

A Review: The Safety Risk Perception of the Workplace

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Abstract: Security is still an important issue in the workplace, and many scholars' security models contain variables such as security risk and security risk perception. Different levels of awareness and perception of security risks will lead to different safety behaviors of employees. This paper combs the research of global scholars on employees' safety risk perception over the past half century, mainly summarizes the concept, antecedent variables and outcome variables of safety risk perception. Based on JD-R (work resource demand) theory and risk aversion theory, it straightens out the logical relationship between safety risk perception and safety behavior, and builds a basic platform for future research.

Keywords: safety risk; safety risk perception; work safety

Poor hazard identification ability and underestimation of safety risks will lead to disastrous safety accidents. However, previous studies have shown that a large number of potential safety hazards are still not recognized in the workplace [1–4]. Similarly, there is evidence that underestimation of security risks is a common problem in the workplace [5,6]. Therefore, in order to improve safety performance, it is essential to correctly understand the workplace factors that affect hazard identification and safety risk perception. When safety risks are underestimated, risk behaviors and safety operation behaviors deviating from the routine are becoming more common. In view of the poor ability of hazard identification and the underestimate of safety risks that may aggravate workplace injuries and accidents, it is very important to study and establish workplace factors that have a positive impact on the level of hazard identification and safety risk perception [4].

1. Connotation of safety risk perception

In the early days, people did not distinguish between risk and risk perception. Beck (1992, P55) believes that risk is a risk of knowledge, and there is no difference between risk perception and risk itself. Obviously [7], this view equates risk with people's reaction to it. This is the same as Rosa's (1998) definition of risk: according to cultural theory and constructivism, risk is risk perception. Similarly [8], Beck (1992, P21) defined risk as a traditional way to deal with the risks and insecurity brought by modernization itself [7]. Now we know that this statement is inaccurate, because risk is not only a product of modernization, it has existed long before the industrial society [9].

With the development of psychology, especially cognitive learning theory, scholars have realized the limitations of confusing risk and risk perception. Aven and Renn (2009) called for distinguishing between risk itself and how risk is perceived, because they are two completely different concepts [10]. Risk means the severity of uncertainty and risk consequences, and risk perception is an individual's awareness and perception of risk matters. Wang (2019) also agreed with this method of distinction. He believed that the risk in the workplace could be

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defined as the degree of personal exposure to hazardous environments [11]. researchers believed that perceived risk refers to an individual's perception of the uncertainty and possible negative consequences of specific events or behaviors [12], and the size of perceived risk depends on the probability of risk occurrence and the degree of potential loss. Aven and Renn (2009) believed that workplace safety risk perception refers to the risk of individual subjective judgment [10].

As for the meaning of security risk perception, in addition to various qualitative explanations, some people try to explain it in a quantitative way. For example, Cox (2008) believes that for a given scenario, security risk is usually calculated as a function of two variables: (a) the expected frequency of security events (such as injuries) and (b) the expected severity of security events, The formula can be expressed as follows: Safety Risk=Frequency of safety incidents X Severity of safety incidents [13]. Later researchers developed a new variable based on this formula, believing that risk perception includes (a) probability of risk occurrence, (b) severity of risk impact, and (c) expected utility of risk [10,12,13]. Based on the above research on risk, Xia et al. (2017) identified four ways of risk perception: (a) perceived probability, (b) perceived severity, (c) perceived negative utility, (d) direct risk perception; They have proved that the first three types of rational risk perception have an impact on direct emotional risk perception, and these four different forms of risk perception have affected the performance of employees' safety compliance and safety participation [5].

