Exploratory study on safety climate in Chinese manufacturing enterprises

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A B S T R A C T

This study was conducted in eastern cities of China; 1060 employees were sampled from 144 enterprises located in East China, and 796 (75.1%) responded validly. The level of safety climate of Chinese manufacturing enterprises as well as the differences in safety climate between large enterprises and small and medium-sized enterprises (SMEs) were examined. This study revealed that the safety climate level that the employees' perceived was rather low in Chinese manufacturing enterprises, and differences in terms of mean scores of total safety climate, factors composing the safety climate, and items to measure this climate between large enterprises and SMEs were statistically significant (at p < 0.05). Among all the factors, the largest difference between large enterprises and SMEs was the employees' perception of safety climate, followed by management support. It suggests that SMEs should pay more attention to safety training and management support to improve the safety climate.

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1. Introduction

In recent years, with rapid development of industries and the improvement of people's living standards in China, various accidents in productions have increased surprisingly, which have directly affected the healthy development of China's economy. The official statistic data showed that among the accidents occurring in China in 2006, the traffic ones accounted for 79.3% of the total deaths, ranking the first; the industrial ones, 12.7%, the second (http://www.chinasafety.gov.cn/). Liu et al. (2005) showed that the industrial accidents occurring in China ranked the first in the world in terms of the total death toll.

According to the statistics of Chinese State Administration of Work Safety, the casualty in small and medium-sized enterprises (SMEs) exceeded in large enterprises in past few years. However, SMEs have long received less attention than large enterprises from researchers of Occupational Health and Safety (OHS) in China, while in Europe the safety issues of SMEs have been concerned broadly, and the studies on these issues are available easily (FIOH, 1998).

Recently, there has been a movement away from safety measures purely based on retrospective data or “lagging indicators” such as fatalities, lost time accident rates and incidents, towards so called “leading indicators” such as safety audits or measurement of safety climate (Flin et al., 2000; Mohamed, 2002). It is expected that these predictive measures could monitor safety condition and reduce accidents. This can also be viewed as a switch from “feedback” to “feed forward” control (Falbruch and Wilpert, 1999).

The term “safety climate” which may firstly be used by Zohar (1980) was defined as a summary of molar perceptions that employees shared about their work environment. Zohar deemed that safety climate was related to safety condition of an organization directly; moreover, analyzing employees' perceptions of safety climate could identify the areas requiring reforming in an organization. Safety climate was considered to be a part of organizational climate (Lin et al., 2008) and reflected the employees' attitudes and perceptions at a particular time and a particular place (Schneider and Gunnarson, 1991; Cox and Flin, 1998; HSE, 1999). Safety climate was also believed to influence the safety behavior of employees at the individual, group, or organizational level (Smith et al., 2005).

In the past decades, safety climate has been recognized as a fundamental and ultimate solution for improving workplace safety in various industries. A substantial amount of researches (Neal et al., 2000; Mohamed, 2002; Oliver et al., 2002; Vredenburgh, 2002; Smith et al., 2006; Arezes and Migual, 2008) showed that lower workplace accident rates were associated with improved safety climates.

As to the safety climate in manufacturing enterprises, there were a lot of investigation reports in many countries. For instance, Zohar (2000) found that safety climate predicted micro-accident records at a manufacturing plant. Baek et al. (2007) reported the level of safety climate in Korean manufacturing industry, and found the underlying problems.
However, as we know, there are very few studies on safety climate issues in China, especially, no one on safety climate of manufacturing industry. Therefore, it is necessary to investigate the safety climate in manufacturing enterprises and find the underlying problems, so as to offer a reference for safety management of manufacturing enterprises, and reduce the industrial accidents and the occupational hazards.

The purpose of this paper is to investigate the status of safety climate of manufacturing enterprises in China, and to explore whether there is a significant difference in safety climate between large enterprises and SMEs. This study may offer a reference for safety management to China's manufacturing enterprises, especially SMEs, and for studies on safety climate in other industries. The ultimate goal of this study is to facilitate the establishment of the safe and healthy environment for workers, to reduce industrial accidents and occupational hazard.

2. Methods

In the study of safety climate conducted by Lin et al. (2008), a questionnaire with 21 items was designed for all of the industrial sectors in Fujian province in Southeastern China. These 21 items were classified into seven factors: (1) safety awareness and competency, (2) safety communication, (3) organizational environment, (4) management support, (5) risk judgment, (6) safety precautions and (7) safety training. In this study each participant was asked to rate each item using a five-point Likert scale (1 = strongly disagree; 5 = strongly agree).

