnel who also had environmental responsibilities had a lower AFR (m: 1,033) than those that did not (m: 1,880). This difference was found to be statistically significant.
- Organisations with OSH personnel who had authority to give orders had a lower AFR (m: 745) than those with personnel who merely gave advice (m: 1909). This difference was found to be statistically significant.
- Organisations with OSH personnel who train, vet subcontractors, have environmental responsibilities and have greater authority had a mean AFR of 520. However, at this level numbers became too low to test for statistical significance.
- Line managers' OSH training and qualifications were compared with average AFR. A three-point ordinal scale was used to represent qualifications. The first (highest) band of qualification 'OSH NVQ 3 or above' had the lowest AFR (m: 211). The second ranked band 'SMSTS/MS (NVQ 2)' had a higher AFR (m: 1,567). The third (lowest) ranked band 'up to two days' training' had the highest AFR (m: 1,825). The differences in AFR were statistically significant.

Conclusions and recommendations

- Investment in suitably experienced and qualified OSH personnel was associated with improved OSH performance. The optimum OSH investment figure of 0.10 per cent of turnover should be treated as a minimum. The mean AFR of those below the minimum was 2,279. The mean AFR of those above the minimum was 1,219. This difference was found to be statistically significant.
- However, a full-time OSH practitioner was found to be more effective than merely relying on external consultants (based on a turnover of at least £4 million), and should be considered as an absolute minimum as turnover approaches £35 million. An external OSH consultant was found to be an effective way to supplement an existing OSH member of staff, but relying on an external consultant only was associated with a higher AFR.

- Above average OSH training and/or qualifications for line managers were associated with the lowest AFR averages. Conversely, lower levels of OSH training and/or qualifications for line managers were associated with a higher AFR. This supports the case for increased OSH training and/or qualifications for line managers.
- In terms of OSH function, organisations with OSH personnel who train, vet subcontractors, have environmental responsibilities, and have greater authority are associated with a lower AFR. Therefore, these functions should be considered by OSH personnel if they do not already do so.
- Having individual or institutional membership of an OSH professional body was also associated with a lower AFR.

The study had some limitations. Too many variables were identified to complete the full level of statistical analysis desired, and more cases would have helped. The sample was positively skewed towards a lower AFR (70 per cent below industry average, 30 per cent above). Finally, all costs used should be considered indicative, and future studies, incorporating more detailed cost data, are advised.

Recommendations for improved industry practice

- Investment in a suitably experienced and qualified internal OSH practitioner should be considered for construction organisations with at least £4 million turnover. External consultants should be seen only as a supplement rather than a replacement. This level of investment should be seen as an absolute minimum as turnover grows to around £35 million.
- Investment in OSH personnel, for organisations with a turnover of £35 million or more, should be at least 0.1 per cent of turnover. However, increasing numbers of OSH personnel indefinitely will not reduce accidents to zero. A recommended maximum is not given, but investment in OSH management will obviously need to be spent elsewhere.
- Investment elsewhere is recommended to provide improved OSH training and/or qualifications for line management, and to enable OSH personnel or the organisation as a whole to attain membership of OSH professional bodies. This is in addition to investment in those areas traditionally associated with improved OSH, such as safety management systems, OSH benchmarking and rewards, behavioural safety schemes and worker engagement.
- The OSH function can be more effective if OSH personnel also train, vet sub-contractors, have environmental responsibilities and have increased authority (through access to senior management).
- OSH professional bodies could give consideration to measuring member organisations' AFR, which could in turn promote a reduction in AFR.

Recommendations for further academic study

- This study covers one leg of the 'Triple Ace Triangle'. A further study is recommended that encompasses all three legs, including management leadership and worker engagement. Such a study could also identify effective methods of engaging migrant workers.
- This study focused on OSH at organisational level. Individual characteristics of superior performing OSH practitioners in relation to the Triple Ace Triangle should also be investigated.

1 Introduction

1.1 General introduction

The Health and Safety Executive (HSE) has always sought to disseminate best practice in the management of occupational safety and health (OSH) via publications, guides and codes of practice.[1] The Department of Business, Enterprise and Regulatory Reform, through its various Constructing Excellence initiatives,[2] has also presented case studies of best practice organisations and benchmark evidence to show improved health and safety performance. However, the question of what makes these organisations superior OSH performers still remains unanswered.

A useful starting point for assessing the processes that might improve OSH performance is the Triple Ace Triangle model.[3] The triangle suggests three factors are necessary (see Figure 1):

- management commitment and leadership
- worker engagement
- access to competent OSH advice.

'Management commitment' is probably the topic most widely covered by research in this area,[4,5] with the implementation of safety management systems being a prominent example of commitment. However, 'worker engagement' and 'access to competent OSH advice' have not been researched to the same extent, especially within the construction industry.[6]

Recently completed research investigating worker engagement, funded by the HSE, evaluated approaches to and techniques of worker engagement that could be developed for the construction industry to secure improved performance in a cost-effective manner.[6] The main driver for this research was the need to look at workforce involvement from a continuous improvement perspective rather than the traditional compliance approach. Clearly, the outputs of the HSE project address one leg of the Triple Ace Triangle. 'Access to competent advice' provides a framework for an organisation's provision of health and safety advice, the competence of the people giving that advice, and the allocation of resources, including time, to such people. This is the focus of attention for the study reported here. The outputs of the HSE project, coupled with the outputs anticipated from this study, could potentially provide a framework showing what strategic metrics can be used to determine the differences between those who perform best in health and safety and those whose record is less good.

Measuring what makes individual organisations in the construction industry superior performers has been extensively investigated in the US,[7–11] in order to identify the key factors in those organisations which consistently outperform others. This research shows that attributes possessed by certain organisations can be linked to superior performance. By contrast, there is little corresponding research for the UK.[12] The dearth of such studies in the UK may be due to the absence of workers' compensation insurance, which is used in the US as a mechanism to cover the financial risk from workers' accidents via an 'experience modification rating' (EMR). The EMR is based on the previous year's accident claims and directly affects the organisation's insurance premium. Therefore, the business case for identifying the optimum strategies for improved OSH performance in the US may be more obvious.

Figure 1
The Triple Ace Triangle[3]

Construction was chosen as the environment for this study for three main reasons:

1. Construction has a poor history of OSH performance, accounting for around 30 per cent of all fatal workplace accidents in the UK.[13] It is an important candidate for improvement, highlighted by the HSE's allocation of resources to a separate construction division and by recent 'health and safety summits'. The construction industry is, potentially, a source of increased OSH professional employment.
2. Because of the relatively high accident rates in construction, the inter-organisation and temporal variability of OSH performance across the sector is almost certainly higher than in other industries. Therefore, any measures of association between OSH performance and other factors such as investment in OSH personnel will be more confidently established.
3. Using a single industrial sector with an easily defined and consistent environment will enable conclusions to be drawn more easily, without having to account for the influence of cross-sector differences.

Even with the high levels of OSH personnel employed in the construction industry, dedicated OSH resources are not seen as necessary by many, especially small and medium-sized enterprises (SMEs), where OSH is invariably managed by individuals in tandem with several other duties, if at all.[14] There is even a suggestion that OSH professionals may be too detached from the operational work of organisations and that OSH would be better managed solely by production managers. The integration of OSH management with a line management function is a perfectly reasonable pursuit.[15] However, there is the danger that unscrupulous contractors may use this as a means to avoid the cost of employing OSH personnel without actually providing properly trained and adequately experienced line managers.

This study has investigated OSH management and performance in UK construction organisations. It has focused on the provision of personnel to undertake the OSH function in line with the triangle in Figure 1.

1.2 Aim and objectives

The aim of this study was to investigate the relationship between the provision and application of OSH personnel and OSH performance in construction organisations.

The objectives of the study were to:

- develop appropriate assessments of OSH personnel provision, accommodating different levels of competence through qualifications and experience
- investigate and select appropriate measures of organisational OSH performance
- investigate and quantify any association between the quantity of competent OSH personnel resources provided by construction organisations and their OSH performance
- translate this into a cost–benefit relationship, assuming a measurable association was established, to provide an economic argument for appointing or training OSH personnel
- investigate, classify and evaluate the variety of organisational structures in which OSH personnel operate, and their consequent influence and authority, taking account of senior management and other organisational support
- investigate any association between the application of OSH personnel, in particular their location and authority in the organisation, and the OSH performance of the organisation
- deliver a comprehensive report of the outcomes of these objectives.

2 Literature review

2.1 OSH provision *vs* OSH performance

Around 2.2 million people work in Britain's construction industry, making it the country's largest employment sector.[16] It is also one of the most hazardous. In the last 25 years, over 2,800 people have died from injuries they received as a result of construction work.[13] Many more have been injured or made ill. Ill health has been particularly difficult to measure in the industry because of the transient nature of its workers. Despite this, the HSE has published figures that show the industry exceeds the all-industry average rates with respect to musculoskeletal disorders, occupational dermatitis, mesothelioma, asbestosis, diffuse pleural thickening and work-related hearing loss, with levels of vibration-related disorders being surpassed only by the extractive industries.[17]

Despite this, the industry is working hard to reverse the trend. Overall, there has been a continuing reduction in the rate of fatal and major injuries since the introduction of the Health and Safety at Work etc Act in 1974.[18] There were 60 fatal construction accidents in 2005/06, a decrease from 69 the previous year, which itself was also the lowest on record.[17] The rates of all reportable accident types per 100,000 workers for 2005/06 were also the lowest on record at 1,790 per 100,000.[17] Disappointingly, provisional statistics for 2006/07 indicate a rise to 77 fatalities. However, there is a large disparity between contractors' performance, especially in relation to the size of the organisation, where larger contractors have generally been found to be safer.[14,19] There are exceptions to this rule, however, where small to medium-sized enterprises (SMEs) have also been shown to perform well.[12]

Researchers have investigated factors associated with OSH performance in the US, but there have been few studies in the UK since the HSE conducted a review of management practices in the organisations with the highest safety performance during the late 1970s and early 1980s.[20] This work resulted in the well-known HSE publication *Successful health and safety management* (HSG65).[21] HSG65 has received several updates in line with current industry thinking but there is little or no evidence of empirical research in relation to factors affecting OSH performance in the UK since then. The HSE's model has therefore stood relatively unchallenged. Therefore, to gain an understanding of the research previously conducted in this area, it was necessary to review the work undertaken mainly in the US.

As mentioned previously, OSH performance in the US is typically measured in both accident rates and EMR (see 1.1 above). The research methodologies invariably use these measures as dependent variables, where correlations are made with independent variables (success factors). This approach has its limitations when considering the multicausal nature of accidents.[22–24] Nevertheless, there has been some consistency over the years in the findings of such research methods.

Jaselskis *et al.*[11] present a useful summary of research conducted from 1976 to 1993. Recurring themes associated with high performance include:

- the senior management's commitment to OSH
- OSH inductions and training
- stable employment conditions
- incentive schemes and goal-setting for OSH performance
- client support for OSH.

Pan-industry studies, which included construction, also found similar factors.[8,9]

Jaselskis *et al.* decided to measure organisational factors at company as well as project level. They found evidence that larger contractors were safer than smaller ones. This is in line with findings in the UK.[14,19] However, there was stronger statistical evidence presenting the organisation's length of experience as more important. When faced with the decision of where to set the threshold for high performers, Jaselskis *et al.* simply took the average rate of accidents for the industry and split the sample into those above average and those below.

Jaselskis *et al.* found six statistically significant factors in relation to superior OSH performance at the company level:

- higher number of pages in the safety manual
- higher budget spent on safety programmes
- higher number of training hours for foremen and safety personnel
- higher number of formal and informal OSH meetings or OSH inspections
- higher percentage of safety co-ordinator's time spent on OSH
- the presence of an alcohol and drug testing programme.

Jaselskis *et al.* decided that the number of pages in the safety manual was a valid measure of the level of detail in a safety programme. However, such an assumption in the UK may be open to criticism because of the perceived bureaucracy linked to construction OSH.[25–28] There are obvious issues of the quality of any OSH document.

Aspects of investment in OSH resources, including training, meetings and time in general spent on OSH matters, can be seen as indicative measures of senior management commitment to OSH. It is interesting also to see time and resources specifically for the management of OSH featuring here. However, the qualifications of OSH personnel were not considered.

At the project level, similar factors were found to be present on the higher performing projects:

- greater project manager experience (including time on similar size projects)
- lower project staff turnover
- higher number of formal and informal OSH meetings
- field safety representatives spending a greater percentage of time on OSH.

The combined organisational and project findings from Jaselskis *et al.* match other industry research findings.

Abudayyeh *et al.*[7] measured organisational profile (size, type, structure and so on) as well as resources such as OSH programmes, staff and budgets. They highlighted a relationship between OSH performance and the time the OSH manager spends on site. Three ordinal categories were used: 'always on site', 'occasionally on site' and 'not on site'. A linear relationship was found, in which having an OSH manager always on site was associated with the lowest incidence rates, having him or her occasionally on site was associated with higher rates, and not having the manager on site was associated with the highest incidence rates (Table 1). However, assuming larger sites tend to be safer, it may be expected that larger (safer) sites would be those where the budget allows for a full-time OSH practitioner. Likewise, the further down the project scale one goes, the less one would expect to find full-time OSH personnel. Another significant finding by Abudayyeh *et al.* was a link between the budget level for OSH (for equipment, training, programmes and so on) and accident rates. A negative linear relationship was found to exist, although it was not significant.

These findings highlight the main factors to consider and help understand what differentials exist between superior performers and the rest. But it must be acknowledged that there are many other factors underpinning these main ones that have not came to the fore, such as safe systems of work, adequate planning and supervision, and site rules. These underpinning factors are assumed to be prerequisites for any organisation.

The provision of OSH staff, called in the US 'staffing for safety',[29] has been prominent in these studies. This area will now be discussed, as it is central to the research aim and objectives of this project.

Is there a safety manager ...	Respondents (% of sample)	Median incidence rate of respondents (per 100 workers)	Mean incidence rate of respondents (per 100 workers)
... always on site?	57.1	2.04	2.13
... occasionally on site?	19.1	4.25	3.48
... never on site?	23.8	7.60	10.97

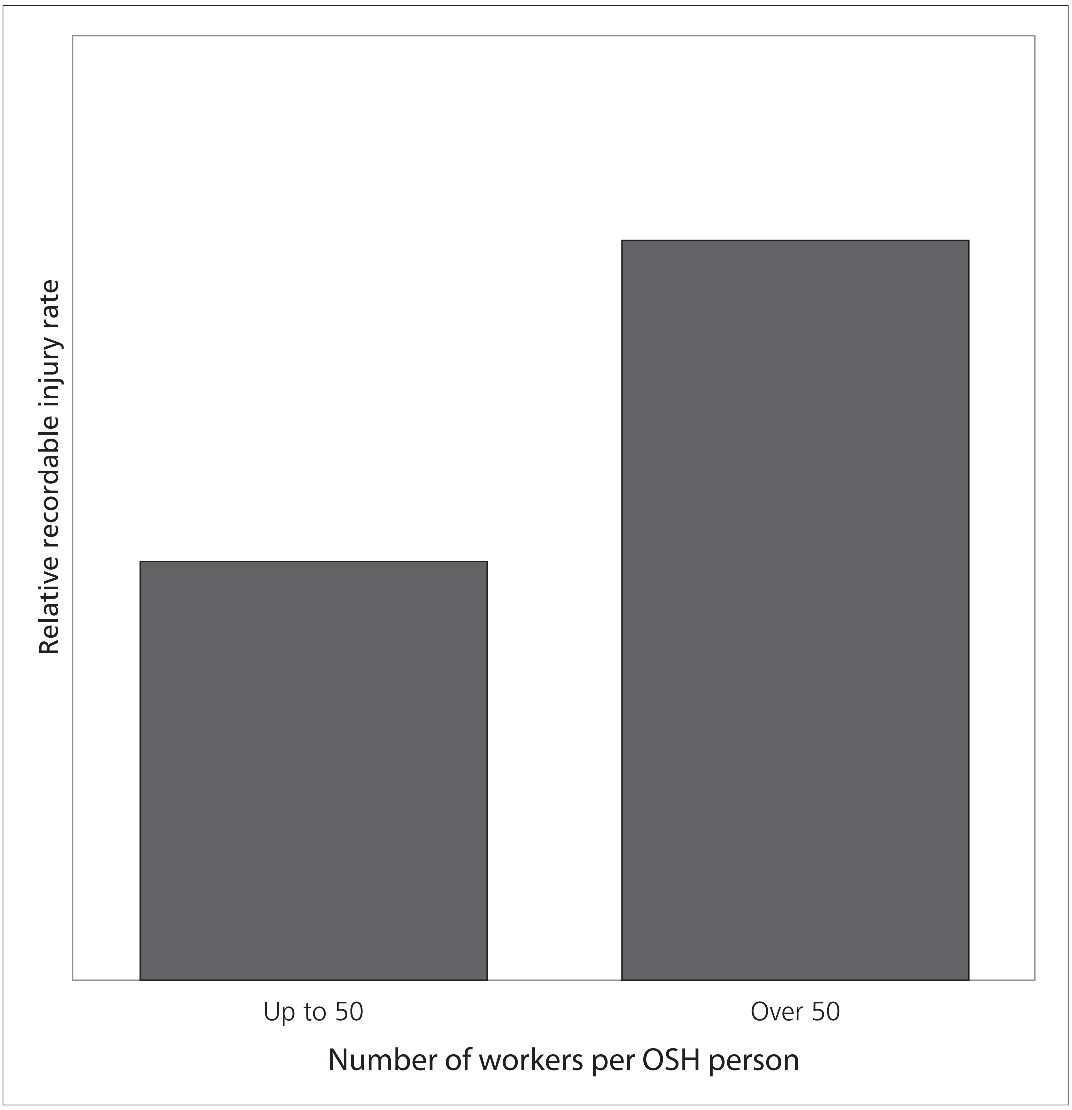
Table 1
The relationship between injury and illness incidence rates and whether the organisation typically has a safety manager at the construction site[7]

2.2 Staffing for safety

OSH personnel in the UK have several titles, including OSH director, OSH manager, OSH adviser, safety representative or OSH technician.[30] The Health and Safety at Work etc Act 1974 was probably a catalyst to help grow the OSH profession, but it was the introduction of the Management of Health and Safety at Work Regulations (the 'Management Regulations') in 1992[31] that explicitly required organisations to enlist 'health and safety assistance' (regulation 7). Since then, there has been no real attempt to quantify this resource or to define clear competence requirements for health and safety assistance. According to the Approved Code of Practice (ACoP) to the 1999 revision of the Management Regulations, the competence of someone providing such assistance should include 'sufficient training and experience or knowledge and other qualities'.[32] The ACoP goes on to describe 'appropriate health and safety qualifications' and 'membership of a professional body or similar organisation' as useful indicators of competence. Regulation 4 of the Construction (Design and Management) Regulations 2007[33] (CDM) and the associated ACoP[34] reiterate the combination of qualifications (Stage 1) and experience (Stage 2) as essential measures of competence. However, no further definition exists beyond this.

