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Safety leadership and safety performance in petrochemical industries: The mediating role of safety climate

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ABSTRACT

This study examines the relationship among three latent variables: safety leadership, safety climate, and safety performance. Employees from 23 plants in seven departments of a petrochemical company in central Taiwan completed a questionnaire survey. From this, a sample of 521 responses was randomly selected. Structural equation modeling (SEM) analysis using the AMOS 5.0 was employed to test the hypothesized model relating the above-mentioned variables. The results indicate that the model was supported, and that safety climate mediated the relationship between safety leadership and performance. Practical implications of these results for process safety management in the petrochemical industries are discussed.

1. Introduction

The petrochemical industry is mainly divided into three components: upstream, midstream, and downstream. The upstream sector includes the production of basic raw materials (such as ethylene, propylene, butadiene, benzene, toluene, and xylene); the midstream sector includes the production of intermediates (such as polyethylene, polypropylene, and polybutadiene); and the downstream sector includes the process and manufacturing of various by-products (such as plastic or rubber products) (Huang, 2007). During the manufacturing, transport, and storage of petrochemical materials, an employee may be exposed to a wide range of occupational hazards such as fires, explosions, toxins, illnesses, and other job related risks.

According to the statistics of Council of Labor Affairs, Executive Yuan, Taiwan (CLAEYT, 2008) from 2005 to 2007, Taiwan's overall frequency of disability (FD) was 2.51, 2.14, and 2.21, while severity of disability (SD) was 325, 219, and 213. This indicates job related accidents in Taiwan had decreased year by year. Yet, during the same period, the FD (2.71, 2.41, and 2.46) and SD (342, 244, and 213) of manufacturing sector were actually higher than the nationwide average. Consequently, people have become increasingly concerned about the sector's occupational safety and health. Furthermore, occupational hazards within the other three sectors (chemical materials manufacturing, rubber products manufacturing, and plastic products manufacturing) are bad enough that demand immediate attention (see Figs. 1 and 2). Fig. 1 demonstrates the FD numbers from those three sectors from 2005 to 2007. Fig. 2 shows that the chemical materials manufacturing sector ranked second in 2005 in terms of SD, and first from 2006 to 2007. Those numbers imply that safety problems within the chemicals material manufacturing sector is getting more serious, and the need to improve its safety performance is increasingly urgent.

Occupational hazards and safety performances are affected by complex reasons. O'Dea and Flin (2003) explored relevant factors associated with positive safety outcomes (incidents, accidents, and near misses), and narrowed them down to four basic factors: senior management factors, management factors, supervisory factors, and employee factors. Senior management factors included safety attitude, leadership style, and trust. Management factors were divided into seven items: commitment to safety, involvement in safety, priority of safety, leadership style, interaction, communication, and humanistic management practice. Supervisory factors included supportive supervision, supervisor

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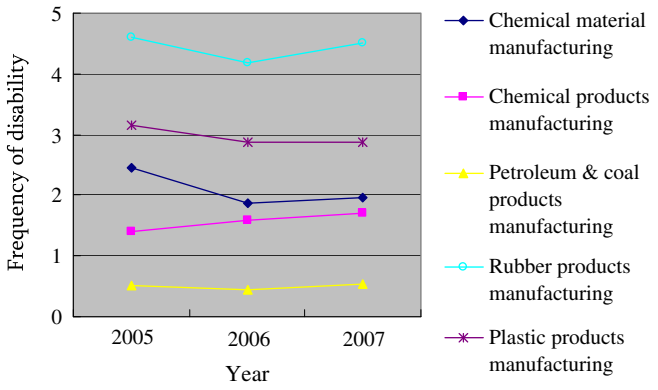

Fig. 1. Taiwanese petrochemical industries frequency of disability, 2005–2007.

involvement, supervisor autonomy, and participative supervision. Finally, employee factors were divided into five items: worker involvement, worker autonomy, worker risk perception, worker cohesion, and worker motivation. Those factors covered a wide range of aspects. They included safety leadership (at senior, middle, and first-line management levels), safety culture/climate, and employee behavior.

Clarke (2000) proposed a theoretical model relating to safety culture and its influence on safety behavior, discovering that safety culture affects safety behavior through two mechanisms: 1) directly through the development of latent failures; and 2) indirectly through the development of a work climate. Latent failures were caused by organizational or management negligence (such as management decision-making oblivious to the issue of safety) that could result in unsafe employee behavior. The work climate tended to serve as a frame of reference for safe or unsafe behaviors. Those behaviors included safety violations, accident reporting, incidents and near misses, and pro-role safety behaviors.

