Occupational health risk

John Smallwood, Department of Construction Management, University of Port Elizabeth, Theo Haupt, Department of Built Environment, Peninsula Technikon

Abstract

Occupational health (OH) hazards in construction include: ergonomic stresses, such as bending and/or twisting the back, handling heavy loads, reaching overhead and away from the body, repetitive movements, and vibration; environmental stresses, such as heat, sun, noise, poor illumination, and work in wet or damp conditions, and skin and respiratory exposure to chemicals and dust. In South Africa, these may add to the health problems already suffered by construction workers because of poor socio-economic conditions, substance abuse and inadequate, or lack of access to health services.

The Occupational Health and Safety Act, and certain regulations require that employers undertake risk assessments and various related OH interventions, such as baseline medical examinations, surveillance and environmental measurements. However, industry 'best practice' amplifies the need for such assessments and measurements, and also for health promotion.

The paper reports on a literature survey, and a descriptive survey conducted among a sample frame of 'best practice health and safety' general contractors. The objectives of these surveys were to determine the nature and frequency at which OH problems are encountered in construction, and the frequency of risk assessment and related OH interventions. Findings include that ergonomic problems predominate in terms of OH problems. Other problems frequently encountered include cement dust and sun exposure. Pre-employment* medicals, OH surveillance, and environmental measurements are rarely conducted.

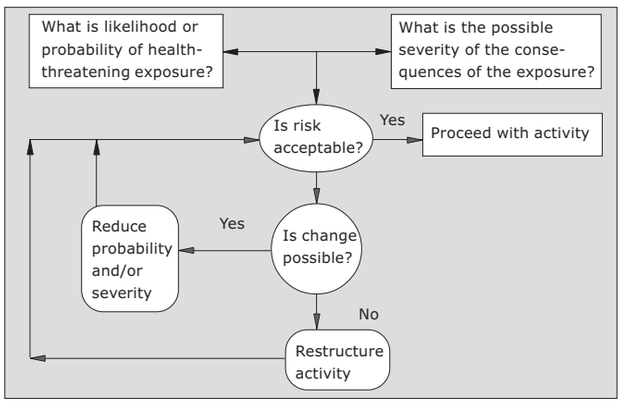


Figure 1. A simple risk assessment model (adapted from Haupt, 2001)

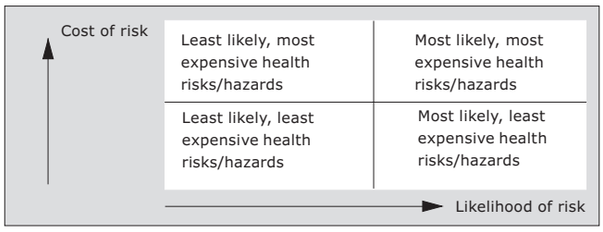


Figure 2. Evaluating relative occupational health risks/hazards

Introduction

Occupational health risk in the working population is largely unrecognised. It has been suggested that while occupation-related illnesses are well documented, they are difficult to recognise in the general practice of medicine (Baxley, 2000). Workers are reluctant for fear of losing their jobs to link a health problem to the nature of their work. Medical practitioners potentially fail to recognise occupational illnesses by not making connections with the working environment. Surveys of hospitalised patients in the United States indicated that 75% of them reported some form of hazardous exposure. Further, about 17% of all workers suspected a link between their illness and their jobs (Baxley, 2000). Reportedly, a large number of deaths occur annually in the working population secondary to some aspect of occupational exposure.

The construction industry for its part has tended to focus on the safety aspects of construction activities while to a large extent ignoring the health hazards to workers posed by these activities. The tragedy is that many of the health-threatening consequences of these activities are preventable while the ensuing occupational illnesses in general are permanent.

Health risk management

Risk and uncertainty are inherent elements in construction (Smith, 2002). While occupational health risks may not in many cases be entirely eliminated (Boothroyd and Emmett, 1996; Franks, 1998), they can be effectively managed (Franks, 1998). However, for risk management to be optimised it is necessary in the first instance to identify the potential sources of health risk early (Simon *et al.*, 1997), namely the pre-project and pre-task stages of the construction process. Once identified, these health risk sources need to be classified in terms of their probability of occurrence and severity of the consequences of their occurrence. Since risks occur when either the outcomes or consequences of activities are less than certain (McKim, 1992), a risk assessment of these activities needs to be conducted.