Most of the work carried out by researchers in the field of occupational health and safety focuses on the assessment of objective risks, and the workplace risk analysis methods used are basically quantitative. Xia et al. (2017) called this way of perceiving risk rational risk perception [5], that is, employees tend to perceive risk through three rational risk formulas (perceived probability, perceived severity, perceived negative utility). However, rational risk perception may have some problems [6]. For example, sociologists and psychologists have proved that only experts in specific fields can have the ability to deal with risks rationally. Outsiders often perceive risks based on emotions, that is, ordinary employees perceive and judge risks mainly through "feeling", a direct and direct way [14]. This risk perception may be irrational and vulnerable to many factors, such as risk characteristics [15], personal variables [16,17], and cultural and socio-economic background [18]. Although it is complex, emotional perception of risk can be assessed by asking individuals about their direct perception of risk; This is his or her direct and intuitive feelings about specific risks [19]. Decision makers' perceptual and intuitive judgments of risk (such as Slovic et al., 2016) will significantly affect the actual actions under risk conditions [14]. As far as possible dangerous behaviors of workers are concerned, personal risk awareness and subjective evaluation of occupational environment may also be important, which may affect objective risks and safety. Therefore, it is crucial to understand how employees perceive the risks or risk factors they face, especially those that are not obvious or visible. This is an important risk management that relies on individual insight. Deviations in risk perception may lead to misunderstanding of potential risk sources and ultimately have a negative impact on workers' safety [20]. To sum up, in terms of risk management, ordinary employees (not risk management experts) tend to perceive risks in a direct and emotional way, which will affect their safety performance.

In addition to the above interpretation of traditional risks, in recent years, scholars have begun to notice that the performance of emerging risks is different from traditional risks. Emerging risks have their own characteristics, such as strong uncertainty [21]. These types represent a new stage of risk growth. At present, there are few researches on emerging risks and their definitions are inconsistent. The focus of this paper is on the traditional risks commonly existing in all kinds of enterprises, but not on emerging risks.

2. Antecedents of security risk perception

Pandit et al. (2019) pointed out that security risk is an important near end factor in the comprehensive security model [4]. Exploring and verifying more and more factors that predict safety risks will help reduce safety accidents and incidents in production. The factors influencing risk perception in the existing literature mainly include: safety atmosphere, hazard identification ability, leader factors, etc., as well as multi factor analysis integrating their own characteristics, work tasks and environment.

Some studies have evaluated the impact of safety atmosphere on hazard identification and safety risk perception [22]. A study shows that the most vulnerable people are also those who have experienced the greatest

physical stress and feel the greatest risk associated with their work situation [21]. Flin and Mearns (1994) advanced this work to the British part of the North Sea (the northeastern marginal sea of the Atlantic Ocean) [23]. They identified three important aspects that may lead to accidents and close escape: (a) personal characteristics (including experience, knowledge, safety attitude, etc.); (b) Work characteristics (work task, environment, work pressure, etc.); (c) Platform characteristics (safety culture, social support, safety management system). The research of Flin and Mearns (1994) also shows that managers' commitment to safety, job satisfaction, attitude to safety, attitude to production and work environment have the greatest impact, which is closely related to workers' risk perception and satisfaction with safety measures, which is consistent with the joint survey results of Cox & Cheyne (2000) on many British industries, The above factors belong to the category of organizational security atmosphere [22,24–27]. Pandit et al. (2019) pointed out that safety atmosphere is an important predictor of hazard identification and safety risk perception, and both are the basis of injury prevention [4].

The research of Pandit et al. (2019) also found that employees who are willing to cultivate a positive safety atmosphere can benefit from higher risk identification ability and more sensitive safety risk perception. Employers who value the safety atmosphere can expect fewer human errors, unsafe performance and accidents in their workplaces. Secondly, their research also clarified the mechanism of the impact of security atmosphere on security risk perception. Specifically, a more positive security atmosphere can bring better risk identification ability, which can then be transformed into a higher level of security risk perception. Therefore, in addition to establishing a positive security atmosphere, efforts to improve the ability to identify hazards can also produce a higher level of security risk perception and related effectiveness [4].

