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Practical application of safety climate: A case study in the Taiwanese steel industry

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ABSTRACT

The purpose of this study was to test the applicability of a Chinese version of a questionnaire designed for measuring safety climate and to connect scores with occupational accidents, using the steel industry in Taiwan as exemplar. The study used safety climate as a lagging indicator of accident records from a period of three years prior to measurement of safety climate and to investigate when the measurement expired. Results showed that group-level safety climate provides a good lagging indicator of occupational accidents. Also, the data revealed meaningful variation between different departments in a single company. This information could be applied to improve workplace safety in an efficient manner and protect employees from occupational hazards. When considering the best period of time over which to measure safety climate, results suggested one year was preferable to a longer time period.

1. Introduction

1.1. Steel industry

As industries and workplaces develop, issues in work safety are increasingly important. This is especially true for occupational accidents, which have received growing attention. Based on data from the Occupational Safety and Health Administration of the Ministry of Labor in Taiwan, manufacturing was the riskiest industry in 2016, with a total of 30.25% of all occupational accidents, leading to 14,628 injuries, 1178 disabilities and 162 fatalities. Furthermore, this report also indicated that fabricated metal products manufacturing, which included the iron and steel industry, was the most dangerous field within manufacturing, contributing 14.15% of all occupational accidents in manufacturing industry. Due to the severity of possible outcomes, occupational safety is an extremely important issue. In the past few decades, researchers have devoted much effort to studying the antecedents of workplace accidents, in an effort to find ways to manage occupational risk (Attwood et al., 2006a,b; Swaen et al., 2004; Willamson and Feyer, 1990). Traditional safety research focused on ad hoc analysis based on historical records, using past accidents rates to assess the core causation, such as Human Factor Analysis and Classification System (Shappel and Wiegmann, 2000), Fault Tree Analysis (Ericson and Ll, 1999), Analytic Hierarchy Process (Saaty, 1990) and etc. Nowadays the accident analysis methodology develops new approaches to investigate the accident analysis in different angle; safety climate is one of the growing interest fields.

1.2. Safety climate

Safety climate was defined by Zohar (1980, p 96) as "shared employee perceptions about the relative importance of safe conduct in their occupational behavior". Safety climate was also conceived as both a leading and lagging indicator of safety events, such as safety behaviors and occupational accidents (Payne et al., 2009). For example, researchers found that safety climate could be used to detect hazards in the workplace, assisting managers with taking remedial actions to prevent the occurrence of occupational accidents (Cooper and Phillips, 2004; Flin, Mearns, O'Connor and Bryden, 2000; Nahrgang et al., 2007). Recent studies of safety climate put much effort into building theory, methodology, and conceptualizations of constructs (Christian et al., 2009; Guldenmund, 2000; Zohar, 2010), but relatively little attention had been given to the practical applications of the previously developed safety climate questionnaire (Bahari and Clarke, 2013; Barbaranelli et al., 2015), especially in non-Western countries. Other practical applications of safety climate focused on developing specific questionnaires based on industry characteristics, assessing safety climate perceptions by administering the questionnaire to staff members of the target industry, and then further investigating safety climate through exploratory factor analysis and confirmatory factor analysis (Huang et al., 2013). Past practical applications of safety climate included the specific industries such as trucking industry (Arboleda et al., 2003; Huang et al., 2013), construction industry (Fang et al., 2006; Gillen et al., 2002; Mohamed, 2002; Zhou et al., 2010), production

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industry (Milijić et al., 2014) and health care industry (Chakravarty et al., 2015; Jimmieson et al., 2016). However, little research that we are aware of has examined safety climate in the steel industry (Roostaei et al., 2011), especially for non-Western country; our study seeks to extend safety climate research to fill this gap in the literature.

1.2.1. Multilevel framework of safety climate

Various studies had shown that even in the same organization, there are still differences in safety climate between levels and sections within a company (Gao et al., 2015; Glendon and Litherland, 2001; Zohar, 2000). A multilevel model of safety climate was developed to discuss how two levels of supervision within the company influence frontline workers' shared perceptions about safety. (Zohar, 2003; Zohar and Luria, 2005). The higher level examined organizational-level safety climate perceptions, focused on the top managers involved in policy making and establishment of procedures. The top managers were responsible for deciding the company's main direction and determined the priority of competing factors, such as productivity and worker safety. Placing a higher priority on fulfilling production demands may sacrifice workers' safety. The lower level focused on group-level safety climate perceptions, including frontline workers' direct supervisors, who were in charge of executing the procedures developed by top managers. Frontline workers' direct supervisors,also sometimes called "first-line managers" or "first-line supervisor", were characterized by direct contact with operators and responsibility for mediating communication between the top managers and workers within the organization(Kines et al., 2011; Kouabenan et al., 2015). When top managers decide the general priorities and give instructions to lower-level supervisors, the supervisors often had the flexibility to decide the degree of compliance. Thus, divergence and inconsistency between the levels of organization could affect the organizational operation. Top managers and lower-level supervisors both face a variety of competing demands in the workplace (e.g., worker safety vs. productivity); the concerns of such competing situations may influence frontline workers' safety climate perceptions and potentially become the causation of occupational accidents (Zohar, 2000, 2010; Zohar and Luria, 2005). For example, if top managers place the highest priority on productivity, supervisors could decide to follow the instruction or, alternatively, to put more effort into assuring frontline workers' safety so that workers could receive more protection and a safer work environment. Conversely, if top managers place the highest priority on workers' safety, supervisors could decide to follow the instruction or could choose to instead aim for higher production efficiency. As the company's policies and instructions pass through different directors, lack of coordination between top managers and lower-level supervisors could be a potential factor harming occupational safety (Zohar and Luria, 2005).

