Investigating the role of the external environment to influence clients' health and safety (H&S) performance in the construction industry

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Abstract

Construction Clients have been identified in many studies to be of great importance to H&S performance in the construction industry. However their participation in H&S implementation remains below the expected and meaningful level. The situation in Southern Africa is not any different from the rest of the world. Therefore developing strategies that enhance clients' H&S culture would ensure a gradual and sustained improvement of H&S in the construction industry.

As a result it was imperative to investigate the feasibility of the postulation that the external environment has a positive influence on construction clients' H&S culture and performance. The study, which was conducted in Botswana and South Africa, utilised the Delphi and structural equation modelling techniques in order to model and validate the said postulation.

Findings from the Delphi study were that the external environment had a significant impact on client H&S performance. Further, clients were 'very likely to' implement H&S elements when influence from the external environment factors was evident. The validation from the structural equation modelling technique further indicated that the influence of the external environment on clients was statistically significant.

Therefore this paper will report on findings from an investigation on the influence of the external environment on clients' H&S performance. The study will highlight the point that environmental influence on clients is vital in order to achieve an improved H&S performance in the construction industry.

Keywords: Clients, external environment, health and safety, performance.

1. Background to the study

It is estimated that the construction industry employs about 180 million people, or seven Percent of global employment (ILO, 2005; Murie, 2007). Despite its size in terms of the

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workforce, the construction industry for example in the European Union causes about 20 to 25% of all fatal accidents (Dias, 2004; Karjalainen, 2004; Ringen & Englund, 2006). The construction sector does not have a good record and its H&S performance can best be described as poor (Haslam et al., 2005).

In the construction industry, the risk of a fatality is said to be at least five times more likely than in other manufacturing based industries (Sawacha et al., 1999; Loughborough & UMIST, 2003). According to Bomel (2001) the construction industry is a hazardous environment. Workers in the construction industry are more at risk of an accident, ill health and or even a fatality at work place than other manufacturing based industries (Loughborough & UMIST, 2003; Hoonakker et al., 2005). Generally construction sites are still one of the most dangerous workplaces because of the high incidence of accidents (Teo et al., 2005; Kines et al., 2007).

The poor record on H&S presented at the global level, is also evident in the construction industry in Botswana and South Africa. The industry in Botswana and South Africa, rank among the worst performing industries (Van Ooteghem, 2006; CIDB, 2008). In South Africa, the construction sector had the third highest number of fatalities per 100,000 workers (CIDB, 2008). This industry has also experienced an increase in the number of accidents that were reported between the periods 2004 to 2008. The CIDB reported that both fatal and non-fatal accidents increased from 224 to 578. In comparison to other manufacturing based industries, the construction industry ranked first in terms of an industry with the most accidents (CIDB, 2008).

Consequently, the issue of Health and safety (H&S) performance improvement in the construction industry has received considerable attention in recent years. For many large construction organisations it is a top priority (Choudhry, Fang, & Mohamed, 2007). This has been in part due to the introduction and the pressure from the legislative environment (Mitropoulos, Abdelhamid & Howell, 2005), coupled with increased personal responsibility of senior managers and organisations for H&S (Fitzgerald, 2005), a need to develop a good or better image of the construction industry (Misnan & Mohammed, 2007) and in certain ways to address the H&S record which in comparison to many industries is undesirable (Mohamed, 2002; Loughborough & UMIST, 2003; Behm, 2005; Haslam, Hide, Gibb, Gyi, Pavitt, Atkinson & Duff, 2005; Kulchartchai & Hadikusumo, 2010). For larger multi-national organisations, the need for H&S improvement is a corporate social responsibility issue and therefore corporate organisations are working at improving their H&S performance (Smallman, 2001).

It is economically important that H&S should be improved in the construction industry. Poor H&S performance is costly and can impact negatively on an industry and indeed on an economy. It is estimated that the costs of accidents account for about four Percent of the global Gross Domestic Product (GDP), (ILO, and 2003). Egan (1998) estimates that accidents can account for about three to six Percent of total construction project costs. Studies conducted in Europe among members of the European Union in 2002 on costs of accidents, revealed that as a percentage of the GDP, H&S costs could be as high as eight-and-a-half Percent (Karjalainen, 2004). In the United Kingdom (UK), the Health and Safety

Executive (HSE) report of 2008/09, indicated that 1.2 million people who had worked during that year were suffering from an illness, both long- standing and new cases caused or worsened by their current or past work, equating to 3,900 per 100, 000 people or three-and-nine-tenths Percent (HSE, 2010). In terms of costs, occupational ill health and injury accounted for almost three Percent (Wright, 2007). In South Africa, it was estimated that occupational injuries and diseases accounted for about three-and-a-half Percent of GDP (Republic of South Africa, 2003). In Botswana, the Botswana Federation of Trade Unions (BFTU) estimates that occupational injuries and fatalities account for over three Percent of GDP (BFTU, 2007). H&S performance improvement is therefore a fundamental issue because it is aimed at eliminating or reducing the risk of accidents and its severity in the construction industry.