Risk assessment

The contractor initially needs to assess the risks

* At the time that the sample frame was drawn, the term 'pre-employment' was commonly in use. The term pre-placement is now preferred.

assessment in construction

subjectively associated with each construction activity, assuming that planned or existing controls are in place. The determination of the severity or tolerability of the risks associated with the particular activity will be based on either the contractor's own experience or the experience of the industry. Severity of the risks will determine the level of resources that the contractor needs to allocate to reduce the risks themselves, and the exposure of workers to them. In particular, risk assessment needs to be carried out for situations where occupational health hazards appear to pose a significant threat and it is uncertain whether existing measures are adequate.

A risk assessment *pro forma* may be used to record the findings of an assessment effort. This form, for example, should cover:

- Details of the work activity;
- Hazard(s) and/or potential hazards;
- Controls in place;
- Levels of risk; and
- Action to be taken once assessment is completed (BS 8800:1996).

Procedures for making an informed determination of risk have to be developed such as safety reviews, checklists, what-if-analysis, failure mode and effects analysis, and cause-consequence analysis (Stavrianidis, 1998). Further, criteria have to be established for deciding whether risks are tolerable where the risk has been reduced to the lowest level that is reasonably practicable.

A simple occupational health risk assessment model is illustrated in Figure 1.

In this model the likelihood or probability of health-threatening exposure occurring while a construction activity is carried out, and the severity of the consequence of the exposure should it occur, is determined before the activity is executed. If the risk is acceptable, the activity proceeds. If the risk is considered unacceptable, the activity is restructured if change is not possible. Where change is possible, the probability and/or the severity is reduced. In either case, the acceptability of the risk involved in the activity is measured before it proceeds.

An alternative way of assessing occupational health risk is represented in Figure 2, adapted from Statzer (1999), where one axis represents the likelihood of a risk occurring and the other its expected cost. It is likely that by using such a matrix, construction firms may discover that they are allocating resources on potential risks that are extremely unlikely, while ignoring less-costly risks that may occur at any time.

The severity of harm needs to be considered regarding the part of the body most likely to be affected.

The nature of the harm could range from slightly harmful to extremely harmful. Table 1 provides an example of an estimator of the level of risk, and the action to be taken regarding each risk level is suggested in Table 2.

The identification of the level of risk will result in the development and implementation of suitable prevention and protection strategies (Lan and Arteau, 1997). In both tables, a risk that is 'tolerable' is taken to imply that the level of risk associated with the construction activity has been reduced to the lowest that is practicable.

Research

Sample frame

The sample frame consisted of 25 general contractors (GCs), which achieved a place in the Building Industries Federation South Africa (BIFSA) National H&S Competition and, or a BIFSA 4 or 5-Star H&S grading on one or more of their projects during the period 1995 – 2001. 11 GCs responded, which represents a response rate of 44%.

Analysis

The analysis of the data consisted of the calculation of descriptive statistics to depict the frequency distribution and central tendency of responses to fixed response questions to determine the frequency at which occupational health (OH) problems are encountered in construction, and the frequency at which OH-related interventions are undertaken by GCs and subcontractors (SCs).

Table 1. Estimator of risk level

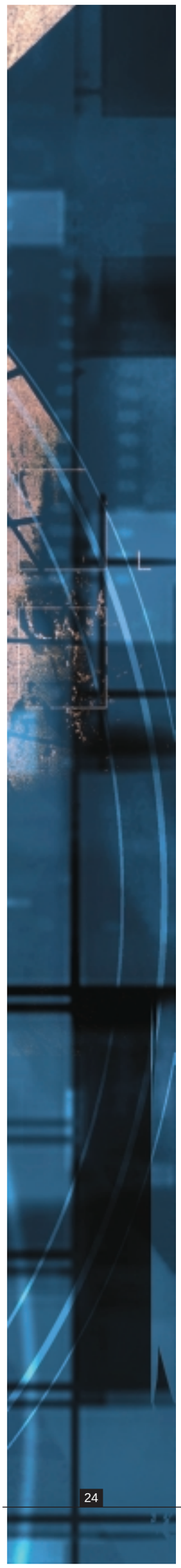
	Slightly harmful	Harmful	Extremely harmful
Highly unlikely	Trivial risk	Tolerable risk	Moderate risk
Unlikely	Tolerable risk	Moderate risk	Substantial risk
Likely	Moderate risk	Substantial risk	Intolerable risk