In the US, Hinze[10,35] compared accident rates in relation to the ratio of workers to safety personnel on site. Using a cut-off threshold of 50:1, it was found that those with ratios over 50 had higher accident rates than those with ratios below 50 (see Figure 2). Further research showed a positive linear relationship between 'workers per safety person' and the median injury rate, although this was not statistically significant because of the small number of cases.[10] This is illustrated in Table 2. Anecdotal evidence seems to corroborate this finding; it was suggested that increased accident rates in some organisations were the direct result of a reduction in safety staff.[36] Another

Figure 2
The number of workers represented by safety representatives and recordable injury rates, according to Hinze[35]



interesting finding was a higher rate of injuries when the safety person was an external consultant.[10] An approximate ratio of 50 workers per safety person is now used in the US as a guide.[37]

However, in these US studies, the use of terms such as 'safety representative' and 'safety person' makes no acknowledgment of standards of professionalism or levels of competence.

Pan-industry research by Fine[38] has resulted in an elaborate formula to determine safety staff numbers. However, this has been recently discredited because of its vagueness and impractical application.[39] Despite this, there is evidence that a great deal of work was involved in the development of the formula. Important issues in the determination of safety staff numbers were considered to be:

- the degree of hazard faced by workers in the organisation
- the number of employees
- the dispersion of employees
- the OSH department's responsibilities.

Having considered the available literature in relation to the appropriate quantity of OSH personnel, the next factor considered with reference to staffing was OSH qualifications.

Table 2
The number of workers per safety person (after Hinze[10])

Workers per safety person	Number of projects	Median injury rate*
1–20	3	1.11
45–70	3	2.81
100–150	8	2.92
181	1	5.10
500	1	8.04

** Defined as the average number of injuries recordable by the US Occupational Safety and Health Administration per 200,000 hours of worker exposure*

Table 3
The UK National Qualifications Framework (NQF), with OSH NVQ titles[40,41]

<table>
<tr><th>NQF level</th><th>National Occupational Standards</th><th>Higher education framework</th></tr>
<tr><td>0</td><td>NQF Entry Level Certificate</td><td></td></tr>
<tr><td>1</td><td>NVQ level 1; Level 1 Certificate; GCSE at grades D–G</td><td></td></tr>
<tr><td>2</td><td>NVQ level 2; Level 2 Certificate; Level 2 Diploma; GCSE at grades A*–C</td><td></td></tr>
<tr><td>3</td><td>NVQ level 3 (in occupational health and safety); A level; Level 3 Certificate; Level 3 Diploma</td><td></td></tr>
<tr><td>4</td><td rowspan="3">NVQ level 4 (in occupational health and safety practice)</td><td>Certificates of higher education</td></tr>
<tr><td>5</td><td>Foundation degree; diplomas of higher education and other higher diplomas</td></tr>
<tr><td>6</td><td>Bachelor's degree; graduate certificates and diplomas</td></tr>
<tr><td>7</td><td>NVQ level 5 (in occupational health and safety management)</td><td>Master's degree; postgraduate diploma; postgraduate certificate</td></tr>
<tr><td>8</td><td>Specialist diploma from a professional body</td><td>Doctoral degree</td></tr>
</table>

The UK National Qualifications Framework (see Table 3) provides a hierarchical list of generic qualifications that matches qualifications, including higher education qualifications, to National Vocational Qualification (NVQ) levels. This provides a means of ranking the wide variety of available OSH qualifications; cross-referencing them to their NVQ level allows them to be compared on a common scale. Scottish Vocational Qualifications (SVQs) are compatible with NVQ levels.

Many UK providers of OSH qualifications, such as the National Examination Board in Occupational Safety and Health (NEBOSH),[42] give details of their qualifications' NVQ level.

The next factor considered with reference to staffing was what OSH personnel do – in other words, their duties and responsibilities.

R Jones conducted research for the Institution of Occupational Safety and Health (IOSH) entitled *What practitioners do*.[43] Although the study was pan-industry, it has been possible to isolate construction respondents' data to ascertain the most common duties for OSH personnel in the industry. These duties are to:

- develop policy and procedure
- do risk assessments
- carry out OSH audits and inspections
- carry out OSH training
- investigate accidents
- vet subcontractors
- perform Planning Supervisor* duties under CDM.

Toone[44] discusses three main roles of a construction OSH professional. These are 'adviser', 'trainer' and 'manager/director'. Toone describes advisers as technical specialists who report to project line management. They therefore have no authority. Trainers are similar as far as authority is concerned. However, the final role of manager/director has added responsibilities beyond merely advising. Managers and directors have responsibility for planning and organising, and in this respect they have more authority. Marchant[30] goes further by discussing where OSH fits into the organisation. For example the OSH function may be grouped with the secretariat if the main function is dealing with insurance claims and enforcement. The human resources department is another possible partner, perhaps suited to the trainer. Marchant explicitly warns against aligning OSH with areas such as quality, because of the potential for it to fade into insignificance. Marchant also places significance on the dual role of adviser and enforcer. This means that OSH professionals need a degree of authority, but Marchant admits that it is rarely given to them. Therefore, a key factor seems to be to what extent senior OSH professionals have implied authority; this will be a function of where they sit in the organisational framework, including whom they report to.

Organisational structure in relation to OSH is covered by Fine,[38] who also discusses responsibility for OSH at the operational level. This can vary from total line management responsibility to total OSH department responsibility. Where responsibility lies will have an impact on resource levels. Responsibility for policy and procedures is dealt with in the same way. N Jones[45] presents data on the level of authority OSH professionals have in relation to proving the business case for proposals or recommendations, in which he finds that only 9 per cent of such proposals are funded without further referral. The impact of this factor on OSH performance would be an interesting one to measure.

Staffing for safety is therefore more than counting heads. It also includes defining their role and function, as well as their responsibilities, position in the organisation and reporting lines. Assessing these will help to define the most useful application of OSH resources in addition to measuring their provision.

2.3 OSH costs

2.3.1 Investment in OSH personnel

IOSH regularly publishes salary surveys, which can help gauge the cost of OSH resource provision.[45] According to this publication, the all-industry average (mean) salary of an OSH professional in 2005

* This study was undertaken while the CDM Regulations 1994 were still in force. The equivalent post under the 2007 Regulations is 'CDM Co-ordinator'.

was £35,500. In the construction industry the figure was slightly higher, at £37,200. Those with over 10 years' experience earn on average £40,300, and those with less than five years' service £28,200 (all-industry figures). Salary scales aligned to qualifications are also given, presented as a histogram (Figure 3).

A separate survey of OSH salaries showed that the average for the construction industry was £32,000, ranging from £22,500 to £39,999.[46] This survey also commented that members of IOSH had higher salaries on average. This would account for the average in N Jones' sample being £37,200, as the report was conducted amongst IOSH members.

2.3.2 Cost of accidents

The HSE has spent a number of years developing formulae for the costs of accidents. Early studies sought to cover all industries and were difficult to interpret,[47] but more recent research has led to the development of a 'calculator' based on key financial and accident data.[48] This has helped to measure accident costs reasonably quickly without having to build up detailed cost data.

The alternative to this is to cost the impact of accidents for each organisation.[49–54] Although there are some differences from country to country, the main costs (to employers) associated with accidents are:

- sick pay
- compensation
- increased insurance premiums
- administration costs
- recruitment
- property damage
- lost production.

This list is probably not exhaustive but these categories appear in all the literature on the subject and can be considered the main ones. The HSE's 'cost calculator' lists three different cost estimates for

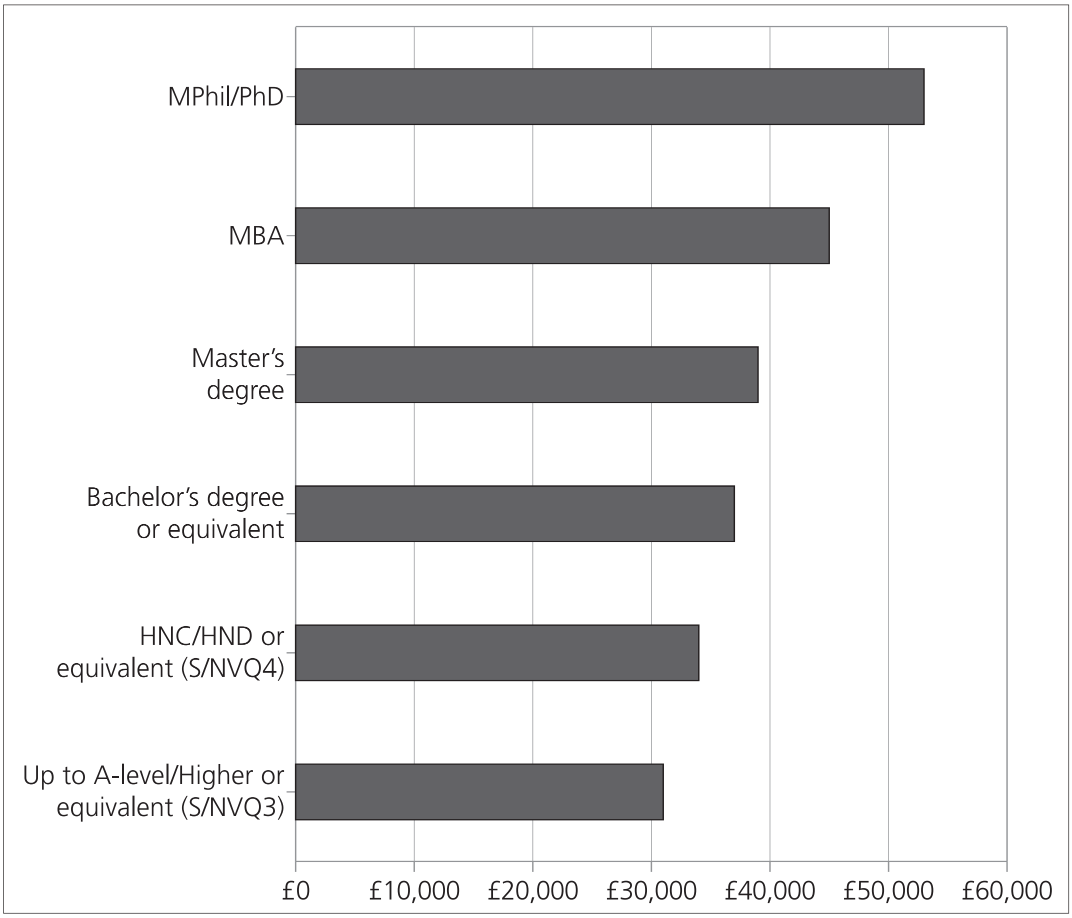
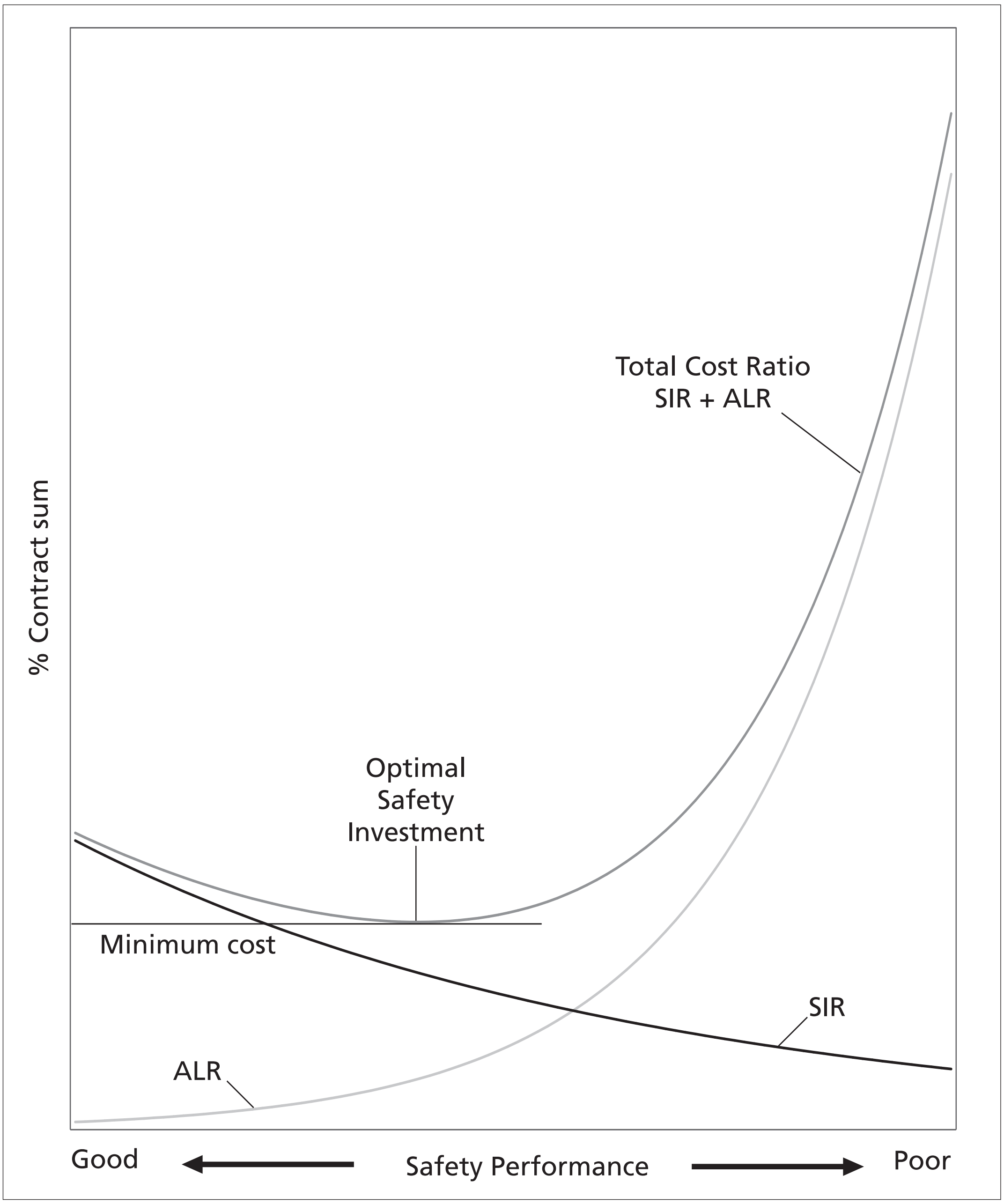


Figure 3
Mean salary of OSH personnel by qualification[45]

accidents. The first two are merely notional amounts based on insurance premiums and numbers employed. The third one is slightly more useful, as it is based on the actual number of accidents experienced per year. Unfortunately, the calculator only uses a single figure for an accident which results in lost time from work: £2,234. This figure does not take account of the severity of the accident and it is not industry-specific. However, the underlying research for the cost calculator can shed further light on the subject.

Original data, collected in 1997, stated that typical costs of accidents in construction were £15,165 for a 'serious or major' accident and £460 for all other 'reportable' accidents. A 'reportable' accident is one that has to be reported to the HSE under the Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995 (RIDDOR).[55] Specific categories of injury are reported under RIDDOR. The least severe is 'over-three-day', where the injured person is unable to attend work for more than three days. Next is a 'major' accident which, as the name suggests, is generally more severe, but only if it falls into certain specified subcategories, such as broken limbs (the full list is given in the Regulations). Finally there is the 'fatal' category of accident (no individual cost is given for a fatal accident). From this we can equate the larger cost figure (£15,165) to a 'major' accident and the smaller figure (£460) to an 'over-three-day' accident.

Figure 4
Tang *et al.*'s cost optimisation model[56]



Updated equivalent figures from the HSE are now £18,531 and £562 at 2003 prices.[48] These figures take account of damage, lost production, administration, compensation and insurance costs. Therefore, they have been used for accident cost calculations in this study (see 3.5 below).
If a cost figure for investment in OSH personnel can be established, together with an estimate of accident costs, then comparison of the two can be done to establish a cost relationship. Tang *et al.*[56] provide a method for safety cost optimisation, based on the cost of OSH provision compared to the cost of accidents. The theory relies on two assumptions:

- that there is a positive relationship between investment in safety and safety performance – ie the higher the safety investment, the better the safety performance
- that there is a negative relationship between accident costs and safety performance – ie if safety performance is good, accident costs will be low.

Tang *et al.* present these relationships as 'curvilinear', assuming an exponential best-fit curve for both relationships, as shown in Figure 4. Tang labels the two relationship curves 'safety investment ratio' (SIR) and 'accident loss ratio' (ALR). The ratio aspect is introduced so that both costs can be compared as a percentage of overall project costs. Adding the two values together produces a third curve called 'total cost ratio'. Tang *et al.* were then able to identify the optimum investment in safety, where the combined costs of SIR and ALR were at their lowest.

Tang *et al.* used project-specific data to compute an optimum safety investment of 0.6 per cent of the contract sum, with 0.23 per cent accident costs. However, they acknowledge that this may be perceived as an 'inhuman impression'. On the face of it, the calculation assumes there will be an acceptable accident cost, equivalent to a minimum project cost. Relying on such a cost calculation obviously ignores the moral and legal imperatives. For this reason, Tang *et al.* recommend that 0.6 per cent is considered the minimum investment. They also acknowledge that intangible benefits could be realised through increased investment in safety. Additional minor accidents (eg those merely requiring first aid) were not included in Tang *et al.*'s calculations. If they were included, the overall accident cost figures would increase, thereby increasing the optimum level of investment in OSH resources.

The method employed by Tang *et al.* included investment in OSH personnel. A similar method could be employed at an organisational level using annual turnover (in place of contract sum), OSH employment figures and annual accident figures. Salary figures can represent investment in OSH personnel and the HSE's accident cost figures can be used in conjunction with accident numbers.

The underlying assumption, that investment in OSH personnel is associated with improved OSH performance, is central to Tang *et al.*'s theory. Findings from the other research on OSH performance identify 'staffing for safety' as an important factor. Therefore, it is worthwhile investigating the nature and extent of investment in OSH personnel within the UK's construction industry.

3 Methods employed

3.1 Introduction
As outlined above, the objectives of the study were to:

- develop appropriate assessments of OSH personnel provision, accommodating different levels of competence through qualifications and experience
- investigate and select appropriate measures of organisational OSH performance
- investigate and quantify any association between the quantity of competent OSH personnel resources provided by construction organisations and their OSH performance
- translate this into a cost–benefit relationship, assuming a measurable association was established, to provide an economic argument for appointing or training OSH personnel
- investigate, classify and evaluate the variety of organisational structures in which OSH personnel operate, and their consequent influence and authority, taking account of senior management and other organisational support
- investigate any association between the application of OSH personnel, in particular their location and authority in the organisation, and the OSH performance of the organisation
- deliver a comprehensive report of the outcomes of these objectives.

The methodologies required to achieve these objectives are now discussed.

3.2 Developing appropriate assessments of OSH personnel provision
In order to discover whether OSH performance is associated with the provision and application of OSH personnel resources, it was necessary to establish a valid and reliable means of measuring these resources. The provision of resources has two primary dimensions: quantity and quality. A classification system of levels of quality, based on OSH qualifications and training and duration of appropriate experience was developed. This system was used to record the quantity of each level of resource in construction organisations in order to produce an objective measure of OSH personnel provision.

The steps to obtain a measurement of quality (of OSH personnel) were as follows:

1. list relevant OSH qualifications and training programmes
2. sort them into a rank order, or classification, according to NVQ level
3. list and classify all types of occupational experience relevant to OSH in construction
4. develop a weighting system to ‘score’ each dimension
5. develop an overall scoring system.

