MEDIATING EFFECT ANALYSIS ON SAFETY ATTITUDE OF SKILLED LABOR MIGRATIONS BETWEEN SAFETY BEHAVIOUR AND SAFETY PERCEPTION

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ABSTRACT: Unsafe behavior, which has aroused extensive concern in recent years, is the subject of numerous safety management studies. However, there have been very few studies on mediating effect analysis on safety attitude of skilled labor migrations between safety behavior and safety perception. The purpose of this study was to summarize human-error into three aspects (safety attitude, safety behavior and safety perception) and to figure out the relationship between these three variables might have. In order to verify the reasonableness of the assumptions, the Structural Equation Modeling（SEM） is estimated using hundreds of individual questionnaire responses from different companies in the form of Likert-type scale. The results obtained with this description showed that certain measures should be adopt to develop the safety attitude, safety behavior and safety perception of the skilled labor migrations (SLMs) purposively. The conclusion of this study will certainly provide the beneficial reference views on the management in infrastructure.

KEY WORDS: Safety behavior; safety attitude; safety perception; skilled labor migrations; SEM;

1 INTRODUCTION

In recent years, with an increasing numbers of farmers leave the land to start a new life, some of whom are trained to master the new technologies to become industrial workers, that is, skilled labor migrations (SLMs) [1]. Accounted for a huge proportion in the whole construction team, SLMs are becoming the key staffs in the engineering construction. However, due to SLMs' own defects such as low level of education, poor technical quality, the lacking of safety consciousness and self-defense capability, SLMs unfortunately become accident high-risk groups. What's more, in pursuit of economic efficiency, SLMs are often required to work overtime even in the highly risky working place. As any experienced engineer knows, prolonged heavy physical labor could easily lead to physical and mental fatigue even may result from SLMs' casualties. According to the accident investigation, SLMs accounts for more than 56% of deaths [2]. Hence, it is high time that safety behavior for SLMs should be paid more attention to.

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Safety Behavior Theory is a subject studying on affecting factors and human's behavior law to encourage safe behavior and suppress unsafe behavior, which was firstly proposed by Gene Earnest and Jim Palmer in 1979 fin the name of BBS(Behavior Based Safety) derived from the behavioral sciences[3]. In the later development, academic achievement in sociology, psychology, physiology such as Maslow's hierarchy of needs[4], F. Herzberg's two-factor theory[5], Victor H. Vroom's expectancy theory, Lawler and Porter's incentive model, Petersen's motivation – compensation – meet model, Neal and Griffin's safety performance model gradually formed [6], which constitute the basic principles of Safety Behavior Theory.

With the deepening of understanding of the safety, improving of safety needs, Safety Behavior Theory has been interpenetrated with security ergonomics, safety systems theory, safety assessment, safety management and safety psychology, which brings to the rapid development of Safety Behavior Theory. Mearns et al [7] proposed that subjective perceptions of risk form the basis for risk acceptance, regardless of the objective or quantified risk, and, such as, they are important for understanding feelings of safety, attitudes to safety, risk-taking behavior and accident involvement amongst the workforce. Heinrich [8] believed that the attitude affected the trend of accidents. However, present research is mainly focused on safety behavior factors and mechanism.

And the relationship between safety perception and risk behavior [7, 9, 10], safety attitudes and risky behavior or unsafe behavior relationships [8, 9, 11], and relationship between safety perception and safety attitudes [12]. Jens Rasmussen et al [13] pointed that safety perception, safety attitudes and safe behavior do have correlation after analyzing the effect of conditioning factors related to affective, motivating aspects of the work situation as well as physiological factors. Brune, R.L., M. et al [14] studied on what extent peers agree with the human behavior models and estimates of human error probabilities (HEPs). Mearns. K. and R. Flin et al [7] suggested that subjective perceptions of risk form the basis for risk acceptance, regardless of the objective or quantified risk, and, as such, are important for understanding feelings of safety, attitudes to safety, risk-taking behavior and accident involvement amongst the workforce. Sim B Sitkin et al [10] reported on two studies that examined a model in which risk propensity and risk perception mediate the effects of problem framing and outcome history on risky decision – making behavior.