Therefore, H&S performance improvement in the industry should be a priority. It is warranted that research should be encouraged on this matter given the importance and dangerous nature of the industry. In addition, much research on H&S performance improvement in the industry is justified to improve conditions in which construction workers operate.

Consequently, a number of studies have been conducted on the subject of H&S performance improvement. However most studies on H&S performance have tended to focus on understanding the causal factors underlying construction accidents, such as the studies conducted by Mansingh & Haupt (2008), Bomel (2001), and Loughborough University & UMIST (2003). Other studies have focused on addressing H&S at the construction stage and on issues such as the use of incentives to improve contractor performance (Tang et al. 2008), and designers' roles and responsibilities (Kartam, Flood & Koushki, 2000). Furthermore, studies that address procedures and systems at the construction stage as well as behavioural issues surrounding workers have been conducted (Goodrum & Gangwar, 2004; Cameron & Duff, 2007).

Further studies have been conducted on improving H&S performance through improving the H&S culture of mostly contracting organisations (Dingsdag et al., 2006; Chinda & Mohamed, 2008; Zhou, Fang & Wang, 2008). The studies on H&S culture have been complimented by studies on behaviour based H&S performance (Duff, Robertson, Phillips & Cooper, 1994; Lingard & Rowlinson, 1997; Petersen, 2000; Keil Centre, 2000; Cooper, 2009) and H&S climate (Zhou, Fang & Mohamed, 2011).

Despite these numerous studies on H&S performance improvement in the construction industry, few studies have addressed the role, contribution, responsibilities and influence of construction clients on H&S performance and how clients themselves may improve on their H&S performance. There is little evidence to show that adequate research has been conducted on the role of construction clients apart from one study conducted by Huang and Hinze (Huang & Hinze, 2006; Lingard et al., 2009). However, the study by Huang and Hinze, evaluated the influence of clients on contractor's H&S performance (Huang & Hinze, 2006). The current study sought to evaluate the influence of the external environment on clients' H&S performance. The rationale behind the study was that, in order for the clients to influence contractor or indeed project H&S performance positively, they need to be motivated to have a good H&S performance. The motivators could be internal or external. The current study evaluated the external motivators.

1.1 The study

A confirmatory factor analysis of the postulated model was conducted. The model comprised two latent factors namely, the external environment and the client culture. The external environment being the exogenous variable and client culture was postulated to be the endogenous variable. The indicator variables of the external environment factor were: legislative (LGN), economic (ECON), social (SOC), professional bodies (PR) and materials and technology (TEC). The theorised model is presented in Figure 1. The theory and basis of the model was derived from literature and a Delphi study. Delphi results have been analysed and presented separately due to limitation of space in the current paper.

Data for the current study was obtained from a questionnaire survey conducted in Botswana and South Africa. Respondents to the survey included construction professionals from, client designer and contracting parties. A total of 281 responses was realised from the survey and 238 responses were analysed. Out of the available 281 cases, 43 cases were skipped because of missing variables.

The model had 57 dependent and 58 independent variables. It also had 108 free parameters. The number of fixed non-zero parameters was 64. The covariance matrix of the model was analysed using the robust maximum likelihood estimation method. Raw data was used for the analysis.

1.2 Findings

1.2.1 Hypothesised relationships

The model generally postulated that the external environment had a direct positive influence on client H&S culture (H1).

Specifically, the model hypothesized that the external environment had a direct positive influence on the following factors of client H&S culture, namely:

1. Leadership – CLLP (H1a);
2. Involvement –CLIP (H1b);
3. Procedures – CLPP (H1c);
4. Commitment – CLTP (H1d);
5. Communication – CLNP (H1e); and
6. Competence – CLCP (H1f)

1.2.2 Goodness-of-fit statistics - RML method

The sample data on the model yield an $S-B\chi^2$ of 2523.9043 with 1218 degrees of freedom. The associated p-value was determined to be 0.000 with a sample of 238 cases. The normed chi-square index, which is the ratio of the scaled chi-square ($S-B\chi^2$) to the degrees of freedom yield a value of 2.072. This value was lower than the upper limit value of 3.0 and therefore indicative of a reasonable fit of the model.

