

Research on the Influence of Safety Climate on Safety Behavior: A Review

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Abstract: Safety issue is the main focus of industries and the society. Exploring the influence mechanism of safety climate on safety behavior is conducive to improving the safety performance of industries. Existing studies have confirmed that safety climate has a significant positive effect on employees' safety behaviors. This paper uses literature analysis to summarize the implication and extension of the concepts of safety climate and safety behavior, sorts out the dimensions of safety climate, and summarizes the influencing mechanism of safety climate on safety behavior. On this basis, combined with the research progress at home and abroad, this paper proposes and forecasts the future research trend of safety climate and safety behavior. This study clarifies the research status of the influence of safety climate on safety behavior and provides a foundation for the follow-up research in this field.

Keywords: Safety climate; Organizational climate; Safety commitment; Safety behavior

Publication date: June 2021; **Online publication:** June 30, 2021

1. Introduction

Safety has always been a major concern of industries, and it is the source of a large number of direct and indirect costs ^[1]. According to the statistics of China's Ministry of Emergency Management, every year in an average at least 70,000 people are killed in work safety accidents, a figure that is among the highest in the world. Accidents can occur for a variety of reasons. In recent years, the theoretical and practical circles are keen to discuss how to use safety climate to explain and predict safety behaviors ^[2]. Foreign studies have found through a large number of theoretical and empirical evidence that the safety climate of an organization is significantly positively correlated with safety behaviors, and a good safety climate can increase employees' safety behaviors, thus reducing accidents and injuries ^[3-4]. In the field of domestic management, researches on safety behaviors are not the mainstream, and there are few researches exploring the influencing factors of safety behaviors, which is not conducive to improving the grim situation of production safety in China ^[5]. The research on the causes of accidents focuses on the industries working conditions, safety measures and other system factors, as well as micro factors such as individual personality traits. However, in-depth investigation of the accident site reveals that organizational climate factors such as safety communication, commitment, and management priority were mostly ignored ^[6]. By reviewing the literature, it is clear that the number of review articles on safety climate is now relatively low. The existing studies are mainly based on the literature published before 2012, which only briefly summarizes the structure, level and relationship between safety climate and safety indicators, and lacks the summary and sorting of the relationship between safety climate and safety behavior. To sum up, the current researches on safety climate are inadequate, most of which are confined to superficial discussion and qualitative

research. The research is behind the practice, the functionality is poor, and it cannot be a good solution to the real problem. As a result, studying the influence mechanism of safety climate on employee safety behavior is both theoretical and practical. This study comprehensively sorted out the concept, dimension and relationship mechanism of safety climate and safety behavior, also proposed the direction of future research on this basis.

2. Concepts of Safety Climate and Safety Behavior

2.1. Concept of safe climate

Safety climate originates from the general concept of organizational climate. Organizational climate is defined as employees' perception of the value of organizational safety^[7], and safety climate is considered as a subset of organizational climate. In recent years, scholars have defined the concept of safety climate roughly from two perspectives, cognitive and cultural, as shown in **Table 1**. At first, scholars expounded the safety climate from the perspective of perception and cognition. For example, Zohar believed that the safety climate was the common opinion of employees on the policies, practices and procedures related to safety within the organization^[8], which has been widely accepted and recognized for a long time. Clarke also believes that the safety climate is the employee's perception of the work environment related to safety^[1]. It explains the safety climate from the perspective of cognition, emphasizes the subjectivity of employees, attaches importance to their feelings and experiences, as well as reflects the transition of safety research from macro to micro. However, its shortcomings are also obvious. As an individual experience, cognition is inconvenient for scientific measurement, so far there are no unified scale to measure the safety climate. Recently, Saedi also pointed out that the current concept of safety climate is mostly based on descriptive perception, which is a somewhat narrow concept^[2]. Based on this, some scholars try to explain the safety climate from the perspective of safety culture, such as Mearns et al.^[9], Zhang et al.^[10] and Zou et al.^[11]. They regard the safety climate as a reflection or state of the safety culture and consider the two as an inclusive relationship. This provides a quantitative basis for the measurement of safety culture and expands the scope of safety culture. However, it also causes further confusion between the concepts of culture and climate, weakens the independence of the concept of safety climate, and is not conducive to the operation of empirical research.

In the field of Safety research, many scholars have followed Zohar's definition of safety climate^[8,14]. These studies enrich the implementation of safety climate and help scholars to expand the research on safety theory. At the same time, there is still no consensus on the concept of safety climate in the field of domestic safety research. The comprehensive arrangement of the concept of safety climate in this paper can provide research basis for domestic scholars.

