FACTORS INFLUENCING THE OCCURRENCE OF LABOUR ACCIDENTS IN VIETNAMESE RESIDENTIAL CONSTRUCTION PROJECTS

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ABSTRACT

There was a sharp increase in the annual injury rate and the annual death rate per 100,000 employees in the Vietnam construction industry (VCI) from 2000 to 2006. This study aimed to identify and analyze factors affecting the occurrence of labour accidents (OLA) in residential construction projects. A survey questionnaire was used to collect data from construction practitioners. The results show that labour accidents in the VCI resulted from factors related to unqualified construction resources, unsafe human behaviour and poor management. The results can be used to gain insight into the OLA in order to deal with high labour accident rate and to develop safety programs in Vietnam as well as in other developing countries.

Keywords: Construction, factor analysis, labour accidents, occupational safety and health, safety, Vietnam.

1. Introduction

It is widely accepted that the construction industry is one of the most hazardous industries. Since labour accidents occur in all types of construction activities (Suraji and Duff, 2001), the safety issues in construction are a very complex phenomenon, which is not amenable to explanations, much less to control (Vaid, 1988). However, Abdelhamid and Everett (2000) confirmed that many major factors, causes, and sub-causes are the main culprits in an accident scenario. Therefore, identifying determinants of construction labour accidents plays a key role in accident prevention.

The Vietnam construction industry (VCI) has been undergoing a boom. However many construction projects continue to proceed without any concern for the health and safety of workers. Recently, Vietnam still suffers the high frequency of fatalities and disabling injuries. Labour accidents in the VCI cause tremendous loss in both economic and humanitarian aspects. Thus, a distinct need has emerged for identifying factors influencing on the OLA in the VCI. Identifying these factors is an initially important step to reduce the high labour accident rate in the VCI.

This paper describes the research on factors affecting the OLA in the VCI. The research objectives are: (1) to identify and rank major factors affecting OLA in the Vietnamese residential construction sector; and (2) to analyze the underlying relationships between these factors for gaining insight into labour accidents.

2. Literature Review

This section consists of two sub-sections: definition of labour accident and factors affecting labour accidents in the construction industry.

2.1. Definition of a Labour Accident

The International Labour Organization (ILO) defines a labour accident as "an accident is accompanied by injuries resulting from contact between workers and physical objects, materials, or other people, the exposure of their bodies to hazardous substances or working

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conditions, or working activities" (ILO, 1980). This definition has been used throughout this research because of its popularity, acceptability and simplicity.

2.2. Factors Affecting the Occurrence of Labour Accidents

Major factors influencing labour accidents in construction industry have been reviewed and critically evaluated in many scientific journals and reports. In this section, these factors are subjectively grouped under four categories: construction resources, working conditions, human behaviour, and management and organization. A description of each group is as follows:

- *Construction resources-related group* consists of factors that can attribute to insufficient or improper construction resources. Insufficient or improper resource allocation such as unsafe construction equipment and tools, unavailable or improper tools, defective equipment, inadequate temporary structure, insufficient personal protective equipment (PPE) and harness, lack of innovation technology and technical guidance, contractor's financial shortage, and unsafe working methods of workers may account for OLA (Kunishima and Shoji, 1996; Erikson, 1997; Holmes et at., 1999; Rechenthin, 2004; Tam et al., 2004; Chi et al., 2005; Haslam et al., 2005; Abudayyeh et al., 2006). Due to inefficient equipment maintenance, improper training for operators, shortage of spare parts, unsuitable equipment regarding site conditions, construction workers may meet labour accidents (Toole, 2002; Tam et al., 2004). Moreover, low education of workers, and lack of experienced project managers and skilled workers are adverse factors frequently cited in previous studies (Mohamed, 2002; Tam et al., 2004; Fang et al., 2006).

- *Working conditions-related group* concerns factors caused by unsafe or inadequate working conditions. They include poor weather conditions, inadequate illumination and ventilation, inappropriate spaces for working, lack of safety booklets and other precautionary measures, and frequent stresses of the construction work (Lan, 1997; Laukkanen, 1999; Haslam *et al*., 2005), lack of prohibition signs and warning symbols (Tam *et al*., 2003), poor communications between management and workforce (Stranks, 1994; Vredenburgh, 2002; Tam *et al*., 2004, Fang *et al*., 2004a; Abudayyeh et al., 2006). In addition, poor housekeeping, untidiness of the work environment, poor order on the sites (Shannon *et al*, 1997; Harper and Koehn, 1998; Lingard and Rowlinson, 1997; Haslam *et al*., 2005), lack of safety barriers (Sklet, 2006), and lack of protection in material transportation and material storage (Tam *et al*., 2004) are common factors related to inadequateness or inconvenience of the workplace.

