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Review

Behaviour Based Safety Approach And Factors Affecting Unsafe Behaviour in Construction Sector: A Review

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ABSTRACT

Objective: Construction sector is a critical sector due to high accidents and fatality rates, while unsafe behaviours like human errors and inappropriate operations has been reported as the main cause of accidents. The purpose of this review is to explore the factors influencing unsafe behaviour and to introduce the Behaviour Based Safety (BBS) approach for accident prevention triggered by those unsafe behaviours.

Method: This paper reviews several relevant studies on unsafe behaviour and Behaviour Based Safety (BBS) approach in the construction sector. Resources for this review are obtained from several online databases where studies are categorized based on their findings.

Findings: The factors behind accidents and unsafe behaviour can be categorized into 8 main categories; Individual Factors, Site condition, Work group, Contractor, Supervision, Project Management, Organization, and Society. Daily observations, workgroups focus and use participative goals with multiple feedback mechanisms are the ideal components of an effective Behaviour Based Safety (BBS).

Conclusion: The review provides a link between unsafe behaviour and Behaviour Based Safety (BBS) approach as an effective process in changing the behaviour of workers in the construction sector.

Keywords: *Construction, accident, unsafe behaviour, Behaviour Based Safety*.

1. Introduction

The construction sector plays a big role in the development process of a country where successful development would contribute towards the economic growth generating additional demands for construction activities (Abdullah & Wern, 2011). However, the construction industry has been identified as one of the most hazardous industries in many parts of the world, as measured by work-related mortality, injury and fatality rates (Pinto et al., 2011). Accidents in construction sector occur at a substantially higher rate than in most of the other sectors and with severe consequences, both for the workers and the public (Sousa et al., 2014).

The inherent hazards and the nature of the job performed by workers contribute to the occurrence of accidents (Khanzode et al., 2011). The causes behind these accidents have been receiving broad attention in the construction engineering and management. Accidents occurred because of various causes, the most of accidents result from a combination of contributing causes and one or more unsafe acts and unsafe condition (Hamid et al., 2008). Fleming & Lardner, 2002 has categorized three major reasons behind accidents occurrence on construction sites; the first, failure to identify working condition that there are before activity or after the start has been expanded, second, the decision to continue working after the worker identified unsafe current conditions and the third decision to unsafe performance regardless of initial conditions at work. Unsafe behaviour of workers, such as human error or inappropriate operation, has been identified as the major risk factor behind accidents and injuries occurring across construction projects (Garrett & Teizer, 2009; Hinze et al., 2005). This human error is defined as an inappropriate human decision or as behaviour that affects safety during construction operations and thus deteriorates a project's cost and schedule performance (Aksorn & Hadikusumo, 2008; Teo et al., 2005). Heinrich, 1941 indicated that the major root causes of 88% of the construction accidents were unsafe acts of workers when they were combined with unsafe working conditions on construction sites. Reducing accidents and improving safety performance can only be achieved by systematically focusing upon those unsafe behaviours at construction sites (Choudhry, 2012; Choudhry & Fang, 2008). The behavioural approach addresses how people behave on the job. According to the theory used by (Fishbein & Ajzen, 1977) on the reasoned action; behaviour is determined by the behavioural intention to emit the behaviour where this intention is affected by attitudes towards act and by subjective norms. Studies in the construction sector have revealed that behaviour based safety technique can be treated in the construction sites. Behaviour Based Safety (BBS) is the way mainly aimed at modification of unsafe behaviour that is traditionally practiced in different industries (Oostakhan et al., 2012). This review will cover the factors behind the unsafe behaviour of workers in construction sites and present the Behavioural Based Safety (BBS) as an effective approach in raising the level of behaviour and safety of workers and a way to prevent accidents and reduce injuries in the construction sector.

2. Materials and Method

Articles and documents used in this review were collected from different online databases such as Science Direct, PubMed and Scopus. These articles were collected based on our objectives and key words "Unsafe Behaviour/Behavior, Behaviour/Behavior Based Safety, injury, accident". Two main parts are the bases of this review. First, to extract the factors affecting unsafe behaviour in construction sites, a several relevant studies on safety behaviour were reviewed; by reference to Khosravi et al., 2014, a quality rating based on the analysis approach i.e., qualitative, quantitative, and mixed analysis of 56 studies related to safety in construction has revealed 14 studies ranked "good", where these studies have a clear objectives, an appropriate empirical research approach, a clear description of appropriate sampling, data collection, data analysis, research findings. These studies are included in this review as they are considered to have a high strength of evidence on factors influencing the unsafe behaviour in construction.