In addition to security atmosphere and hazard identification, researchers also found the role of leaders in security risk perception [26]. Hofmann (2017) proposed that when employees have a good relationship with their supervisors and managers, they tend to commit themselves to safety and keep open communication on safety issues, and vice versa [27]. Zohar (2012) suggested that attention to employee safety is mainly expressed and implemented through the attitude and behavior of supervisors or leaders [28]. The consistent safety attitude, supervision behavior and reaction performance between supervisors and employees effectively promote the common recognition of safety priorities among employees. Wu (2005) defined safety leadership as the interaction process between leaders and followers. In the case of organizational and personal factors, leaders can achieve the organization's safety goals through their influence on members [29]. Some studies have shown that safety leadership can be an important factor in reducing employees' perceived risk level. Nielsen and Clel (2011) reported the negative correlation between real leadership and risk perception [30]. Oah et al. (2018) found that the important role of safety leadership in the field of occupational health and safety is increasingly recognized by people [3]. They pointed out that if supervisors implement active safety leadership, as an organizational or team factor, the risk level of workers may be reduced.

Generally speaking, many events are not caused by a single factor, but the result of a series of factors interacting at different levels of the system. Similarly, perception of injury or accident risk is also affected by multi-level factors, including individual characteristics, work tasks, work environment, leaders in charge, organizational atmosphere, government participation, culture, etc [27]. Man, Chan and Wong (2017) investigated more than 400 workers at construction sites in Hong Kong, and found that work pressure has a significant negative impact on safety risk perception [31]. The greater the work pressure, the lower the risk perception ability of workers. Mohamed et al. (2016) believed that workers' attitudes towards work safety could affect their risk perception level, in addition to safety management models, processes and rules [32]. Oah et al. (2018) tested a comprehensive antecedent model including safety atmosphere, safety leadership, workload and accident experience [3]. The results showed that workload and accident experience had a positive impact on cognitive risk perception, while safety leadership and safety atmosphere had a negative impact on cognitive risk perception and emotional risk perception. In the field of safety research, the transition from psychological interpretation to sociology and organizational framework will help us better understand risk perception and risk behavior. Rundmo (2010) pointed out that testing the risk perception model in the case of uncertain security atmosphere and working environment does not seem to be an appropriate strategy [33]. In the occupational environment,

employees' risk judgment must be related to the safety environment and other organizational and social factors, which are necessary for safe work. However, as pointed out by Oah et al. (2018), few studies have systematically examined many plausible multi-layer antecedents of perceived risk [3], such as a person's workload, accident experience, leadership in charge of safety and organizational safety atmosphere. To sum up, identifying the relative impacts and interrelationships of various factors affecting risk perception is helpful to determine which factors should be given priority when implementing security management policies.

Some studies have deeply discussed the specific effect process of safety risk perception on safety performance. Xia et al. JD-R theory was put forward in 2001 and is often used to explain work stress [34]. According to the work demand resource theory, all types of work characteristics can be divided into two categories: work demand and work resources. Job demand is defined as the physical, psychological, social or organizational aspects of work that requires sustained physical and/or psychological effort and is therefore related to certain physical and/or psychological costs. They are specific pressures associated with the work environment [35]. In a high-risk environment, examples of job demands include exposure to risks and hazards, physical demands, and complexity of work [36]. Work demands as work pressure will consume personal resources or energy to express the expected behavior of the organization, thereby reducing personal work performance (such as safety performance). Oah et al. This review of the study is in response to the suggestion of Oah et al. (2018) and is committed to analyzing the importance of security risk perception [3].

3. Result variables of security risk perception

Through the analysis of relevant literature on safety risk perception, it can be seen that the outcome variables of safety risk perception are mainly reflected in safety performance, risk taking behavior and protective behavior. There are many literatures on the impact of risk perception on safety performance in the field of safety. A meta analysis study by Christian et al. (2009) shows that risk perception is negatively related to unsafe performance [25]. Arezes and Miguel (2008) also believed that risk perception was crucial to promoting safety performance [20]. Pandit et al. (2019) found that the safety atmosphere can affect the safety performance of miners by affecting the level of hazard identification and safety risk perception [4], and found that employees who can perceive a higher level of safety risk may be more reluctant to take risk behaviors. This phenomenon can explain why some workers may choose to take dangerous behaviors, while others may be more inclined to avoid risks under similar circumstances, even if the relevant safety hazards have been identified. In view of these different findings and conclusions, it is necessary to further clarify the relationship between risk perception and safety performance.

