CONSTRUCTION HEALTH AND SAFETY PERFORMANCE IN DEVELOPING AND DEVELOPED COUNTRIES: A PARALLEL STUDY IN SOUTH AFRICA AND SINGAPORE

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ABSTRACT

According to relevant literature, the difference in accident rates between developed and developing countries is remarkable. This disparity of construction health and safety performance between developing and developed countries prompted the research team to examine the underlying causes for such a disparity. This study was initiated by the Southern African Built Environment Research Center to examine (1) the construction health and safety practices adopted by construction practitioners in both developing and developed countries, and (2) the sources of the disparity of construction health and safety performance between developing and developed countries. To achieve these aims, parallel surveys were conducted in South Africa (SA) and Singapore. Singapore was chosen because of its improved health and safety performance and the recent review of its health and safety regulatory framework. The results show that there are significant differences both in people's perceptions of construction site health and safety and in the frequency of various types of accidents between the two nations. The findings of this study have practical impacts on enhancing health and safety performances for developing countries. It is timely to ascertain the disparity of construction health and safety performance between SA and Singapore given that the construction regulations of SA are currently under review so as to achieve improved health and safety performances.

Keywords: Construction health and safety; Safety climate; Safety performance

1. INTRODUCTION

Although the field of occupational health and safety has always been a focus of academic research, only a few researchers have investigated or compared the occupational health and safety performance or approaches between developing and developed countries (King and Hudson 1985; Suazo and Jaselskis 1993; Koehn et al. 1995; Hamalainen et al. 2006). As shown in Table 1, the disparity in occupational accident rates between different regions is remarkable (Hamalainen et al. 2006). Regions in Table 1 were divided by using the World Bank divisions (The World Bank Group 2001). Both the fatality rates and the accident rates in Other Asia and Islands (21.5 and 16434 per 100 000 workers respectively) and Sub-Saharan Africa (21 and 16012 per 100 000 workers respectively), which consist mainly of developing countries, are much higher than that of Established Market Economies (4.2 and 3240 per 100 000 workers), which consists of developed countries.

Table 1 Occupational accidents by regions

Region	Fatality rate (per 100 000 workers)	Accident rate (per 100 000 workers)
EME [1]	4.2	3240
FSE [2]	12.9	9864
OIA [3]	21.5	16434
SSA [4]	21.0	16012
LAC [5]	17.2	13192
MEC [6]	18.6	14218
Singapore	9.8	7452
South Africa	19.2	14626

[1] Established Market Economics; [2] Former Socialistic Economies; [3] Other Asia and Islands (excluding China and India); [4] Sub-Saharan Africa (Including South Africa); [5] Latin America and the Caribbean; [6] Middle Eastern Crescent.

Source: Hamalainen et al. (2006)

Construction projects and activities by their nature are characterized by high risk of exposure to hazards. According to King and Hudson (1985), there are three times as many fatalities on construction sites in developing countries than in industrialized ones. They attributed this disparity partly to the weak regulatory systems in developing countries. This viewpoint was further supported by the research of Suazo and Jaselskis (1993) through their in-depth comparison of construction health and safety codes in the United States and Honduras. Koehn et al. (1995) compared the approach towards construction health and safety in a developed country, namely the United States, and a typical developing country, namely India. Lack of health and safety training, management commitment, and various health and safety procedures and insufficient health and safety rules and regulations were identified as the main causes leading to the poorer health and safety performance in developing countries such as India (Koehn 1995).

Generally, there is a lack of comprehensive analysis of the underlying causes of the difference in construction health and safety performance between developing and developed countries. This study was initiated by the Southern African Built Environment Research Center with the purpose of examining the sources of such a disparity. The objectives of this research are to investigate (1) the construction health and safety practices adopted by construction practitioners in both developing and developed countries, and (2) the sources of the disparity of construction health and safety performance between developing and developed countries. To achieve these aims, parallel surveys were conducted in South Africa and Singapore. Singapore was chosen because of its improved health and safety performance and the recent review of its health and safety regulatory framework. As indicated in Table 1, both the accident and the fatality rates in South Africa (19.2 and 14626 per 100 000 workers respectively) are significantly higher than those of Singapore (9.8 and 7452 per 100 000 workers respectively). It is timely to identify the sources of the disparity in construction health and safety performance between SA and Singapore given that the construction regulations of SA are currently under review so as to achieve improved health and safety performance across the construction sector.