The second part is to introduce the effectiveness of Behaviour Based Safety; studies that investigated and implemented the BBS approach were reviewed. Intervention studies were the most relevant in order to evaluate the impact of implementing by comparing the before and after intervention changes on the workers' behaviour and injury rate. The BBS most effective components that have been found in previous studies were extracted to develop the ideal BBS process for the best results.

3. Findings and discussion

3.1. Factors influencing unsafe behaviour

A detailed description of the studies used to extract the contributory factors is presented in Appendix 1. Many variables were tested in their influence on the unsafe behaviour and their association to accidents and injuries in the construction sites.

From the conceptual framework developed by (Khosravi et al., 2014), 28 elements out of 50 elements were the total of variables extracted and 8 main factors: Project Management, Society, Work group, Organization, Site condition, Supervision, Individual Factors and Contractor. Figure 1

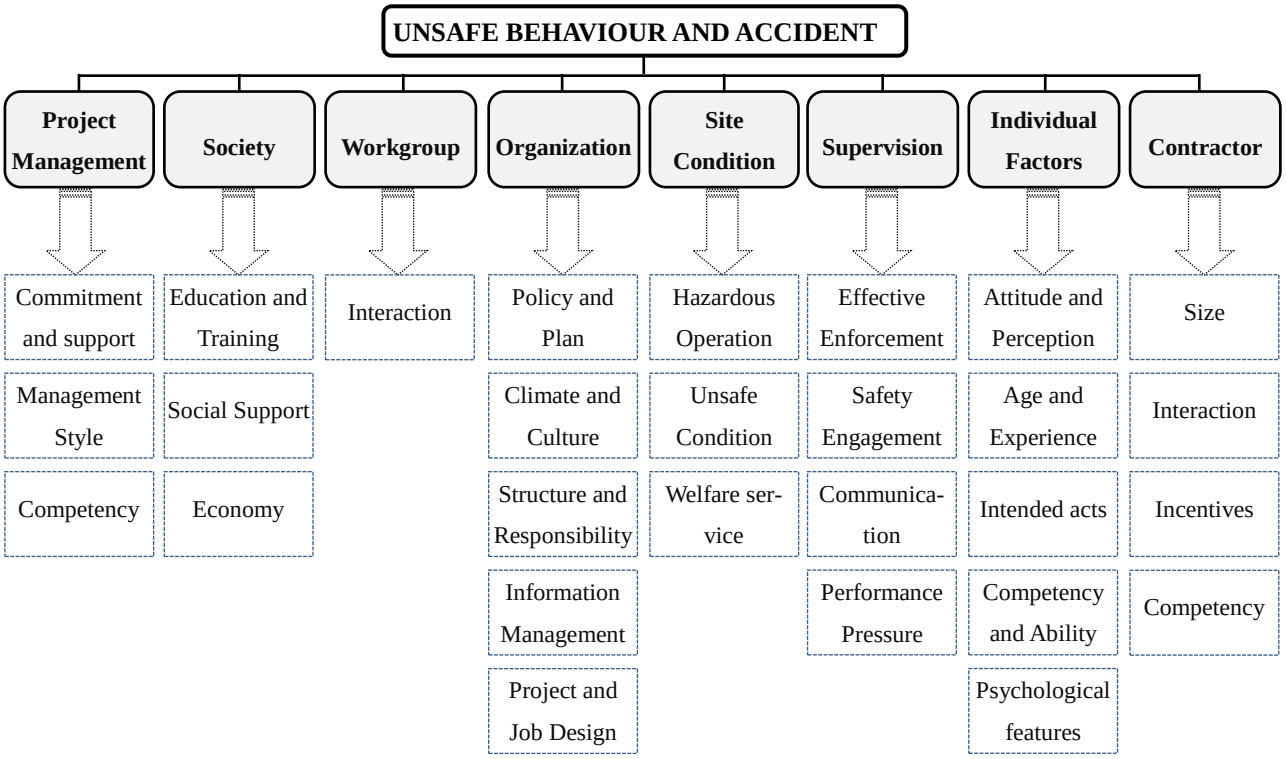

Figure 1: Factors contributing to unsafe behavior and accidents in construction sites

summarizes each factor and their elements contributing to unsafe behaviour and accidents in the construction site.