Repeated exposure to various hazards in the work environment will lead to risk adaptation, which may lead to unsafe performance and violations through slow perception; In addition, the perception of the risk of an accident or injury can also lead to psychological stress (i.e. anxiety, pain or tension), reducing positive physical and mental resources. Specifically, frequent exposure to dangerous work environments will lead to physical fatigue, cognitive processing ability limitations and negative emotions, thus encouraging employees to complete work quickly [37]. In this process, the possibility of risky behavior increases the possibility of accidents and injuries [38].

A large number of observations and studies have confirmed the relationship between risk perception and protective behavior. In a study, 118 commercial pilots of China Southern Airlines were investigated, and it was found that risk perception and risk tolerance significantly affected their safety performance [39]. The study observed that risk perception directly affected the safety performance of pilots. Pilots with high risk perception are more likely to adopt safer behaviors than their peers with low risk perception. This study also found that the impact of safety risk on prevention behavior was regulated by risk perception: high risk perception reduced the negative impact of safety risk on safe operation behavior, while medium and low risk perception increased the negative impact. Gyekye (2006) found in a study of 320 Ghanaian workers that people who are often victims of accidents have quite negative views on workplace safety [16], safety matters and their supervisors [40]. Brewer et al (2007) shows that the perception of risk possibility, vulnerability and risk severity are variables that significantly predict safety performance [41].

According to the risk aversion theory, when there are gains (high risk perception), decision-makers are more concerned about asset losses (risk aversion) [42]. The relationship between risk aversion and risk perception shows that if a person thinks something is high-risk, he or she may take protective actions [39,40]. A laboratory study on 80 subjects showed that people who believed that the risk around them was very high would actively increase the behavior of wearing gloves to prevent hand injuries during painting, while subjects with low risk perception only chose to wear goggles according to the test requirements. Similarly, Kouabenan et al. (2015) [40] found that if front-line managers realized that their employees might face a high level of risk in the workplace, they would actively participate in safety management. It can be seen from the above that the level of risk perception affects people's behavior choices.

However, few studies focus on the impact of risk perception on safety compliance and safety participation, although these are two important and distinct employee safety performance [42]. In order to comprehensively test the impact of risk perception on safety performance, someone divides safety performance into two dimensions: safety compliance and safety participation. As a form of expression of specified safety performance, safety compliance is defined as a core activity that individuals need to carry out to maintain workplace safety [43]. Security participation refers to those behaviors that do not directly contribute to personal security, but help to form a security environment. In hazardous industries, front-line workers are directly exposed to workplace hazards and accidents. It can be speculated that if workers perceive high risks, they may take safety compliance measures to avoid or mitigate risks. Safety compliance aims to ensure that employees comply with the company's internal safety procedures and rules and regulations, including complying with standard work procedures, working in a safe manner, etc. Obviously, these actions can be a direct and effective way to prevent workers from falling into accidents or dying themselves. In addition to complying with safety regulations, safety participation is also an effective and proactive way to reduce risks due to the increasing complexity and uncertainty in the workplace [43]. Safety participation includes voluntary participation in safety activities, promotion of safety plans, helping colleagues solve safety related problems, participation in safety meetings and other activities [24,43]. To sum up, in the workplace, employees who perceive high risks may choose safety compliance and safety participation as effective preventive measures to reduce risks or hazards. Table 1 shows the research on safety risk perception outcome variables.

Table 1. Study on representativeness of safety risk outcome variables.