2. MEASUREMENT OF CONSTRUCTION HEALTH AND SAFETY PERFORMANCE

Health and safety performance can be used by owners to compare health and safety performance of different organizations to assess which organization has a better health and safety record. It also allows comparison of health and safety performance between projects and can also be used by organizations internally to maintain line accountability for health and safety and to pin point problem areas. Health and safety performance can be broadly classified into two groups which are lagging indicators like accident rates and leading indicators like measurement of health and safety climate (Flin et al. 2000).

The research of Teo and Fang (2006) clearly demonstrates that the players in the construction industry are aware that historic and statistical data do not accurately reflect health and safety performance. The results of their research have shown the importance of leading indicators over lagging indicators to measure a construction organisations expected health and safety performance. The advantage of using health and safety climate is that actions can be taken to alter the course of health and safety performance if an indicator predicts poor performance, for example, changes can be implemented to increase the probability of good health and safety performance (Hinze, 1997; Fang et al, 2001).

Accident frequency rate, however, is still considered as an important indicator of health and safety performance. As stated by the U.S. Department of Labor (1955), frequency is a more valuable indicator of health and safety performance than severity, since blind chance usually plays a greater part in determining the seriousness of an injury than it does in determining how frequently accidental injuries occur. Therefore, accident frequency

rate is the most commonly used indicator for health and safety performance despite it only reflecting one aspect of health and safety performance.

To determine the disparity of construction health and safety performance between developing and developed countries and explore the underlying reasons of such a disparity, both leading indicators such as health and safety climate and lagging indicators such as accident frequency rate are employed in this research. The in-depth comparison of all dimensions of construction health and safety climate and the frequency rate of different types of accidents between South Africa and Singapore enables us to understand what causes the disparity of construction health and safety performance between developing and developed countries.

3. DIMENSION OF HEALTH AND SAFETY CLIMATE

Health and safety climate is deemed as an explanatory measure indicating the perception of the workforce and its attitudes towards health and safety within the organizational environment at certain or given point in time. Various previous studies (Flin et al, 2000; Mohamed, 2002; Toole, 2002; Mearns et al, 2003) have defined measuring of health and safety climate as taking the 'health and safety temperature' of an organization. Dimensions are the major features or levels of a health and safety climate (Glendon and Stanton 2000). Dimensions of a health and safety climate differ from industry to industry (Fang et al. 2006). In the construction industry, many researchers have attempted to find the common dimensions of health and safety climate (see Table 2). Although there are various factors to measure a health and safety climate, the dimensions in several of the latest research studies demonstrate strong similarities (Glendon and Litherland 2001; Mohamed 2002; Fang et al. 2006; Teo and Fang 2006). Mohamed's factor structure could be deemed as representative since the dimensions were derived from an extensive literature review rather than through the factor analysis method. Teo and Fang (2006) compared the health and safety climate framework in Singapore and Hong Kong and found that there is very little difference between the two countries. The two additional significant factors of Singapore health and safety climate framework are communication and feedback and IT Intelligence.

Table 2 Review of health and safety climate in construction industry

Author(s)	Dimension
Dedobbeleer and Beland (1991)	Management commitment; Risk/involvement.
Niskanen (1994)	Work pressure; Supervision; Work value; Responsibility.
Glendon and Litherland (2001)	Communication and support; adequacy of procedures; work pressure; personal protective equipment; relationships; Health and safety rules.
Mohamed (2002)	Commitment; Communication; Health and safety rules and procedures; Supportive environment; Supervisory environment; Workers' involvement; Personal appreciation of risk; Appraisal of work hazards; Work pressure;

	Competence.
Fang et al. (2006)	Health and safety attitude and management commitment; Health and safety consultation and training; Supervisor's and workmate's roles; Risk taking behavior; Health and safety resources; Appraisal of health and safety procedure and work risk; Improper health and safety procedure; Worker's involvement; Workmate's influence; Competence.
Teo and Fang (2006)	Communication & Feedback; Supervisory Environment & Supportive Environment; Health and Safety Rules & Procedures; Training Program & Competence Level; Health and Safety Investment; Workers' Involvement & Work Pressure; Personal Risk Appreciation & Appraisal of Work Hazards; IT Intelligence.