The robust CFI index was found to be 0.844. The CFI index was less than 0.900 which is the lower limit value for model acceptance. However, a two statistic strategy is considered satisfactory to accept or reject a model (Hu & Bentler, 1999). Therefore RMSEA and SRMR statistics were used to decide on the acceptability of the model.

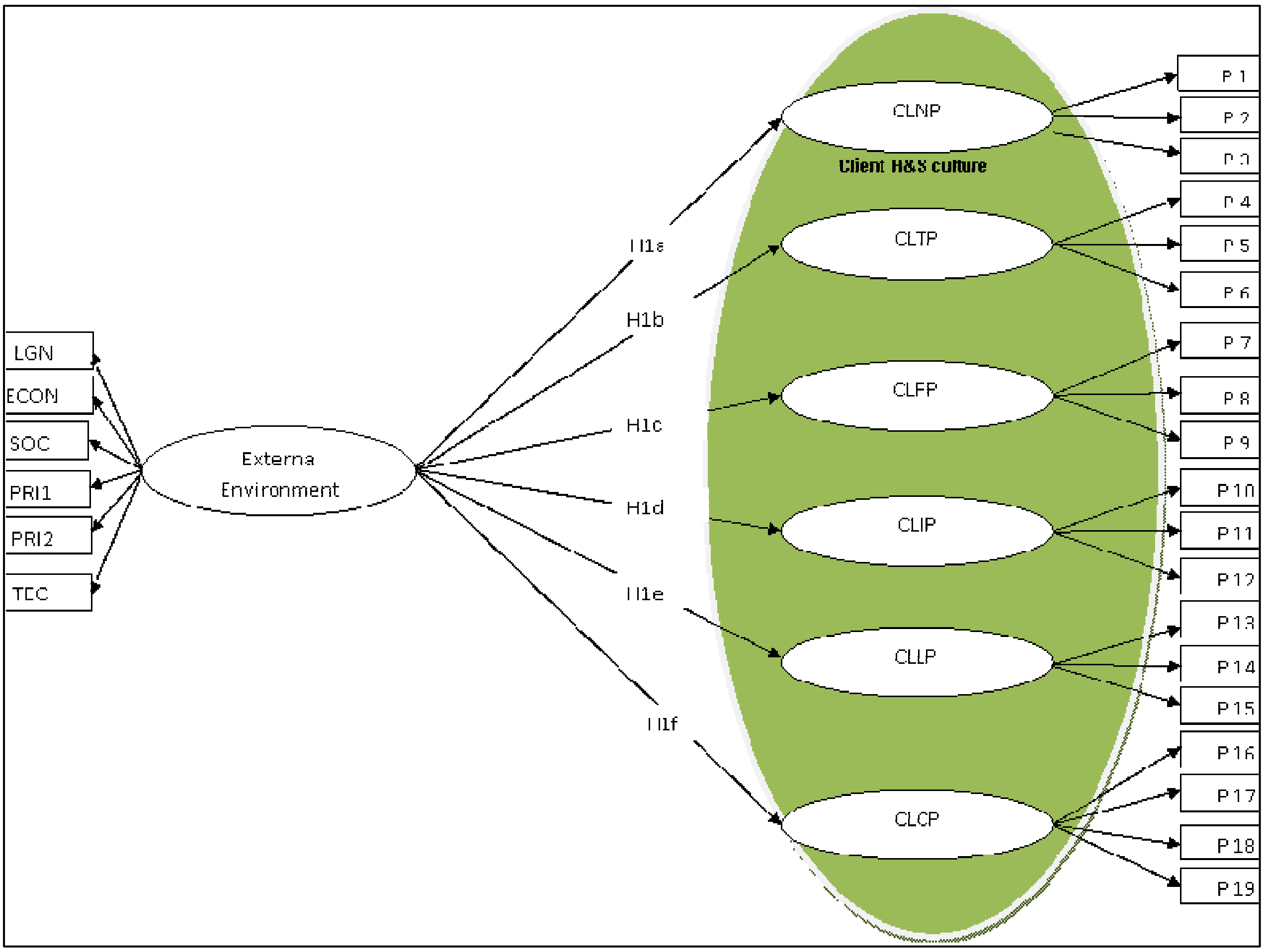

Figure 1: Hypothesised model of external environment's influence on client H&S performance