- *Human behaviour-related group* consists of factors that can attribute to bad or inappropriate human behaviour toward safety performance. Negative attitudes of employees toward safety (Stranks, 1994, Jaselskis and Suazo, 1994; Tam *et al*., 2001; Johnson, 2003; Schultz, 2004; Fang et al., 2006, Choudhry and Fang 2007), poor safety awareness of site supervisors and contractor's managers (Smith and Roth, 1991; Salminen et al, 1993**;** Jaselskis and Suazo, 1994; Kartam and Bouz, 1998; Tam et al., 2004; Fung et at., 2005), reckless operation, and reluctant to input resource for safety (Tam et al., 2004), lack of employee involvement (Harper and Koehn, 1998; Ariss, 2003; Smith, 2003; Abudayyeh et

al., 2006) are typically adverse factors resulting from awareness and attitude of the workforce. Lack of teamwork in safety program (McGowan and Norton, 1989; Krause 1997; Ulloa and Adams 2004), competition and friction among workers (Hinze, 1981; Shannon et al, 1997; Harper and Koehn, 1998; Gillen et al., 2002; Haslam et al., 2005), lack of motivation (Hinze and Harrison, 1981**;** Vaid**,** 1988; Gun and Ryan, 1994; Laukkanen, 1999; Dessler, 2000; Neal and Griffin, 2002, Gambatese et al., 2005; Larsson et al., 2007) and worker's praise (Hinze, 1981**)**, frequent facing with deadlines (Hinze, 1981, Salminen et al., 1993; Holmes et al., 1999), and worker's poverty (Vaid, 1988) are other adverse factors frequently cited in previous studies.

- *Management-and-organization-related group* comprises adverse factors that related to inherently negative characteristics as well as poor performance of management and organization towards safety. Lack of management support and organizational commitment (Shannon et al., 1997; Sawacha et al, 1999; Wilson and Koehn, 2000; Rechenthin, 2004; Abudayyeh et al., 2006), poor communication between managers and workers (Shannon et al, 1997; Fang et al., 2004b; Haslam et al., 2005), fatigue of workers due to overtime (Lan, 1997**)**, ineffective safety programs, poor safety climate, poor enforcement of safety laws and regulations (Tirachai, 2000; Gillen et al., 2002; Fang et al., 2004a; Lingard and Holmes, 2001; Teo and Ling, 2006; Johnson 2007; Burt et al, 2008), unclear and unrealistic safety goals (Weber, 1992; Pierce, 1995; Cameron and Duff, 2007), careless contract drafting (Wildman and Castelli, 2004), lack of incorporation of construction safety knowledge into the design phase (Gambatese, 1998; Gambatese and Hinze, 1999; Gambatese et al., 2005) and unclear responsibility and ineffective delegation for safety performance (Anton, 1989; Abudayyeh et al., 2006) are common factors attributable to management responsibility. Hazardous work methods (Hinz et al., 1998), improper construction procedures, inadequate site supervision (Gun and Ryan, 1994; Shannon et al, 1997; Fang et al., 2004a), lack of protection in material storage, poor first aid measures, insufficient safety officers (Hinze and Harrison, 1981; Boden et al, 1984; Simard and Marchand, 1994; Salminen, 1995; Tam et al., 2004**)**, poor accident records (Simonds and Saafai-Sahrai, 1977; Kartam and Bouz, 1998), lack of periodic safety program evaluation (Abudayyeh et al., 2006), poor error management (Mitropoulos et al., 2005), inadequate preparatory training of workers (Hinze and Harrison, 1981; Wilson, 1989; Gun and Ryan, 1994; Harper and Koehn, 1998; Sawacha et al., 1999; Lingard and Holmes, 2001; Toole, 2002; Tam et al., 2004; Fang et al., 2006; Cameron et al., 2007; Choudhry and Fang, 2007), and ineffective first aid training (Lingard, 2002) are factors resulting from poor performance and failures of management procedures, and defectiveness in the management system of organizations. Factors concerning poor safety planning and monitoring, and construction planning such as lack of effective safety plan, shortage of safety management manual, reckless attitudes of safety code, unorganized site layout (Tam et al., 2004; Saurin et al., 2007), unreliable production planning to reduce task unpredictability (Mitropoulos et al., 2005) and inadequate planning of construction work (Tirachai, 2000; Wilson and Koehn, 2000) often were pointed out in previous articles.