2.2. Concept of safe behavior

Safety behavior is a kind of safety result, which refers to the response behavior taken by employees when they face safety matters at work. The evaluation of safety behavior in the past focuses on the compliance of employees with safety regulations, which is obviously too simple and biased. Neal et al. established a two-dimensional model of safety behavior based on Performance Theory of safety compliance and safety participation^[15]. Safety compliance refers to employees complying with the industry safety rules and regulations and carry out safety production in strict accordance with the prescribed procedures, which belongs to the category of task performance. Safety participation refers to employees' voluntary participation in safety activities to improve the safety environment. It is a kind of autonomous behavior and belongs to the category of situational performance. This classification has been in use for 20 years, providing many empirical studies with the concept of operational safe behavior^[16].

Table 1. The definition of safety climate

Perspective	Author (year)	Definition
From the perspective of perception	Zohar (1980)	Employees' common views on safety policies, practices and procedures within the organization.
	Neal & Griffin (2006) ^[12]	A perceived safety atmosphere is an individual's perception of policies, procedures, and practices to pay attention to workplace safety.
	Clarke (2010)	Employees' perceptions of a safety-related work environment.
	Xia et al. (2020) ^[13]	The safety climate is a true reflection of the environmental safety status of an organization or workplace. In the theory of enterprise safety, the safety climate of an organization is an employee's perception of whether the working environment is safe or not.
From the perspective of culture	Mearns, Whitaker & Flin (2003)	The safety climate is seen as a reflection of the underlying safety culture in the current state.
	Zhang et al. (2009)	Safety climate mainly refers to employees' safety attitude, safety belief and safety value, etc., which is one aspect of safety culture.
	Zou et al. (2020)	The safety climate is the "snapshot" of the safety culture, and the safety culture and the safety climate are a relationship of inclusion and inclusion.

3. Dimensions of Safety Climate

With the research on the definition of safety climate, the scholars have discussed how to measure the safety climate scientifically. According to the literature review of safety climate, these dimensions and measurements of safety climate in different times have the following in common: first, it recognizes that safety climate is a concept that must be tested at different levels. Second, it is recognized that the measurement of safety climate in different industries should be differentiated in dimension. Third, most studies on the dimensions and structure of safety climate contain several common contents: safety attitude, safety communication, safety awareness, safety commitment and safety management priorities. Although scholars' classification methods of safety climate are diverse and difficult to unify, we still find that these dimensions can be classified into the following categories according to different subjects:

- (1) Organizational management such as management commitment, safety priority, safety communication, safety training, safety policy and practice, and leadership style.
- (2) Job characteristics such as work schedule, influence of safety on promotion, work safety tension, structure and attribute of work quality.
- (3) Employee participation such as safety attitude, safety awareness, safety motivation, employee involvement and participation, colleague support.

The representative studies of Chinese and foreign scholars on the dimensions of safety climate are summarized in **Table 2.** as follows:

Table 2. Dimensions of safety climate

Author (year)	Dimensions
Zohar (1980)	Safety management attitude, the impact of safety behavior on promotion, the impact of work schedule on safety, the status of safety officials, safety guidance, safety training, safety risk perception, the impact of safety behavior on social status.
Neal & Griffin (2006)	Group safety climate (group level), perceived safety climate (individual level)
Christian et al. (2009)	Management commitment, human resource management practices, Safety systems, supervisory support, team processes, boundary management, risk and work pressure.
Morrow (2010) ^[17]	Safety management, colleague safety, work safety tension.
Bronkhorst (2015) ^[18]	Senior supervisor's safety priorities, supervisor's safety commitment, group norms and team behavior.
Beus (2010) ^[19] , Hofmann et al. (2017) ^[20]	Safety management commitment, safety priorities, safety policy, practice and procedure awareness, safety training, safety communication, employee participation in safety activities.
Newaz (2019)	Management commitment, supervisor behavior, colleague behavior, employee personal participation, safety rules.
Curcuruto et al. (2018) ^[21]	Management commitment, employee participation, safety training, safety communication, safety management system, policy, practice.
Pandit et al. (2019)	Management commitment to safety, supervisor support for safety, project level safety measures, worker stress.
Bian et al. (2019) ^[22]	Management commitment, safety policy, safety training, safety communication.