The robust RMSEA with 90% confidence interval was found to be 0.067. (Lower bound value = 0.063 and upper bound value = 0.071) The RMSEA index was just above the upper limit of 0.050 for the model to be described as good. However the value of 0.67 indicated that the model was acceptable. In addition, the absolute fit index, SRMR, was found to be 0.074. The SRMR fit index indicated an adequate fit of the full structural model to the sample data.

All the indexes with the exception of the CFI met the condition for model acceptance. Although the fit index CFI did not matter so much in the two fit statistic strategy, its value of 0.844 was not far from the lower limit value of 0.900 for model acceptance. See Table 1.

Table 1: Robust fit indexes for SEM Model 1.0

Fit Index	**Cut-off value**	**Model 1.0**	**Comment**
χ^2		2523.9043	
Df	0≥	1218	Acceptable
CFI	0.9≥ acceptable 0.95≥Good fit	0.844	Inadequate
SRMR	0.08≤acceptable 0.05≤ Good fit	0.074	Acceptable
RMSEA	0.08≤acceptable 0.05≤Good fit	0.067	Acceptable
RMSEA 90% CI		0.063:0.071	Acceptable range

1.2.3 Hypotheses testing

The statistic reported on for hypothesis testing was the parameter estimate divided by its standard error and therefore it functioned as a Z-statistic to test that the estimate (which is the relationship strength between two variables) was statistically different from zero. The significance test was used to evaluate the hypotheses $H1_a$ to $H1_f$.

It was generally hypothesised that the external environment had a direct positive influence on client H&S culture (H1). Specifically the hypotheses were that the external environment had a direct positive influence on the six factors of client H&S culture, namely: leadership, involvement, procedures, commitment, communication and competence.

Results from the SEM analysis yield support for all the hypothesised relations, $H1_a$ to $H1_f$. The hypothesised relationships between the external environment and all endogenous factors of client H&S culture were found to be significant and they all had definite positive directions. The relationship between the procedures factor and the external environment was found to be the most significant. The parameter coefficient for this relationship was 0.933 and the Z-statistic was 10.610. Similarly, the relationship between the communication factor and the external environment was found to be statistically significant. This relationship had a parameter coefficient of 0.932 and a Z – statistic of 9.781. These values are presented in Table 2.

Therefore the general hypothesis that the external environment had a direct positive influence on client H&S culture could not be rejected (Table 2). In terms of the magnitude of the parameter coefficients, a comparison of these revealed that the influence of external environment on the commitment factor was found to be the lowest at 0.784.

Table 2: Model 1.0 factor loadings and Z-statistic

Label	Hypotheses External environment has a positive direct influence on the factors of client H&S culture namely :	Factor loading (λ)	Z- Statistic	Significant?
$H1_a$	Leadership	0.880	9.569	Yes
$H1_b$	Involvement	0.791	8.938	Yes
$H1_c$	Procedures	0.933	10.610	Yes
$H1_d$	Commitment	0.784	9.455	Yes
$H1_e$	Communication	0.932	9.781	Yes
$H1_f$	Competence	0.867	9.534	Yes

(Robust statistical significance at 5% level)

1.2.4 Solution evaluation of the model

The robust fit indexes of SRMR and the RMSEA met the cut-off index criteria and the parameter estimates were found to be statistically significant and reasonable. The postulated structural model was therefore acceptable and considered to adequately fit the sample data. Since the analysis was confirmatory, there was no need to further improve the fit of the structural model at this stage. Furthermore, the LM test did not indicate a significant evidence of model mis-specification. Byrne (2006) points out, that for most models, model improvement is merely an exercise that tries to fit small characteristic features of the sample and does not necessarily add value to that already fitted. Therefore the hypothesised model was accepted with its level of fit.