3. Research Methodology

Identifying potential factors affecting OLA is the important initial step of this research. A set of potential factors was uncovered from a rigorous literature review and annual national reports of labor accident included in a preliminary questionnaire. Because potential factors mostly based on literature, it was decided to test these factors with selected professionals to get feedback on each factor in order to fit with VCI conditions. The preliminary questionnaire was tested with an expert group of nine practitioners and three researchers. The nine practitioners are five project safety managers; two site supervisors and two site managers. Both of them have at least fifteen years of experience about the safety in construction. Participants were asked to critically review the questionnaire. Their comments about the naming and appropriateness of factors, the structure of questionnaire, and the lack/excess of factors were carefully discussed and used to revise the questionnaire. After revising, the second pilot questionnaire was presented to this group. At this time, the responses were positive and the modification was unnecessary. This process provided 44 potential factors affecting OLA (Table 2). These factors were subjectively divided into construction resource-related, working condition-related, human behaviour-related and management-organization-related factors. The final survey questionnaire was then designed and distributed to a random sample of construction professionals, who worked for residential construction projects in Vietnam. Face-to-face delivery was preferred to obtain high response rate but several means such as email and post were also employed. The respondents were asked to rate factors based on five-point Likert-scale rating (from 1=’very weak influence on OLA’ to 5=’very strong influence on OLA’). Project managers, who have highest authority to manage safety programs, are accountable for providing a safe and healthy environment for construction workers (Aksorn and Hadikusomo, 2007). Site personnel such as site engineers, foremen, site supervisors, safety inspectors, safety officers have to work day-to-day at the job site. Therefore, project managers and site personnel can thoroughly perceive factors affecting the OLA. This paper focuses on these two types of construction professionals.

The analysis of the questionnaire included ranking the factors in terms of level of influence. To determine the ranking of different factors, the relative influence index (RII) was computed as follows:

$$RII = \frac{\sum W}{5 * N}$$

where: W=the weighting given to each factor by the respondents (ranging from 1 to 5); 5=the highest weight; N=the total number of respondents.

The RII is normalized to fall within 0-1 that helps to easily compare the importance of each factor against other factors without concerning maximum value of scale. This type of index has been widely used in other researches. Based on these ranking, it is possible to compare the relative influence of factors from the project managers and site personnel’s viewpoints. The Spearman’s rank correlation coefficient was used to measure correlation between the ranking orders of two respondent groups. The correlation between two groups was verified by hypothesis testing at the 1% significant level.

Furthermore, Levene’s test was used to assess the equality of variance in the responses of two respondent groups (i.e., project mangers and site personnel). If the resulting p-value of Levene’s test is less than 0.05, there is a difference between the

variances in respondents' replies. Based on the result of Levene's test, a two-sample t-test was employed to test the difference in the means of responses of two respondent groups (i.e., project managers and site personnel). Finally, factors analysis was employed to uncover interrelationships among factors affecting the OLA.

4. Findings and Analysis

4.1. Profile of Respondents

Three hundred and seventy questionnaires were randomly distributed to project managers and site personnel who have experienced in residential projects. The authors received 150 responses showing a response rate of 40.54%. This rate is appropriate for surveys in the construction industry (Arditi et al., 1985). Table 1 shows the respondent's profile. The proportions of respondents in terms of number of years involved in construction were: less than 5 years (29.3%) and equal to 5 years or more (70.7%). It would have been better if the proportion of respondents with 5 years or more could be increased.

Table 1: Respondent's profile

Number of years involved in construction	Project manager	Site personnel	Total
< 5 years	2	42	44
%	8%	33%	29%
>= 5 years	22	84	106
%	92%	67%	71%
Total	24	126	150
	100%	100%	100%

Among site personnel, two-thirds were experienced in construction for 5 years or more while one-third were experienced in construction for less than 5 years. Similarly, among project managers, nine - tenths were experienced in construction for 5 years or more. In addition, the large proportion of the respondents was site personnel (84%). These imply that the research focuses on practical aspects of the OLA. Moreover, more than half (51%) of the respondents were experienced in private projects while 49% of them were experienced in public projects.