OSH qualifications are offered by many training organisations, including NEBOSH,[42] the British Safety Council[57] and other national training organisations under the Employment National Training Organisation (ENTO).[58,59] In addition to this, further and higher eucation qualifications are available. In terms of classification, R Jones[43] uses five levels of OSH qualification, while N Jones[45] uses six. These lists are shown side by side in Table 4.

Both lists can be aligned at NVQ level 4 (rank position 5). R Jones’s research found that this level of qualification was the most frequent. There is room for different interpretations of qualifications above and below this threshold. Therefore, it was decided to rank OSH qualifications in the following three bands:

Table 4
Classification of OSH qualifications

Rank	R Jones	N Jones
1	Master’s or research degree in OSH	MPhil or PhD
2		MBA
3	Postgraduate diploma or certificate in OSH	Master’s degree
4	BSc or BSc (Hons) in OSH	Degree or equivalent
5	Higher education diploma; S/NVQ 4 in OSH; NEBOSH Dip2	Higher National Certificate or Diploma (S/NVQ 4)
6	Other safety qualification	Up to A level (S/NVQ 3)

1. postgraduate diplomas and Master's degrees in OSH
2. OSH NVQ 4 (eg NEBOSH Diploma, Bachelor's degree)
3. OSH NVQ 3 or below (eg NEBOSH Certificate).

Where it was not possible to map a qualification to an NVQ level (eg an unknown qualification from the data collection), the assessment body of the OSH qualification was contacted to agree a suitable level. No overseas qualifications were found in the data.

Experience of OSH personnel was measured in terms of years. It was decided to use 'relevant' experience, ie construction OSH, due to the specialised nature of OSH in construction. R Jones and N Jones both use age bands to categorise experience. Table 5 shows how they compare.

The two lists in Table 5 are very similar. The only exception is that R Jones includes a further band above 20 years, whereas N Jones stops at over 10 years. It was decided that over 10 years would be a suitable cut-off point for experience. This had the added benefit of creating three rank-points for experience to match qualifications:

1. less than five years
2. five to 10 years
3. over 10 years.

Therefore, quality of OSH personnel could be measured using a three-by-three table as shown in Table 6.

The next step was to give each possible combination in this matrix a value, based on its costs of provision. From the literature, it was possible to extract average salaries depending on qualifications or experience. However, there was no existing salary scale which took account of both together. The average salary scales for each element (based on figures gathered in 2005) are shown in Table 7.

In order to calculate a representative salary for each combination, the arithmetic mean was used. Therefore, the calculation was:

Rank	R Jones	N Jones
1	Over 20 years	Over 10 years
2	11–20 years	5–10 years
3	6–10 years	Under 5 years
4	0–5 years	

Table 5
Classification of OSH experience

OSH qualification	Years' experience in construction OSH		
	< 5 years	5–10 years	> 10 years
Postgraduate diploma/Master's degree	£	£	£
OSH NVQ 4	£	£	£
OSH NVQ 3 and below	£	£	£

Table 6
OSH qualifications and experience

Qualification	Average salary*	Experience	Average salary*
Postgraduate diploma/Master's degree	£45,000	Over 10 years	£42,500
OSH NVQ 4	£34,000	5–10 years	£32,000
OSH NVQ 3 and below	£31,000	Under 5 years	£29,500

* *Excluding on-costs, such as National Insurance contributions and overheads*

Table 7
Average salaries for construction OSH professionals

$$\frac{\text{'qualification' average salary + 'experience' average salary}}{2}$$

So, for example, a person with a postgraduate diploma or Master's degree and five to 10 years' experience would be given a representative salary of:

$$\frac{£45{,}000 + £32{,}000}{2} = £38{,}500$$

Table 8 shows the representative salaries calculated in this way.

No figures have been used for higher OSH qualifications at the 'under five years' band. This is because of the impact of less experience on overall salary, regardless of qualifications. Therefore, £30,250 is the maximum salary allocated to any person with less than five years' experience. Furthermore, R Jones' research shows that higher qualifications were generally associated with longer experience.[43] However, there are always exceptions to such 'rules of thumb', with higher salaries linked to lower qualification levels.

The steps to obtain a measurement of quantity were as follows:

1. obtain from each organisation data to establish:
   a. the number of OSH personnel in the organisation
   b. the amount, or proportion, of time that each OSH person spends in relation to OSH (in large organisations, sample each type of position)
   c. the qualifications and experience of each OSH person, defined by the classes identified in the measurement of quality
2. weight each member of OSH personnel according to the quantity measurement process, and determine a score for the whole organisation.

The easiest way to measure the number of OSH personnel within an organisation is simply to count them. However, the calculation also needed to account for any part-time staff. This was dealt with by allowing a pro-rata fraction for those who did not spend their full time working on OSH – so half time was represented by 0.5, one day out of five was represented by 0.2, and so on.

However, there was a further complexity to deal with. This was external OSH personnel – ie OSH consultants. Analysis of data from the Contractors' Health and Safety Assessment Scheme (CHAS)[60] proved useful here. CHAS uses a questionnaire to assess the health and safety competence of contractors and is primarily intended for the construction industry. A key subject is the requirement for access to OSH advice in compliance with Regulation 7 of the Management Regulations (see 2.2 above). Contractors who use external advisers typically state to what extent they use them on the CHAS questionnaire. A representative figure for consultant use is one or two days per month. Assuming one calendar month equates to approximately 20 working days, two days of consultant input can be noted pro rata as 0.1.

Multiplying the number of OSH personnel (with pro rata fractions where necessary) by the representative salary for quality (competence) therefore gives a measure of OSH provision. Tang *et al.*[56] measured OSH provision as a percentage of the contract sum to give the figure a measure of proportion. However, the present study is based on organisational measures as opposed to project measures, so a comparable base figure is annual turnover. Therefore, the measure of OSH provision is calculated as:

$$\text{OSH provision} = \frac{\text{each OSH person x pro rata fraction x representative salary}}{\text{turnover}} \text{ x } 100$$

Table 8 Representative salaries for combinations of OSH qualifications and experience

OSH qualification	Years' experience in construction OSH		
	< 5 years	5–10 years	> 10 years
Postgraduate diploma/Master's degree	–	£38,500	£43,750
OSH NVQ 4	–	£33,000	£38,250
OSH NVQ 3 and below	£30,250	£31,500	£36,750

The mere provision of resources is not, in itself, a full measure of resource commitment. The effectiveness of the provision also depends on the organisational setting in which it operates. In particular, it is normal for production managers, who may well be charged with OSH responsibilities, to have a wide variety of other duties; the time available to focus on OSH management issues can thus be seriously reduced. In any audit of the quantity of OSH resource provision, this factor must also be measured so that the absolute numbers of production managers with OSH duties and qualifications can be determined.

Ideally, these assessments of OSH personnel resources would be consolidated into a single measure of resource commitment, taking into account numbers, time commitment to OSH duties, qualification and experience. However, designing satisfactory units for this consolidated measure was too difficult and was potentially unreliable (eg in the case of deciding on a suitable pro rata measurement). Also, if line managers carry out a significant number of OSH duties within certain organisations then the data collection process may be too much of a burden for them. Therefore, line managers were considered separately (see 3.6 below).

3.3 Measures of organisational OSH performance

Organisational OSH performance can be measured in a number of different ways. The first, and most frequently used, is by accident frequency or incidence rates. These were recorded for all organisations in the research data sample. These rates are clearly the most important outcomes for OSH managers, since they represent their ultimate measure of success; any association between them and OSH personnel provision needs to be investigated.

Unfortunately, though accident frequency data are indeed valid measures of OSH performance, they are not always particularly reliable. This is because, for major or fatal accidents, which are generally low in number, they are often extremely volatile. Such ‘serious’ accident frequencies can be adequate measures of performance for very large organisations, or when applied over long periods, as this allows averaging to produce a degree of smoothing of the data. However, for short periods or smaller organisations, the volatility can make the data unreliable as measures of the quality of safety performance. A fatal accident can occur in an otherwise very safe, well-managed organisation, and a poorly managed organisation can have short accident-free periods. Accidents also ‘lag’ any safety intervention, such as the work of an OSH practitioner. Additionally, it is well known that minor and ‘over-three-day’ accidents often suffer from serious under-reporting, adding to the unreliability of accident frequency statistics as measures of safety performance.

In order to overcome these problems, the intention was to supplement accident frequency data with data produced by OSH systems and behavioural and workplace condition auditing. However, the accident and organisational data required were historical, looking back at the previous year. Any alternative measures would need to be collected in the following year. Because the two datasets would refer to different periods, there would be a danger that they would not reflect the same underlying circumstances (eg organisational structure or culture). A pilot questionnaire was developed for data collection (see 3.7.1 below). This included a request for two records of site audits from the period under analysis. This generated a poor response; the information requested was provided by only one of the five pilot respondents. Even collecting the data manually would have required just over 100 site visits during the full data collection phase. Therefore, accident rates were the only measure available to use.

The accident frequency rate (AFR) is the most common measure used in the UK, including by the HSE, to calculate and compare industry OSH performance. Other measures are available, but the AFR is the easiest to calculate and also provides the best opportunity for obtaining the necessary data from organisations. The data needed to calculate the AFR are the number of accidents and the average number of employees per annum. The AFR is calculated thus:

$$\frac{\text{Number of reportable accidents}}{\text{Average number employed}} \times 100{,}000$$

Reportable accidents are those covered by RIDDOR (see 2.3.2 above). In order to make valid comparisons between organisations, it was necessary to break down accident types, identify types of injured parties and arrive at common definitions of those employed. This is because different organisations record accident data at different levels of detail; it is wrong to assume all figures are comparable. For example, some organisations collect data only for ‘reportable’ accidents, whereas others may include minor accidents. Furthermore, construction organisations tend to subcontract work but not all will record accidents suffered by subcontractors’ staff. There is also variation in who is counted in the 'average number employed' figure; again, subcontractors may not be counted. Additionally, the ratio of administration and office staff to manual on-site workers can distort the figures, as manual site workers are at a considerably higher risk of experiencing an accident than office staff.[19] Therefore, if two organisations of similar size had the same number of site workers but one had more office staff, then this organisation would return a misleading lower AFR for the same number of site accidents.

Therefore, the following distinctions were introduced to isolate the required data:

1. accidents:
   a. detail the number of accidents in each level of severity – fatal/major, over-three-day, minor
   b. cross-tabulate these accidents to employees, subcontractors and members of the public
2. average number employed:
   a. distinguish between site employees, site subcontractors and office staff.

By isolating these figures it was possible to calculate a more reliable AFR thus:

$$\frac{\text{Number of reportable accidents (including subcontractors)}}{\text{Average number of site workers (including subcontractors)}} \times 100{,}000$$

Ideally, several years' data would help smooth out any volatile peaks and troughs in the AFR. However, the likelihood of obtaining several years' data is lower in many cases, so it was decided to use data for one financial year only. OSH provision for the same period was also measured. These data are therefore a snapshot in time and do not reflect any previous influences on OSH performance.

3.4 Association between the number of competent OSH personnel and OSH performance

The assessments of OSH personnel provision and OSH performance were statistically tested for association, using measures of correlation.

The measures of the variables for OSH provision and OSH performance could be tested as interval data. This would normally dictate a parametric test of correlation, such as Pearson's. However, the two variables were measured in such a fashion that there were no negative values. In such cases, values have a tendency to cluster towards zero, but have a long tail off towards higher values, which are infinite. Moreover, accident rates within any sample are expected to gravitate towards the lower end of the scale, since this is the direction organisations would hope to move in. Both of these phenomena result in a skewed sample. Parametric tests rely on the sample being normally distributed, but non-parametric tests do not.[61] Therefore, the data needed to be treated as ordinal and required an alternative test for correlation. As a result, Spearman's rho was used, with a 5 per cent test for significance (p-value 0.05).

It may thus be possible to demonstrate association between OSH personnel resource provision and OSH performance. This does not prove a causal relationship, but it does give considerable support to the hypothesis that one exists and provides a measure of the mathematical strength of that association.

3.5 The cost–benefit relationship for OSH personnel

Assuming the number of OSH personnel is correlated with OSH performance in the form of accident frequency rates, it is possible to establish a relationship between the cost of OSH provision and the cost of accidents.

Using the results of previous studies on the costs of accidents at work,[47,48,62] it was possible to relate accident frequency rates with cost rates to recalibrate OSH performance in cost units (see 2.3.2). This was achieved by reducing OSH performance to an exponential 'best-fit' line using the software package 'Statistical Package for the Social Sciences' (SPSS), following Tang *et al.*'s[56] methodology. OSH performance was converted to a cost using the HSE figures discussed in 2.3.2, namely:

- each major accident = £18,531
- each over-three-day accident = £562.

The variability in recording minor accidents made them unreliable. OSH performance was therefore represented with accident cost data for major and over-three-day accidents. In each case the cost was presented as a percentage of the organisation's turnover.

Data on personnel costs from collaborating organisations was used to develop a model of the costs of provision of OSH personnel (see 3.2). This was achieved by reducing OSH investment to an exponential 'best-fit' line following the same method for OSH performance mentioned above. OSH investment was already measured as representative salary costs, which were presented as a percentage of each organisation's turnover.

The combination of these recalibrated scales of OSH personnel provision and OSH performance provided a simple cost–benefit relationship. This demonstrated the economic benefits of investment in OSH personnel resources by using an adapted version of Tang *et al.*'s cost optimisation methodology in line with Figure 4 (see 2.3.2). The adapted model is shown in Figure 5.

3.6 Organisational structures in which OSH personnel operate

Two further important factors in the effectiveness of OSH personnel resources is the function they perform and the level of authority they hold. Most OSH staff do not have line management positions. This is particularly the case for practitioners employed full-time in advisory positions, where they often have little direct influence over the production process, which is where the OSH risk exposure in construction is greatest. In this situation, their effectiveness will depend

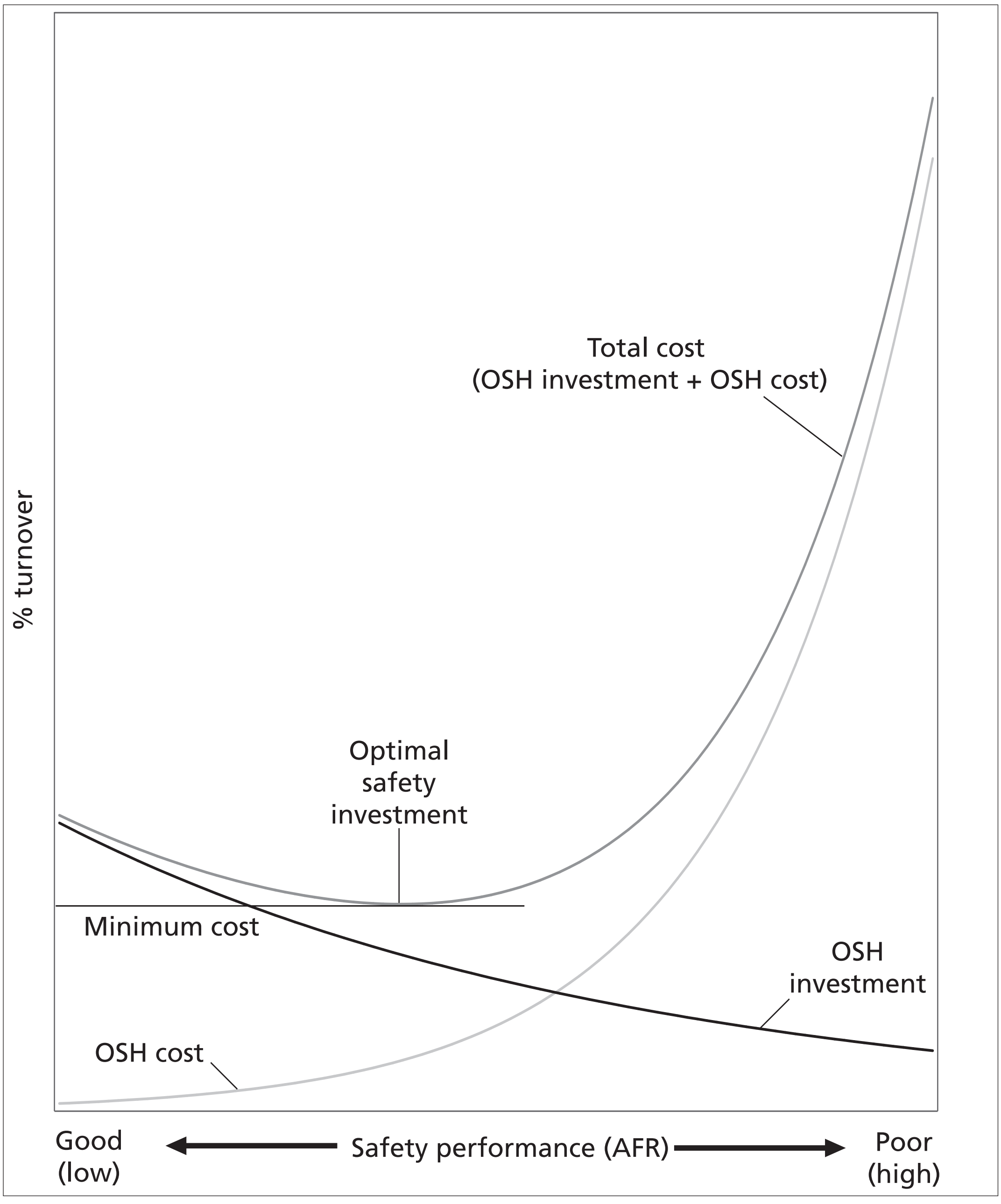


Figure 5
OSH personnel cost optimisation model

heavily on the level of support that the OSH function receives from the senior management and board.

The literature provided possible areas to investigate in terms of the main duties performed by OSH staff (see 2.2):

- developing policy and procedure
- doing risk assessments
- carrying out OSH audits and inspections
- carrying out OSH training
- investigating accidents
- vetting subcontractors
- performing Planning Supervisor duties under CDM.

The level of authority held by OSH personnel was measured on a three-point ordinal scale: 'give advice only', 'enforce rules' and 'give orders'. The provision and size of any OSH budget was also measured. Finally, the area covered by OSH personnel (in square miles) was also collected (see Appendix).

The effect of these moderating factors was investigated through collection and evaluation of data on company policy and practice for each of the organisations in the sample data set, with the objective of comparing their AFR.

Since the data were skewed (see 3.4), nonparametric tests were used to detect statistically different means. Comparisons between two means were tested using the Mann-Whitney test, a common nonparametric test for two independent samples.[63] The threshold for significance was set at 0.05. Comparisons between three or more means were tested using the Kruskal-Wallis test, a nonparametric equivalent of the 'analysis of variance' (ANOVA) test.[63] Kruskal-Wallis, however, detects only an overall difference between three or more means. A *post hoc* test was required to identify specific differences. Mann-Whitney was used for the *post hoc* tests with the Bonferroni adjustment to control for Type I errors; in other words, the standard threshold for significance (p-value) of 0.05 becomes 0.017 for three means and 0.0083 for four means. These tests were performed using SPSS.

Other factors identified in the literature were:

- the level of OSH training for line managers
- senior management's commitment to OSH
- the extent of training for employees and subcontractors
- client commitment
- the presence and extent of a formal documented safety management system (SMS)
- the presence and extent of a behavioural safety programme
- the involvement of trade unions (ie whether the employer is unionised or not).

