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Determinants of Occupational Accidents in the Woodworking Sector: The Case of the Malayasian Wooden Furniture Industry

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Abstract: Studies on occupational accidents in the value-added wood products industry, particularly the wooden furniture industry is grossly lacking. Therefore, the risk factors for injuries to workers in the Malaysian wooden furniture industry were studied in fifty wood-furniture manufacturing factories, using a structured questionnaire. The three primary risk factors for accidents in the wooden furniture industry were: Nature of work, workers characteristics and prevailing safety climate, while the use of dangerous machinery and poor layout were found to be secondary accident causing risk factors. The findings of the study show conclusively that the prevailing safety climate and workers' characteristics have the strongest influence on accident rate in the wooden furniture industry. It must also be recognized that the production oriented mentality prevalent in the industry appears to contribute towards the compromised occupational safety and health standards in the industry. In this context, it is essential for the policy makers to implement binding legislations that would safe guard the safety and health of the workers, while mandating the factory management to show commitment towards the workers health and safety to ensure a safe working environment in the wooden furniture manufacturing industry.

Key words: Risk factors, safety and health, work environment, wooden furniture industry, accidents

INTRODUCTION

Although, the nature of occupational accidents in the woodworking industry has been well studied (Sheehy and Chapman, 1987; Holcroft and Punnett, 2009), most of the reports are focused on the primary processing sectors, particularly the saw-milling industry. Despite providing useful information to lay the foundation for occupational safety and health practices in the woodworking sector, the application of the findings of these reports to value-added wood products manufacturing, especially furniture, remains debatable (Ratnasingam and Bennet, 2009). This is argument stamps from the fact that the processing technology in the saw-milling sector is markedly different from that used in the furniture manufacturing industry, and to draw similarity in the causes of occupational accidents may be misleading (Holcroft and Punnett, 2009). Further, the furniture industry has evolved from being a cottage based, skill-dependent industry to a highly mechanized and labour intensive industry operating in high-volume production environments (Rampal and Nizam, 2006). Inevitably, the lack of studies on occupational accidents in the furniture manufacturing industry is seriously hampering efforts to improve the safety and health practices within the industry. Against this background, there is a growing need to breach the information gap in occupational accidents in the wooden furniture industry, which is becoming an increasingly important socioeconomic sector in countries of the South East Asian region.

The wooden furniture manufacturing industry has emerged as the fastest growing sub-sector within the wood-based sector in Malaysia, and its socioeconomic importance, both in terms of workforce employment and foreign exchange earnings has increased significantly over the years. In 2008, the sector contributed US$ 2.7 billion in export earnings, while employing almost 68,000 workers (Ratnasingam and Bennet, 2009). Nevertheless, the large workforce is faced with a high risk of accidents in the work environment, which is often regarded as dirty,

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dangerous and degenerative, i.e., "3D environment". However, the work environment related accidents in the Malaysian wooden furniture industry has been inadequately researched and hence, reports on the subject are sparse (Ratnasingam and Bennet, 2009; Ratnasingam *et al.,* 2010a, b). Nevertheless, published statistics on accidents in the manufacturing sector by the National Institute of Occupational Safety and Health (NIOSH), suggest that rate of industrial accidents in the wooden furniture industry is above the national average of the manufacturing sector and resulted in a total compensation of almost US$ 1.3 million in 2007-2008, implying that studies into this subject is warranted (NIOSH, 2009). Further, the impact of accident on workers on the overall industrial productivity is a matter of national and international interests, especially when industrial dictates the competitiveness of the wooden furniture industry (Guldenmund, 2000; Clarke, 2006a; Pousette *et al.*, 2008; Wu *et al.*, 2008; Gyekye and Salminen, 2009; Shannon and Norman, 2009).