Based on the comprehensive literature review on construction health and safety climate in combination with the objectives of this research, an eight-factor health and safety climate structure is used as the indicator for health and safety performance to facilitate the comparison of the construction health and safety performance in South Africa and Singapore. Using this, the relatively poorer health and safety practices in developing countries such as South Africa could be identified. The eight dimensions of construction health and safety climate are management commitment, communication and feedback, supervisory environment, supportive environment, health and safety rules and procedures, training and competence, workers' involvement and personal risk appreciation, and work pressure. As a lagging indicator of health and safety performance, the frequency rate of different types of accidents is also discussed in this paper to further expound on the effects of the eight dimensions have on construction health and safety performance.

4. METHODOLOGY

A questionnaire survey is an effective method to gain data on attitudes toward issues and causal relationships. It is a widely used method to describe general perceptions about health and safety practices (Ojanen et al. 1998; Mohamed 2002; Fang et al. 2006). For this particular study, a questionnaire survey was selected as the method of data collection. Parallel surveys in South Africa and Singapore were conducted to examine the construction health and safety practices adopted by construction practitioners in both countries and the causes of work site accidents. The questionnaire was designed with three major parts. The first part asked for general information of the respondents. The second part comprised of 32 statements on the health and safety practices on construction sites. The final part of the questionnaire consisted of 8 statements about the causes of accidents on construction sites. Respondents were required to rank the factors on a 5-point scale where 1 = strongly disagree/ never/ not at all and 5 = strongly agree/ always/ very much for the statements found in the questionnaire.

The population consisted of all parties in the construction industry of Singapore and South Africa. Questionnaires in Singapore were sent out by post, with self-addressed and pre-stamped envelopes, to randomly selected parties (Table 3 and Table 4). In the Singapore survey, the response rate was 12.67% and more than 80% of the respondents were top management where their average working experience was 16 years. The minimum and maximum working experiences were 2 years and 36 years respectively, with 58% of the respondents having more than 15 years of experience. In the South Africa survey, questionnaires were handed out for completion to 325 delegates attending national health and safety training workshops over a 12 month period. The minimum and maximum working experiences of SA respondents were 0.8 years and 40 years respectively.

Table 3: Distribution of respondents in Singapore

Designated Respondents	Sampling Frame	Sent Out	Returned
Authority (Land and Transport Authority, Ministry of Manpower and Building and Construction Authority	N.A.	3	1
Architect	Singapore Board of Architects	54	5
Engineer	Professional Engineers Board	60	2
Main Contractor	BCA Contractors Registry	100	22
Sub-contractor	BCA Contractors Registry	63	3
Health and safety Auditor	MOM	20	5
Total		300	38

Table 4: Distribution of 325 respondents in South Africa

Designated Respondents	Sampling Frame	Completed
Top management	Workshop delegates	26.4%
Site supervisor	Workshop delegates	49.8%
Workers	Workshop delegates	23.8%
Total		100.0%

Statistical analysis was conducted using the Statistical Package for Social Sciences (SPSS) software package. Comparison of the mean value of the perceptions of health and safety practices on construction sites in the two countries was carried out to check whether there were differences in the perceptions of health and safety practices in both countries. The mean value of the frequency of different types of accidents from the questionnaire was calculated to obtain the rank of different types of accidents on

construction sites so that the common types of accidents could be compared between South Africa and Singapore.

5. FINDINGS

Construction health and safety climate of Singapore and South Africa

Thirty-two statements about health and safety climate were categorized under eight dimensions of construction health and safety climate (Table 5). The mean scores of responses to each statement were calculated and compared between the two countries. As can be seen in Table 5, among the eight dimensions of health and safety climate, obvious differences existed in three of them, namely (1) management commitment, (2) supervisory environment, and (3) training and competence level.