Data on OSH training for line managers was extracted from the dataset, then ranked in a similar manner to that used for OSH personnel, ie by NVQ level. However, a number of OSH qualifications and training programmes for line managers were considered to be outside the NVQ structure, including some awareness training provision. Therefore, the following ranking was used:

1. OSH NVQ 3 or above
2. Site Management Safety Training Scheme/Managing Safely (NVQ 1–2)
3. up to two days' awareness training.

The Site Management Safety Training Scheme (SMSTS) is a five-day course accredited by CITB-Construction Skills. The equivalent IOSH course is Managing Safely (MS), which is set at NVQ level 2. All short duration courses (two days or less), one-off events and in-house seminars were ranked below SMSTS/MS.

Rank categories were also developed for the remaining factors as shown in Table 9.

Even if the tests of association between OSH performance and OSH personnel provision prove positive, there are unlikely to be high levels of correlation in data of this kind, given the complexity of other mitigating factors.

3.7 Data collection and analysis

3.7.1 Pilot questionnaire

In the first instance, data were collected via a questionnaire. A pilot was conducted in line with most research designs involving questionnaires.[64] This allowed for feedback on how well the questionnaire was drafted, including whether any questions were misleading or confusing. This led to a refinement to produce the final questionnaire (see Appendix).

The pilot questionnaire was developed to gather the data required, and completed by contractors known to the research team. Five organisations participated in the pilot. A contact within each organisation completed the questionnaire and also commented on the relative difficulty in interpreting and answering the questions. This led to some modification of the final questionnaire. The pilot organisations' data were not used for the main study.

3.7.2 Full questionnaire

Target respondents for the questionnaire were chosen from IOSH's Construction Specialist Group's email database, industry contacts and the HSE's construction web forum. The only eligibility criterion for participation was that the respondents should work for a contractor in the UK construction industry. The full questionnaire is shown in the Appendix.

A total of 32 completed questionnaires were received. However, an alternative source of data was found during the research. This was CHAS, a health and safety competence assessment scheme. The assessment used by CHAS includes a questionnaire with similar questions to those used in the present study. The scheme has a website interface[60] that allows access to contractor information, including a contact name. It is also linked to another database, Construction Line,[65] which provides financial information for organisations listed on both databases. This gave the opportunity to extend the dataset for analysis.

3.7.3 CHAS and the Construction Line database

The CHAS website states that it has 14,000 contractors in its database.[60] However, the research parameters and the existing completed questionnaires dictated which organisations could be selected. Moreover, there were issues specific to the CHAS database that restricted which files could be used. The parameters for selection were as follows:

- The database has basic functionality for searching. The most convenient way to find construction contractors was to select organisations labelled 'Construction and Refurbishment'. This reduced the database to a possible 750 organisations.

Table 9
Other organisational factors

Factor	Ordinal points (rank)
Senior management's commitment to OSH	1. OSH is part of promotion criteria 2. Discretionary incentives 3. None
Training for employees and subcontractors	1. Over four days 2. Two to four days 3. One day
Client commitment	1. Regular audits by clients 2. Provide notes of accidents to clients 3. None
Safety management system	1. OHSAS 18001 or similar 2. HSG65 or similar 3. In house 4. None
Behavioural safety programme	1. Management and workers 2. Workers only 3. Partial or sporadic initiatives 4. None
Involvement of trade union safety representatives	1. Joint working 2. Safety representatives on some sites 3. None

- The database lists very small organisations, including those with fewer than five employees. The smallest number of employees found within the returned research questionnaires was 40. This figure was therefore used as a minimum threshold.
- The required information was contained in the contractor's completed CHAS questionnaire, which can be viewed online. However, not every file included the contractor's questionnaire, and some questionnaires were either difficult to read (scanned copies of handwritten documents) or were incomplete. These files were ignored.
- In order to access financial information, the file needed to have a corresponding Construction Line file. Those without a corresponding Construction Line file were also ignored.
- Finally, the person listed as the firm's contact was emailed or phoned to check some details and to confirm that the organisation's information could be used.

The combination of CHAS and Construction Line data allowed almost all the required information to be gathered. The remaining data that needed to be confirmed by the contractor were:

- numbers of subcontractors employed and whether they are included in accident statistics
- OSH duties and authority (sometimes this was already on the CHAS questionnaire)
- other organisational factors (those covered in questions 12–17 of the research questionnaire: see Appendix)
- any items obtained from CHAS or Construction Line that needed clarification.

Data from 70 contractors were obtained using this method.

3.7.4 Data analysis and reporting

The data were analysed using the software package SPSS after some initial conversions were performed in Microsoft Excel. These conversions consisted of the calculations to convert OSH provision and accident data into the quantifiable measures discussed above.

Excel was also used to present the 'OSH personnel cost optimisation' model (see Figure 5), as this function is absent in SPSS. This was achieved by using the exponential equations generated by SPSS to create the two curves for OSH investment and accident cost (where x = AFR):

OSH investment: $y = 0.187 \exp(-0.00018\, x)$
Accident cost: $y = 0.0046 \exp(0.00054\, x)$

4 Findings

4.1 Description of the sample

The sample consisted of 32 research questionnaires and 70 datasets obtained from CHAS and Construction Line. This made a total of 102 datasets (of which 91 were main contractors and 11 subcontractors). The Department for Business, Enterprise and Regulatory Reform classifies construction work into two broad subsectors: 'civil engineering' and 'building'. There was a high number of building contractors in the sample; however, civil engineering contractors were adequately represented. Table 10 shows the industry sub-sectors for the sample. As contractors tend to work in more than one industry sector, the frequencies total more than 102.

Descriptive statistics for the organisations' average age, turnover and numbers employed (including subcontractors) are shown in Table 11, revealing a wide range of contractor sizes in the sample. For example, turnover varies from a minimum of £4 million to a maximum of £700 million. The 102 organisations in the sample employed a total of 660 OSH personnel (617 internal, 43 external) and 201,193 workers (including subcontractors).

Table 11 also shows a noticeable difference between the mean and median of 'turnover' and 'numbers employed'. This is indicative of a skewed sample and is confirmed by Figure 6. A 'positively skewed' histogram is expected with this type of data for the reasons discussed in section 3.4.

The dependent variable for this study is the AFR (per 100,000 site workers). Figures 7 and 8 illustrate how this variable is distributed for the sample. The values are positively skewed as predicted in section 3.4. Figure 7 also shows an isolated bar at an AFR of approximately 2,000. The box plot in Figure 8 reveals this extreme outlier as case number 29. A re-examination of this case revealed that the unusually high AFR was a one-off spike for the year used in the data collection. This freak value was therefore removed from the sample, as it was considered an unrepresentative outlier and thus would hinder estimation in the statistical analysis.

This left 101 datasets for the sample. The revised histogram is shown in Figure 9. A reference line, showing the industry average AFR of 1,790, is also included. Approximately 70 per cent of the sample were below the industry average. The mean AFR for the sample was 1,586 (median 952), with standard deviation of 1,580. The sample also includes two contractors with an AFR of zero (turnovers of £8 million and £43 million).

The other key (independent) variable was investment in OSH personnel. Figure 10 shows the distribution of this variable, which is also positively skewed. The mean is 0.22 per cent of turnover (median 0.16 per cent), with a standard deviation of 0.20.

Table 10
Industry subsectors

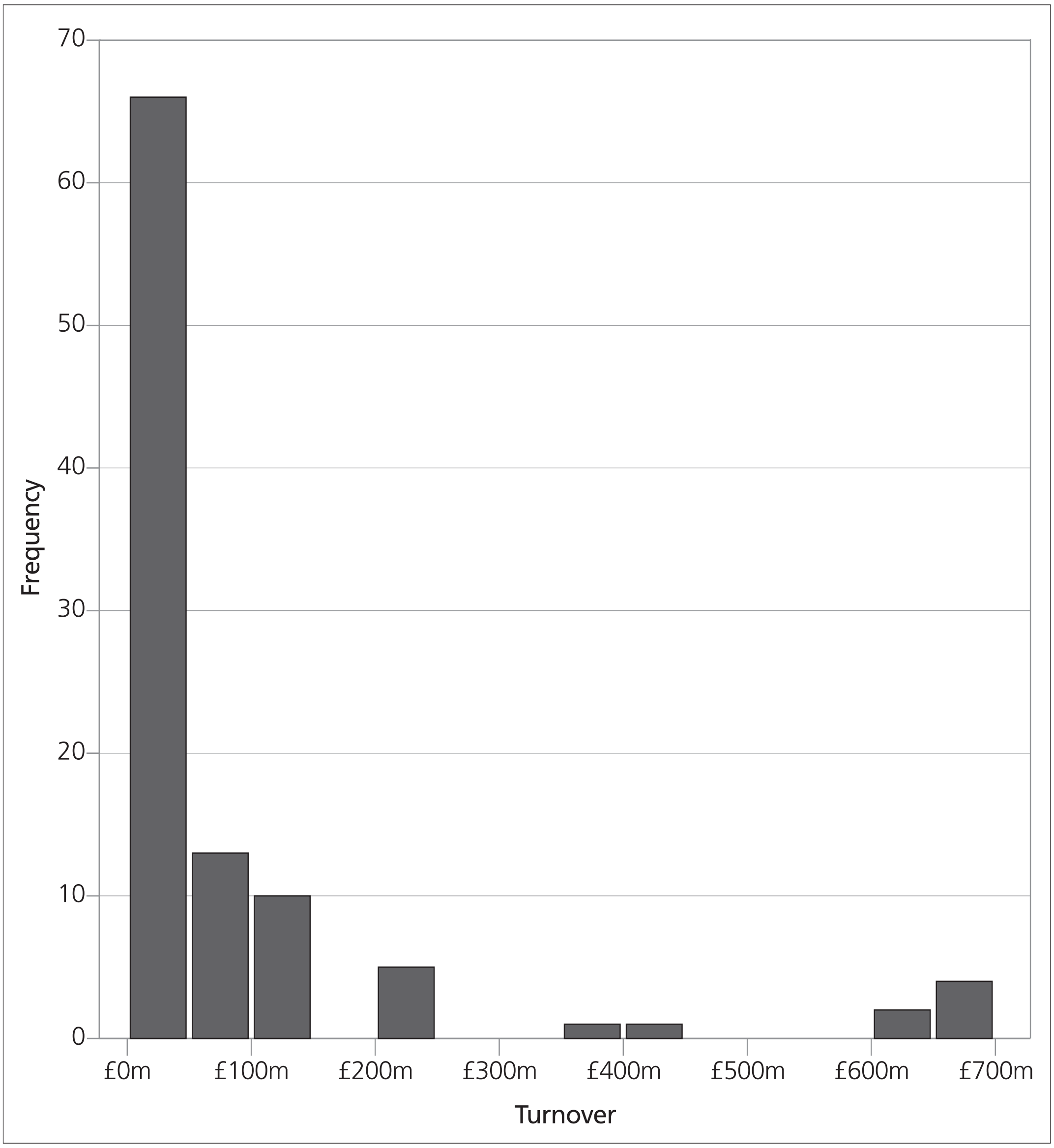
Sector	Subsector	Number
Civil engineering	Services/utilities	27
	Transport	27
Building	Housing	73
	Commercial/industrial	90
	Demolition	5
Total		222

Table 11
Organisation age, turnover and numbers employed

Variable	Mean	Median	SD	Minimum	Maximum
Age of company (years)	37.9	30.5	29.5	2	147
Turnover (£m)	90	30	200	4	700
No. employed*	1972	293	7995	48	60500

** Including subcontractors*

Figure 6
Respondent organisations' turnover



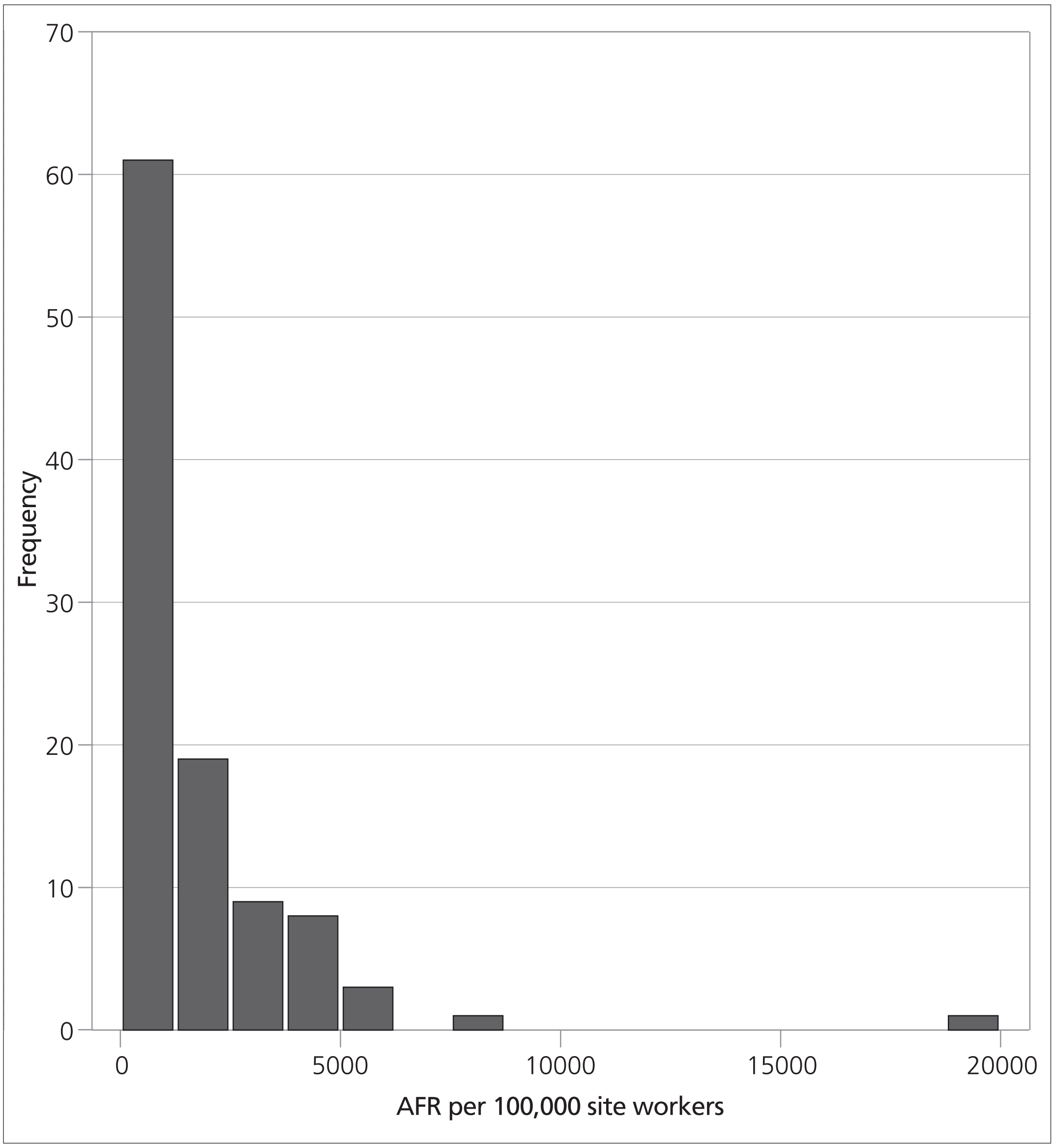
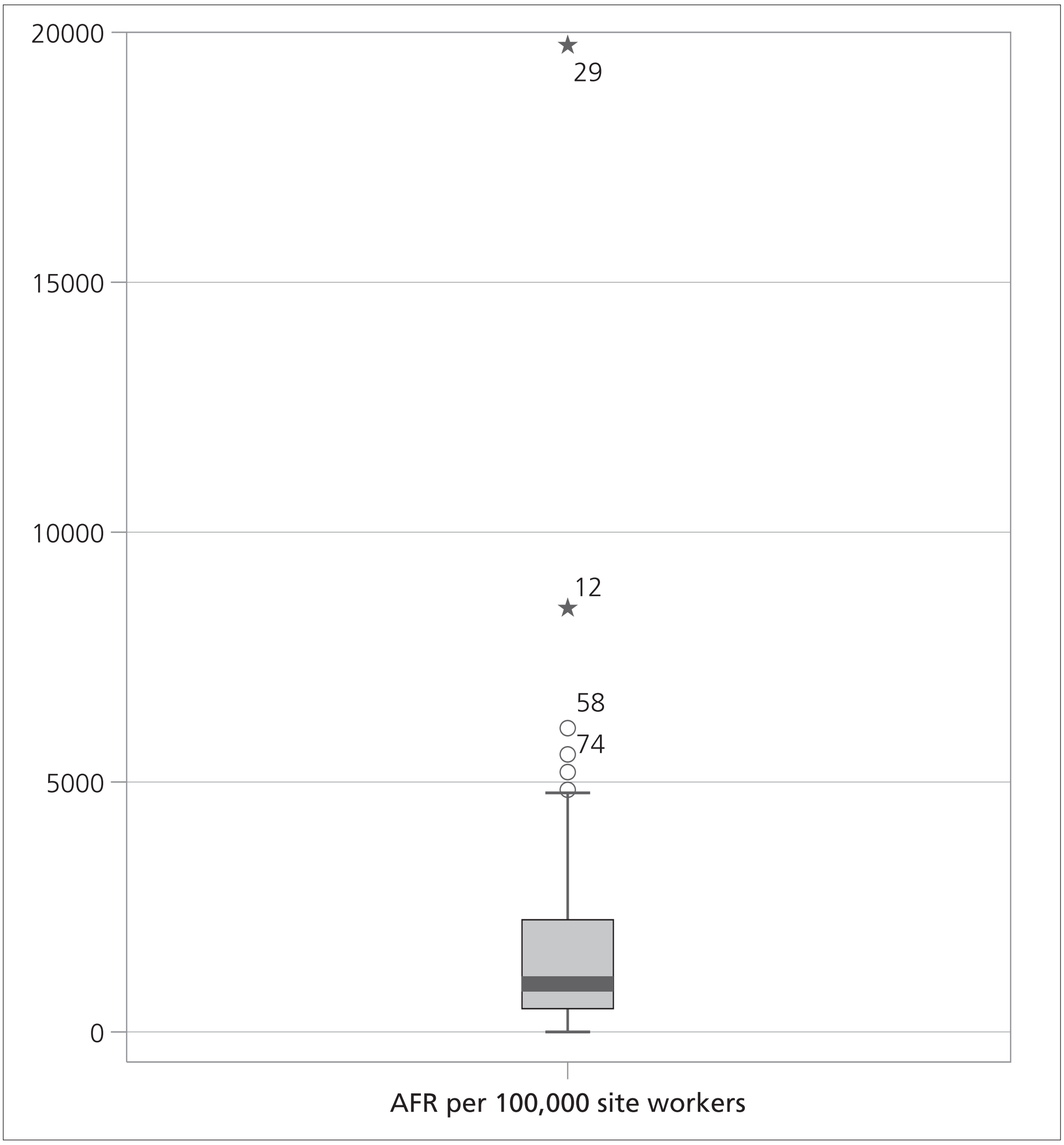