It can be easily concluded from the studies mentioned above, there do exist relationships among risk perception, safety attitude and safety behavior. However, there have been very few studies on the relationship among them. Structural Equation Modeling (SEM), developed in recent years. Due to its unique advantages in researching the causal relationship between subject and object, SEM is becoming a common studying means in expressing this causal relationship in the form of the model and Path diagram, which will be used to study on the safety behavior's relationship between safety perception and safety attitudes in order to reduce human error and improve the safety of infrastructure operation.

2 THEORETICAL BACKGROUND AND HYPOTHESES

2.1 Safety perception

Safety perception indicates the degree of awareness about the possibility of accidents, seriousness of the consequences and hazards which may cause accidents when individuals are engaged in related work. Ramsey et al [15] thought that the individual's safety perception of the reaction process can be divided into five important processes including feeling of risk, hazard perception, decided to avoid, capability for disaster prevention and safe behavior. As long as any link negligence, accident could occur. Therefore, any underestimate of external situation or overestimate of personal abilities may be incorrectly perceived risk. In that way, the SLMs couldn't take actions timely and effectively to avoid or mitigate the risks, which may lead to unsafe behavior, causing accidents. Based on the above analysis, it could be easily concluded that safety perception of SLMs have a significant impact on their safety behavior. Safety perception in infrastructure includes five factors: supervisor, work, practice, management, and colleague.

Supervisors are important bodies to achieve safe production, whose safety perception ability is a key factor in promoting construction's safety management capacity and preventing accidents in infrastructure [16]. Thus, safety perception of supervisors is treated as an important evaluation index of safety perception. Working conditions have a great impact on the construction in infrastructure, mainly due to much more high operating, underground operating, large-scale machinery, electrical work and inflammables, thus easily leading to accidents. Therefore, safety perception of work is one of the important factors of safety perception.

Practice is the sole criterion for testing truth. The better is implementation of SLMs' safe production responsibility system, the better is the security situation. Thus, safety perception of practice is treated as an important evaluation index of safety perception.

Any work is inseparable from the management, whose level has a direct impact on the merits of the work, especially in infrastructure [17]. Therefore, the management has a pivotal position in safety perception.

Getting along with colleagues is one of the prerequisites for good work, thus creating a harmonious working atmosphere and promoting efficient completion of tasks. Accordingly, safety perception of colleague is a momentous factor of safety perception.

2.2 Safety attitude

The importance of attitude in construction safety management has long been realized. Seaboch [18] believed that one's attitude in the moment is very important to understand the behavior of a person in a particular case. Oppenheim [19] defined attitude as specific behaviors or reactions individuals tend to in the face of certain stimuli. Safety attitude not only refers to steady response bias the individual held for safe production, but also

awareness of the importance of safety in production. Besides, it also meant to the emotion and commitment for implementing the safety rules and regulations for individuals. Heinrch [8] proposed that an inappropriate attitude of individuals is an important cause of their unsafe behavior. Li et al [20] found that attitudes have a direct impact on the safety of driving behavior. Li et al [21] highlighted the importance of safety attitude to safety performance. A general conclusion is that where safety attitudes are more favorable, workers are less likely to behave unsafely and therefore accidents are less likely to occur. Through the analysis mentioned above, it can be inferred that safety attitude has a significant impact on safety behavior.

Knowledge about safety may be a determining feature of the attitude the individual holds in relation to the safety, although attitudes are also likely to be influenced by social and cultural factors such as the commitment of management and co-workers to safety, job satisfaction and safety satisfaction. In addition, attitudes to safety at the workplace will be constrained by the values, norms, rules and regulations that the system has in place. Thus safety attitude is broken down into safety knowledge, safety awareness and safety commitment.

2.3 Safety behavior

To define the safety behavior from the perspective of human error, safety behavior refers to delays in the work processes and losses in equipment and property since the operator is unable to complete movements under the required accuracy, timing and procedure. A lot of research has been done on the type, causes and mechanism for human error. One of the most famous is the architecture named a "Skill – Rules – Knowledge" proposed by Rasmussen [11]. In his theory, the operator's behavior was divided into three aspects including skill-based behavior, rule-based behavior and knowledge-based behavior. Based on Rasmussen's findings [11], safety behavior of infrastructure SLMs can be defined as a target behavior in the process of infrastructure operation to complete work safely and avoid accidents.