To sum up, many scholars have made some achievements in the dimension construction and measurement establishment of safety climate, but the existing classification standards are still not unified, and the authoritative scale is still not established. Therefore, it is worthy of further examination and discussion by future researchers on how to select a more reasonable dimension division standard and compile a corresponding scientific scale according to the research needs.

4. Influence of Safety Climate on Safety Behavior

Experts in the field of safety have proved that there is a positive correlation between safety climate and safety behavior ^[21]. Studies by different scholars have found that the influence mechanism of safety climate on safety behavior can be divided into direct influence and indirect influence, and the model diagram is shown below.

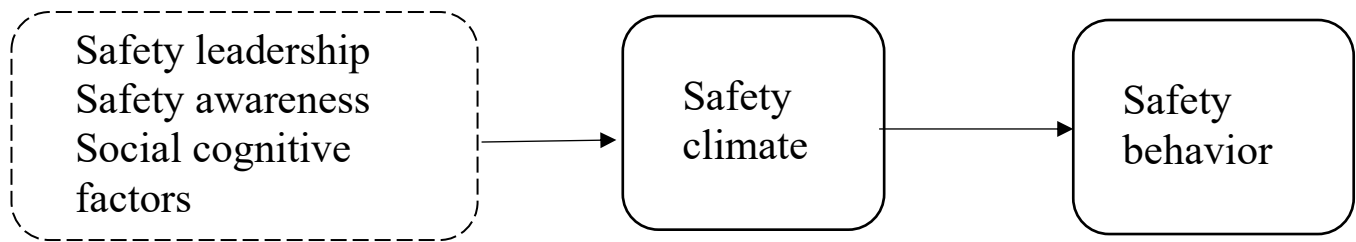


Figure 1. Mechanism of direct influence of safety climate on safety behavior

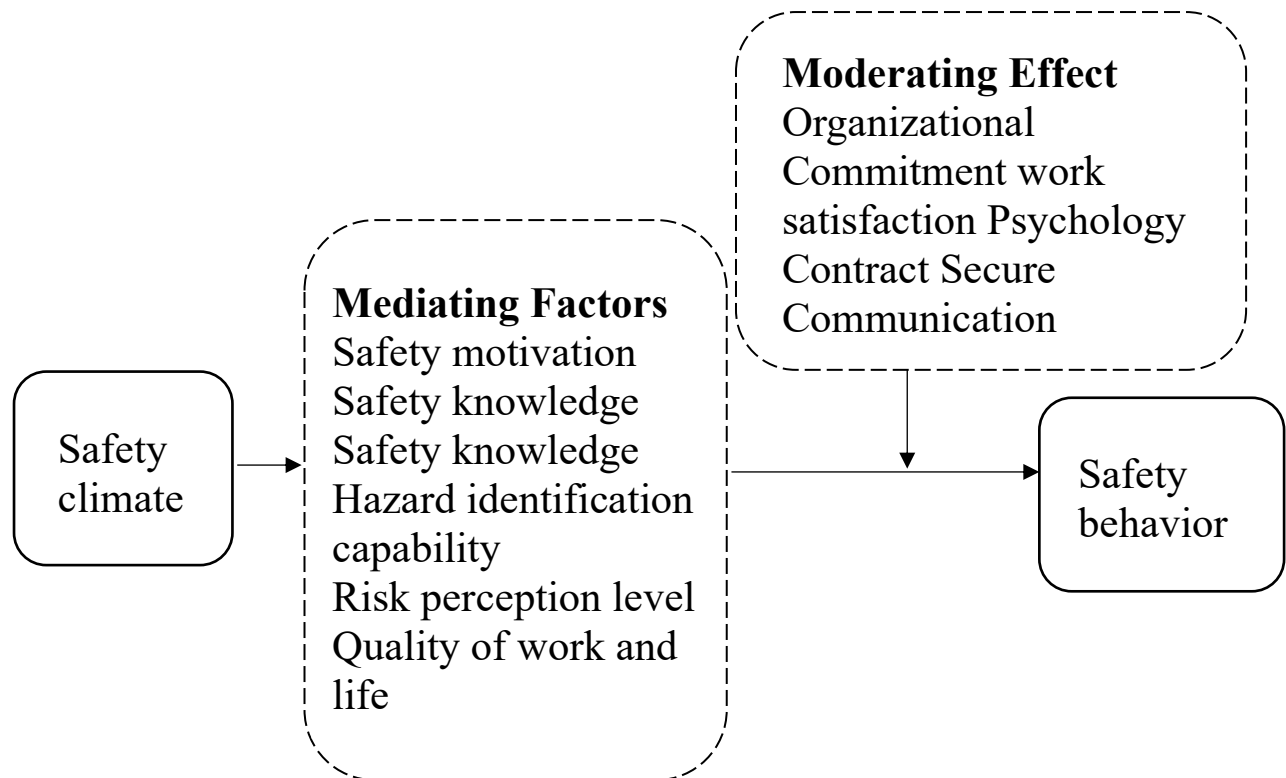


Figure 2. Indirect influence mechanism of safety climate on safety behavior

Among them, Clarke ^[23], Wang ^[24] and Bian et al. ^[22] have done a lot of researches on the direct correlation between safety climate and safety behavior, and they believe that Safety climate is a proximal factor in the influencing mechanism of employee Safety behavior. The studies of Neal ^[13], Christian ^[4] and Newaz et al. ^[16] have confirmed that there are mediating or regulating factors between safety climate and safety behavior. This is because with the deepening of research, scholars found that the effect of safety climate on safety performance is not completely consistent in different industrial backgrounds, and there may be regulatory factors between safety climate and safety behavior. In fact, in many studies, the relationship between safety climate and safety behavior is a comprehensive model, which not only has a direct correlation between safety climate and safety behavior, but also has been tested to play a role as a regulator or mediator in the model. In the study of the relationship between Safety climate and Safety behavior, in addition to the study of the direct and indirect relationship, the concept of Psychosocial Safety Climate (PSC) also appeared in recent years, emphasizing the importance of mental health and Safety. There are currently few studies in this field, but those that exist show the positive impact of a psychological safety climate on employee safety behavior. To summarize, while the research in this topic is relatively abundant, it is still insufficient. In the