Figure 7
Respondent organisations' AFR per 100,000 site workers – histogram

Figure 8
Respondent organisations' AFR per 100,000 site workers – box plot



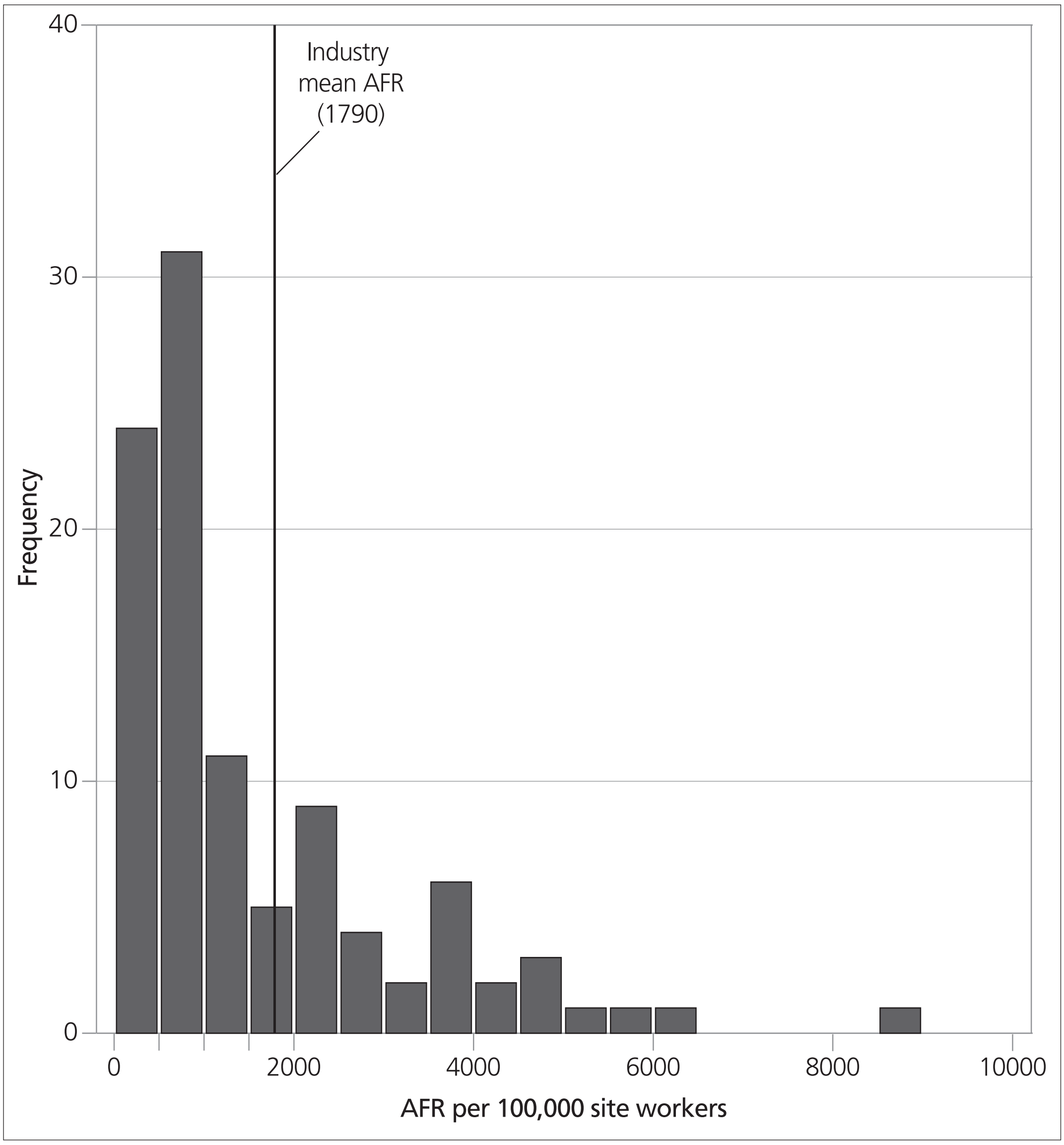
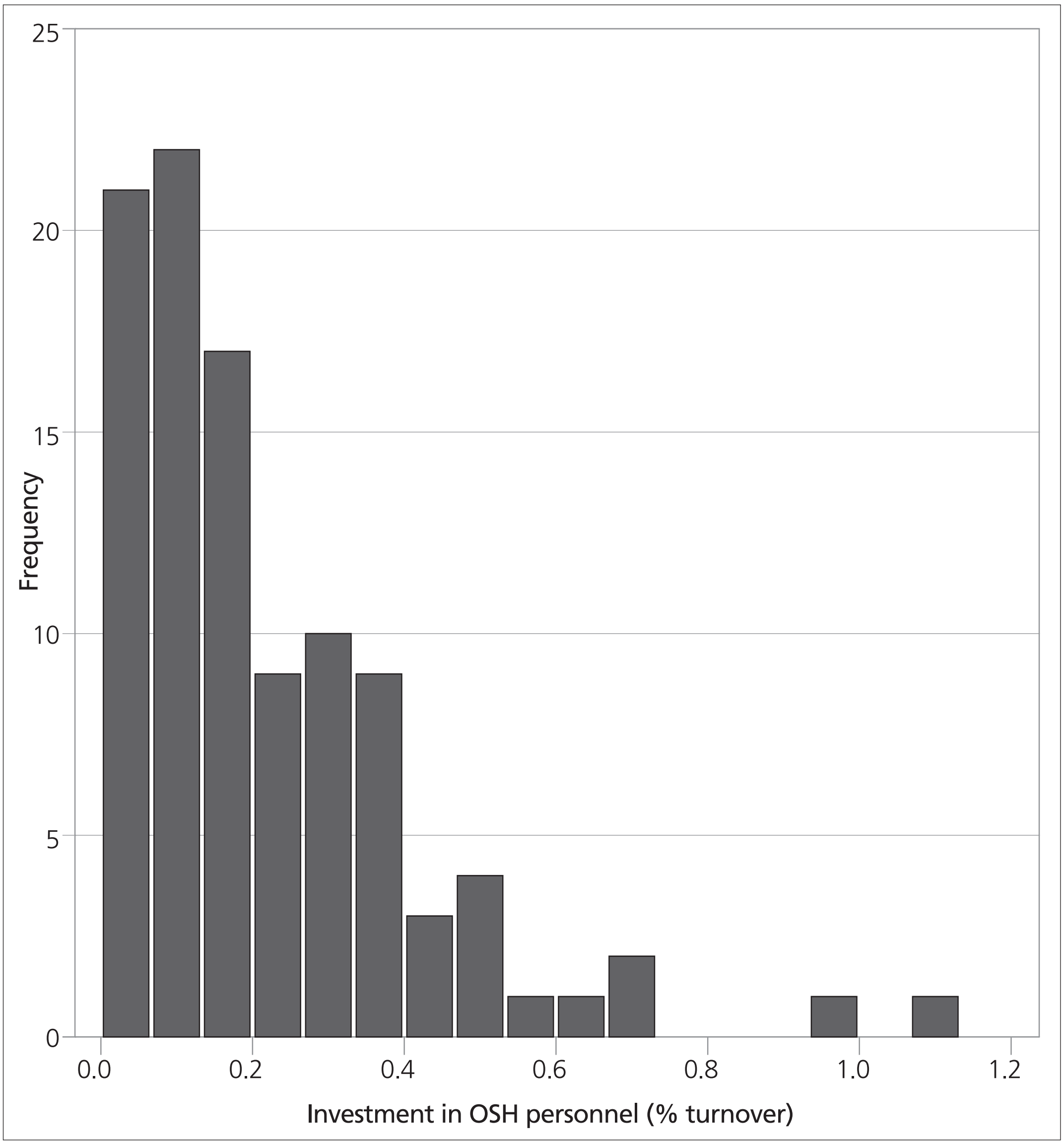


Figure 9
Respondent organisations' AFR per 100,000 site workers – revised with the removal of case 29

Figure 10
Investment in OSH personnel as a percentage of turnover



4.2 OSH investment *vs* OSH performance

Investment in OSH personnel is represented by the number of designated OSH people employed by the organisation (quantity), multiplied by a representative salary based on qualifications and experience. It also assumes external consultants are counted as 0.1 of an internal member of staff (based on average of 2 days worked out of 20 per month). The sensitivity of this assumption was checked and found that increasing the pro rata fraction for consultants to 0.35 had a negligible effect.

A statistically significant negative relationship was observed between investment in OSH personnel and the AFR, using the nonparametric test (see 3.4) Spearman's rho: ($r = -0.25$, $p = 0.011$). Therefore, a curvilinear line was attempted. Figure 11 estimates this relationship using an exponential 'curvilinear' regression line.

The strength of a linear (or curvilinear) relationship is determined by how close observations are to the line of best fit. Points on the scatter plot (Figure 11) generally drop from left to right as anticipated, but the relationship is not obvious. However, this relationship can also be illustrated

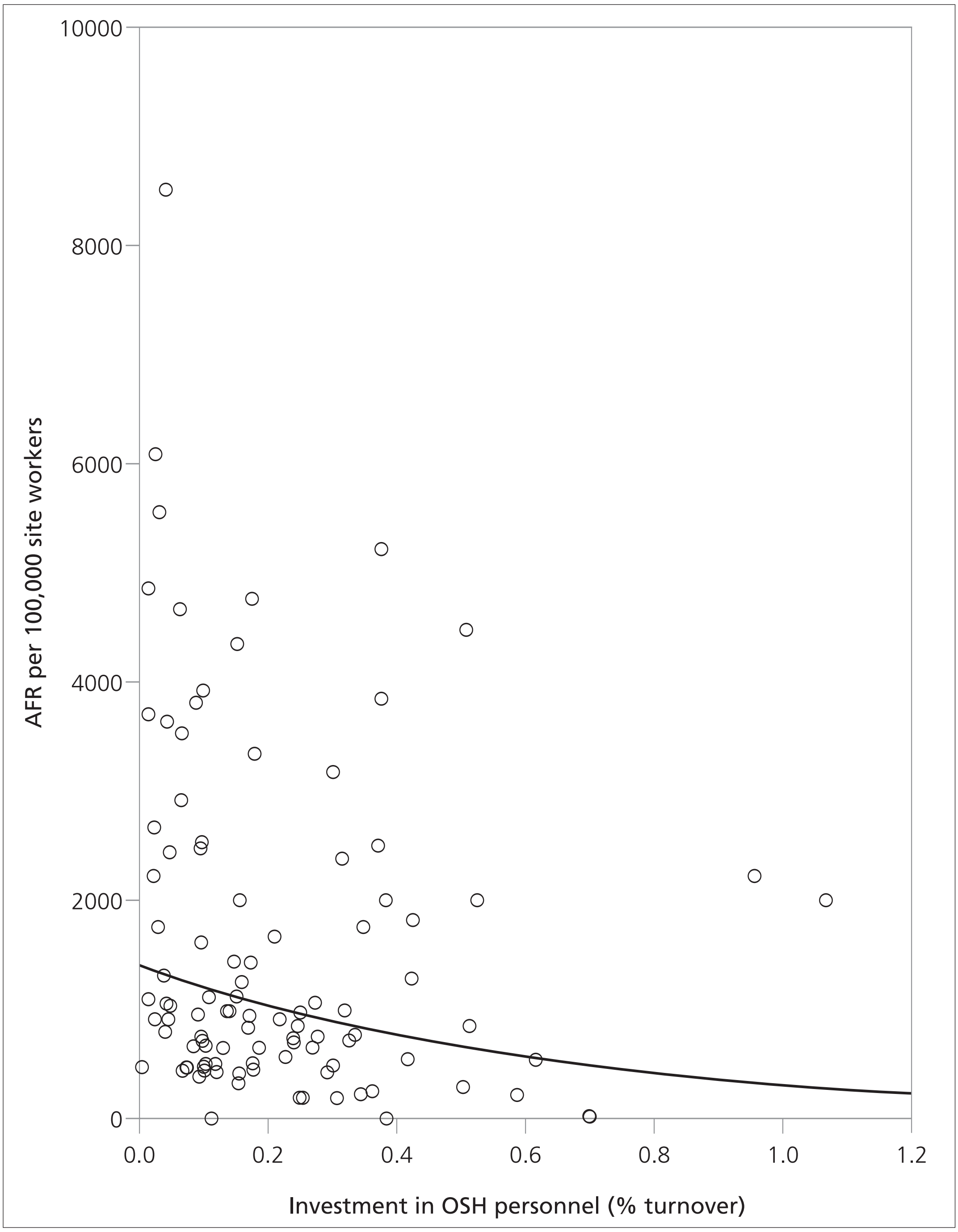


Figure 11
Investment in OSH personnel and OSH performance

using median AFR values. Figure 12 shows how the median AFR is reduced as investment in OSH personnel is increased. Confirming some level of association allows further analysis to be done, but any findings need to be treated with caution.

The next area analysed was the potential impact of other organisational factors on the AFR. This includes the nature and function of the OSH department or OSH personnel, as well as other organisational factors not directly linked to OSH.

4.3 Comparison of organisational factors

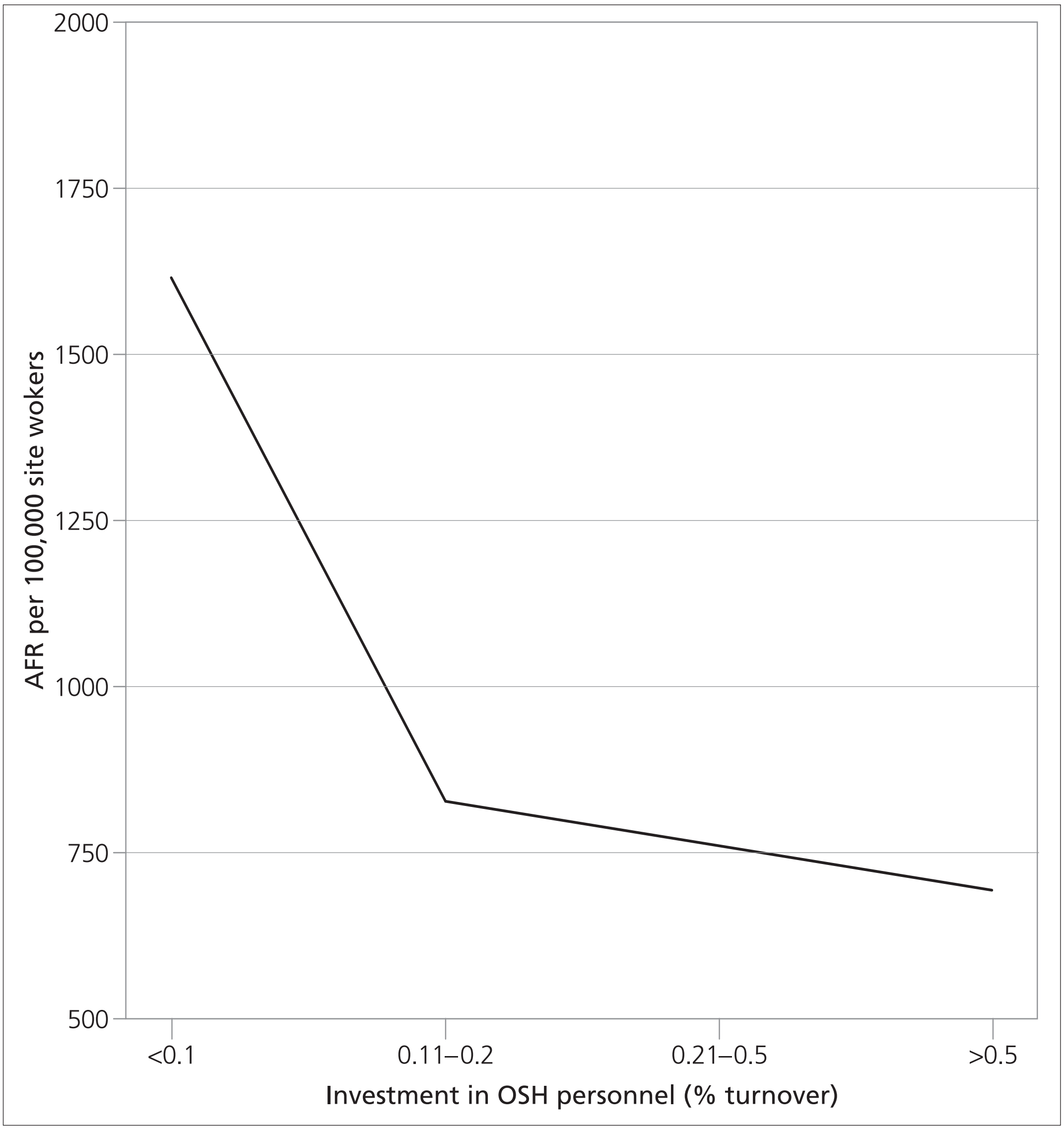
Organisational factors were compared using mean AFR. Comparisons of two means were performed using the Mann-Whitney test. Comparisons of three or more means were performed using the Kruskal-Wallis test, with *post hoc* Mann-Whitney tests and Bonferroni adjustment for significance. The rationale and description of these tests are given in section 3.6.

4.3.1 OSH personnel: internal, external or both

Organisations may choose to invest in internal staff to perform the OSH function or engage an external consultant. The sample consisted of three types of organisation in this respect – those who employ:

- internal staff only
- internal staff and external consultants
- external consultants only.

Figure 12
Investment in OSH personnel and OSH performance (median values)



The average AFR for each category is shown in Table 12. Both the mean and the median AFRs for contractors with internal OSH personnel were considerably lower than those with only external consultants. The mean ranks for 'internal only' and 'internal and external' were 45.57 and 54.08 respectively. The mean rank of 'external only' was 74.69. The Kruskal-Wallis chi-square test was significant beyond the 0.01 level: χ^2 (2) = 11.06; p = 0.004. *Post hoc* Mann-Whitney tests (with Bonferroni adjustment) found a significant difference between 'internal only' and 'external only': U = 187; p = 0.001 (two-tailed). Therefore, the difference in AFR between organisations that employ only internal OSH staff and those that use only external consultants was statistically significant, with 'internal' being lower.

However, Table 13 shows that the majority of contractors who use only external consultants (10 of the 13), have a turnover of less than £25 million. Previous research has shown that increasing contractor size (in terms of turnover, number of employees and size of site) is related to a reduced AFR (a negative correlation). Therefore, considering the bias of external consultants towards smaller contractors, a higher AFR may be expected. Table 14 shows the relationship between turnover and AFR. As turnover increases in the sample, the AFR reduces as expected. The negative correlation was found to be significant using Spearman's rho (r = –0.490; p < 0.001).

Since this turnover–AFR relationship existed in the sample, it was worthwhile repeating the internal/external OSH personnel analysis with the effect of contractor size controlled for by comparing only contractors with turnover of less than £25 million.

Table 15 shows how the gap between 'internal only' and 'external only' was reduced when controlling for contractor size. Mean ranks for 'internal only', 'external only' and 'internal and external' were 19.24, 26.50 and 16.78 respectively. The differences were not significant using the Kruskal-Wallis chi-square test: χ^2 (2) = 3.794; p = 0.15.