(BS 8800:1996)

Table 2. Action for risk levels

Risk level	Action and timescale
Trivial	No action is required and no documentary records need to be kept.
Tolerable	No additional controls are required. Consideration may be given to a more cost-effective solution or improvement that imposes no additional cost burden. Monitoring is required to ensure that the controls are maintained.
Moderate	Efforts should be made to reduce the risk, but the costs of prevention should be carefully measured and limited. Risk reduction measures should be implemented within a defined time. Where the moderate risk is associated with extremely harmful consequences, further assessment may be necessary to establish more precisely the likelihood of harm as a basis for determining the need for improved control measures.
Substantial	Work should not be started until the risk has been reduced. Considerable resources may have to be allocated to reduce the risk. Where the risk involves work in progress, urgent action should be taken.
Intolerable	Work should not be started or continued until the risk has been reduced. If it is not possible to reduce risk even with unlimited resources, work activitiy has to remain prohibited.

(BS 8800:1996)



To rank fixed response items according to the central tendency of responses, importance indices (II) were calculated as follows:
Unsure; Never; Half-yearly; Monthly; Fortnightly; Weekly; Daily questions:

$$II = \frac{1n_1 + 2n_2 + 3n_3 + 4n_4 + 5n_5}{n_0 + n_1 + n_2 + n_3 + n_4 + n_5}$$

Where n_0 = Unsure/Never, n_1 = Half-yearly, n_2 = Monthly, n_3 = Fortnightly,
n_4 = Weekly, n_5 = Daily

Unsure; Never; Rarely; Sometimes; Often; Always questions:

$$II = \frac{1n_1 + 2n_2 + 3n_3 + 4n_4}{n_0 + n_1 + n_2 + n_3 + n_4}$$

Where n_0 = Unsure/Never, n_1 = Rarely, n_2 = Sometimes, n_3 = Often, n_4 = Always

Findings
Table 3 indicates the frequency at which twenty-nine OH problems are encountered in construction in terms of percentages relative to 'unsure' and on a scale of never to daily, and a ranking based upon an II with a minimum value of 0, and a maximum value of 5,0. Given that the top fifteen OH problems have II values above the midpoint value of 2,5 they can be deemed encountered. Those OH problems ranked from 1st to 7th have II values >3,34 ≤4,17, which indicates that they are encountered between fortnightly to weekly/ weekly. It is significant that four of the seven are ergonomic related, including the 1st ranked, and two of the three joint 3rd ranked OH problems. It is also notable that two out of five dusts are ranked among the top seven.

Those OH problems ranked from 8th to 15th have II values >2,51 ≤3,34, which indicates that they are encountered between monthly to fortnightly/fortnightly. It is significant that the other four ergonomic related problems occur in this range. Those OH problems ranked from 16th to joint 21st have II values >1,68 ≤2,51, which indicates that they are encountered between half-yearly to monthly/ monthly. Those OH problems ranked from 22nd to 27th have II values >0,83 ≤1,68, which indicates that they are encountered between never to half-yearly/half-yearly. The last two ranked OH problems have II values >0,0 ≤0,83, which indicates that they are basically never encountered.