According to the characteristics of manufacturing industry, we developed a 6-factor structure model, in which the 21 items given by Lin et al. were classified into the following factors: employees' safety commitment (the Safety Climate Factor 1, denoted by SC1), management support (SC2), risk judgment (SC3), safety communication (SC4), employees' safety competency (SC5), and safety training (SC6).

Thousand sixty employees were then sampled from 144 manufacturing enterprises located in East China (Shandong, Zhejiang, and Jiangsu province) in 2007 and 2008. Of the 144 enterprises, 34 (23.6%) were selected from the list of Chinese large enterprises which was issued by National Bureau of Statistics of China in 2006, and the rest (110) are SMEs, selecting randomly from the eastern region of China. Fifteen employees were selected randomly from each large enterprise, and 5 from each SME. The enterprises which were sampled in this study distributed over the following manufacturing industries: food, steel, paper, electronic and electrical engineering, petrochemicals, chemicals etc., which may have potential accidents such as toxic release, fire, mechanical injury and electric shock.

Seven hundred and ninety six (75.1%) complete and valid questionnaires were received from the 1060 respondents. Of the complete and valid questionnaires, majority (77.5%) respondents have had at least high school education, more than one-half (53.1%) have worked for the organization for five years or more at current work place. 46.7% of valid responders were employed at current work place. 46.7% of valid responders were employed at current work place. 46.7% of valid responders were employed at current work place. 46.7% of valid responders were employed at current work place. 46.7% of valid responders were employed at current work place.

After the questionnaires were returned, the valid data were input into an Excel spread-sheet, and transferred into a data file of Statistical Package for Social Sciences (SPSS) to run a statistical analysis. Some of the 21 items were negatively worded, and these numerical scores were reversed to positive. Based on these data of the large scale survey, we conducted confirmatory factor analysis (CFA) on Lin's 7-factor-model and our 6-factor-model to test which is better. We then used the better one to study the differences of safety climate between large enterprise and SME. In the following analysis, one-way ANOVAs on the grand mean scores over 21 items and the factors of safety climate were calculated with two kinds of enterprise (large enterprise vs. SME) to test the differences of total safety climate and its factors between the two kinds of enterprises.

3. Result

The result of CFA on the alternative models indicated that the 7-factor structure of Lin's model could not be accepted based on the data in our survey, while the 6-factor structure model of ours had a very good goodness-of-fit measures.

The alphas of the six factors of our model were 0.88 for SC1 (employees' safety commitment), 0.85 for SC2 (management support), 0.82 for SC3 (risk judgment), 0.84 for SC4 (safety communication), 0.84 for SC5 (employees' safety competency), and 0.83 for SC6 (safety training).

The employees' perceptions of safety climate in Chinese manufacturing enterprises were shown in Fig. 1. The mean score of total safety climate (TSC) and its standard deviation (in parentheses) were 3.60 (0.64), and the means (corresponding standard deviation in parentheses) of the six factors were 3.83 (0.84), 3.71 (0.88), 3.72 (0.81), 2.84 (0.96), 3.94 (1.02), and 3.32 (1.13), respectively. Among them, SC3 (employees' safety competency) with the highest mean was on the level of "agree", whereas SC4 (safety communication) with the lowest mean fell between "disagree" and "Neither agree nor disagree". SC1 (employees' safety commitment), SC3 (risk judgment), SC2 (management support), and SC6 (safety training) fell between "uncertainty" and "agree". This result suggested that the employees had the highest perception of employees' safety competency and the lowest perception of safety communication in safety climate in China's manufacturing enterprises.

The difference of mean scores of safety climate between large enterprises (3.74) and SMEs (3.48) was significant. A one-way ANOVA for mean scores of safety climate was calculated with different enterprise sizes (large enterprises vs. SMEs), and produced a main effect of enterprise size, F = 33.158 (p < 0.05) (shown in Table 1); the mean of the safety climate scores of SMEs (M = 3.48, SD = 0.58) was smaller than that of large enterprises (M = 3.74, SD = 0.67). This result revealed that the safety climate of SMEs was significantly worse than that in large enterprises in China's manufacturing industry.