The individual factors are represented in five elements: attitude and perception, age and experience, intended acts, competency and ability and psychological feature. Several studies showed that these elements highly contribute to unsafe behaviour of workers. Suraji et al., 2001, have also found that an inappropriate action like an unsafe act during work or inappropriate use of the personal protective equipment (PPE) can be an immediate cause of accidents.

The diversity of activities during the multiple stages of construction leads to define a new category of site condition, this category covers the hazardous operation, unsafe condition and welfare services. Work related activities in construction are often risky, such as working at high, Outdoor operation in a bad weather condition and various equipments are used. These elements are coupled with the workers' attitude towards safety behaviour (Choudhry & Fang, 2008).

The workgroup interaction is another factor has been found to be influencing the workers' behaviour. Aksorn & Hadikusumo, 2008, have revealed that a successful management at work is built from a positive safety attitude within a group of workers which can be achieved by a good safety culture.

In the construction sector; contractor size, interaction, incentive and competency are considered as factors influencing the unsafe behaviour. According to (Sa et al., 2009), accidents and unsafe behaviours are negatively associated with the company's size. A large construction project often hires other subcontractors based on contract to complete the project in time, where generally a little margin of the contract's price is invested in occupational safety and health (Petrovic et al., 2007).

The supervision on the construction site is another factor; where safety effective enforcement, safety engagement, communication and performance pressure are the main elements found to be associated with safety performance and safety behaviour. Meliá & Becerril, 2009, have found that supervision is influenced by multiple factors such as a lack of feedback and poor relation and communication with superiors, where these factors are considered as a cause of occupational stress and work pressure affecting safety performance in the workplace. Studies have also revealed that employees who are engaged on safety are highly focused on their work and less likely to make mistakes.

The project management level is also playing a big role in safety performance, where commitment and support, management style and competency are the three main elements influencing safety in the construction site. Several studies

have shown that management commitment to safety is playing a significant role in keeping a safer workplace and decreasing the accident/incident rate (Aksorn & Hadikusumo, 2008; Gittleman et al., 2010; Lai et al., 2011; Teo et al., 2005). The project management needs high skills to successfully achieve a higher safety performance.

The Organization is highly highlighted in previous studies; policy and plan, climate and culture, structure and responsibility, information management and project and job design are the five main factors have been described in affecting safety performance in the construction sites. Researchers have categorized the safety climate as a multidimensional construct that usually used with safety culture (Goldenhar et al., 2003). Safety climate can provide the perception of workers and what workers think about safety their working environment which can lead to increasing safety culture and safety performance (Choudhry et al., 2009). The wide range of activities in the construction industry gives daily changes in the nature of the work, the workplace and the site condition what make the construction industry known as organic rather than mechanistic where it relies on decision-making roles, the use of the workforce, and training facilities for workers to carry out non-standardized operations (Choudhry & Fang, 2008).

The society is the last factor affecting the unsafe behaviour where education and training, social support and economy are the three main elements. Social supports were the most highlighted by previous studies, the national culture, ethnicity and language barrier between workers can lead to unsafe behaviour and accidents (Choudhry & Fang, 2008; Goldenhar et al., 2003; Meliá & Becerril, 2009). Workers in construction can be directly influenced multiple external factors like the environment conditions, pressure from work and community and other economic impact which can distract them from performing safely their tasks, in the other hand the head of projects is under different factors as economic, social and political pressure. This cause and effect process can lead to an inappropriate planning or inappropriate construction control procedures leading to a bad site conditions, unsafe worker actions, or inappropriate construction operations (Suraji et al., 2001).

3.2. Behaviour Based Safety

Behaviour Based Safety (BBS) is known as an interventional process to correct the workers' unsafe behaviour and reduce the incident/accident rate. The achievement might focus on analyzing previous incidents occurred by the interaction between workers and their working environment. The aim is to determine which antecedents lead to unsafe behaviour, for example; absence of equipment leads to the use of improvised tools) to take the appropriate corrective actions (Cooper, 2009).

Early 1970s was the first use of behavioural safety approach where supervisors observed workers' behaviour and they gave their feedback and corrective reinforcement; early 1980s started the development of an overall process conducted based on observation provided by feedback focusing on the workers' behaviour. In 1990s, a cultural approach based on the concept of management and workers partnership was developed.