Table 12
AFR and source of OSH advice

Source of OSH advice	Mean AFR	Median AFR	Number	SD
Internal only	1273.54	780.00	68	1244.21
External only	3167.62	2439.00	13	2438.80
Internal and external	1622.75	1185.50	20	1365.88
Total	**1586.49**	**952.00**	**101**	**1580.27**

Table 13
Cross-tabulation: source of OSH advice and turnover

Source of OSH advice	Turnover				Total
	< £25m	£25m–£50m	£50m–£100m	> £100m	
Internal only	21	16	11	20	68
External only	10	2	1	0	13
Internal and external	9	7	1	3	20
Total	**40**	**25**	**13**	**23**	**101**

Table 14
Cross-tabulation: turnover and AFR

Turnover	Mean AFR	Median AFR	Number	SD
< £25m	2443.20	2000	40	1859.24
£25m–£50m	1343.32	952	25	1258.92
£50m–£100m	1130.77	714	13	1245.15
> £100m	618.43	500	23	380.19
Total	**1586.49**	**952**	**101**	**1580.27**

4.3.2 Membership of industry or professional bodies

An organisation or the OSH personnel employed by it may be members of industry or professional bodies. Five professional bodies were identified from the data:

- Association for Project Safety (APS)
- British Safety Council (BSC)
- Institution of Occupational Safety and Health (IOSH)
- International Institute of Risk and Safety Management (IIRSM)
- Royal Society for the Prevention of Accidents (RoSPA)

As organisations or individuals can join more than one of these bodies, most of the datasets included membership of more than one body. The average AFR for each category is shown in Table 16.

Table 16 shows that a majority of organisations represented in the sample (81) have OSH personnel who are members of IOSH. Since the organisations in the sample were, on many occasions, also members of other professional bodies, comparisons were difficult to make due to lack of exclusivity. However, a difference can be measured if all members of professional bodies are grouped together and compared with respondents not affiliated with any professional body. The foot of Table 16 shows this comparison. The mean and median AFRs for organisations affiliated to a professional body were lower than those not affiliated to any. A Mann-Whitney U test showed this difference to be significant: $U = 325.5$; $p < 0.01$ (two-tailed).

4.3.3 OSH function: duties and authority

The organisational function of the OSH personnel or department was analysed to establish any activities associated with superior performance. Most activities were evident in the majority of cases; for example, 'developing OSH policy and procedures' was performed by at least one of the OSH personnel in 100 cases out of the 101 observed. However, categories where some variation existed between organisations generated interesting findings. These categories are shown in Table 17. Organisations with OSH personnel or departments that undertake training, vetting of sub-contractors or environmental management generally had a lower AFR than those that did not. All three differences were statistically significant at the 0.01 level using Mann-Whitney U tests (two-tailed).

Table 15 Cross-tabulation: source of OSH advice and AFR for firms with less than £25 million turnover

Source of OSH advice	Mean AFR	Median AFR	Number	SD
Internal only	2127.43	1818.00	21	1463.95
External only	3591.10	2553.00	10	2532.37
Internal and external	1904.56	1667.00	9	1429.71
Total	**2443.20**	**2000.00**	**40**	**1859.24**

Table 16 Cross-tabulation: membership of OSH industry or professional bodies and AFR

Industry/professional body	Mean AFR	Median AFR	Number	SD
APS	1742.50	1742.50	2	106.77
BSC	1842.80	1250.00	15	1714.23
IOSH	1347.67	766.00	81	1349.40
IIRSM	1691.23	909.00	13	1897.71
RoSPA	1647.64	1038.50	14	1621.77
Total with membership of industry/professional body	**1419.87**	**847.00**	**87**	**1410.70**
No membership of industry/professional body	2621.86	1964.50	14	2168.94

The final variable in Table 17 is ‘authority’. This variable originally had three ordinal categories: ‘advise’, ‘enforce rules’ and ‘order’. However, only ‘advise’ and ‘order’ were chosen in the datasets obtained. The difference in AFR between ‘advise’ and ‘order’ was significant, with that of respondents with the authority to give orders being lower: Mann-Whitney U test U = 528; $p < 0.01$ (two-tailed).

Table 17 also shows the combined effect of these ‘function and authority’ variables. Cases where all categories were ‘yes’ or ‘order’ had a mean AFR of 520. The mixed cases had a mean of 1,609. Those with ‘no’ or ‘advise’ in all cases were higher still at 3,233, although at this level of analysis numbers became too low to test for statistical significance.

Table 18 shows analysis of OSH training for line management. Higher levels of training were associated with a lower AFR. The mean rank of ‘Above OSH NVQ 3’ was 11.00; ‘SMSTS/MS (NVQ 2)’ was 50.49; and ‘up to two days’ was 57.81. The Kruskal-Wallis chi-square test was significant beyond the 0.01 level: χ^2 (2) =11.175; p = 0.004. *Post hoc* Mann-Whitney tests (with Bonferroni adjustment) found a significant difference between ‘Above OSH NVQ 3’ and ‘SMSTS/MS (NVQ2)’: U = 31; p = 0.001 (two-tailed). There was also a significant difference between ‘Above OSH NVQ 3’ and ‘Up to two days’: U = 9; $p < 0.001$. Therefore, the average AFR of organisations that train line managers to the highest level was significantly different from those with lower levels of OSH training, but the difference between the middle rank (SMSTS/MS (NVQ 1–2)) and lowest rank (up to two days) was not significant.

4.4 Other organisational factors

Previous research has found organisational factors other than investment in OSH personnel associated with superior performance. These were also analysed. Variables with statistically significant differences (Kruskal-Wallis test; $p < 0.01$) were:

- good OSH performance rewarded
- client’s influence

Table 17 Cross-tabulation: AFR and OSH function and authority

Variable	Category	Mean AFR	Median AFR	Number	SD
Training	No	1973.42	1282.00	43	1772.96
	Yes	1312.89	750.00	57	1375.23
Vetting subcontractors	No	3105.56	2330.50	16	2375.30
	Yes	1300.54	831.00	85	1201.31
Environment	No	1879.82	1073.00	66	1699.41
	Yes	1033.34	543.00	35	1158.33
Authority	Advise	1909.41	1111.00	73	1716.88
	Order	744.57	606.00	28	609.56
All	All no/advise	3233.00	1988.00	8	2918.70
	Mixed	1608.73	984.00	79	1388.87
	All yes/order	520.07	453.00	14	390.45

Table 18 Cross-tabulation: AFR and OSH training for line managers

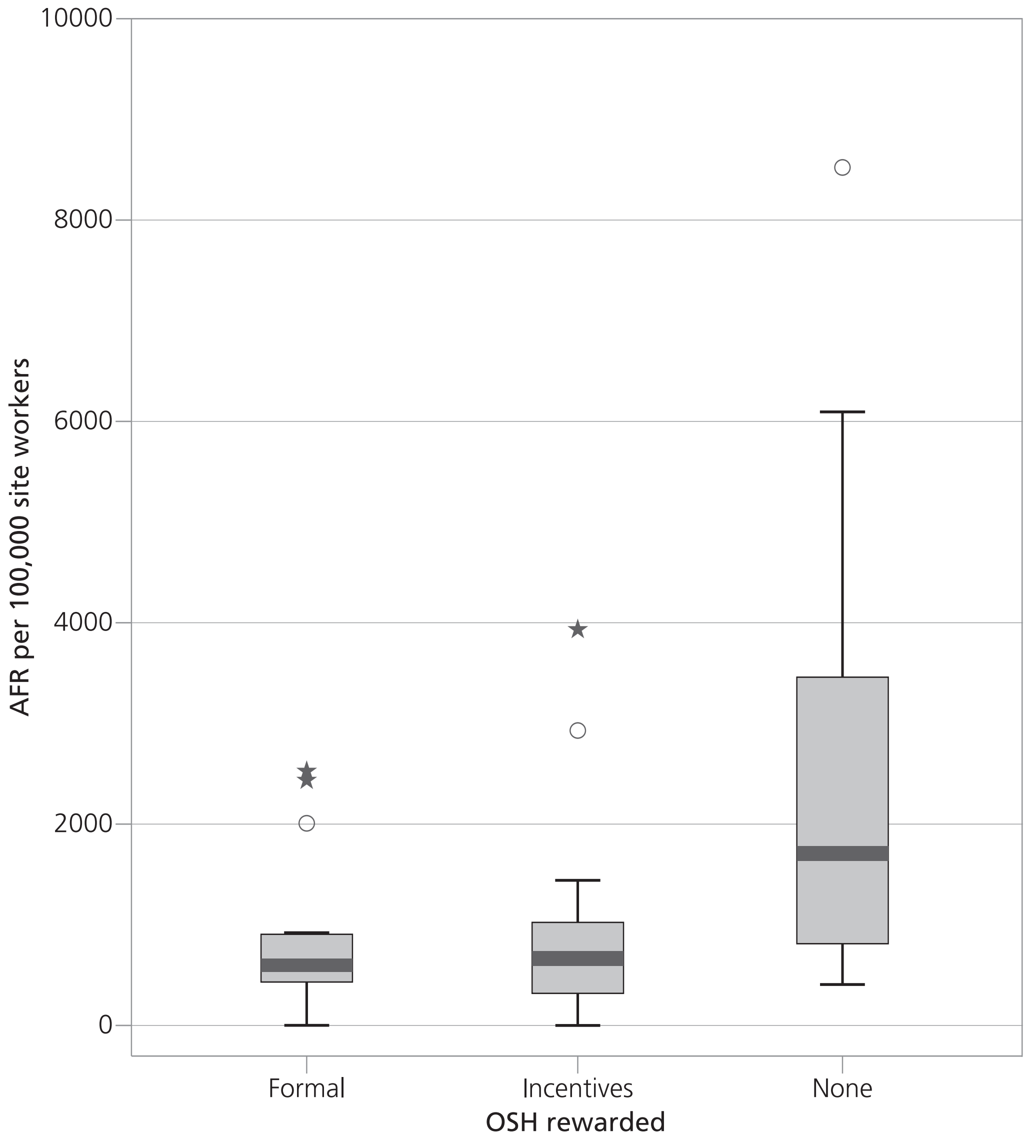
OSH training for line managers	Mean AFR	Median AFR	Number	SD
Above OSH NVQ 3	210.60	222.00	5	215.41
SMSTS/MS (NVQ 2)	1566.56	968.00	62	1652.54
Up to two days	1825.15	1047.50	34	1472.27
Total	**1586.49**	**952.00**	**101**	**1580.27**

- presence of a safety management system
- presence of a behavioural safety scheme

Box plots and statistical tables are shown for these variables in Figures 13, 14, 15 and 16 below.

The mean rank for organisations where good OSH performance is not rewarded was 63.56. Those with 'formal rewards' or 'incentives' had mean ranks of 35.14 and 35.47 respectively. The Kruskal-Wallis chi-square test was significant beyond the 0.01 level: χ^2 (2) = 23.109; $p < 0.001$. *Post hoc* Mann-Whitney tests (with Bonferroni adjustment) found a significant difference between 'formal' and 'none': U = 174; p = 0.001 (two-tailed). There was also a significant difference between 'incentives' and 'none': U = 382.5; $p < 0.001$. Therefore, the differences in AFR between organisations with

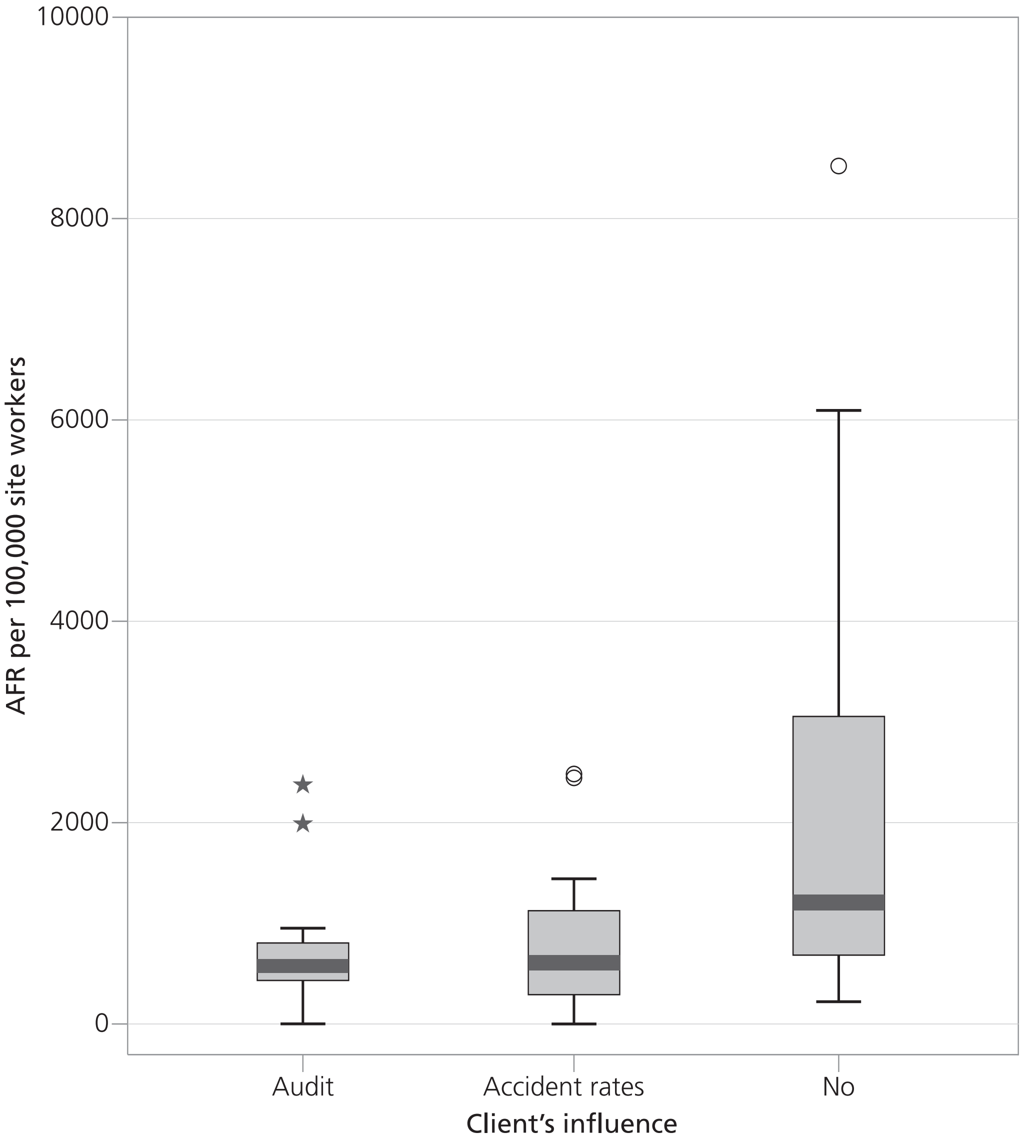
Figure 13
Good OSH performance rewarded



OSH rewards	Mean AFR	Median AFR	Number	SD
Formal	869.00	605.50	14	811.21
Incentives	812.45	662.00	31	810.72
None	2194.34	1710.50	56	1783.67
Total	**1586.49**	**952.00**	**101**	**1580.27**

rewards or incentives for good OSH performance and those without was significant, with those having no rewards being higher.

The mean rank for organisations whose clients do not generally take an interest in OSH performance was 59.35. Those with clients who 'audit' or 'request accident rates' had mean ranks of 32.37 and 34.97 respectively. The Kruskal-Wallis chi-square test was significant beyond the 0.01 level: χ^2 (2) = 16.981; $p < 0.001$. *Post hoc* Mann-Whitney tests (with Bonferroni adjustment) found a significant difference between 'audit' and 'no audit': U = 237; p = 0.001 (two-tailed). There was also a significant difference between 'requesting accident rates' and not: U = 317; p = 0.001. Therefore, the differences in AFR between organisations with clients who either audit or request accident rates and those with clients who do neither was significant, with those having no client influence being higher.

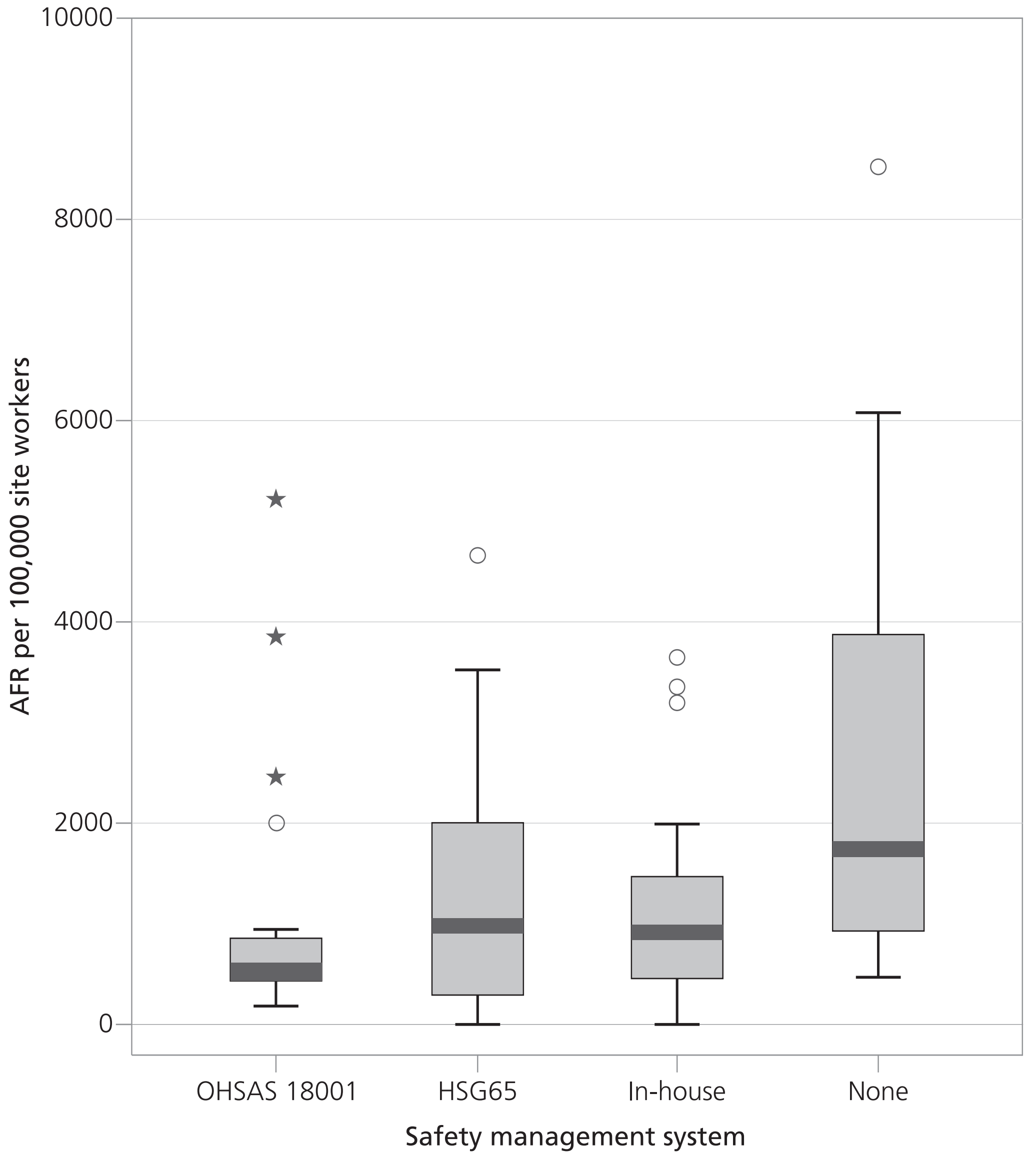


Client's influence	Mean AFR	Median AFR	Number	SD
Audit	721.00	563.00	15	668.72
Accident rates	811.78	602.50	18	720.77
None	1982.47	1196.50	68	1736.06
Total	**1586.49**	**952.00**	**101**	**1580.27**

Figure 14
Client's influence

The mean rank for organisations with an OSHAS 18001-accredited SMS was 37.59. Those with HSG65 or 'in-house' SMSs had mean ranks of 46.76 and 44.67 respectively. Organisations with no SMS at all had a mean rank of 68.90. The Kruskal-Wallis chi-square test was significant beyond the 0.01 level: χ^2 (3) = 17.885; $p < 0.001$. *Post hoc* Mann-Whitney tests (with Bonferroni adjustment) found a significant difference between 'OSHAS 18001' and 'none': U = 122; $p < 0.001$ (two-tailed). There was also a significant difference between 'in-house' and 'none': U = 213; $p = 0.001$. Therefore, the differences in AFR between organisations with OSHAS 18001 or an in-house SMS and those with no SMS was significant, with those having no SMS being higher.