Table 4 indicates the frequency at which fourteen possible OH related interventions are conducted by

TABLE 3. FREQUENCY AT WHICH OH PROBLEMS ARE ENCOUNTERED IN CONSTRUCTION

Problem	Response (%)							II	Rank
	Unsure	Never	Half-yearly	Monthly	Fortnightly	Weekly	Daily		
Chemicals:									
Acids/alkalis	8,3	25,0	33,3	0,0	8,3	8,3	16,7	1,75	21=
Bitumen/pitch/tar	9,1	36,4	27,3	18,2	0,0	0,0	9,1	1,09	27
Epoxy-resins	0,0	27,3	36,4	18,2	0,0	9,1	9,1	1,55	23
Fumes:									
Metal cutting	8,3	16,7	25,0	8,3	8,3	16,7	16,7	2,17	16=
Soldering/welding	8,3	16,7	33,3	0,0	8,3	16,7	16,7	2,08	19
Waterproofing	8,3	25,0	16,7	16,7	8,3	25,0	0,0	1,75	21=
Mineral wools	27,3	36,4	18,2	9,1	9,1	0,0	0,0	0,64	29
Oils/petrol	0,0	8,3	25,0	0,0	8,3	0,0	58,3	3,42	7
Vapours (adhesives/ paints/solvents)	0,0	8,3	25,0	0,0	16,7	16,7	33,3	3,08	11=
Cold	8,3	8,3	50,0	8,3	0,0	0,0	25,0	1,92	20
Dusts:									
Asbestos	8,3	58,3	16,7	8,3	0,0	0,0	8,3	0,75	28
Block/brick	0,0	8,3	25,0	0,0	0,0	0,0	66,7	3,58	3=
Cement	0,0	8,3	16,7	8,3	0,0	0,0	66,7	3,67	2
Concrete	8,3	0,0	33,3	0,0	0,0	0,0	58,3	3,25	8
Quartz	33,3	33,3	8,3	0,0	8,3	0,0	16,7	1,17	26
Ergonomic:									
Bending/twisting the back	0,0	0,0	8,3	25,0	16,7	0,0	50,0	3,58	3=
Climbing & descending	0,0	0,0	16,7	16,7	8,3	8,3	50,0	3,58	3=
Handling heavy loads	0,0	8,3	16,7	0,0	16,7	8,3	50,0	3,50	6
Reaching away from the body	8,3	8,3	16,7	8,3	8,3	0,0	50,0	3,08	11=
Reaching overhead	8,3	8,3	16,7	8,3	8,3	0,0	50,0	3,08	11=
Repetitive movements	0,0	0,0	30,0	20,0	0,0	0,0	50,0	3,20	9
Use of body force	0,0	0,0	8,3	25,0	0,0	8,3	58,3	3,83	1
Vibration	0,0	8,3	16,7	16,7	0,0	25,0	33,3	3,17	10
Heat	0,0	8,3	41,7	25,0	0,0	0,0	25,0	2,17	16=
Illumination (poor)	8,3	25,0	8,3	25,0	0,0	8,3	25,0	2,17	16=
Noise	0,0	8,3	25,0	16,7	8,3	0,0	41,7	2,92	14
Sun exposure	8,3	16,7	16,7	0,0	8,3	8,3	41,7	2,83	15
Ventilation (poor)	16,7	41,7	8,3	8,3	8,3	8,3	8,3	1,25	25
Wet or damp work	8,3	8,3	41,7	16,7	8,3	16,7	0,0	1,67	24

TABLE 4. COMPARISON OF FREQUENCY AT WHICH GCS AND SCS CONDUCT OH RELATED INTERVENTIONS

Intervention	General Contractors		Sub-contractors		Mean	
	II	Rank	II	Rank	II	Rank
Pre-employment assessment:						
General:						
Questionnaire-based consultation	2,42	2	1,22	1	1,82	1
Medical examination	1,00	6=	0,56	3=	0,78	6
Audiometric test	0,92	8=	0,33	5=	0,63	7=
Lung function test	0,83	11	0,33	5=	0,58	11
Chest X-Rays	0,92	8=	0,33	5=	0,63	7=
Occupational health surveillance:						
General:						
Questionnaire-based consultation	1,83	4	0,56	3=	1,20	3
Medical examination	0,91	10	0,33	5=	0,62	9
Audiometric test	0,73	12=	0,22	9=	0,48	12=
Lung function test	0,73	12=	0,22	9=	0,48	12=
Chest X-Rays	0,73	12=	0,22	9=	0,48	12=
Environmental measurement:						
Air quality	1,00	6=	0,22	9=	0,61	10
Lighting level	1,92	3	0,22	9=	1,07	4
Noise	1,50	5	0,22	9=	0,86	5
Health promotion/awareness	2,83	1	0,78	2	1,81	2