In infrastructure construction, SLMs possess lower level of education, and even the lack of security knowledge and self-protection capabilities, resulting in unsafe behavior. In addition, violation of operating rules of construction is one of the causes of multiple accidents, such as using the wrong method, not to deal with hazardous condition in time, not obeying the command and so on. So skilled-based behavior, rule-based behavior and knowledge-based behavior are regarded as safety behavior's important indicators.

2.4 Research aim and hypotheses

The present study aims to better understand the mediating effect on safety attitude of SLMs between safety behavior and safety perception. To this end, this paper develops and tests an integrative model of construction workers' safety attitude which proposes the relationships among safety perception and safety behavior using structural equation modeling. This model posited sequent effects of safety perception at the macro organizational level on safety attitude, via factors at the micro organizational level (i.e., safety perception of person in charge, safety perception of work, safety perception of management, safety perception of practice, safety perception of colleague) and then safety attitude on safety behavior.

Based on the current study, the following hypotheses were formulated (Specific hypothesis is shown in Figure 1.):

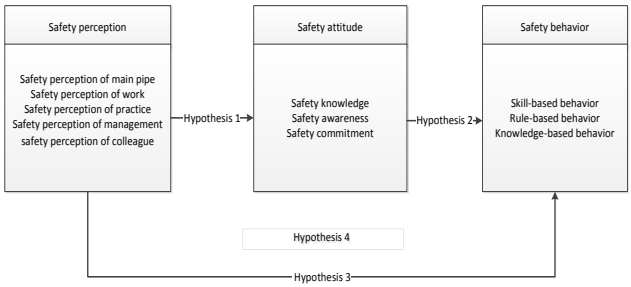

Figure 1. Research hypotheses

H1: safety perception of SLMs has a significant impact on their safety attitude;

H2: safety attitude has a significant impact on safety behavior;

H3: safety perception has a significant impact on safety behavior;

H4: safety attitude has a mediating effect between safety perception and safety behavior.

3 SCALES DESIGN

3.1 Safety Perception Scale

Referring the Safety Perception Scale established by Martin [22] and the Work Safety Consciousness Scale produced by Hayes etc. [23],

Safety Perception Scale was made by removing the title whose factor loadings were less than 0.60 in the SLMs' safety perception scale. The Scale was divided into five dimensions (Supervisor Safety Perception, Practice Safety Perception, Job Safety Perception, Management Safety Perception and Coworker Safety Perception), 20 topics. Likert's 5-point Scale was applied in the scale. 1= strongly disagree, 2= Disagree, 3= neither agree nor disagree, 4= agree, 5=strongly agree. The higher the total score, the higher the degree of safety perception.

3.2 Safety Attitude Scale

Based on the attitudes to safety questionnaire established by Cox [24] and Safety Attitudes Scale produced by Seaboch [18], Safety Attitude Scale was made by removing the title whose factor loadings were less than 0.60. The scale is divided into three dimensions (safety knowledge, safety awareness and commitment to safety), a total of 18 questions. Scoring is exactly the same way as Safety Perception Scale. The higher the total score, the higher the degree of safety attitude.

3.3 Safety Behavior Scale

Referring Rasmussen's [11] study, self-reported scale was applied in Safety Behavior Scale. Safety Behavior Scale was divided into three dimensions (skill-based behaviors, rule-based behaviors and knowledge-based behavior), a total of 18 questions showed in Table 1. Likert's 5-point Scale is also adopted in this scale. 1 to 5 points were given for never, seldom, sometimes, often and always. Total scores of questions in each dimension is the performance intensity for SLMs' safety behavior in each dimension.