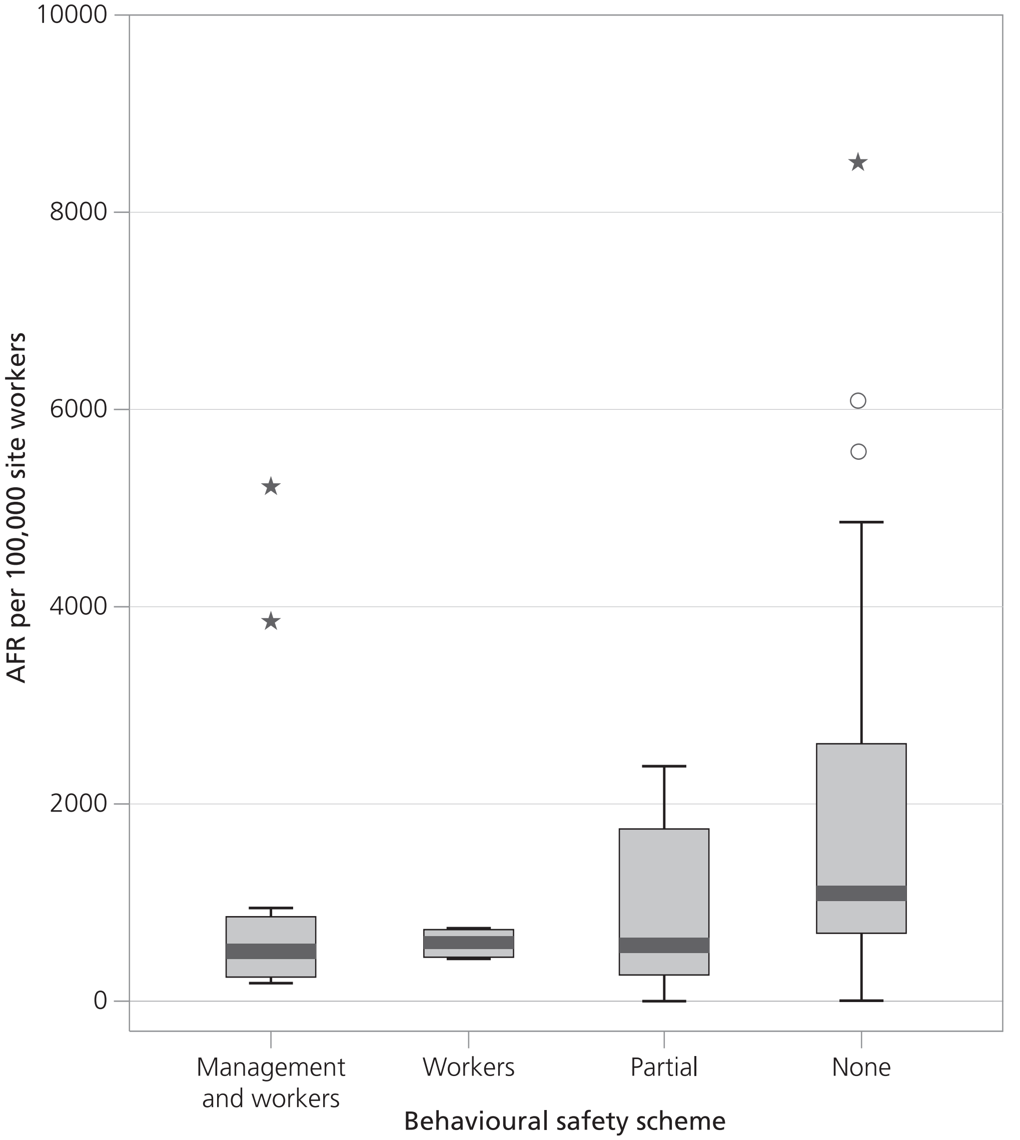
Figure 15 Presence of a safety management system



Safety management system	Mean AFR	Median AFR	Number	SD
OHSAS 18001	1062.00	550.50	22	1260.53
HSG65	1343.76	984.00	21	1249.83
In house	1124.26	909.00	27	973.36
None	2525.71	1754.00	31	2000.66
Total	**1586.49**	**952.00**	**101**	**1580.27**

The mean ranks for organisations with a formal behavioural scheme for 'managers and workers' or 'workers' only were 34.11 and 30.13 respectively. Those with a partially implemented scheme had a mean rank of 37.80. Organisations with no behavioural safety scheme had a mean rank of 58.62. The Kruskal-Wallis chi-square test was significant beyond the 0.01 level: χ^2 (3) = 14.327; p = 0.002. *Post hoc* Mann-Whitney tests (with Bonferroni adjustment) found a significant difference between 'managers and workers' and 'none': U = 244; p = 0.004 (two-tailed). Therefore, only the difference in AFR between organisations with a formal behavioural scheme for 'managers and workers' and those with none was significant, with those having none being higher.

Figure 16
Presence of a behavioural safety scheme



Behavioural safety scheme	Mean AFR	Median AFR	Number	SD
For management and workers	1072.36	492.50	14	1509.58
For workers only	591.25	584.00	4	139.38
Partial	941.73	563.00	15	848.32
None	1893.10	1102.00	68	1682.55
Total	**1586.49**	**952.00**	**101**	**1580.27**

4.5 Cost–benefit analysis

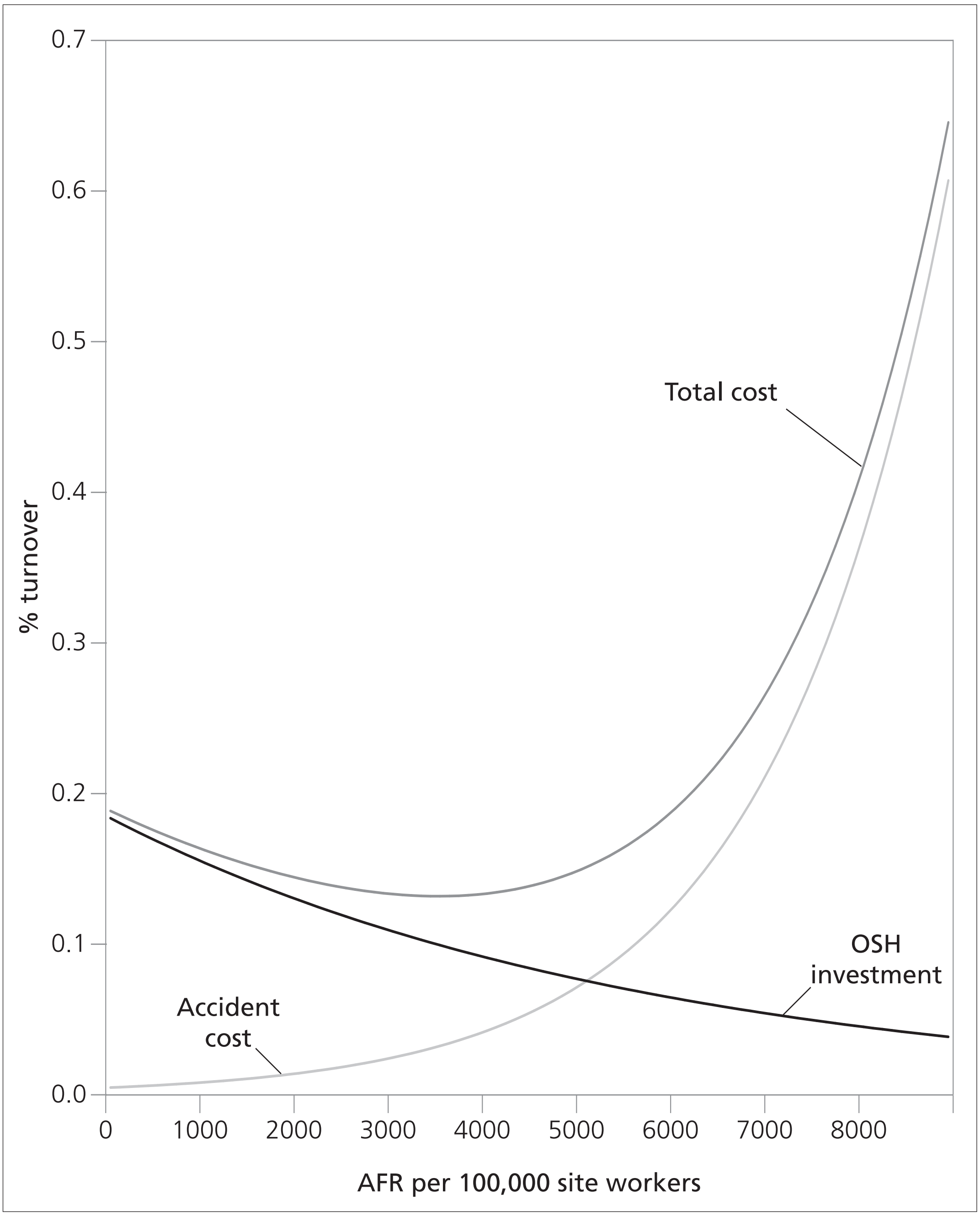
Cost–benefit analysis was carried out using data from 'investment in OSH personnel' and accident costs for major and over-three-day accidents (see 3.5 and 3.7.4). Two exponential curves were produced using the regression method to represent 'OSH investment' and 'accident costs'. These curves were found to be:

OSH investment: $y = 0.187 \exp(-0.00018\,x)$
Accident cost: $y = 0.0046 \exp(0.00054\,x)$

where x represents AFR. These curves are plotted as shown in Figure 17. The curve representing the combined values is also shown as 'total costs' following Tang *et al.*'s method.[56]

The coefficient of correlation for the curves representing OSH investment and accident cost were 0.26 and 0.60 respectively. The minimum value for 'total cost' was found where AFR = 3,600, and where minimum total costs equal 0.13 per cent of turnover, which consists of:

Figure 17
Cost optimisation model



- OSH investment, 0.1 per cent of turnover
- accident cost, 0.03 per cent of turnover.

If the sample is re-examined, using 0.1 per cent investment in OSH as a minimum, then mean AFR can be compared between those above and below the threshold. There were 35 organisations below the 0.1 per cent threshold, with a mean AFR of 2,279. Conversely, the remaining 66 organisations, with OSH investment above 0.1 per cent, had a mean AFR of 1,219. A Mann-Whitney U test showed this difference to be significant: $U = 727.5$; $p = 0.002$ (two-tailed).

5 Discussion and conclusions

5.1 Discussion of findings

5.1.1 The sample

The sample was positively skewed, which prevented parametric statistical tests. However, this was expected because of the nature of the data. Besides the mathematical reasons, it was expected that organisations with the resources and inclination to collect the information required for analysis would also be conscientious employers in terms of health and safety. Therefore, the majority would probably have lower than average accident rates. The mean AFR for the sample was 1,586 compared to an industry average of 1,790.

The two main industry sectors of civil engineering and building were adequately represented in the sample, although it was biased towards building. However, infrastructure (civil engineering) accounts for only around 10 per cent of new work by value in the UK, with building, including house building, forming the remainder.[16] Contractor size is a more problematic criterion to assess. Although the majority of construction work in the UK is done by SMEs, they tend to be working for a larger (main) contractor. The contractors in the sample have provided data for their subcontractors, so issues of representation may not be a problem. However, 11 organisations in the sample were themselves subcontractors, so there is a slim chance that some of their data are duplicated by other main contractors in the sample.

5.1.2 OSH investment *vs* OSH performance

Previous research examining the relationship between OSH personnel and OSH performance has shown construction organisations with more OSH personnel per worker generally perform better.[7,10,35] However, merely comparing the number of OSH personnel per worker to the AFR returned no correlation.

After weighting for competence (experience and qualifications) was established, an association was observed as discussed in section 4.2. However, the coefficient of correlation was only –0.25. An observation of –1 would have been a perfect correlation, with 0 representing no correlation. This may be expected, considering the possible influences on the AFR other than investment in OSH personnel, such as safety culture, training line managers and worker engagement. Tang *et al.*,[56] for example, were happy to accept a coefficient of correlation of 0.25 for their 'safety investment ratio', which included safety personnel, safety equipment, and safety training and promotion.

Median values for the AFR were correlated with investment in OSH personnel (see Figure 12) to give an alternative measure of central tendency. This showed a linear association, where the median AFR drops considerably as investment in OSH personnel approaches 0.1 per cent of turnover. The line then tails off at a lower gradient after this point as investment is increased. This indicates that an obvious benefit in terms of reduced AFR can be achieved by investing between 0.1 and 0.2 per cent of turnover in OSH personnel. However, the payback begins to diminish after this point. This trend is consistent with the theory of diminishing returns. Nevertheless, an association has been established which allows further cost analysis. This issue is discussed further in section 5.1.8 and 5.1.9 below.

5.1.3 OSH personnel: internal, external or both

Organisations that use only external consultants for their OSH function returned an average AFR approximately three times higher than those with internal OSH staff (see 4.3.1). The difference in AFR between organisations that employ only internal OSH staff and those that use only external consultants was statistically significant. This finding is consistent with Hinze,[10] who found a higher rate of injuries within construction organisations when the safety person was an external consultant.

However, the size of organisation had an evident influence on this measure. When smaller organisations were compared (turnover less than £25 million), the gap in AFR between organisations using just internal and just external OSH personnel was greatly reduced. The difference was not statistically significant at this point, but organisations with internal OSH staff still had, on average, a lower AFR than those with only external consultants. Furthermore, a third category of organisation – those who use a mixture of both internal and external – had a lower average AFR than both the others (again when restricted to organisations with turnover less than £25 million). In most occasions the OSH provision consisted of one internal practitioner and at least one consultant. Therefore, it would seem that smaller organisations can benefit in terms of reduced AFR by employing a consultant to supplement an existing OSH practitioner rather than relying solely on a consultant.

5.1.4 Membership of industry or professional bodies

Over 80 per cent of the sampled organisations had access to IOSH members. This is expected, given the number of IOSH members employed in the construction industry.[40] However, organisations and/or their OSH personnel and consultants are also members of other industry or professional OSH bodies (see 4.3.2). In most cases (81 out of 87) membership of these other professional bodies was in addition to membership of IOSH.

Fourteen organisations were not affiliated to any industry or professional body. The mean AFR for these organisations was approximately twice that of those with organisational or individual membership of such a body. This difference was statistically significant. Intuitively, this may confirm the benefit of having access to the best practice resources and networks that an industry or professional body can offer.

The impact of this factor has not been investigated before. However, other bodies, such as the Major Contractors Group (MCG), regularly compare the AFR of their members with the industry average.[66] The average AFR for MCG members in 2005/06 was 837. Therefore, while organisations affiliated to professional bodies have an average AFR lower than the industry average (1,790), there is still room for improvement. Also, measuring the AFR of member organisations has been demonstrated by the MCG as the first step to reducing them.

5.1.5 OSH function: duties and authority

Differences in organisations' AFR with respect to OSH function relied on whether or not a particular function was performed by at least one member of OSH personnel. Statistically significant differences in average AFR were observed based on the presence or absence of training (performed by OSH personnel for their staff), vetting of sub-contractors, and inclusion of environmental responsibilities in the OSH personnel's remit (see 4.3.3).

Giving training courses is the 13th most common activity for OSH practitioners in the UK.[43] Organisations that have at least one member of OSH personnel who undertakes this function had a lower AFR than those which did not. This difference was found to be statistically significant. This may reflect the fact that giving staff in the organisation OSH training should influence their competence levels. However, if the person (or team) delivering the training is also responsible for working closely with staff on general OSH matters, the impact of the training may be reinforced. It is reasonable to assume that the trainers in these circumstances will know the audience through long-term relationships as a result of working as part of the OSH team.

Vetting or assessing sub-contractors is undoubtedly a key function of any construction organisation, because of the prevalence of sub-contracting in the industry. Organisations with at least one OSH practitioner who assesses sub-contractors had a lower AFR than those without. This difference was found to be statistically significant. Assessing subcontractors for OSH competence is a legal requirement under CDM. It may therefore be erroneous to assume this function has not been carried out simply because no OSH practitioner has done it. It may be performed by line managers in such cases. While integration of OSH management with line management is commendable,[15] there may be occasions where people have been given the task who are not competent to perform it properly. This finding raises the possibility that such a failing exists.

Also included in possible OSH functions were 'additional' duties. One such additional duty was environmental management. Organisations in which at least one OSH practitioner also managed environmental issues had a lower AFR than those who did not. This difference was found to be statistically significant. According to R Jones, 16 per cent of OSH practitioners in the UK have environmental responsibilities.[43] N Jones[45] found that OSH practitioners with job roles including environmental responsibilities command higher salaries, reflecting greater responsibility. Therefore, having responsibility for environmental management may be associated with more experienced OSH personnel. Moreover, individuals with more responsibility may also command greater influence and authority in the organisation.

Alongside function, authority is also important. Organisations that have at least one member of OSH personnel with the authority to give orders (rather than just advice) had a lower AFR than those which did not. This difference was found to be statistically significant. Organisations in which all OSH practitioners only give advice actually had, on average, twice the AFR. This finding needs to be considered carefully. If OSH practitioners are given a support role without authority, their effectiveness can be hindered. If the authority is derived from senior management – through reporting lines to senior management – then OSH recommendations and concerns may have a greater chance of being implemented or dealt with. In all cases, the OSH practitioner(s) with full authority held a senior position in the organisation.

5.1.6 Line management OSH training

The effective management of OSH requires input and action from line management. Therefore, investment in OSH training for line managers was measured. The ratio of line managers to OSH personnel in each organisation meant there were restrictions on the level (and detail) of data that could be collected. Therefore, only the level of OSH qualification or training possessed by line managers was measured. The subsequent ranking of qualifications and training was compared with mean AFR (see 3.6 and 4.3.3).

An ordinal association between the level of OSH training and AFR was found in the sample. Organisations with line managers trained to a relatively low level (up to two days of training) had the highest AFR. Organisations with line managers trained to the industry-recognised SMSTS standard or IOSH Managing Safely (five and four-day courses respectively) had the second highest AFR. Those with the highest level of OSH qualification in the sample – OSH NVQ 3 or above – had the lowest AFR, although there was a relatively small number of cases (five) in this final category. The average AFR of organisations that train line managers to the highest OSH level was significantly different from those with lower levels of OSH training. But the difference between the middle rank (SMSTS/MS (NVQ 2)) and lowest rank (up to two days of training) was not significant.