1.2.2. Safety climate issues in the steel industry

As a high-risk and manpower-intensive industry, the steel industry is in urgent need of a method to deal with frequent occupational accidents. Safety climate is an important strategy to consider in efforts to understand and reduce accident occurrence in the steel industry, but there are multiple ways to examine safety climate in research. For example, safety climate can be both a good leading and lagging indicator of occupational accidents, as it serves both the alert and tracing function (Bergman et al., 2014; Payne et al., 2009; Payne et al., 2010). Furthermore, the steel industry provides a relevant example of issues related to multiple levels of management in organizations (Zohar and Luria, 2005). Steel industry organizations typically separate into different departments, due to the different operation processes. Thus, steel companies not only have top managers deciding on higher-level polices, but also have lower-level supervisors managing each department's manufacturing process. The company's policies often pass through the top managers to lower-level supervisors, making lower-level supervisors mediators between top managers (representing the organization) and frontline operators.

1.3. Connected data with history record

Bergman et al. (2014) proposes that the relationship between safety climate and accidents depends on three primary factors: (a) the kind of accident; (b) the time period over which incident rates are accumulated; and (c) whether safety climate is a leading or a lagging indicator of incidents. Therefore, as one of these three primary factors, the consideration of time period was important to our study. Safety climate was a dynamic cognition and changes over time (Gao et al., 2015; Neal and Griffin, 2006). Different time periods were expected to affect the accuracy of measurement and lead to differential results. If organizations used inappropriately timed safety climate scores and accident records, they might follow the "wrong" information and therefore took inappropriate remedial action (Gao et al., 2015; Neal and Griffin, 2006; Neal et al., 2000).

When using safety climate as a leading indicator, measurement of safety climate was conducted prior to collection of accident records, with the expectation that safety climate scores could signal hazards ahead of their occurrence. On the other hand, when using safety climate as a lagging indicator, focused on the retrospective aspect, measurement of safety climate was conducted after the accident records, with the expectation that safety climate scores served as an antecedent of occupational accidents (Payne et al., 2009). Both measurement strategies (i.e., leading and lagging indicators) observed the connection of safety climate and accidents; the difference was that a leading indicator would be influenced by the time period of measurement and accident records, while a lagging indicator would be influenced by the reaction after an accident occurred. An organization's reaction to an accident might have a stronger impact on employees' safety concerns than the accident itself (Neal et al., 2000; Payne et al., 2009). Another advantage of using safety climate as a leading indicator was that organizations does not need to wait a period of time for accident records to be collected (Gao et al., 2015; Neal et al., 2000; Payne et al., 2009). Payne and colleagues' (2009) literature reviewed compiled all of the published safety climate research and revealed that retrospective studies greatly outnumber prospective studies.

Several researchers investigated the use of time period to determine when safety climate-accident relationships expired. Payne et al. (2009) showed empirical support for both the leading and lagging functions of safety climate. Later research by Payne et al. (2010) stated that the safety climate measurement process should be conducted within one year before or after the accident records. Further, Bergman et al. (2014) separated the work-related incident into three kinds based on severity and discussed each accident's relationship with safety climate scores as both leading and lagging indicators within a four-year period surrounding measurement of safety climate. Results showed safety climate was a good leading indicator for less severe incidents over at least two years following safety climate measurement, as well as for and more severe incidents over three months following measurement. Additionally, safety climate served as a good lagging indicator for learning events, near misses, and safety incidents periods of time varying from one month to two years prior to safety climate measurement.

1.4. The current study

Altogether, the purpose of the current study was to verify whether the translated Chinese generic questionnaire of safety climate could be applied in non-western countries and steel industries. As for the practical application of safety climate research, we expected the generic questionnaire could be as a useful indicator of occupational accident. The time period analysis considered the relationship between safety climate and occupational accident within three years.