2. Discussion and conclusion

The general hypothesis was that the external environment had a direct and positive influence on client H&S culture (H1) and this hypothesis could not be rejected. All six specific hypotheses which collectively formed the H1 hypothesis could not be rejected. The specific hypotheses stated that the external environment had a direct positive influence on the factors of client H&S culture namely: leadership, involvement, procedures, commitment, communication and competence. The results indicated that at least 62.6% of variance in client H&S culture was explained by the external environment. The external environment's influence was weakest on client H&S involvement compared to the influence on other factors of client H&S culture. The effect was found to be strongest on the factor, procedures. Generally the findings suggested that clients were more likely to lead, be involved, set up procedures, be committed, communicate on H&S issues and develop competence in H&S as a result of the external environment influence. Specifically, the results suggested that it was possible for client H&S culture to be modified as a result of external environment's influence. It was this change in client H&S culture that was needed for H&S performance to be realised in the construction industry. Bomel (2001) observed that the culture of client organisations presented considerable opportunities for H&S improvement in the construction industry.

The implications of this finding are that clients may effectively participate in H&S management and if they do, they would influence project H&S performance continuously and therefore lead to a general H&S improvement on construction projects. Research in Southern Africa has shown that despite the acknowledged significance of clients to H&S performance, clients have not participated significantly in H&S management (Kikwasi, 2008; Musonda & Smallwood, 2008; Musonda, Haupt & Smallwood, 2009). Similarly, a study conducted by Loughborough & UMIST (2003), established that clients give insufficient consideration to H&S despite their obligations under the CDM regulations. Bomel (2001) observed that the culture of client organisations presents considerable opportunities for H&S improvement in the construction industry. The findings in the current study were therefore significant in the sense that with an increased incentive to clients to participate in H&S management through their culture change resulting from all factors of the external environment, the much desired participation of clients in H&S management may be realised. Further, the findings make it possible for policy makers to address factors of the external environment namely, legislative, economic, social, professional bodies and materials and technology in such a way that the external environment enables or motivates clients' participation in H&S management.

The impact of legislation, which is one of the indicator variables in the current study, has been noted in other studies. INSAG (1991) argue that the manner in which people act is conditioned by requirements set at a high level such as legislation. Findings by CIDB (2008) in South Africa, also affirm the importance of legislation. The CIDB found that there was a general perception in the construction industry that the construction regulations promulgated in 2003 in South Africa seemed to have had a positive impact. This was also found to be the case in the UK concerning the CDM regulations (CIOB, 2009).

The other indicator variable used to describe the external environment in the current study was the economic factor. The use of economic incentives on organisations has been evaluated before. The European Agency for Safety and Health at Work (2010) observe that economic incentives can be effective in promoting H&S. Pan, Soetanto & Sidwell (2010) observed that the economic situation in the UK influenced the homebuilders (clients) to slow down on the use of cross walls precast technology despite the benefits that came with the new technology when the housing markets were promising. The clients' decision on the type of technology to use in this case was highly influenced by the economics despite the benefits including the H&S benefits that would have arisen. In this case, due to a lack of economic incentive in the method, H&S was the casualty. The situation described by Pan et al. (2010) lend support to the findings in the current study that the economic situation as is the case with the legislative framework had a significant influence on client decisions and hence client H&S performance.

An observation by Pan et al. (2010) on the influence of technology change, noted that clients, influenced by the new technology were forced to assume new roles such as producing outline designs, detailed design coordination, procurement and construction. In other words, they were influenced to change the way they did things as a result of technology. The technology and materials factor used to characterise the external environment in the current study seem to have an influence on client H&S culture. In a study by Pan et al. (2010), on projects where the new technology was deployed, an observation was made that they had experienced a reduction in the H&S risk and also enhanced the building quality (Pan et al., 2010).

Worker unions (social), as a factor of the external environment, have also been found to influence H&S in the construction industry and therefore ties in with the findings of the current study. According to Fraser (2007), unions in Australia, influenced a significant improvement in regulations concerning workers' H&S. It would appear therefore that client H&S culture could be enhanced with an increased participation from the social economic environment such as the workers union.

Therefore the finding that the external environment exhibited a direct positive influence on client H&S culture not only collaborate what other authors have stated before but it also offered a platform and a set of minimum factors that may be required to be addressed in order to change or influence client H&S culture. It would seem that a single approach may not be so successful. The European Agency for Safety and Health at Work (2010), observed that incentives and legislation were complementary. For example, clients in the UK were slow to take up their responsibilities on H&S even though the CDM regulations required them to do so (Baxendale & Jones, 2000). It could be argued that what they probably needed was an incentive from the external environment as established in the current study. Economic, social, technology and the legislative environment all have to be supportive of client H&S culture.