Management commitment

Table 5 clearly showed the disparity in management commitment between Singapore and South Africa. The results showed that management commitment in South Africa was not as strong as that in Singapore. Five out of seven statements about management commitment raised in the questionnaire survey had higher mean scores in Singapore than in South Africa (see Table 5). Arguably, this difference might be one of the major reasons for the poorer construction health and safety performance in South Africa considering that several previous studies have demonstrated the critical role management has in improving health and safety performance (Abudayyeh et al. 2006; Zohar 1980; Jaselskis et al 1996). The head office management in South Africa was less intolerant of poor construction health and safety (mean score of 3.641) and did not address health and safety issues (with the mean score of 3.667) as much as in Singapore (mean scores of 3.946 and 4.000 respectively). The lack of management's commitment to site health and safety in South Africa was confirmed by less support for incentive or punitive programs (mean scores of 3.329 and 3.087 respectively) than in Singapore (mean scores of 3.703 and 3.865 respectively). The research conducted by Koehn et al. (1995) parallels this research finding, suggesting that there tends to be a lack of management commitment to health and safety programs and various procedures in developing countries.

Supervisory environment

Differences were found in the supervisory environments of South Africa and Singapore. As shown in Table 5, the four statements covering the dimension of supervisory environment had different mean scores in each country. There was a relative lack of proper supervision in South Africa (mean scores of 2.750 and 2.003 in South Africa and Singapore respectively), in terms of trained H&S staff (3.376 in South Africa and 4.162 in Singapore) or representatives (3.686 in South Africa and 4.027 in Singapore) and regular H&S inspections on site (3.152 in South Africa and 4.000 in Singapore). A successful health and safety management system program is based upon the premise that health and safety is both a management responsibility and a line function (Mohamed 2002). While top management help develop the health and safety program, its actual

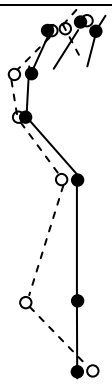
success depends upon the ability of supervisory personnel to ensure the implementation of the program during daily operations (Agrilla 1999). Therefore, the lack of proper supervision in South Africa could be another major contributor to the disparity in construction health and safety performance in South Africa and Singapore.

Training and competence level

The third category of construction health and safety performance difference between Singapore and South Africa was evident in the disparity of training and competence levels on construction sites in each of the countries. More health and safety training and education was needed in South Africa (mean score of 4.134) than in Singapore (mean score of 3.730) since workers in South Africa did not receive as much education and training about site health and safety, such as regular training programs (3.202 in South Africa and 3,711 in Singapore), orientation/instruction for new workers (3.748 in South Africa and 4.162 in Singapore) and training in the proper care and use of PPE (3.732 in South Africa and 4.026 in Singapore). The finding of relatively poor training and competence level in developing countries is similar to the findings of Koehn's research (Koehn et al. 1995), which indicated that on many construction sites in India, a typical developing country, no training programs for the staff and workers existed; therefore, no orientation for new staff or workers was conducted. Workers were required to learn from their own experiences. Training is a major factor influencing health and safety levels (Jaselskis et al. 1996). Competence level is a measure of workers' confidence that they had the skill to perform a particular job safely (Mohamed 2002). To ensure safe work performance and sound health and safety management, training is essential for both workers and management to achieve the required competence levels (Teo and Fang 2006). Enhancing health and safety training on construction sites in developing countries could be one of the most powerful ways to effectively reduce the disparity in construction health and safety performance between developing countries and developed ones.

Table 5 Comparison of H&S practices in Singapore (SG) and South Africa (SA)

Factor/Health and safety practice	SG	SA	Plot
MANAGEMENT COMMITMENT	**Mean**	**Mean**	**2 3 4 5**
The H&S of workers is important to the head office management	4.054*	4.016*	
The head office management ensure compliance with H&S legislation and regulations	4.081*	3.793*	
The head office management always address H&S issues	4.000*	3.667*	
The head office management are intolerant of poor construction H&S	3.946*	3.641*	
Workers are rewarded for good H&S	3.703*	3.329*	
The firm penalizes workers for poor H&S	3.865*	3.087	
The head office management insists on the elimination of hazards	3.838*	3.703*	
COMMUNICATION AND FEEDBACK			
We have regular H&S meetings	4.158*	3.609*	
Workers are encouraged to report unsafe and unhealthy behavior and working conditions	3.946*	4.082*	
Results of H&S inspections are always discussed at H&S meetings	3.730*	3.647*	
All workers are kept informed of the provisions of the H&S plan	3.568*	3.409*	
SUPERVISORY ENVIRONMENT			
The firm employs trained H&S staff on projects	4.162*	3.376*	
We have trained H&S representatives on site	4.027*	3.686*	
H&S inspections are done regularly and at least daily	4.000*	3.152	
There is a general lack of proper supervision	2.003	2.750	
SUPPORTIVE ENVIRONMENT			
Workers are responsible for the H&S of their fellow workers	3.865*	3.795*	
HEALTH AND SAFETY RULES AND PROCEDURES			
We have a written H&S policy in place	3.892*	3.992*	
Each project has a project specific H&S plan	3.59	3.61	