Table 1 The questions in the Self-report scales

Dimension	Questions
Skill-based behaviors	Whether safety equipment such as helmets, gloves, safety glasses can be wear correctly Whether the safety equipment has been checked Whether the location of fire extinguishers and other workplace emergency protective equipment will be paid attention to. Whether calm can be stayed when accident happens; Whether the job was wrongly done unknowingly Whether the routine work have been handy Whether the dangerous behavior of colleagues will be stopped. Whether the safety tool canbe correctly used
Rule-based behaviors	Whether procedure of the work is clear Whether the each step of the work will be paid attention to in process Whether the work will be completed gradually comply with the provisions of safe operating procedures Why the work can't be completed although the correct methods of work was used, Whether tools will be finished and put on original position after the work completed. Whether help will be asked if a problem occurs in working process, Whether the wrong approach was used occasionally in the work process
Knowledge -based behavior	Whether an emergency can be deal correctly Whether the work security knowledge has been known Whether the decision-making is often off adoption in the working process

4 METHODOLOGY

4.1 Descriptive statistics analysis

In order to ensure the quality of data collected before starting data analysis, all the completed questionnaires (N = 400) were checked against systematic response patterns and more than 5% missing items. Through this data screening process, 22 out of 400 completed questionnaires were dropped from data set. The responses with 5% or less unanswered items were retained for data analysis. Missing data points were imputed with the median of nearby points in each case.

To code responses for data analysis, the researchers identified each item as being favorable or unfavorable toward its factor to be measured. For items that measure skill-based behaviors, rule-based behaviors, knowledge-based behavior, the higher the assigned value, the more favorable these constructs were indicated.

4.2 Reliability analysis

Cornbrash's α coefficient statistics and corrected item-total correlation coefficients of the

collected data were used to evaluate the consistency and reliability of each construct. Table 4 showed the Cornbrash's α values and corrected item-total correlation coefficients of each factor achieved the recommended level of 0.7. The results therefore showed adequate inter item reliability.

Exploratory factor analysis exploratory factor analysis was conducted to gain a better understanding of the factors underlying the 18 measurement items. Mean and standard deviation scores for all measurement items were presented in Table 1. As the factors cannot be observed directly, there is a random error in variables that is affected by the factors. This analysis is taken to assess the common basic factors of the scale in this study and explain the degree of variance.

4.3 T-test analysis

T-test analysis was used to test the expectation that two groups of data are equal to determine whether the significances of the two groups of variables show consistency or not, and at the same time verify the significant differences among the variables.

5 RESULTS OF EMPIRICAL ANALYSES

5.1 The sample recovery profile

Data were collected through sampling from workers of Three Gorges ship lift including steel fixer, welder, bricklayer, carpenter, etc. Approximately 400 workers were randomly selected and provided questionnaires while they were attending safety training programs at three different training centers. Anonymity was assured by providing each respondent an addressed envelope that allowed he/she returned the completed questionnaire to the researchers. 400 questionnaires initially distributed, 378 were completed and returned. Of those, 342 were sufficiently completed to be included in data analysis, producing a usable response rate of 85.50%. Respondent characteristics are shown in Table 2. The sample size and response rate is comparable with previous safety studies using structural equation modeling. Profile projects mainly consists of demographics including gender, age, education level, length of service, marital status and other personal background information. The questionnaires recovery profile results are showed in the Table 2.

Table 2. List of the research questionnaires recovery profile

The number of questionnaires	Number of questionnaires recovered	Recovery rate	Effective number of questionnaires	Valid recovery rate	Invalid number of questionnaires
400	378	94.50%	342	85.50%	36

Table 3. Basic information on samples

Item	Category	The number of people	Proportional /%
Sex	Man	301	88.01%
	Woman	31	11.99%
Age	20 ~ 30	29	8.48%
	30 ~ 40	87	25.44%
	40 ~ 50	119	34.80%
	>50	107	31.29%
Seniority/a	<1	78	22.81%
	1 ~ 3	136	36.56%
	3 ~ 5	87	23.39%
	5 ~ 10	51	13.71%
	>10	20	5.37%
Educational background	elementary school	94	27.49%
	middle school	161	47.08%
	high school or technical secondary school	43	12.57%
	Junior college	34	9.94%
	over junior college	10	2.92%

5.2 Reliability and validity on scale

In order to test the measurement model, a confirmatory factor analysis was conducted using AMOS 22.0 with the covariance matrix and ML estimation. The result of the model showed acceptable fit.

Then, the convergent and discriminant validity, as well as reliability, of factors were then tested using SPSS 21.0. The standard minimum threshold is higher than 0.7.