Previous studies have shown that industrial accidents are closely related to the prevailing work environment and tasks carried out (Cooper, 2000; Clarke, 2006b; Das *et al.*, 2008). Work environment related accidents could be attributed to the: (1) prevailing environment (noisy, dusty, chemical exposure, poor lighting), (2) nature of work (repetitive, shift work, fatigue, physical workload), (3) handling (manual, machine, postural stress), (4) ergonomic (work design, repetitive motions), (5) machine (machine-paced, operator-paced, dangerous tools and machines), (6) training (formal training, on-the job training), (7) maintenance (poor maintenance culture, lack of supervision, poor housekeeping, psychosocial environment), (8) plant layout (work flow, machine organization), (9) workers characteristics (gender, age, skill level, knowledge, experience) and (10) safety climate (safety system, management commitment) and the risk posed by each of these factors may vary from factory to factory (Das *et al.*, 2008; Holcroft and Punnett, 2009).

Against this background, a study was undertaken to evaluate: (1) the work environment related risk factors for injuries in the Malaysian wooden furniture industry and (2) the relationship between the prevailing risk factors and accidents rate in the wooden furniture industry.

MATERIALS AND METHODS

The study was conducted in 50 large (employing more than 100 workers, with an annual turnover in excess of US$ 10 million) wooden furniture-manufacturing companies in Malaysia, using a four-part structured questionnaire. The companies were selected from the database of the Malaysian Furniture Industry Council (MFIC), after being identified from the industrial accidents report published by the National Institute of Occupational Health and Safety (NIOSH). In this study, accident rate refers to number of accidents at the workplace per million work hours and the accident leads to at least an hour of production loss. All the companies had consented to participate in the study, which was carried out during the period of February 2009 to June 2010. The study was conducted in four parts.

Part 1 related to the measurements of risk factors for accidents in the factories using a questionnaire, which had 26 variables (Table 1, 2). The variables were

Table 1: Six-factor solution for risk factors for accidents in the wooden furniture industry

	Loading of factors					
Variables	1	2	3	4	5	6
Dusty, noisy and chemical exposure	0.57	0.16	0.07	0.09	0.10	0.31
Insufficient lighting	0.56	0.10	0.24	0.26	-0.07	0.29
Stressful posture	0.23	0.63	-0.03	0.95	-0.02	0.08
Physically taxing work	0.38	0.59	0.18	0.14	0.07	0.12
Repetitive work	0.04	0.74	0.45	0.02	0.17	-0.05
Poor ergonomics	0.30	0.51	0.35	0.16	0.04	0.21
Manual handling	0.28	0.33	0.77	0.07	0.01	-0.22
Dangerous tools and machines	0.13	0.38	0.69	0.04	0.04	-0.18
Poor maintenance	0.26	0.08	0.60	0.41	-0.08	0.02
Poor work flow	0.05	0.55	0.09	0.55	0.13	0.15
Poor machine organization	0.35	0.75	0.25	0.61	-0.05	-0.15
Improper technology	0.48	0.02	0.22	0.55	0.38	0.03
Poor housekeeping	0.19	0.04	0.10	0.72	-0.05	-0.03
Lack of safety work culture	0.01	-0.05	0.41	0.07	0.49	0.63
Lack of training	0.31	0.05	0.54	0.08	0.58	-0.03
Age	-0.15	0.05	0.03	0.01	0.53	-0.35
Gender	0.10	0.08	0.19	-0.08	0.65	-0.05
Years at work	0.50	-0.24	0.19	0.09	0.71	0.18
Insufficient safety precautions	0.35	-0.29	0.33	0.11	0.28	0.59
Insufficient information	-0.18	0.25	0.46	0.19	0.41	0.69