●	5*	2*	
○ **TRAINING AND COMPETENCE LEVEL**			
All workers undergo orientation/induction before they are allowed to start work on site	4.162*	3.748*	
Construction accidents are caused by unsafe worker acts or behavior	4.054*	3.673*	
Workers are trained in the proper care and use of PPE	4.026*	3.732*	
More H&S education and training is needed	3.730*	4.134*	
Workers are regularly trained in H&S	3.711*	3.202	
WORKERS' INVOLVEMENT AND PERSONAL RISK APPRECIATION Workers have the right to refuse to work in unsafe conditions	4.184*	4.275*	
Workers are responsible for their own H&S	3.865*	3.549*	
Most workers on site view health and safety as important	3.632*	3.656*	
Workers are involved with H&S inspections	3.297	3.298	
Workers are consulted when the H&S plan is compiled	3.162	2.914	
Workers participated in the formulation of the H&S policy	3.054	3.027	
Workers regularly report unsafe and unhealthy behavior and working conditions	3.612*	3.485*	
WORK PRESSURE			
The firm is only concerned with getting job done as quickly as possible	3.676*	2.924	
Workers often work shifts or overtime	3.622*	3.810*	
Singapore ***South Africa***			

* Statistically significant at 5% level

Comparison of frequency rate of different causes of accidents on construction sites

According to the annual H&S report of the Ministry of Manpower of Singapore (2006), the most common causes of accidents resulting in injuries or fatalities on construction sites include step on, struck against or by objects, falls of persons, struck by falling objects and caught in or between objects (Table 6). These categories of accidents result in 78% of total number of injuries and 96% of the total number of fatalities in 2006. In South Africa, however, there were differences relative to the dominant causes of accidents resulting in injuries in terms of frequency rate when compared with that of Singapore. Lifting of heavy or awkward or irregular materials ranked highest among the

eight common causes of construction site accidents in South Africa. Another cause of accidents not found as a common cause of accidents in Singapore was related to ergonomics, or working in awkward postures and positions, losing balance, slipping and tripping. This ranks as the third most common cause of accidents on sites in South Africa. In addition, caught in or between objects ranked fourth in Singapore. This cause is less frequent than contact with hot substances/objects, exposure to/contact with electricity, and exposure to/contact with harmful substances.

Table 6: Rank of types of accidents on construction sites in Singapore in 2006

Rank	Type	Injuries*	Fatalities
1	Step on, strike against or by objects	661	1
2	Fall of persons	596	15
3	Struck by falling objects	362	5
4	Caught in or between objects	275	2
5	Exposed /contact with harmful substances	16	0
6	Contact with hot substances /objects	14	0
7	Exposed /contact with electricity	5	0
8	Fire/ explosions	4	0
	Others	482	1
	Total	2415	24

** Figures include both fatal and non-fatal injuries*

Source: www.mom.gov.sg

Table 7: Rank of types of accidents on construction sites in South Africa

Rank	Types of Accidents in Construction Industry	N	Mean
1	Lifting of heavy or awkward or irregular materials	253	3.020
2	Struck by objects	253	3.004
3	Working in awkward postures and positions, losing balance, slipping and tripping	252	2.960
4	Falls of persons	253	2.909
5	Contact with hot substances /objects	251	2.873
6	Exposed /contact with electricity	249	2.695
7	Exposed/contact with harmful substances	251	2.574
8	Being caught in or between objects	249	2.430

6. DISCUSSION

The differences found between South Africa's and Singapore's most common causes of accidents resulting in injuries and fatalities of workers on construction reflects the difference of health and safety practices in the construction industry of the two nations and can be explained by another finding of this research. That is, the differences of health and safety climate mainly exist in the three dimensions of management commitment, supervisory environment, and training and competence level.