future, we can focus on exploring more different regulatory or intermediary factors to further expand the research on the influencing mechanism of safety behaviors.

Table 3. Representative studies on the relationship between safety climate and safety behavior

Relationship Type	Authors (date)	Research design	Outcomes
Direct relationship: Safety climate is directly related to safety behavior	Clarke (2013)	Use the meta-analysis method to study the related literature; SEM was used to test the hypothesis model.	Perceived Safety atmosphere plays a partial mediating role in the relationship between transformational leadership and Safety participation. It plays an intermediary role in the relationship between transactional leadership and safety compliance.
	Wang et al. (2018)	A total of 164 questionnaires were sent to 15 construction teams, with data from both supervisor and employee levels. Use HLM software for statistical analysis.	Safety atmosphere positively regulates the positive correlation between individual safety consciousness and safety behavior.
	Bian et al. (2019)	A questionnaire survey was conducted among 260 petroleum and construction workers in Shandong province. SPSS17.0 software was used for statistical analysis of the data.	Both safety climate and psychological empowerment have a positive predictive effect on safety behavior.
	Hussain (2019) ^[25]	A PLS path model was established for data analysis of 396 truck drivers in Pakistan.	Safety climate has a significant negative effect on dangerous driving behavior (unsafe behavior).
Indirect relation: Safety climate is indirectly related to safety behavior	Neal & Griffin (2006)	A longitudinal sampling survey was conducted among more than 700 employees in Australian hospitals over five years.	Individual safety climate has a lag effect on safety behavior through safety motivation.
	Christian et al. (2009)	The antecedents and consequences related to safety behavior are examined through the meta-analysis path model.	Safety climate have positive influence on safety behavior through safety knowledge and safety motivation.
	Clarke (2010)	A safety behavior synthesis model is tested by meta-analysis path analysis.	Safety climate regulates safety behavior through employee work attitude (organizational commitment and job satisfaction).
	Hu et al. (2014)	268 questionnaires were distributed to large domestic	Safety climate has a positive influence on safety behavior