4.2. Rankings of Causes of High Labour Accident Rate

Table 2 shows the top 23 factors perceived as having significant influence, RII higher than 0.5 as a rule of thumb, on the occurrence of labour accidents. The reliability analysis resulted in Cronbach's alpha coefficient to be 0.841 with project managers and 0.879 with site personnel. This coefficient is large enough to confirm the reliability of the measure scale used in the questionnaire. The following is the discussion about factors and their influence on the occurrence of labour accidents in the VCI.

Poor safety awareness of site supervisors and project managers, fatigue of workers due to overtime, insufficient PPE and harness, low education of workers, and lack of effective safety plan are factors, which had high ranks. It can be said that labour accidents in the VCI resulted from factors related to unqualified construction resources, unsafe human behaviour and poor management. Most Vietnamese owners and contractors are small and medium in size. They often face financial difficulties. This results in unqualified

construction resources, such as low education of workers and insufficient PPE, because little money has been paid for improving construction resources. Since the competitiveness is severe in Vietnamese construction market, many construction firms have to work on very small margins. They expect that there is no accident in their projects. Therefore, poor safety awareness of site supervisors and project managers is natural. Thus changing poor safety awareness of project managers and site supervisors should be considered as one of key issues in labour safety improvement programs. Moreover, to cope with severe competition, many contractors often resort to low bid prices to win contracts. Top managers of those are willing to cut off the budget for safety planning as well as for safety management. Thus safety plan is ineffective because it is prepared to cope with the inspection of government authorities rather than to prevent labour accidents. Since ineffective selection of construction equipment, unsafe utilization of tools, unorganized storage of construction materials, uncomfortable access, and frequent overtime is very common at construction sites, high labour accident rates may result from lack of effective safety plan. The high ranks of the top 6 factors imply that improving construction resources, obtaining good human behaviours toward safety performance, and achieving effective safety management are top priorities in safety programs.

Factors ranking from seventh to fifteenth (overall) relate to construction resources, working conditions and management/organization groups. Frequent stresses and strains of construction works and inadequate preparatory training of workers meet the agreement between project managers and site personnel on both rank and mean values. Stress and strain in construction works could result from many sources, such as ergonomics; and cause workers less concentration on works. Workers in construction projects have been rarely trained about what they do, so they can easily get stuck in trouble. Furthermore, they very often work in bad conditions. Inadequate illumination at workplace, lack of accident precautionary measures, poor housekeeping also lead them to improper manipulation. The other four factors in this range are management-related and resource-related problems. Management-related problems, such as unorganized site layout and improper construction procedures, are always headache arising in almost all projects in Vietnam. Some reasons can be referred to excuse for problems of resource. Of these reasons, money and attitude of managers are the two most frequently blamed ones. Improper working postures and inadequate temporary structures are not the exceptions.

Less influencing on safety performance than aforementioned causes, problems ranking from sixteenth to twentieth (overall) are contributed by management/ organisation and working conditions related issues. A program to secure health and safety before launching a construction project is stipulated in government regulations. In fact, the implementation is very cursory just to pass the requisite. Project managers ranked poor safety programs low is not difficult to explain. Setting up and realizing a program is the responsibility of managers. Looking down their own works is something unusual behaviour. Site supervision is a different tough problem in VCI. Skilled personnel are insufficient. Rating superintendent is mostly based on years of working but not on training or knowledge. Vietnam is a tropical country with two distinguished seasons. The rainy season with high rainfall and dry

season with high temperature which have bad effects on health of workers especially who work outdoors. Inadequate spaces for working and inadequate ventilation are the two difficulties related to the characteristics of construction works.