The unavailability of a wide variety of machinery and equipment for materials handling on construction site could be one of the major factors causing the high rate of injuries resulting from lifting of heavy or awkward or irregular materials in South Africa. In most developing countries, which tend to have more labor-intensive construction industries, the use of modern technology may be resisted by employers for the sake of lower labor costs. Additionally, public sector clients may dictate the more intensive use of labor due to government policy and high rates of unemployment. Further, little consideration has been given to repackage materials with workers in mind through standardization and weight reductions. To reduce this causal factor, a clear commitment from management to construction health and safety should be demonstrated by increasing the health and safety budget to address improvements for equipment, technology and materials. The higher incidence of injuries resulting from working in awkward postures and positions, losing balance, slipping and tripping in South Africa is mainly due to inappropriate worker techniques, poor work organization, a lack of respect for the wellbeing of workers, inadequate labor protection, and general lack of site supervision. The accidents due to contact with hot substances/objects, exposure to /contact with electricity, and exposure to/contact with harmful substances in South Africa is partly attributable to the general 'do not care' attitude of workers and management,, the absence or improper use of PPE, and the general lack of site supervision.

In most developing countries, there is a strong tendency for construction workers to be highly mobile. They tend to frequently transfer from one site to another and even transfer from one trade to another. The majority of the workers may not even understand the job and do not possess the necessary skills to perform the job. According to Koehn (1995), lack of understanding of the job is one of the major causes of construction accidents in developing countries. Levitt and Samelson (1993) report that even small amounts of time (less than one hour) spent on health and safety orientation for new workers before they begin working can significantly reduce injuries to new workers. Therefore, health and safety training and orientation become important management driven initiatives to inculcate workers with the necessary techniques and awareness of health and safety issues.

In addition, the proper use of PPE after mitigating hazard exposure has been an effective way to prevent workers from being injured or to alleviate the injuries to some extent in developed countries. For the majority of contractors in developing countries, however, maximizing profit is the prime concern and the health and safety budget is limited. Workers on such projects are more likely to be directly exposed to all kinds of hazards.

To alter this situation, top management should demonstrate their commitment by increasing the health and safety budget of projects.

Finally, as Mahalingam and Levitt (2007) found, while education or training could be a long-term strategy to grow health and safety culture in developing countries, safety policy enforcement was an effective way to achieve short-term improvement of health and safety performance. Because of the lack of an appropriate health and safety culture in the construction industry of developing countries, workers are less sensitive to health and safety issues. Therefore, it is necessary to enhance site health and safety supervision accompanied by regular health and safety inspections. The findings of this paper suggest that management commitment, supervisory environment, and training and competence level are three relatively weak aspects of construction health and safety practices in developing countries such as South Africa than those of developed countries such as Singapore.

Hence, the difference in incidence of the common causes of accidents on construction sites in South Africa and Singapore further supports the previous finding that the main sources of disparity between the two nations lie in management commitment, supervisory environment, and training and competence level.

7. CONCLUSIONS

In this paper, the disparity of construction health and safety performance between developing and developed countries was ascertained and the main sources of this disparity were investigated through a comparative study in a developing country, South Africa, and a developed country, Singapore. Management commitment, supervisory environment, and training and competence level were identified as the major sources of the disparity of construction health and safety performance in developing and developed countries. This finding is further confirmed by the difference in the incidence of different causes of accidents resulting in injuries and fatalities on construction sites in South Africa and Singapore. The findings of this particular research do not mean that other factors are not important for improving construction health and safety performance in developing countries, but rather, that a developing country such as South Africa does not perform as well in these three areas of construction health and safety. The findings of this research have practical implications for improving construction health and safety performance in developing countries. Learning from developed countries with better construction health and safety performance relative to the practices and experiences of management commitment to site health and safety, enhancement of the supervisory environment, health and safety training or orientation, and raising the competence levels of workers could be useful to enhance construction health and safety performance in developing countries.

One potential limitation of this research is the self-reported data collection method.The conclusion would be more persuasive if more objective evidence such as site health and safety inspection records, health and safety management system audit records, or

comprehensive health and safety statistics in developing countries could be included in future studies.

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