		groups, and the mediating effect method was used to conduct empirical tests on variables.	through part mediating effect of work and life quality.
	Newaz (2019)	In surveys conducted at five construction sites in Australia, 352 pieces of data were collected using automated answering systems with hand-held remote controls.	Safety climate has a positive effect on safety behavior through the regulation of psychological contract.
	Pandit et al. (2019)	Data of more than 280 workers at 57 construction sites in the United States were collected and empirically tested.	Safety climate influences safety behavior through hazard identification and risk perception level.
	Zamanni et al. (2020) ^[26]	The communication network of 36 excavator workers was analyzed with 259 valid questionnaires.	Safety climate regulates the mechanism of action on safety behavior through safety communication.
The relationship between psychosocial safety climate and safety behavior	Zadow (2017) ^[27]	The physical and psychological injuries of 214 employees in 18 teams of the hospital were investigated.	Safety climate was the strongest predictor of physical and mental injury at work. Psychosocial Safety and emotional exhaustion also play a role.
	Yu & Li (2019) ^[28]	A three-month cross-sectional survey was conducted in Shanxi Province, and 862 male employees were investigated from 30 coal mines. SEM and HLM models were used for empirical analysis.	The psychosocial safety climate can reduce the unsafe behaviors of miners through the mediating effect of job stress and job burnout.
	Mansoarn (2019) ^[29]	A questionnaire survey was conducted among more than 500 nurses in Canada.	The psychosocial safety climate has a significant influence on the avoidance behavior of nurses through the mediating effect of job burnout.

5. Conclusion and Future Research

This paper summarizes the concept, dimension, and relationship between safety climate and safety behavior, and finds that the concept of safety climate is still ununified, and its dimension and measurement are not scientific or comprehensive, which is hindering the development of empirical research in the field of safety behavior and the solution of various safety problems in industries. Although the relationship between them has been proved to be a positive correlation, its specific mechanism of action still needs to be further explored. Combined with previous research results, future research can be explored from the following aspects.

5.1. Expand the model of the relationship between safety climate and safety behavior

5.1.1. To strengthen the research on the influencing factors of the relationship between safety climate and safety behavior

The common antecedents of safety climate include factors at multiple levels, such as organization, team

and individual. These antecedent variables affecting safety climate on safety behaviour performance, such as leadership style, type, and power distance in safety leadership, can be further extended with the current change, the improvement of management level. Role cognition and psychological factors in individual factors; The characteristics of the current era, such as job enlargement and job autonomy; Institutional features, cultural background and other situational factors in the organizational environment.

5.1.2. In-depth exploration of the relationship between safety climate and individual outcomes Most of the safety studies focuses on the physical safety and injuries of employees, and few of the existing studies involve the mental health of individuals. Mental health has been found to be significantly associated with occupational accidents, but has not received much attention from researchers. The safety climate is impacted by a similar lack of work-family balance. Further research is needed to better understand the mechanisms behind the connection between an employee's personal health and family status and their probability of being involved in an accident.

5.2. The dimension and measurement of Safety climate shall be further studied

Safety climate has been widely concerned in the field of safety research for a long time. However, there is no consistent dimension and measurement method of safety climate in the research literature and practice organizations. The existing safety climate measurement methods based on industry characteristics lack effective verification in other industries. This is not conducive to the development of empirical research in the field of safety, and a complete and scientific measurement method is urgently needed for the dimension of safety climate.

5.3. Expansion of research methods and research samples

5.3.1. Increase longitudinal research.

At present, most of the research designs are cross-sectional ones, but few are longitudinal ones with longer span. In order to enhance the scientific and objectivity of empirical research, more than half a year or even several years of longitudinal research should be advocated. At the same time, ways to establish a management system of continuous attention for safety issues should be studied in-depth so that this safety culture can be truly embedded in the core operation process of employees and will not change with the passing of time.

5.3.2. Increase cross-level and cross-organizational research

Traditional safety research focuses on personal safety (unsafe behaviors, injuries and accidents, etc.), which is far from enough. Safety accidents are mainly caused by defective systems and processes, so a comprehensive review of safety climate and safety behavior should be made from the perspective of organizational systems. Therefore, it is suggested that a variety of research methods and designs should be adopted in the future research, and multi-level and multi-dimensional comprehensive models should be investigated in detail to explain more complex organizational system factors.

5.3.3. Add samples from different geographical areas and cultural backgrounds

Different countries, regions and nationalities have specificity in safety behavior, and there are a large number of different regulatory factors and mediators. The development background with Chinese characteristics provides a broad sample for us to do scenario-specific safety research. In view of the current few similar studies, domestic researchers still have a lot to do. Different industrial and occupational backgrounds are also important areas for the existence of regulatory factors. The current safety studies mainly focuses on the construction industry, industrial and mining industry, manufacturing industry, transportation environment, medical environment, and there are many other industrial conditions that can be explored and need to be explored by new researchers.

Funding

2020 Zhaoqing University Scientific Research Fund Project (Project number: 2020012541)

Disclosure statement

The author declares no conflict of interest.

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