We have performed in-depth interviews with some managers and workers in SMEs to discuss why the safety climate in SMEs was worse than that in large enterprises. Many managers felt lack of training because they were too busy in production. A lots of workers also felt lacking of training, which led them to lack of safety knowledge, unknowing how to protect themselves.

Fig. 1. Safety climate in Chinese manufacturing enterprises. (Key: employees' safety commitment (ESC1); management support (MS); risk judgment (RJ); safety communication (SC); employees' safety competency (ESC2); safety training (ST); total safety climate (TSC).
Table 1
ANOVA for mean safety climate scores in two enterprise groups with different sizes.

<table>
<thead>
<tr>
<th></th>
<th>Sum of squares</th>
<th>df</th>
<th>Mean square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between groups</td>
<td>13,012</td>
<td>1</td>
<td>13,012</td>
<td>33.158</td>
<td>.000</td>
</tr>
<tr>
<td>Within groups</td>
<td>311.591</td>
<td>794</td>
<td>.392</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>324.603</td>
<td>795</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2
Mean scores of each factor and corresponding differences between large enterprises and SMEs.

<table>
<thead>
<tr>
<th>Factors</th>
<th>Large enterprise mean score (rank)</th>
<th>SMEs mean score (rank)</th>
<th>Differences</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESC₁</td>
<td>3.93 (2)</td>
<td>3.75 (2)</td>
<td>0.18</td>
</tr>
<tr>
<td>MS</td>
<td>3.87 (3)</td>
<td>3.56 (4)</td>
<td>0.31</td>
</tr>
<tr>
<td>RJ</td>
<td>3.84 (4)</td>
<td>3.61 (3)</td>
<td>0.23</td>
</tr>
<tr>
<td>SC</td>
<td>2.95 (6)</td>
<td>2.75 (6)</td>
<td>0.20</td>
</tr>
<tr>
<td>ESC₂</td>
<td>4.07 (1)</td>
<td>3.83 (1)</td>
<td>0.24</td>
</tr>
<tr>
<td>ST</td>
<td>3.55 (5)</td>
<td>3.13 (5)</td>
<td>0.42</td>
</tr>
</tbody>
</table>

Key: employees' safety commitment (ESC₁); management support (MS); risk judgment (RJ); safety communication (SC); employees' safety competency (ESC₂); safety training (ST).

Table 3
ANOVA for mean score of each factor in two enterprise groups with different sizes.

<table>
<thead>
<tr>
<th>Factors</th>
<th>Sum of squares</th>
<th>df</th>
<th>Mean square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESC₁</td>
<td>6.853</td>
<td>1</td>
<td>6.853</td>
<td>9.714</td>
<td>.002</td>
</tr>
<tr>
<td>MS</td>
<td>19.808</td>
<td>1</td>
<td>19.808</td>
<td>26.366</td>
<td>.000</td>
</tr>
<tr>
<td>RJ</td>
<td>10.991</td>
<td>1</td>
<td>10.991</td>
<td>16.934</td>
<td>.000</td>
</tr>
<tr>
<td>SC</td>
<td>7.903</td>
<td>1</td>
<td>7.903</td>
<td>8.743</td>
<td>.003</td>
</tr>
<tr>
<td>ESC₂</td>
<td>11.658</td>
<td>1</td>
<td>11.658</td>
<td>11.380</td>
<td>.001</td>
</tr>
<tr>
<td>ST</td>
<td>35.322</td>
<td>1</td>
<td>35.322</td>
<td>28.791</td>
<td>.000</td>
</tr>
</tbody>
</table>

Key: employees' safety commitment (ESC₁); management support (MS); risk judgment (RJ); safety communication (SC); employees' safety competency (ESC₂); safety training (ST).

Table 4
Differences (above 0.30) in mean item scores between two enterprise groups with different sizes.

<table>
<thead>
<tr>
<th>Item</th>
<th>Large enterprises</th>
<th>SMEs</th>
<th>Differences</th>
</tr>
</thead>
<tbody>
<tr>
<td>SC₁–2</td>
<td>3.83</td>
<td>3.53</td>
<td>0.30</td>
</tr>
<tr>
<td>SC₁–5</td>
<td>3.73</td>
<td>3.20</td>
<td>0.53</td>
</tr>
<tr>
<td>SC₁–1</td>
<td>3.67</td>
<td>3.14</td>
<td>0.53</td>
</tr>
<tr>
<td>SC₁–2</td>
<td>3.42</td>
<td>3.11</td>
<td>0.31</td>
</tr>
</tbody>
</table>

SC₁–2: management concerns safety problems at my workplace; SC₁–5: I can get safety information from the company; SC₁–1: I am trained with safety knowledge; SC₁–2: safety training fits to my job.