Table 2: One-factor solution for company accident prevention

Variable	Loadings
Information on accidents	0.88
Measures for preventing accidents	0.81
Supervision for accident prevention	0.77
Safe work methods	0.74
Inspections for safety	0.65
Safety training	0.61

selected based on the previous study by Zhou *et al.* (2009) and Holcroft and Punnett (2009), as well as after discussions with industrial health and safety experts. All the variables were rated based on the Likert's five-point rating scale where higher rating indicated stronger positive opinion. The questionnaire were distributed to every worker in the fifty factories by the respective factory manager and collected in sealed envelopes one week later. The total number of workers who had participated in the study from all fifty factories was 5214, which provided a response rate of 83%. The risk factors for accidents were determined by means of factor analysis. Factor analysis is a method that enables a large number of variables to be described in a compact manner, using fewer new variables (Holcroft and Punnett, 2009). Through the use of rotation, it is possible to arrange the factor matrix in such a way that it is easier to interpret. The Kaiser-Meyer-Olkin test was used to estimate whether the data was suitable for analysis, i.e. factor analysis cannot be used if the Kaiser-Meyer-Olkin test index is below 0.5. The maximum likelihood method and varimax rotation were used in the analysis. All factors whose eigenvalue was greater than 1.0 were accepted, while factors that consisted of three or less variables were rejected, because according to Holcroft and Punnett (2009), it takes at least three variables to define a factor.

Part 2 related to the measurement of the work environment related accident risk in the factories, in which 12 variables were evaluated based on the Likert's five-point rating scale (Table 3). The senior managers at the respective factories were interviewed to determine the ratings for the variables. These variables were then grouped into groups, namely: (1) the accident prevention activities of the factory management, (2) anticipation of accidents and (3) training. The means of factors were calculated as the means of all those variables that were included in each factor.

Part 3 focused on the measurement of the accident risk in the factories, which was carried out based on correlation between the accident risk factors and the accident rate in the work environment. The accident risk factors at the work environment were evaluated on the degree of compliance of each of the factories to the 30 checkpoints, as reported in Ratnasingam and Bennett (2009).

Part 4 evaluated the work stations and production operations that resulted in the highest rate of accidents, based on interviews with 25 workers, selected randomly from each of the respondent factories. A total of 1250 workers had participated in this part of the study, which ensures representative and unbiased responses.

RESULTS

Part 1: Accident risk factors in wooden furniture manufacturing: When the correlation matrix that represented the variables concerning accident risk factors and rate of accident received a Kaiser-Meyer-Olkin test index of 0.86, the results was deemed to be suitable for analysis. The analysis produced six factors. The analysis accounted for 48% of the total variance, a result that was statistically acceptable. The first factor represented the nature of work (variables 3, 4, 5, 6), the second was risky technology (variables 7, 8, 9), the third was the plant layout (variables 10, 11, 12, 13), the fourth was the workers' characteristics (variables 15, 16, 17, 18) and the fifth was the prevailing safety climate in the factory (variables 14, 19, 20). All five factors were internally consistent. Because the sixth factor consisted of only two variables, it was rejected.

When the correlation matrix that represented the variables concerning the company's accident prevention received a Kaiser-Meyer-Olkin test index value of 0.94, the results were found to be suitable for analysis. The analysis produced one factor. The solution accounted for 78% of the total variance, which was acceptable. On the basis of these analyses, the determinants of work environment related accidents in the wooden furniture manufacturing industry could be attributed to: (1) nature of work, (2) risky technology, (3) plant layout, (4) workers characteristics and (5) safety climate The Cronbach-α was 0.83 1, 0.68 2, 0.51 3, 0.86 4 and 0.93 for factor 5. Based on the satisfactory reliability level of 0.80, the reliability of factors 2 and 3 were considered too low.

The results suggest that although the work environment related accidents in the wooden furniture involve five risk factors, the prevailing safety climate in the factory, the workers' characteristics and the nature of the work were the predominant causes of work environment related accidents in the wooden furniture industry. This finding supports the findings of previous studies by Clarke (2006a) and Holcroft and Punnett (2009), who reported that the prevailing safety climate and workforce characteristics predetermined the rate of accidents in wood products manufacturing industries. Inevitably, the results of this study emphasizes the fact that work force characteristics and the factory