Regardless the BBS approach, many researches have addressed to find the most efficient process for good results (DePasquale & Geller, 2000; Sulzer-Azaroff & Austin, 2000). As a general process for a structural and an ideal behavioural safety starts by identifying the unsafe behaviour through analyzing the previous records of injuries, incidents and near misses, then establishing an appropriate checklist for observation including all the unsafe behaviours, after that an educative program should be performed including training and observation for everyone, next step is to carry out a behavioural observation to evaluate the current safety behaviour, finally, to provide the feedback and discuss the results for positive improvement. Figure (2) summarizes the behavioural safety process.

The observation is the basis of Behavioural Based Safety where unsafe behaviours can be identified, feedback can be provided and trainings can be selected. Researchers have identified two main factors that can have an effect on the observed outcomes; frequency and focus (Cooper, 2009). The frequency is explained by the rate of contact between the observer and those observed, McSween, 2003, has found that the greater the contact rate, the larger the impact on incident and injury rates. The focus of observation should be based on the aim of reducing injuries and changing behaviours. Different approaches of observation have been suggested by researchers; McSween, 2003, has adopted a one-by-one observation of workers during performing their work and provide feedback. While Cooper, 1998 has suggested a workgroup observation where a trained observer can keep an eye on the colleagues' behaviour during work, and results of the observation can be analyzed and discussed weekly during the workgroup meeting.

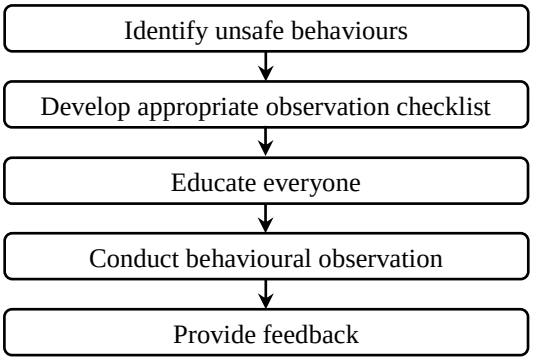

Figure 2: Behavioural Safety Process

Researchers have highlighted the high value of feedback; as it is for the aim of improving the behaviour and allow for workers to get better performance (Cameron & Duff, 2007; Grindle et al., 2000). The most efficient approach regarding to (Coplen et al., 2007) is the verbal feedback between the observed and the observer. Graphs and charts can be also displayed in the workplace to show how the behaviour is safe based on the records of observations. Other mechanisms use the writing feedback, which can be as a result of observations and presented to the management for further improvement to achieve better performance.

After observation and feedback, a design structure represented as an intervention program should be made in place, Cameron & Duff, 2007, have suggested goal-settings or trainings as the two effective processes. Goal-setting is to motivate the workers by focusing on their behaviour to turn their vision on safety in any particular course of action; target goals are set by the managers, workers' behaviour is measured at the beginning of the process as a starting point to achieve the goals and to make the safe behaviour habitual. Safety trainings are focusing on the unsafe behaviour in specific operations, taking an example of scaffolding and handling materials, selected from analyzing the observation data.

The diversity of steps in BBS approach makes sense of the attempt of finding the best influential process in changing the workers' behaviour as an individual result or reducing the incidence rate at the company level. Researchers have found that Behavioural Safety works, and has a positive effect on behaviour changing and incident reduction.

Cooper, 2009, has conducted a structural review on Behavioural Safety; this study was based on reviewing previous academic and professional studies in different sectors including the construction sector as our point of focus. Cooper has found that:

- Behavioural safety works better with a stable workforce and stable environment,
- Daily observation was revealed effective in injury reduction with a slightly larger impact on behaviour changing,
- Workgroup based observations had a greater effect on behaviour change and injury reduction rather than individuals or focus on outcomes,
- The most effective mechanism of feedback was found is the combination of posts, verbal and written feedback, presented and discussed in a weekly meeting.
- Goal settings, training and feedback as a design structure have a greater effect on injury reduction, and participative goals were the best for behavioural change.

A successful intervention and implementation of the BBS program in construction sites was revealed in the study by Choudhry, 2014. Before the implementation process, safety behaviour measurements have been taken place, where five categories were measured using checklist: Personal Protective equipments, housekeeping, access to heights, plant and equipment, and scaffolding. The goal-setting sessions were organized with workers' participation to target the desired level of performance that has been presented as a feedback charts. The process has included a recognition and support for workers who behave safely during performing their job, a direct contact and discussion between the observers and the workers by providing feedback and trainings was used in this process. Weekly scores were taken and discussed in weekly meetings. The results have shown an increase in safety performance from 86% (3rd week) to 92.9% (9th week) with a remarkable increase in unsafe behaviour and high decrease in safe behaviour of workers which can be explained as a good and effective BBS process.