Table 4. Reliability analysis

The variable	Cronbach's α
Director of safety perception	0.711
Practice safety perception	0.735
Work safety perception	0.834
Manage safety perception	0.776
Safety perception of colleague	0.845
Safety knowledge	0.887
Safety awareness	0.764
Security Commitment	0.893
Skills safe behavior	0.717
Rules of safe behavior	0.791
Knowledge of safe behavior	0.873

Generally speaking, it is reasonable that the value of is between 1 and 3. The value range of GFI, NNFI and CFI is between 0 and 1, the critical value is 0.9. The value is fitness because it close to 1. The changing interval of RMSEA and SRMR is between 0 and 1, it is also fitness because it is close to 0. The critical standard is 0.05. As is shown in Table 5, the values of each scale's , GFI, NNFI, CFI, RMSEA and SRMR are within a reasonable range. The fitting degree of scale's SEM is higher.

Table 5. Fitting results of scales

Scale	χ^2/df	RMSEA	SRMR	GFI	CFI	NNFI
Safety perception	2.28	0.059	0.041	0.916	0.934	0.968
Security attitude	1.73	0.071	0.030	0.907	0.951	0.942
Safe behavior	2.64	0.032	0.025	0.943	0.926	0.953

Table 6 Fitting results of models

Model	χ^2/df	RMSEA	SRMR	GFI	CFI	NNFI
M_1	2.95	0.040	0.045	0.977	0.914	0.922
M_2	1.73	0.071	0.036	0.923	0.972	0.934
M_3	2.54	0.052	0.028	0.941	0.934	0.957

5.3 Model fitting and analysis

Three SEMs model (M1 refers to relationship between safety perception and safety behavior; M2 refers to relationship between safety perception, safety attitudes and safe behaviors; M3 was used to verify the relationship between the various dimensions of the three latent variables) were establish to verify the hypothesis (Figure 2 - 4).The resulting model fit indexes of AMSO21. 0 maximum likelihood estimation methods are shown in Table 6. As can be seen from Table 6, the absolute fit index of three models are respectively 2.95,1.73,2.54, less than the critical value (3); RMSEA of three models (0 040,0 071, 0.052.) and SRMR of them(0 045, 0. 036, 0. 028.) are both less than the critical value (0.05); GFI of three models (0. 977, 0. 923, 0. 941), CFI (0. 914, 0. 972, 0. 934), NNFI (0. 922, 0. 934, .957) are higher than the critical value (0.9). Resulting overall fitting degree of three assumptions is excellent. Shown in Figure 2, in M1, the standardized path coefficient for safety perception to safe behavior is 0.26, indicating that safety perception has a significant positive impact on safety behavior. Shown in Figure 3, in M2, the standardized path coefficient for safety perception to safety attitude is 0.25, which suggests that the safety perception has a significant positive direct impact on safety attitude. Besides, the standardized path coefficient for safety attitudes to safe behavior is 0.61, which indicates that the safety attitude has a significant positive impact on safety behavior directly. Meantime, direct path coefficient perception for safety perception to safety behavior is reduced to 0.11. This shows that the safety attitude plays a mediated effect partially on safety behavior and safety perception, and mediating effect share the proportion of overall effect by 57% (0. 25 × 0. 61/0. 26).