Table 3: Variables for accident prevention practices

Factor	Variable involved	Average score for factor
Management Role	(1) Management involvement	4.39
	(2) Provision of safe working procedures to employees	
	(3) Erection of signs on potential accident hazards	
	(4) Accident information and regulations	
	(5) Keeping up-to-date with accident causing matters	
Anticipation of Hazards	(1) Accident hazard analysis	3.46
	(2) Investigation of near accidents	
	(3) Maintenance	
	(4) Regular safety inspection	
Training	(1) Safety training	3.89
	(2) Accident prevention training for management, safety manager, line supervisor, workers	
	(3) System for familiarizing new employees to safety and accident prevention rules	

Table 4: Sections with high risk for accidents in the furniture factory

Section	Frequency of accidents (Average value over one year period)	Total loss of production time due to accidents (man-hours)	Ranking
Lumber yard	167	544	3
Rough mill	96	305	4
Machine shop	279	819	1
Sanding and assembly	81	218	5
Finishing	219	633	2
Packaging	45	137	6

management's commitment towards accident prevention must be accorded primary importance in any safety system implemented in the wooden furniture manufacturing industry, to ensure that work environment related accidents is minimized, if not avoided (Ratnasingam and Bennet, 2009).

Part 2: Accident prevention practices: In evaluating the accident prevention measures in the factories involved in the study, it was found that the accident prevention activities of the management received the highest score, followed by training and finally the anticipation of accident (Table 3).

The work environment accident risk factors 4 and 5, workers characteristics and company's prevailing safety climate were strongly correlated with the anticipation of accident hazards ($r = 0.794$ and $r = 0.891$ at $p<0.05$, respectively), which describes the company's accident prevention practices. However, factors 1, 2 and 3 showed no correlation with the company's accident prevention practices. In this context, an effective company safety precaution is able to pre-empt any possible accident hazard that may arise in the work environment, while the roles of the company management and training appear to have minimum effect on the accident prevention practices. This finding emphasizes the fact that although the company management may demonstrate a high degree of concern for accidents in the work environment, no amount of training and management intervention can replace the effectiveness of the company's accident precautionary scheme built into the operational system on the factory shop-floor to ensure an accident-free work environment (Gyekye and Salminen, 2009).

Part 3: Rate of Work Environment Accident: The work environment accidents risk factor 4, workers characteristics and factor 5, company's prevailing safety climate showed strong correlations with the rate of accidents ($r = 0.882$ and $r = 0.870$ at $p<0.05$, respectively), while the other three factors did not show any such relationship. In this context, the rate of work environment related accidents in the Malaysian wooden furniture industry is affected primarily by the prevailing safety climate in the factory and also the characteristics of the workforce employed. This finding is parallel to the findings of the previous reported by Holcroft and Punnett (2009).

Part 4: Accident prone work stations: Based on the interviews conducted and the subsequent analysis of the information gathered, it was apparent that the work stations with the highest risks for accidents are the machining section, followed by the finishing/spraying section, and finally the lumber yard (Table 4). On the other hand, the rough mill, sanding, assembly and packaging sections were deemed to be less accident prone. Table 5 shows that the machines with the highest risk for accidents were in the order of router>shaper>surface planner>band-saw>cross-cut saw. Other machines were regarded not as dangerous, to an extent of posing serious risk for accidents. This result is essential as it show the operations that warrant special attention by the safety

Table 5: Accident risks for woodworking machines

Machine	Average risk for accident	Ranking
Cross cut saw	0.75	5
Rip saw	0.62	8
Surface planer	0.85	3
Thicknesser	0.59	9
Moulder	0.55	10
Narrow band saw	0.79	4
Shaper	0.91	2
Router	0.97	1
Borer	0.52	11
Mortiser	0.49	13
Tenoner	0.73	6
Press/clamp	0.35	16
Wide belt sander	0.68	7
Portable sander	0.48	14
Edge sander	0.48	14
Brush sander	0.41	15
Spray gun	0.50	12

personnel, to ensure work environment related accidents are minimized, if not avoided (Ratnasingam and Bennet, 2009).