Researcher	Research design	Research results
Pandit et al. (2019)	Data was collected from convenient samples of 57 construction projects in the United States, and SAS 9.3 statistical software was used to test the proposed assumptions.	Safety atmosphere is an important predictor of hazard identification and safety risk perception, and both are the basis of injury prevention; Employees who can perceive a higher level of security risk may be more averse to taking risks.
Oah, Na, & Moon (2018)	The valid data provided by 376 employees from different manufacturing enterprises were analyzed. The hypothesis was tested by correlation analysis and hierarchical regression analysis, and the IBM SPSS software (version 23) was used for statistical analysis.	Workload and accident experience have a positive impact on cognitive risk perception, while safety leadership and safety atmosphere have a negative impact on cognitive risk perception and emotional risk perception.
Ji et al. (2011)	The data of 118 commercial pilots of China Southern Airlines were investigated.	It was found that risk perception and risk tolerance significantly affected the safety performance of employees, and risk perception directly affected the safety performance of pilots.
Gyekye (2006)	320 Ghanaian workers were investigated.	People who are often victims of accidents have quite negative views on workplace safety, safety matters and their supervisors, and have a high level of risk perception, thus improving protective behavior.
Huang et al. (2007)		Exposure to dangerous work environments can lead to physical fatigue, cognitive processing limitations and negative emotions, thus encouraging employees to complete their work quickly.
Kouabenan, Ngueutsa, & Mbaye (2015)	The participants were 63 first-line managers from two nuclear plants of French Nuclear Corporation, who were investigated through a questionnaire composed of several measurement scales related to different variables.	The higher the risk perception, the higher the participation in security management. Similarly, employees who think the safety atmosphere is good are more willing to participate in the safety management than employees who think their safety partners are not good.
Taylor & Snyder (2017) [44]	The data were collected from the end of 2012 to the beginning of 2013 for undergraduates majoring in psychology in a large university in southwest China. Laboratory research based on a study published by Probst (2002).	Performing tasks without safety procedures is more risky than performing tasks with safety procedures. Risk perception under the compliance framework will be positively related to compliance with security procedures.
Rubin et al. (2020) [45]	The data were collected from workers recruited from open-pit and underground mines in New South Wales and Queensland, Australia. A series of potential predictors of the risk frequency of Australian coal miners were tested using exploratory longitudinal research methods.	There is a negative vertical correlation between the age of workers and their risk-taking behavior in the mining industry, indicating that younger miners are more likely to take greater risks. Therefore, in the organizational safety performance model, the impact of age on employees is more important.
Brocal et al. (2021) [46]	The manifestations of new risks are determined through three cases: exoskeleton, nanomaterials and industrial automation.	The characteristic of determining emerging risks is strong uncertainty, causing serious physical and mental harm to workers. In this paper, the meta-learning strategy is proposed through qualitative methods.

Data source: collated from literature

4. Conclusion and future research

It can be seen from the above literature that the research and application of the concept of risk perception in the security field are very extensive [4,27]. We find that previous researchers have done a lot of research on the antecedents of risk perception in terms of individuals, work tasks and organizational climate. However, research on how employee organization relationship affects risk perception is still lacking, especially on the relationship between employee organization economic exchange relationship and risk perception. In addition, various studies on risk perception outcome variables in the existing literature have shown their impact on safety performance, but there is a lack of discussion on the impact of safety risk perception on safety performance in the two different

dimensions of safety participation and safety compliance.

It is suggested that future research should explore the impact on safety risk perception from the perspective of social exchange theory and work stress, and examine the impact process of safety risk perception on compliance and participation of safety performance, which not only responds to Pandit et al, It also responded to the suggestion of Xia et al. (2017) that the relationship between the two dimensions of safety risk and safety performance should be specifically examined [5]. In recent years, the focus of research on security risk perception has changed. Some scholars have shifted from individual perception to group perception [43], which will be an interesting change. In addition, the global prevalence of COVID-19 has forced enterprise management to make changes. Research on risk perception should take covid-19 as an important factor [47].

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Conflicts of Interest

The authors declare no conflict of interest.

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