4. Conclusion

This review had linked two parts; the factors influencing unsafe behaviour leading to accidents and injuries at construction sites, and the Behaviour Based Safety (BBS) approach as an effective process to improve the safety behaviour and reduce the accident rate. Findings have shown that the causes of unsafe behaviour are multi-factorial, these factors were classified into 8 main categories: Individual Factors, Site condition, Work group, Contractor, Supervision, Project Management, Organization, and Society. The results of this review have shown, in the second part, that an effective BBS design includes daily observations, focus on workgroups and use participative goals with multiple feedback mechanisms. This design has shown remarkable results in changing the behaviour and reducing the accident rate more than any other designs.

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Conflict of interest

There is no potential conflicts of interest persists in this review paper.

Ethical issues

None

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Appendix 1: Factors affecting unsafe behaviour and accidents in construction sites:

Reference/ Country	Title	Study Design	Study Type	Method of data collection	Analytical Method	Results
(Cheng et al., 2012), Taiwan	Applying data mining techniques to explore factors contributing to occupational injuries in Taiwan's construction industry.	Cross sectional study	Quantitative study	Accident reports (n=1542)	Data mining, Chi-square test	To minimize falls/tumbles/collapse in private projects, the following should be acknowledged: • Source of injury (structure and construction facilities) • Accident location (ladder, platform, or structural steel member) • Work content (site clean-up, work preparation, or repair work) • Unsafe conditions (absence of PPE, unsafe methods or procedures) • Unsafe behaviour (workers failed to use PPE or ignored hazard warning signs). • Project contract amount • Project type (road and bridge projects) • Contractor size (30–99 workers).
(Cheng et al., 2012), Hong Kong.	Exploring the perceived influence of safety management practices on project performance in the construction industry.	Cross sectional study (15 construction sites)	Quantitative study	Worker questionnaire (n=232)	Exploratory factor analysis, Hierarchical regression analysis	Exploratory factor analysis extracted three safety management practice categories: • Safety management information, • Safety management process, • Safety management committees. Project performance were associated with: • Information (+) • Committees (+).
(Choudhry & Fang, 2008). Hong Kong	Why operatives engage in unsafe work behavior: investigating factors on construction sites.	Case study	Qualitative study	Semi-structured interviews with 7 workers who had been accident victims, 2 site engineers, 2 safety managers	Grounded theory	Factors which can have an influence on worker's safety behavior were: • Management such as involvement management, toolbox talks with managers, implementation of safety management system and Provision personal protective equipment • Safety procedure such as safety policy, toolbox talks and orientation trainings • Psychological feature such as comfortable feel with supervisors and living conditions of workers on site

Reference/ Country	Title	Study Design	Study Type	Method of data collection	Analytical Method	Results
				and 1 project manager.		• Economic feature such as productivity bonuses • Self-esteem such as exhibition of being "Tough guys", co-worker encouragement to undertaking risky tasks, exhibition of having more site experience, avoidance from being teased by co-workers • Experience such as awareness of safety requirement, "learning by doing" and formation of rigid routines • Performance pressure such as the boss is in the habit of saying "hurry up" and take shortcuts • Perceived risk such as perceptions of risk differ from one person to another and may differ time to time even within one person • Working environment such as access to heights, scaffolding, steel erection, use of mechanical plant and equipment and working with chemicals such as asbestos, epoxy and explosives • Job security and education such as local worker and cultural and language problems and non directly-employed staffs • Incompatible training, absence of job specific training, uneducated persons and training does not focus on changing attitudes of workers to safety.
(Choudhry et al., 2009), Hong Kong	Measuring safety climate of a construction Company.	Cross sectional study	Quantitative study	Questionnaire (n=1120)	Factor analysis, Multiple regression analysis	Multiple regression analysis confirmed that these Good following climate factors were significant predictors of workers' perceptions of safety performance: • Management commitment • Employee involvement • Inappropriate safety procedure • Work practices
(Gittleman et al., 2010), USA	[Case Study] City Center and Cosmopolitan Construction Projects, Las Vegas, Nevada: Lessons learned from the	Cross sectional study, 4 case studies	Sequential mixed method study	Questionnaire study with workers (n=5268), foremen (n=134), supervisors	Content Analysis, T-tests, Analysis of variance, Multivariate analysis of	Content analysis revealed 10 distinct safety-related themes. These included: • Lack of management action, • Health hazards • Unsafe procedures • Lack of coordination/planning • Individual responsibility • Lack of appropriate safety equipment