Table 2. Ranking of factors affecting the occurrence of labour accidents

Factor affecting labor accidents	Project managers		Site personnel		Overall		t-test
	RII	Rank	RII	Rank	RII	Rank	
Poor safety awareness of site supervisors and contractor's managers	0.933	1	0.848	1	0.861	1	0.053
Fatigue of workers due to overtime	0.875	3	0.810	2	0.820	2	0.207
Insufficient or inadequate personal protective equipment (PPE) and harness	0.883	2	0.790	3	0.805	3	0.051
Unsafe construction equipment and tools	0.850	5	0.789	4	0.799	4	0.214
Lack of effective safety plan	0.875	3	0.770	6	0.787	5	0.052
Low education of workers	0.800	6	0.781	5	0.784	6	0.713
Frequent stresses and strains of construction works	0.783	8	0.767	7	0.769	7	0.708
Inadequate preparatory training of workers	0.792	7	0.754	8	0.760	8	0.430
Inadequate illumination at workplace	0.725	16	0.751	9	0.747	9	0.505
Improper construction procedures	0.767	11	0.741	10	0.745	10	0.530
Lack of accident precautionary measures	0.725	16	0.737	11	0.735	12	0.779
Improper working postures	0.775	9	0.735	12	0.741	11	0.357
Unorganized site layout	0.767	11	0.727	14	0.733	13	0.388
Poor housekeeping	0.758	13	0.724	15	0.729	14	0.426
Inadequate temporary structures	0.775	9	0.711	16	0.721	15	0.127
Poor safety programs	0.667	19	0.729	13	0.719	16	0.103
Inadequate site supervision	0.733	15	0.710	17	0.713	17	0.597
Poor weather conditions	0.717	18	0.705	18	0.707	18	0.805
Inadequate or inappropriate spaces for working	0.758	13	0.695	19	0.705	19	0.205
Inadequate ventilation	0.642	21	0.683	20	0.676	20	0.397
Financial shortage of contractors	0.600	23	0.670	21	0.659	21	0.162
Unavailable or improper tools	0.642	21	0.656	22	0.653	22	0.761
Untidy construction sites	0.650	20	0.635	23	0.637	23	0.746

From Table 2, three factors having low ranks are financial shortage of contractors, unavailable or improper tools, and untidy construction sites. The characteristics of the VCI may account for lowest ranks of these factors. Labour accidents in the VCI may result from contractor's financial shortage. Recently, Vietnam is still a relatively poor country with US$726 per capita at the market exchange rate (2006 estimate). The VCI intensively needs funds to meet its rapid growth. However, the financial capacity of Vietnamese investors cannot always meet the capital demand. As mentioned early, many Vietnamese contractors often resort to low bid prices to win contracts. This frequently leads them to financial shortage. Consequently, contractors are willing to cut off safety costs because they consider these expenses as their profit lost. Labour accidents may therefore increase. The improper or unavailable portable tools are also one of labour accident causes. Most construction projects in Vietnam request the utilization of modern equipment and portable tools. Construction workers have used portable tools in their day-to-day work. However, these tools are either unavailable or second-hand because of financial difficulties and poor awareness of contractor's top leaders. Due to unavailable construction tools, workers have to use other tools instead. The utilization of such tools has naturally accounted for the occurrence of labour accidents. On the other hand, in Vietnam, untidy construction sites may cause labour accidents. In the two decades since Vietnam has gone from the centralized economy to a form of the market economy, construction management, which is very popular in capitalistic countries, is still a new concept in Vietnam. Untidy and disorderly construction sites, which result from poor management skills of site managers, are common in Vietnam. Such untidy construction sites provided no formal and safe site access routes for workers to move from one place to another. Hence, workers often choose a route being the shortest or the most convenient for them. This habit may lead them to meet with labour accidents.

4.3. Different in Perception between the Two Groups

The Spearman's correlation coefficient for rank order of significant factors between project managers and site personnel was 0.841. This coefficient suggested that there is a very good agreement between project managers and site personnel in the ranking order of factors.

The results of Levene's test proposed that there were no differences between the variances in the respondents' answers. The two-sample t-test was then conducted. Table 3 shows P values at which hypothesis of equality of mean values across two groups could be rejected. The results of the two-sample t-test suggested that there were not statistically significant differences in rating scores between two respondent groups over 23 factors (at significant level of 5%). This noticed a consensus among the respondents on 23 factors affecting the OLA. Hence, further attempt to analyze factors based on the different groups of respondents is not meaningful.

5. Conclusion

Labour accidents in construction industry cause serious outcomes for all project participants as well as community. There are various factors affecting the occurrence of labour accidents. This paper provides a comprehensive investigation of factors that are important to prevent the labour accident in the Vietnam construction industry.

Twenty three factors were identified as the most influential in construction accidents. In overall context, *poor safety awareness of site supervisors and*

contractor's managers; fatigue of workers due to overtime; insufficient or inadequate PPE and harness; unsafe construction equipment and tools; lack of effective safety plan; low education of workers are the six most severe causes. The top 6 factors are management-and-organization-related, construction resource-related, and human behaviour-related factors which imply that allocating sufficient construction resources, obtaining good human behaviours toward safety performance, and achieving effective safety management hold top priorities in safety programs. The results of this survey can be used to gain better understanding of labour accidents in the VCI.

Although the research questions seem to be localized, the findings are expected to be useful for participants in construction not only in Vietnam but also in other developing countries because of their similar circumstances.

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