Safety behavior is a component of safety performance (Neal & Griffin, 2002). Safety performance is attributed to safety behavior (Garavan & O'Brien, 2001). Clarke's model suggested that two important prior causes greatly affect safety behavior and performance: safety leadership and safety climate. Guldenmund (2000) described how the process of safety culture affects safety behaviors, in which he modified the original Eagly and Chaiken (1993) model and pointed out that the basic assumptions were the core of safety culture. These assumptions imply that decision on what is acceptable safety behavior is better accomplished by first controlling the acceptable group behavior. These assumptions may include group habits, rewards or punishments, norms.

Kuo, Tsaur, and Chang (2006) pointed out that if an institution has a well-established safety culture, then safety values and beliefs

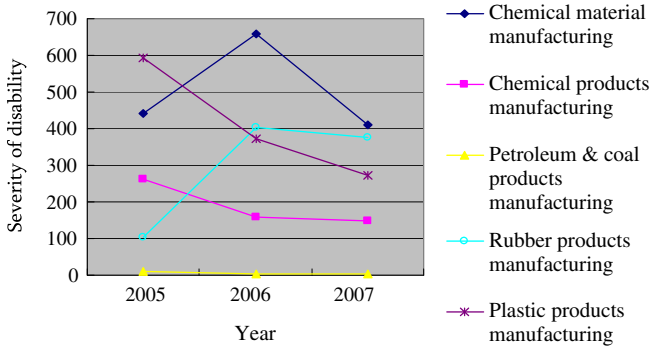

Fig. 2. Taiwanese petrochemical industries severity of disability, 2005–2007.

can be well integrated into working life. Only through such a viable safety-conscious workforce can a common understanding of labor safety behavior be achieved.

Thus, safety leadership, safety climate, and safety performance affect each other in many ways. Fig. 3 shows the relationship among these three variables. Past empirical studies from other industries support this claim (e.g., the food and beverage industry by Barling, Loughlin, & Kelloway, 2002; metal processing industry by Zohar, 2002; the glassware manufacturing industry by Clarke & Ward, 2006; and higher education industry by Wu, Chen, & Li, 2008). Based on empirical evidence, the following hypotheses can be asserted:

H1. Safety leadership positively impacts safety climate in petrochemical industries.

H2. Safety leadership is positively related to safety performance in petrochemical industries.

H3. Safety climate partially mediates the effects of safety leadership on safety performance in petrochemical industries.

2. Methods

2.1. Population and sample

The study focused on one chemical material manufacturing industry in central Taiwan; it included 23 plants in seven business departments: plastics, polyolefin, Tairylan, chemicals, maintenance, inspection, engineering, and construction. A survey was conducted in which 1556 employees served as the target population; 1460 employees were male (93.83%) and 96 were female (6.17%). The research adopted simple random sampling to select 1200 participants. A questionnaire, along with a souvenir and reply envelope, was sent to each participant. Later, 1079 responses were received. After subtracting 38 invalid responses, the result was 1041 viable responses serving as the data pool for subsequent analyses. Those viable responses represented a response rate of 86.75%.

The analysis started out by first randomly splitting responses into two sub-sample groups (N1 = 520 and N2 = 521). The first sub-sample (N1) used for the pilot study which was designed to develop measures (results of N1 item analysis and exploratory factor analysis have been published in a journal by Wu, Lin, & Shiau, 2009). The second sub-sample (N2) verified the relationship among safety leadership, safety climate, and safety performance. For N2, the average age was 35.53 years old (SD = 7.30), average year of work experience was 10.00 years (SD = 6.73), 91.75% were male, and 58.35% were basic level employees, 59.12% had always worked on a day shift, and 40.69% were on a rotating shift basis.

2.2. Measures

The questionnaire included four major parts: general information, safety leadership scale (SLS), safety climate scale (SCS), and safety performance scale (SPS). General information contained

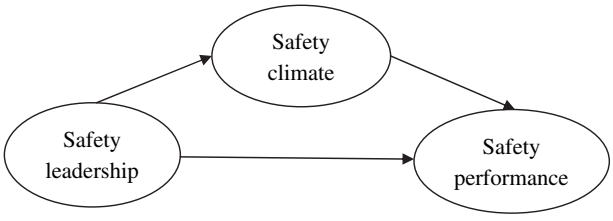

Fig. 3. Path diagram of proposed model (adapted from Wu et al., 2008).