Reference/ Country	Title	Study Design	Study Type	Method of data collection	Analytical Method	Results
	use of multiple sources and mixed methods in a safety needs assessment.			(n=61) and Executive managers (n=17)	variance, Multiple regression analysis.	• Need for improved communication, training/hiring practices • Problems with housekeeping. Safety-Related Outcomes were significantly related with: • Management commitment to safety • Safety practices.
(Glendon & Litherland, 2001), Australia	Safety climate factors, group differences and safety behaviour in road construction.	Cross sectional study	Quantitative study	Worker questionnaire and behavior observation study (n=192)	Factor analysis, Multiple regression analysis	Safety climate derived six factors: • Communication and support • Adequacy of procedures • Work pressure • Personal protective equipment • Relationships • Safety rules
(Mohamed et al., 2009), Pakistan.	National culture and safe work behaviour of construction workers in Pakistan	Case series	Quantitative study	Interview based questionnaire survey with Frontline workers (n=140) from 8 large construction sites.	Factor analysis Logistic regression. Pearson correlation.	Attitude and perception of workers included three dimensions: "Awareness and Beliefs", "Physical Work Environment" and "Supportive Environment". • Workers reported a medium-to-high perception of risk level for high risk situations • Higher the level of worker' awareness towards safety, the less likely they were to continue working unsafely • "Awareness and Beliefs" factor was a strong predictor of workers' intentional behavior • "Physical Work Environment" and "Supportive Environment" factors were partial predictors of workers' intentional behavior • National culture included three dimensions:"Collectivism and Femininity", "Uncertainty Avoidance" and "Power Distance" • "Collectivism and Femininity" and "Uncertainty Avoidance" predict intentional behavior • "Power Distance" did not predict any intentional behavior
(Pousette et	Safety climate	Cross	Quantita-	longitudinal	Confirmatory	Safety climate was found to significantly predict self-reported safety behavior 7

Reference/ Country	Title	Study Design	Study Type	Method of data collection	Analytical Method	Results
al., 2008), Sweden.	cross validation, strength and prediction of safety behaviour.	sectional study	tive study	questionnaire study with worker (n=801)	factor analysis; Intra-class correlation coefficient (ICC)	months later.
(Gambatese et al., 2008), USA	Design's role in construction accident causality and prevention: perspectives from an expert panel.	Case series	Sequential mixed method study	Experienced safety and health professionals (n=12), Sample projects (n=25)	Delphi survey, Total Recordable Injury Rate (TRIR), Pearson's correlation	The most important elements (top 3) should be Good implemented through the combined efforts of the project team were: • Clear project safety authority, Responsibility, • and accountability; • Employee empowerment to stop work authority; • Contractor selection based on safety
(Törner & Pousette, 2009), Sweden.	Safety in construction—a comprehensive description of the characteristics of high safety standards in construction work, from the combined perspective of supervisors and experienced workers.	Single case study	Qualitative study	Interview with safety worker representatives (n=5) and first-line managers (n=19)	Phenomenographic methodology	Four main categories of work safety preconditions and components were: • Project characteristics and nature of the work, which set the limits of safety management • Organization and structures, with the subcategories planning, work roles, procedures, and resources • Collective values, norms, and behaviors, with the subcategories climate and culture, and interaction and cooperation • Individual competence and attitudes, with the subcategories knowledge, ability and experience, and individual attitudes.
(Zhou et al., 2008), China.	A method to identify strategies for the improvement of human	Cross sectional study	Quantitative study	Personnel questionnaire (n=4719)	Bayesian Network (BN) based modeling	BN-based analysis demonstrated that: • The safety climate factors may have a more significant influence on an employee's safety behavior than personal experience factors • The simple strategy could be more effective when safety climate factors were

Reference/ Country	Title	Study Design	Study Type	Method of data collection	Analytical Method	Results
	safety behavior by considering safety climate and personal experi-ence					properly controlled • A strategy via controlling multiple factors (or joint strategies) may even better improve the safety behavior • A joint control of both safety climate factors and personal experience factors worked most effectively.