References

Alves Dias, L.M. (2004). Occupation safety and health coordination in the construction industry in European Union countries. Lisbon: International Social Security Association-Construction Section.

Baxendale, T. and Jones, O. (2000). Construction design and management safety regulations in practice - progress on implementation. International Journal of project management, 18, 33-40.

Behm, M. (2005). Linking construction fatalities to the design for construction safety concept. Safety Science, 43(8):589-611.

Bomel (2001). Improving health and safety in construction. Phase 1: Data collection, review and structuring. Norwich: HSE Books.

Botswana Federation of Trade Unions (2007). Policy on health and occupational safe environment in Botswana. Gaborone: BFTU.

Byrne, B.M. (2006). Structural equation modelling with EQS- Basic concepts, Applications and programming 2nd ed. Mahwah: Lawrence Erlbaum Associates, Inc.

Cameron, I. and Duff, R. (2007). Use of performance measurement and goal setting to improve construction managers' focus on health and. Construction Management and Economics, 25, 869–881.

Chinda, T. and Mohamed, S. (2008). Structural equation model of construction safety culture. Engineering, Construction and Architectural Management, 15(2):114-131; 114.

Chinda, T. and Mohamed, S. (2007). Causal relationships between enablers of construction safety culture. Conference proceedings of the Fourth International conference on construction in the 21st century (CITC-IV) conference held in Gold coast from July 11-17. CITC

Choudhry, R.M., Fang, D. and Mohamed, S. (2007). Developing a model of construction safety culture. Journal of Management in Engineering, 23(4):207-212.

Choudhry, R.M., Fang, D. and Mohamed, S. (2007). The nature of safety culture: A survey of the state-of-the-art. Safety Science, 45(10):993-1012.

CIDB (2008). Construction health and safety in South Africa. Pretoria: Construction Industry Development Board.

CIDB (2004). South Africa construction industry status report - 2004. Pretoria: CIDB.

CIOB (2009). Health and safety in the construction industry 2009. Berkshire: Chartered Institute of Building.

Dingsdag, D.P., Biggs, H.C., Sheahan, V.L. and Cipolla, C.J. (2006). A construction safety competency framework: Improving OH&S performance by creating and maintaining a safety culture. Brisbane: Cooperative Research Centre for Construction Innovation.

Duff, A.R., Robertson, I.T., Phillips, R.A. and Cooper, M.D. (1994). Improving safety by the modification of behaviour. Construction Management and Economics, 12, 67-78.

Egan, J. (1998). Rethinking construction. London: Department of Trade and Industry.

Fitzgerald, I. and Howarth, T. (2009). A study of migrant worker health and safety issues in the UK construction industry. In Working together: Planning, designing and building a healthy and safe construction industry. Conference Proceedings of the CIB W099 Conference held in Melbourne from 21-23 October. CIB

Fraser, L. (2007). Significant developments in occupational health and safety in Australia's construction industry. International Journal occupational environmental health, 13, 12-20.

Goodrum, P.M. and Gangwar, M. (2004). Safety incentives, a study of their effectiveness in construction. Professional Safety, July, 24-34.

Government of the Republic of South Africa (2003). The national occupational health and safety policy.3rd Ed. Pretoria: Government of the Republic of South Africa.

Haslam, R.A., Hide, S.A., Gibb, A.G.F., Gyi, D.E., Pavitt, T., Atkinson, S. and Duff, A.R. (2005). Contributing factors in construction accidents. Applied ergonomics, 36, 401-415.

Hoonakker, P., Loushine, T., Carayon, P., Kallman, J., Kapp, A. and Smith, M.J. (2005). The effect of safety initiatives on safety performance: A longitudinal study. Applied Ergonomics, 36, 461-469.

HSE (2010). Self-reported work-related illness and workplace injuries in 2008/09: Results from the labour force survey. Caerphilly: HSE Books.

Hu, L. and Bentler, P.M. (1999). Cut-off criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. Structural equation modelling, 6(1):1-55.

Huang, X. and Hinze, J. (2006). Owner's role in construction safety. Journal of Construction Engineering and Management, 132(2):164-173.

ILO (2003). Safety in numbers: Pointers for a global safety culture at work. Geneva: ILO.

INSAG (1991). Safety culture. Vienna, IAEA.

Karjalainen, A. (2004). A statistical portrait of health and safety at work in the construction industry: Actions to improve safety and health in construction. Luxembourg: European Agency for safety and health at work.