GCs and subcontractors in terms of an II with a minimum value of 0, and a maximum value of 4,0. A mean has also been computed to enable an overall assessment. Relative to GCs, only health promotion/awareness, and a questionnaire-based consultation upon pre-employment have II values above 2,0, and thus can be deemed conducted. However, the environmental measurement of lighting level falls marginally outside this range. Relative to SCs and the mean for GCs and SCs, no interventions have II values above the midpoint value of 2,0. Those interventions with II values below 2,0 can be deemed not conducted. II values: $>2,4 \leq 3,2$ indicate that an intervention can be deemed to be undertaken between sometimes to often/often; $>1,6 \leq 2,4$ between rarely to sometimes/sometimes; $>0,8 \leq 1,6$ between never to rarely/rarely, and $>0,0 \leq 0,8$ never.

CONCLUSION

Construction health risk management becomes effective and optimal when the potential sources of health risks are identified early. During the pre-project and pre-task planning stages of construction, contractors can assess both the likelihood of health-threatening exposure and the severity or tolerability of the consequences of exposure associated with each construction activity. This study suggests that the most common occupational health problems encountered in construction are those related to the use of body force, bending and/or twisting the back, climbing and descending, and exposure to dust from cement and masonry. Contractors can use common procedures for risk determination such as safety reviews, checklists, what-if-analysis, and cause-consequence analysis. In this way they can develop and implement suitable prevention and protection strategies to deal proactively with these problems. The findings of this study suggest that the most frequent interventions that both general contractors and subcontractors conduct are the use of questionnaire-based consultations during pre-employment assessments and occupational health surveillance, health promotion and awareness, and the measurement of lighting and noise levels.

Although construction workers are exposed to a range of hazards, they may have been exposed to similar hazards while working in a different industry prior to working in construction. In the absence of appropriate occupational health risk assessments and interventions, contractors may expose themselves to substantial legal liability should workers such as these contract similar occupational diseases. Given the prevalence of occupational health hazards in construction, general contractors and subcontractors are advised to conduct all the requisite occupational health interventions.

REFERENCES

Baxley, M. (2000) Health risk management in construction. In: Coble, R., Haupt, T. and Hinze, J. (eds.) The Management of Construction Safety and Health, Rotterdam, A.A. Balkema.

Boothroyd, C. and Emmett, J. (1996) Risk Management – A practical guide for construction professionals, London, Witherby.

BS 8800 (1996) British Standard 8800. Occupational Health and Safety Management Systems.

Franks, J. (1998) Building Procurement Systems: A client's guide, Harlow, Addison Wesley Longman.

Haupt, T. (2001) The Performance Approach to Construction Worker Safety and Health, Unpublished Ph.D. dissertation, University of Florida.

Lan, A. and Arteau, J. (1997) Limits and Difficulties in applying the Quebec Safety Code for the Construction Industry – The Case of Excavations. In: Ratay, R.T. (ed.), Construction Safety affected by Codes and Standards, Proceedings of a session sponsored by the Design Loads on Structures during Construction, Standards Committee and the Performance of Structures during Construction, Technical Committee of the Structural Engineering Institute, Minneapolis, 5–8 October, pp. 1–7.

McKim, R.A. (1992) Risk Management – Back to basics. Cost Engineering, 34 (12), pp. 7–12.

Simon, P., Hillson, D. and Newland, K. (1997) Project Risk Analysis and Management (PRAM) Guide, Ascot, Association for Project Management.

Smallwood, J.J. and Ehrlich, R. (2001) Occupational health in the South African construction industry: Management and worker perceptions. African Newsletter on Occupational Health and Safety, 11 (1), pp. 10–12.

Smith, N. (2002) Risk Management. In: Kelly, J., Morledge, R., and Wilkinson, S. (eds.) Best Value in Construction, Oxford, Blackwell Science.

Statzer, J.H. (1999) An integrated approach to business risk management. Professional Safety, American Society of Safety Engineers, August, pp. 30–32.

Stavrianidis, P. (1998) Reduce risk with performance-based safety standards. Hydrocarbon Processing, 77 (10), pp. 91–95.