This finding is not surprising, considering the abundance of research confirming the importance of OSH training to OSH performance.[7,10,11,35] However, the linear association is of greater importance. The extent of OSH training or qualification may be expected to be a significant factor in relation to competence, but no research was found to confirm this assumption. Therefore, this finding reinforces the argument for pursuing higher levels of OSH training and qualification for line managers.

Integrating OSH management with the line management function can only be done when line managers are competent enough to accept this responsibility.[15] It is therefore worthwhile to establish, among other things, the minimum level of OSH training or qualification needed to reach this level of competence.

5.1.7 Other organisational factors

The influence of other factors was measured because of their prominence in relevant literature. However, they were not central to the main focus of the study; rather, they were considered confounding factors. Not all, however, returned statistically significant results. Those that did were OSH rewards, client's influence, having a SMS, and having a behavioural safety scheme.

Unfortunately, not enough datasets were available in the sample to allow complex analysis which could control for these factors. Nonetheless, the four variables with significant differences in AFR provide useful data for further studies on superior OSH performance.

5.1.8 Cost–benefit analysis

The 'optimal' investment in OSH personnel was found to be 0.1 per cent of turnover, with 0.03 per cent accident costs. This calculation was based on Tang *et al.*'s method.[56] Tang *et al.* make it clear, however, that the optimal investment figure should not be considered the maximum investment. In fact they recommend that it should be used as a minimum amount, as increasing investment will lead to other intangible benefits, such as impact on safety culture and staff morale. The present study, like Tang *et al.*'s, did not consider the cost of minor accidents. If this cost was included, the minimum figure would increase.

This analysis only considered salary costs and could not include moral and legal imperatives which obviously need to be considered at all times. However, the commercial argument is strengthened by comparing the mean AFR of organisations below and above this threshold. Those with OSH investment below 0.1 per cent had a mean AFR of 2,279, whereas those above had a lower mean AFR, of 1,219. This difference was statistically significant, supporting the case for increased investment in competent OSH personnel.

5.1.9 Interaction of factors

Correlation analysis found that up to 0.1 per cent of turnover investment in OSH personnel has a strong influence on OSH performance (in terms of AFR), but that this influence begins to diminish after 0.2 per cent. Cost optimisation analysis confirms that the optimal investment is indeed 0.1 per cent. The average salary for an OSH professional in construction is around £35,000 (excluding on-costs). Taken at face value, this means that an organisation would need to have a minimum turnover of £35 million to justify a full-time OSH position. Therefore, an OSH consultant (at lower investment) may seem more feasible.

However, organisations with full-time OSH personnel have, on average, a lower AFR than those with only external consultants; this is true even in the case of those with turnover less than £25 million. The minimum turnover observed in the sample was £4 million. Therefore, a full-time OSH practitioner is most effective in all cases (above £4 million), and should be considered as an absolute minimum as turnover approaches £35 million, ie the 0.1 per cent minimum threshold. The findings show that an external OSH consultant can be considered an effective way to supplement an existing OSH member of staff at this point. But relying on an external consultant only is associated with a higher AFR. If an average OSH salary of £35,000 is assumed, then additional internal OSH staff should be considered at a minimum of every £35 million increment in turnover.

This investment ratio is separate from the investment required for line management. The findings show that above average OSH training and qualifications for line managers are associated with the lowest AFR averages. Also, investment in attaining individual or corporate membership of OSH industry or professional bodies should be considered.

In terms of OSH function, training of other staff, vetting sub-contractors and including environmental responsibilities are associated with lower AFR. However, this is in addition to other basic functions of OSH which should not be disregarded, such as developing policy and carrying out site audits. Moreover, if these increased functions are implemented then attention to adequate resources needs to be considered as discussed above. In addition to function, the authority of OSH personnel is also significant. In other words, reporting lines of OSH personnel are most effective when they lead to senior management.

There was a combined effect for training other staff, vetting subcontractors, including environmental responsibilities and increased authority. Organisations with OSH personnel who did all of these had a mean AFR of 520. However, at this level of analysis, the numbers were too low to test for statistical significance. This was also true of the other organisational factors, namely OSH rewards, client's influence, having a SMS, and having a behavioural safety scheme.

5.2 Conclusions and recommendations

5.2.1 Conclusions

The aim of this study was to investigate the relationship between the provision and application of OSH personnel and OSH performance in construction organisations. A total of 101 contractors' data were used for analysis, collected using a combination of questionnaires and information from the CHAS database. The 101 contracting organisations employed a total of 660 OSH personnel and over 200,000 workers, including subcontractors.

The first objective of the study was to develop appropriate assessments of OSH personnel provision, accommodating different levels of competence, qualification and experience. OSH personnel were measured in terms of quantity and quality.

The quantity measure was 1 unit per full-time OSH practitioner, including a fractional count for part-time staff. A notional fraction of 0.1 was used for external consultants. This was based on actual time spent by consultants working for construction organisations.

The quality measure was based on experience and qualifications of OSH practitioners. Average salaries, connected to experience and qualifications, were developed from existing survey data to establish a representative salary incorporating both elements. A three-by-three matrix with a salary representing each combination was the result. The quality measure was normalised by presenting it as a percentage of turnover.

The second objective was to investigate and select appropriate measures of organisational OSH performance. The AFR for one full year was used, as recommended by the HSE. The calculation was:

$$\frac{\text{Number of reportable accidents}}{\text{average number employed}} \times 100{,}000$$

Subcontractor numbers were included, but office staff were excluded for increased accuracy.

The third objective was to investigate and quantify any association between the quantity of competent OSH personnel resource provided by construction organisations and their OSH performance.

- A non-parametric test (Spearman's rho) was used to test OSH investment against OSH performance. No parametric test was conducted because the sample was skewed. The skewed data were expected rather than being the result of poor sampling. A significant negative correlation was observed between investment in OSH personnel and OSH performance ($r = -0.25$, $p = 0.011$).

The fourth objective was to translate the data into a cost–benefit relationship, to provide an economic argument for appointing or training OSH personnel. The cost–benefit model required two elements: a cost for OSH investment and a cost for accidents.

Investment in OSH personnel was already calculated as a representative salary, being a percentage of turnover. Accident costs, based on HSE research, were used for 'major' and 'over-three-day' accidents. These were multiplied by the number of accidents experienced by each organisation before being converted to a percentage of turnover.

- Exponential curves for each element were produced using regression. The coefficient of correlation for OSH investment and accident costs were 0.26 and 0.60 respectively. Combining the values for each produced a third curve, which was then used to obtain an optimal measure of OSH investment. This was found to be 0.1 per cent of turnover, resulting in 0.03 per cent accident costs.

The fifth and sixth objectives were to investigate, classify and evaluate the variety of organisational structures in which OSH personnel operate, and their consequent influence and authority, taking account of senior management and other organisational support, and then to investigate any association between these.

- Organisations with internal OSH personnel had a lower AFR (m: 1,274) than those who used only external consultants (m: 3,168). This difference was found to be statistically significant.

- External consultants were concentrated at the smaller end of the sample (turnover less than £25 million). The difference in AFR was reduced when these small organisations were compared. However, a third category, 'internal and external', was ranked with the lowest AFR for these smaller organisations. In other words, smaller organisations that employ a mixture of internal OSH staff and an external consultant tend to perform best within the under-£25 million turnover band.

- Organisations affiliated to an OSH professional body or employing OSH personnel who are members of an OSH professional body had a lower AFR (m: 1,420) than those with no such affiliation (m: 2,622). This difference was found to be statistically significant.

- Organisations with OSH personnel who train their own staff in OSH had a lower AFR (m: 1,313) than those without such staff (m: 1,973). This difference was found to be statistically significant.

- Organisations with OSH personnel who vet (or assess) sub-contractors had a lower AFR (m: 1,301) than those without (m: 3,106). This difference was found to be statistically significant.

- Organisations with OSH personnel who also have environmental responsibilities had a lower AFR (m: 1,033) than those without (m: 1,880). This difference was found to be statistically significant.

- Organisations with OSH personnel who had authority to give orders had a lower AFR (m: 745) than those with OSH personnel who merely gave advice (m: 1,909). This difference was found to be statistically significant.

- Organisations with OSH personnel who train, vet sub-contractors, have environmental responsibilities and have greater authority had a mean AFR of 520. However, at this level of analysis, numbers became too low to test for statistical significance.

- Line managers' OSH training and/or qualifications were compared with organisations' average AFR. A three-point ordinal scale was used to represent qualifications. The first (highest) band of training/qualifications, ‘OSH NVQ 3 or above’, had the lowest AFR (m: 211). The second ranked band, ‘SMSTS/MS (NVQ 2)’, had a higher AFR (m: 1,567). The third (lowest) ranked band, ‘up to two days’ training’, had the highest AFR (m: 1,825). The differences in AFR were statistically significant.

The interactions between these findings can be summarised as follows:

- Investment in suitably experienced and qualified OSH personnel was associated with improved OSH performance. The minimum investment was found to be 0.1 per cent of turnover.
- The mean AFR of those below the minimum investment level was 2,279. The mean AFR of those above the minimum was 1,219. This difference was found to be statistically significant.
- However, a full-time OSH practitioner was found to be more effective than merely relying on external consultants (based on turnover of at least £4 million), and should be considered as an absolute minimum as turnover approaches £35 million.
- An external OSH consultant was found to be an effective way to supplement existing OSH personnel. But relying on an external consultant only was associated with a higher AFR.
- Above average OSH training and qualifications for line managers were associated with the lowest AFR averages. Conversely, lower levels of OSH training and qualifications for line managers were associated with a higher AFR. This supports the case for increased OSH training and qualifications for line managers.
- In terms of OSH function, organisations with OSH personnel who train, vet sub-contractors, have environmental responsibilities and have greater authority are associated with a lower AFR. This suggests that the role or activities of OSH personnel are important for OSH performance.
- Investment in attaining individual or institutional membership of an OSH professional body was also associated with lower AFR.

5.2.2 Limitations of the study

The final sample used for the study was 101 construction organisations. Although this was not a small sample, detailed analysis was hindered due to the number of independent variables identified. Therefore, more cases or fewer variables would have helped.

In terms of representation of the population, the sample included both building and civil engineering contractors, the mean AFR (1,586) was close to the industry average (1,790) and there was a wide spread of sizes of organisation. However, the sample was positively skewed towards a lower AFR (70 per cent below industry average, 30 per cent above). This is common in such studies, where organisations with the resources and inclination to collect the information required for analysis would also be conscientious employers in terms of health and safety. Furthermore, no contractors with turnover under £4 million were observed. However, this was expected because of the nature of the data collected.

There were 11 subcontractors in the sample. This means that there is a chance that data may have been duplicated between these sub-contractors and the other main contractors in the sample. This error would occur if any of the sub-contractors worked for one of the main contractors in the sample during the period measured. This possible error was too difficult to control for without eliminating the subcontractors from the study. It was decided that the benefit of keeping the subcontractors’ data outweighed any potential threat to validity or reliability. However, the threat is still acknowledged.

The method for assessing investment in OSH personnel was cumulative: in other words, it is the sum of OSH salaries based on experience and qualifications. This analysis was only concerned with detecting an ‘overall effect’ of investment. A large investment in OSH personnel could be several personnel with a low level of qualifications or experience or a few highly qualified or experienced staff. The analysis did not allow for discrimination between these two scenarios or for mismatches between pay and qualification levels. However, the method developed assumes the number of OSH personnel (quantity) is the main factor and the experience/qualifications of OSH personnel (quality) is a moderating factor. As mentioned above, the study did not account for the influence of the many other factors that affect OSH performance – such as safety culture – in addition to OSH professionals.

The skewed data prevented use of parametric tests, which are considered more powerful than non-parametric tests. However, parametric tests in these circumstances may have led to misleading results.

Similarly, and as indicated earlier, the method of OSH performance measurement did not include minor accidents and ill health, dangerous occurrences or less tangible measures, such as reputational damage. These are likely to lower the performance level or increase the cost of ‘accidents’. If it were possible to take these into account, there would be an increase in the minimum level investment. Therefore all costs used should be considered indicative and further studies incorporating more detailed cost data are advised.

5.2.3 Recommendations

The recommendations are divided into two categories: those for improved industry practice, and those for further academic study.

Improved industry practice:

- Investment in a suitably experienced and qualified internal OSH practitioner should be considered for construction organisations with at least £4 million turnover. External consultants should be seen only as a supplement to, rather than a replacement for, internal staff. This level of investment should be seen as an absolute minimum as turnover grows to around £35 million.
- Investment in OSH personnel in organisations with a turnover of £35 million or more should be at least 0.1 per cent of turnover. However, increasing numbers of OSH personnel indefinitely will not reduce accidents to zero. A maximum is not recommended, but some investment in OSH management will obviously need to be spent elsewhere.
- Investment elsewhere is recommended to provide improved OSH qualifications for line management, and to attain membership of OSH professional bodies (for individuals or the organisation), as well as to support those areas traditionally associated with improved OSH, such as SMSs, OSH benchmarking and rewards, behavioural safety schemes and worker engagement.
- The OSH function can be more effective if OSH personnel also participate in training, vet sub-contractors, have environmental responsibilities and have increased authority (through access to senior management).
- Individual or institutional membership of an OSH professional body was associated with a lower AFR than non-membership of such bodies. These bodies could consider following the lead set by the MCG of collecting annual AFR measures from member organisations. The MCG considers this a key step towards reducing AFRs among its membership.

Further academic study:

- This study covers one leg of the Triple Ace Triangle. A further study is recommended, which encompasses all three legs, including management leadership and worker engagement. The latter could also identify effective methods of engaging migrant workers.
- This study focused on OSH at organisational level. The characteristics of OSH individuals with superior performance in relation to the Triple Ace Triangle should also be investigated.

This study sought to investigate the relationship between the provision and application of professionally competent OSH personnel and OSH performance in construction organisations. An association was found between the two as well as several other factors of interest. It is hoped that these findings will be of use to industry practitioners and academic scholars alike.

Appendix: Questionnaire

Impact of occupational safety and health (OSH) provision on OSH performance

Organisation's anonymous reference number:

Contact details

Name	
Phone	Email

This questionnaire has been developed by Glasgow Caledonian University for research funded by the Institution of Occupational Safety and Health (IOSH). The aim of the research is to investigate the relationship between the provision and application of professionally competent OSH management personnel and OSH performance in construction organisations.

General note

All questions relate to work undertaken in the UK only. Relate all answers to the same timeframe, ie the most recent financial year. Where your answer is an estimate, place an E beside it.

1 In general, which category best describes your organisation? *(Please tick one)*

1a Principal/main contractor (most of the time) ☐

1b Subcontractor (most of the time) ☐

2 What industry sectors does your organisation work in? *(Please tick any that apply)*

2a	Civil	Services/utilities	☐	
2b		Transport	☐	
2c		Other *(please state)*	☐	
2d	Building	Housing	☐	
2e		Commercial/industrial	☐	
2f		Other *(please state)*	☐	
2g	Demolition	General	☐	
2h		Other *(please state)*	☐	

3 How long has your organisation worked in the construction industry?

____ years

4 What was your organisation's turnover in the last financial year?

£

5 What types and numbers of accidents were there in your organisation in the last financial year?

	Employees	Sub-contractors	Public	Total	Dangerous occurrences (5e)
5a Fatal/major					
5b Over three days					
5c Minor/first aid					
5d Totals					

Complete only the boxes with numbers that you can easily calculate – so use totals if there are no individual figures available. If you provide totals only, please circle which out of employees, subcontractors and/or the public the figures apply to.

Please answer EITHER question 6 OR question 7

6 What was the average number of workers employed during the last financial year?

6a Site employees

6b Site subcontractors

6c Office employees

6d Total

Please give a total even if you do not have figures for 6a–6c.

7 What was the total number of hours worked in the last financial year?

7a Site employees

7b Site subcontractors

7c Office employees

7d Total

If the hours worked data are based on an estimated working week, please give:

Average hours worked per week   Average weeks worked per year

8 Does your organisation have any designated OSH personnel?

	Please tick		
8a Yes – internal staff		How many?	*Please go to question 9*
8b Yes – external consultants		How many?	*Please go to question 9*
8c No		*Please go to question 11*	

9 For the lowest level of OSH manager/adviser, what is the largest area covered by any one person?

square miles

10 OSH resource provision. *Please fill in one line per OSH practitioner in your organisation. Copy this page before starting if you need more space.*

	Position*								OSH duties*							other duties*			Authority*			
Job title	External consultant	Director/senior manager	Middle manager	Site-based	Full time or fraction†	Experience (years)	Highest OSH qualification or training	Membership of OSH professional bodies‡	Develop policy/procedure	Do risk assessments	OSH audits/inspections	OSH training	Accident investigation	Vet subcontractors	CDM Planning Supervisor	Quality	Environment	Other (please specify)	Advise only	Enforce specific rules	Orders must be obeyed	Own discretionary budget for OSH (before approval is needed)

** Tick as many boxes as are applicable. † Full time = 1; two days a week = 0.4; and so on. ‡ Use more than one line if necessary.*

11 **Job types by line management status.** *(Group types of manager together, eg directors, project managers, site managers)*

Line management job types	No. in category	Highest OSH qualification or training*	No. with this level

** If managers of the same 'type' have different kinds of OSH qualification, list each qualification separately.*

12 How is good management of health and safety rewarded in your organisation?

12a Formal part of pay and promotion ☐

12b Discretionary incentives ☐

12c None ☐

13 How much OSH training is provided by your organisation, and to whom?

13a	Over four days:	Employees and subcontractors ☐	Employees only ☐	No-one ☐
13b	Two to four days:	Employees and subcontractors ☐	Employees only ☐	No-one ☐
13c	One day:	Employees and subcontractors ☐	Employees only ☐	No-one ☐

14 Do your organisation's clients request measures of OSH performance during projects?

14a Most clients audit sites (more than just accidents) ☐

14b Most clients ask for accident rates on site ☐

14c Most clients do not measure OSH performance ☐

15 Does your organisation have a safety management system?

15a Yes – accredited by a third party (eg OHSAS 18001) ☐

15b Yes – own system, unaccredited, based on HSG65 or similar ☐

15c Yes – own system, unaccredited, in-house design ☐

15d No ☐

16 Does your organisation have an OSH behavioural programme in place?

16a Yes – structured programme with budget, aimed at managers and workers ☐
16b Yes – structured programme with budget, aimed at workers ☐
16c Partial – no specific programme or budget, aimed at workers ☐
16d No ☐

17 What relationship does your organisation have with trade union safety representatives?

17a Management and safety representatives regularly meet and work together on initiatives ☐
17b Safety representatives are active on isolated sites ☐
17c There are no union safety representatives ☐

18 Financial information – costs and benefits *(Please complete as much of this table as you can. Partial information is still useful to us. We will use these data to calculate accident costs for your organisation)*

18a Total annual salaries for dedicated OSH personnel	£
18b Other related costs for OSH personnel (eg NI, pensions, overheads)	£
18c Total annual cost of external OSH consultants	£
18d Current year's employer's liability insurance premium	£
18e Any other insurance premiums covering accidents	£
18f Gross profit margin for year	%

Please tick the box to show that you have included an organisational chart showing OSH reporting lines and functions in relation to the rest of your organisation: ☐

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