Kartam, N.A., Flood, I. and Koushki, P. (2000). Construction safety in Kuwait: Issues, procedures, problems and recommendations. Safety Science 36, 163-184.

Kikwasi, G.J. (2008). Client involvement in construction safety and health. In Evolution of and directions in construction safety and health. Edited by. Hinze, J., Boener, S. and Lew, J., Rotterdam: In-House publishing, 55-69.

Kines, P., Spangenberg, S. and Dyreborg, J. (2007). Prioritizing occupational injury prevention in the construction industry: Injury severity or absence? Journal of Safety Research 38, 53-58.

Kulchartchai, O. and Hadikusumo, B.H.W. (2010). Exploratory study of obstacles in safety culture development in the construction industry: A grounded theory approach. Journal of construction in developing countries, 15(1):45-66.

Lingard, H. and Rowlinson, S. (1997). Behaviour-based safety management in Hong Kong’s construction industry. Journal of Safety Research, 28, 243-256.

Lingard, H., Blismas, N., Cooke, T. and Cooper, H. (2009). The model client framework - resources to help Australian government agencies to promote safe construction. International Journal of managing projects in business, 2(1):131-140.

Loughborough University and UMIST (2003). Causal factors in construction accidents. Norwich: HSE Books.

Mansingh, K.S and Theo Haupt, T.C. (2008). Construction Accident Causation: An Exploratory Analysis. In Evolution of and Directions in Construction Safety and Health. Edited by Hinze, J., Boehner, S and Lew, J, CIB W099, Rotterdam, 465-482.

Misnan, M.S. and Mohammed, A.H. (2007). Development of safety culture in the construction industry. In proceedings of the conference on sustainable building South East Asia. Kuala Lumpur: CIB.

Mitropoulos, P., Abdelhamid, S.T and Howell, G.A. (2005). Systems model of construction accident causation. Journal of Construction Engineering and Management, 131(7):816-825.

Mohamed, S. (2002). Safety climate in construction site environments. Journal of Construction Engineering and Management, 128(5):375-384.

Murie, F. (2007). Building Safety-An international perspective. International Journal occupational environmental health, 13, 5-11.

Musonda, I and Smallwood, J.J. (2008). Health and safety awareness and implementation in Botswana’s construction industry. Journal of Engineering, Design and Technology, 6(1):81-90.

Musonda, I., Haupt, T.C. and Smallwood, J.J. (2009). Client attitude to health and safety - A report on contractors' perceptions. Acta Structilia, 16(2):69-85.

Pan, W., Soetanto, R. and Sidwell, R. (2010). How Environments Shape Innovation: The Case of Precast Concrete Cross-wall for Multi-Storey Residential Building Construction. In Proceedings of CIB 2010 World Congress. Edited by Barrett, P., Amaratunga, D., Haigh, R., Keraminiyage, K., Pathirage, C., Salford: CIB, 14-25.

Ringen, K. and Englund, A. (2006). The construction industry. Annals of the New York academy of sciences, 1076(1):388-393.

Sawacha, E., Naoum, S. and Fong, D. (1999). Factors affecting safety performance on construction sites. International Journal of project management, 17(5):309-315; 309.

Smallman, C. (2001). The reality of revitalizing health and safety. Journal of Safety Research, 32, 391-439.

Tang, W., Qiang, M., Duffield, C. F., Young, D.M. and Lu, Y. (2008). Incentives in the Chinese construction industry. Journal of Construction Engineering and Management, 134(7):457-467.

Teo, E.A.L., Ling, F.Y.Y. and Chong, A.F.W. (2005). Framework for project managers to manage construction safety. International Journal of project management, 23(4):329-341.

The Keil Centre. (2003). Behaviour modification to improve safety: Literature review. Edinburg: HSE Books.

Van Ooteghem, P. (2006). Work-related injuries and illnesses in Botswana. International Journal occupational environmental health, 12, 42-51.

Wright, F. (2007). Health and Safety Commission – A case for reform? Law, science and policy, 3, 157-175.

Zhou, Q., Fang, D. and Mohamed, S. (2011). Safety climate improvement: Case study in a Chinese construction company. Journal of Construction Engineering and Management, 137(1):86-95.

Zhou, Q., Fang, D. and Wang, X. (2008). A method to identify strategies for the improvement of human safety behaviour by considering safety climate and personal experience. Safety Science, 46, 1406-1419.