DISCUSSIONS

The results of this study, which corresponds to the findings of Varonen and Mattila (2000), Smith *et al.* (2006), Hahn and Murphy (2008), Baek *et al.* (2008) and Holcroft and Punnet (2009) that emphasizes that work environment related accidents are highly influenced by the prevailing safety climate in the factories and the workforce characteristics. Nevertheless, it must be emphasised that safety rules and regulations alone are not the answer to accident prevention. Safety researchers have identified and advocated several approaches in addition to enforcement to help understand this complex problem. Going beyond external regulatory systems, past research have shown that occupational safety can be improved in accident prone areas by changing the work ergonomics and equipment safety features (Sheehy and Chapman, 1987). Holcroft and Punnett (2009) have conclusively shown that the most productive path to reducing accidents is through a greater use of techniques from industrial psychology and organizational science.

The analysis presented in this study enables the identification of primary accident risk factors for the wooden furniture industry. Although, the risks associated with the immediate work environment (such as air-borne dusts from machining operations, noise emission, chemicals exposure and manual handling of materials) are often of concern to workers the workers in line with the prevailing "3D environment" (Gazo *et al.*, 2002), it is the prevailing safety climate within the wooden furniture sector that creates the culture of safety. In this context, the senior management of the organization need to do more than just pay lip service to safety and accident prevention, as they need to cultivate an organizational culture that truly believes in and values safety. Leadership for safety must also be shown throughout the managerial ranks in the organization, especially by the plant manager and supervisors (Clarke, 2006b). The human resource practices that ensure a workforce that can meet goals for safety, productivity, and quality is valuable for increasing safety performance.

Hence, as shown in this study, the accident prevention measures taken as part of the standard operating procedures on the factory shop-floor has the strongest influence on creating the highest safety climate, as previously reported by Michael and Leschinsky (2003). Although training and workers' characteristics plays a role in the prevailing safety climate, their influence is somewhat limited by the quality of the workforce in the Malaysian wooden furniture industry, which is predominated by contract foreign-workers. According to Clarke (2006b), the characteristics of the workforce is crucial in determining the motivation training and accident prevention and as shown in this study, appears to limit the influences of training and supervision on the rate of accidents in the wooden furniture industry.

Industrial implications: Health and safety regulations alone will not reduce, if not eliminate the work environment related accidents in the wooden furniture industry. In the case of Malaysia, the governing legislations are the Occupational Safety and Health Act (1967) and the Factories and Machinery Act (1994), together with the supplementing regulations Minerals Dust Regulations in (1989) and Noise Exposure Regulations (1989), have been somewhat generally applied throughout the industry with minimal effect on reducing the rate of accidents in the wooden furniture industry (Ratnasingam *et al.*, 2010a). With growing degree of automation and the increasing influx of contract foreign workers, the adaptability of these legislations to the present day work environment may be limited. Hence, as suggested in this study, policy makers must redress the existing legislations and its applicability in reducing, if not avoiding, accidents within the highly competitive wooden furniture industry.

Nevertheless, the findings of the study enunciates the fact that it's the management's commitment and built-in safety precautions that would ensure a safe work environment, which in turn would ensure accident-free work environment, which will in turn create a productive workforce (Ratnasingam *et al.*, 2010a). Managers of wooden furniture mills would be wise to remember that a successful safety program not only requires their own buy-in, but also requires bottom-up involvement from the

workforce. An effective system of manufacturing practices with built-in safety precautions, as advocated by the ISO 18000 scheme will encourage the safety-related involvement of all employees, is even more valuable when dealing with contract foreign-workers, as in the case of the Malaysian wooden furniture industry, to drive for improved safety performances in the wooden furniture industry.

CONCLUSIONS

Even though the working environment in the wooden furniture industry is deemed unsafe, in reality the prevailing work environment related accidents in the wooden furniture manufacturing industry is dependent on the prevailing safety climate in the factory as well as the workers' characteristics. Improving safety performance should be a primary concern for managers at all levels, as it has far reaching economic and social bearings in the competitive wooden furniture manufacturing industry.

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