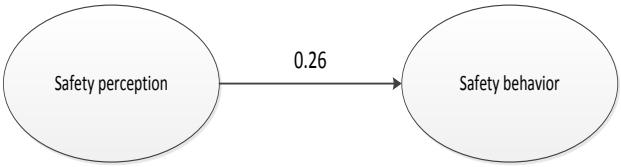

Figure.2 Results of model M1

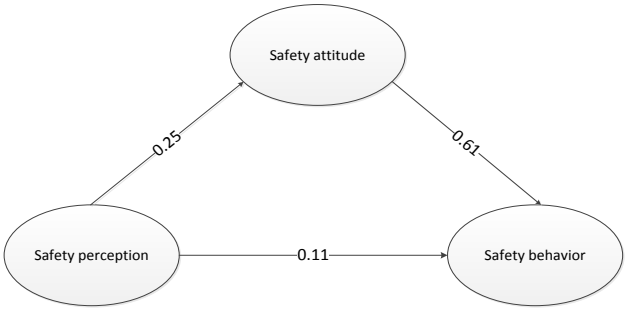

Figure.3 Results of model M2

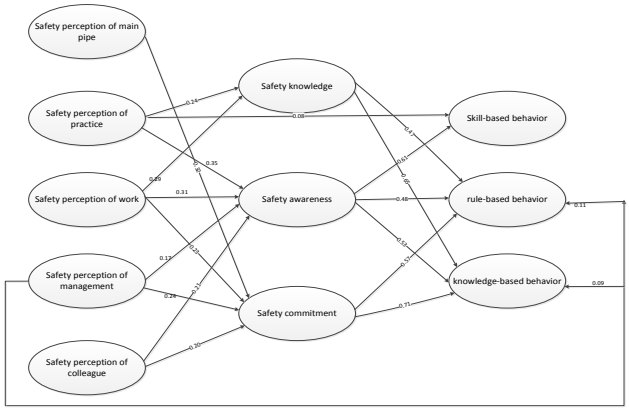

Figure.4 Results of model M3

As shown in Figure 4, In M3, Safety perception of supervisor whose standardized path coefficient is 0.32 has a significant positive impact on safety commitment;

Safety perception of practice produces a significant positive impact on safety awareness, safety commitment and skill-based behaviors (standardized path coefficient are 0.24, 0.35, and 0.08, respectively); safety perception of work has a significant positive impact on safety knowledge, safety awareness and safety commitment (standardized path coefficients are 0.29, 0.31, and 0.23, respectively). It descripted that safety attitude plays mediated effects between safety perception and safety behavior fully. Safety perception of management has a significantly positive impact on safety awareness, safety commitment, knowledge-based behavior and rules (standardized path coefficients are 0.17, 0.24, 0.11, and 0.09, respectively). Safety perception of colleague has a positive effect on safety awareness and safety commitment (standardized path coefficients are 0.21, 0.20, respectively). The standardized path coefficient for safety knowledge to rule-based behaviors and knowledge-based behavior were 0.5 47, 0 65, which shows that safety knowledge has a significant positive effect on knowledge-based behavior and rules. The standardized path coefficients for Safety awareness to skill-based behaviors, rules and knowledge were 0.61, 0.48, and 0.53, indicating that the safety awareness has a significant positive effect on skill-based behaviors, knowledge and rules. The standardized path coefficients for safety commitment to safe behavior of rules and knowledge are 0.57, 0.71, indicating that safety commitment has a significant positive effect on knowledge-based behavior and rules.

Through the above analysis, safety perception has a significant positive impact on safety attitude and safety behavior. Therefore, Hypothesis 1 and Hypothesis 2 have been verified. Safety attitude has a significant positive effect on safety behavior, showing that hypothesis 3 has been verified. Safety attitude plays a partially mediates effects between safety perception and safety behavior. Eventually, hypothesis 4 has been partially verified.

6 CONCLUSION

On the basis of the analysis, through SEM model and empirical research methods to explore interaction mechanism between safety perception, safety attitude and safety behavior, conclusions can be drown as follows:

In previous studies, based on the preparation and correction of safety perception and safety attitude scale, and with the reference to Rasmussen's [11] study, safety behavior scale was prepared by dividing the safety behavior into safe behavior of skills, rules and knowledge. Proven that three scales have good reliability and validity.

Safety perception has a significant positive impact on safety behavior. From the research results, the total effect of the safety perception of safe behavior is 0.26 which means the safety perception has a positively predict for safe behavior. Accordingly, in the infrastructure safety management practices, the role of safety perception should be paid much attention to. Improving staff's level of safety perception can have a positive effect on controlling the unsafe behavior of employees [25].

Safety attitude plays a partially mediated effect between safety perception and safety behavior. From research results, safety perception and attitude of the infrastructure safety of SLMs have a significant positive correlation, and safety attitude plays a positive predict towards safety behaviors.

As a stable behavioral tendencies security attitude helps to control unsafe behavior. Accordingly, in the infrastructure maintenance work, for some of the higher operational risk positions, higher level of safety perception and safety attitude staff can be chosen to undertake the job.

The close link between safety behavior, Safety perception and safety attitude of the infrastructure SLMs is an important factor affecting the safety of infrastructure operation. Based on analysis mentioned above, the corporation should pay full attention to safety perception and safety attitude of the infrastructure SLMs. Conducting effective safety perception and enhancing safety attitudes can help reduce human error, protect the safety of infrastructure operation

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