4. Discussion

The main purpose of the study was to explore the level of safety climate in China’s manufacturing industry. According to above statistical analyses, the mean score of total safety climate was 3.60, falling between “Neither agree nor disagree” and “agree”. This result showed a weak safety climate in China’s manufacturing enterprises, which may reflect the status of safety climate in East China’s manufacturing industry. Generally speaking, manufacturing industry was thought to be one of “high reliability” industries, where significant hazards were rarely realized (Flin et al., 2000). So the mean score (3.60) of population safety climate implied that there was some unsafety problem. Smith et al. (2006) found that in America the mean score of total safety climate in manufacturing industry (3.75) was lower than that in rest industries, while in our study it was even lower than 3.75. One explanation was that we employed different survey instrument or sample data in this study; another one, which should not be ignored, was that manufacturing enterprises in USA paid more attention to production safety than that in China. These two reasons may lead to the difference in perceptions and attitudes with respect to safety climate between employees in China and America. The descending order of the six factors by their average scores was as follows: employees' safety competency (3.94), employees' safety commitment (3.83), risk judgment (3.72), management support (3.71), safety training (3.32) and safety communication (3.24). This showed that Chinese employees had strong perceptions of employees' safety competency and employees' safety commitment, while weak perceptions of safety communication and safety training. This result showed that Chinese workers put more emphasis on the first two factors. This may result from the employees' familiarity (Robbins, 1993) which affected the perceptions when selecting. By contrast, employees may lack adequate knowledgeable on safety training and safety communication, resulting in their weaker perception of these facets.

This study found a significant difference in safety climate between large enterprises and SMEs, which confirmed our hypothesis. This finding was consistent with the result of (Garcia et al., 2004) study that employees in large enterprises exhibited stronger perception of safety and better safety climate than those in SMEs.

The difference of mean scores of the factor of safety training between large enterprises and SME was the largest one among those of the six common factors, and that of the factor of management support, the second. The factor of safety training can raise the levels of employees' quality, skills and the knowledge of safety, affect employees' safety commitment, and improve the employees' attitude to management, which may further improve the perception.
of management support. This may be the reason why the mean score difference of the factor of management support between large enterprises and SMEs ranked the second.

However, SMEs in China paid less attention to safety training than large enterprises (Zhang and Mei, 2005; Qiang et al., 2006). For saving costs, SMEs employed migrant workers extensively who lack basic knowledgeable on healthy and safety issues. Our survey showed that the safety training performed rarely on SMEs, which led to the frequent occurrence of accidents injuries. The reason why SMEs paid less attention to safety training may be that the employers viewed training as something wasting time (Raymond et al., 2003). Even though it is generally believed that training contributed to long-term production efficiency, SMEs usually ignored safety training due to that the benefits of safety training were neither clear nor immediate, moreover, the employers in SMEs were in keen for the production instead of the safety. By contrast with SMEs, large enterprises pay more cost for safety training in general, which changes the employees’ attitude to management, and improves the perception of management support. These results are consistent with our in-depth interviews. The previous studies (De-Joy, 1994; Grote, 2008) showed that management support was one of the strongest contributors to employees’ perceptions of safety climate, which makes employees feel more comfortable in raising concerns about safety issues. The significant difference in safety training has led to significant difference in safety climate between large enterprises and SMEs.

5. Conclusion

The present study demonstrated that employees had poor perception of safety climate in questionnaire-based measures in manufacturing enterprises in China. The result showed that safety climate in large enterprises was significantly better than that in SMEs. The largest and the second large differences of mean score were found in the factors of safety training and management support between large enterprises and SMEs among the six common factors. It suggested that improving workers’ safety training is of paramount importance; the safety training should be put focus on to reduce industry injuries; and the management support is another vital factor in manufacturing enterprises, especially in SMEs in China. We hope that these findings can be helpful to improve the environment of safety and health in the workplace.

Acknowledgements

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References


