

# Impact of LMX on Coal Mine Safety Culture in China

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**Abstract**—Safety culture and the leader interaction with member are the keys to accident prevention. An equation of structure model (ESM) involved Leader-member exchange (LMX) and each element of safety culture is constructed based on literature review. And it is verified by this empirical study in China. 625 questionnaires are distributed and 333 valid samples are obtained with a response rate of 53% at coal mines. Research results from statistic analyses display safety culture is positively impacted by LMX. The conclusion gives advice to the practice of safety culture improvement by LMX promoting at coal mines in China.

**Keywords**—coal mine; Leader-member exchange (LMX); safety culture.

## I. INTRODUCTION

As the important index of organization management, safety culture determines the efficiency of safety management<sup>[1]</sup>. It is emphasized as the first of the five keys of safety management by the government of China<sup>[2]</sup>. Some summarized papers even proposed that accident can be prevented by valid safety culture<sup>[3]</sup>.

Study relating to the element of safety culture is to be the fresh trend step by step in China<sup>[4]</sup>. Some conclusions illustrate that the factors which influence safety culture including leadership, organization structure, human resource, management system, strategy and flow path<sup>[5]</sup>. Leader, as one of the factors, is the initiator to the culture, whose behaviour develops safety culture crucially.

As well known, coal mine industry is the vital strategic energy to every country in the world. Unfortunately, the terrible safety situation still puzzles the managers of coal mines in China. Fatal accidents occur usually. Some studies pointed out that three defects which including the lack of leader safety awareness, the comprehension bias to safety culture, the improper method to safety improvement, which cause employees slack the safety problems, finally result in safety failure at coal mine industry in China<sup>[6]</sup>.

Well, research regarding how and the level of leadership conduct safety culture is almost a blank space in China. It is even brought to the forefront of attention by energy industry abroad since disasters happened occasionally since Three Mile Island reactor explosion<sup>[7]</sup>. More funds and technology subsidizes about safety control were invested into the programs relating the leadership and safety performance in USA. In the same way, the rules of the law ask for the safety responsibility of leaders in UK.

Based on these above, the research on the impact of

leader-member exchange on safety culture is valuable to the practice of safety at coal mines in China. Meanwhile, the conclusion will provide empirical case then extend the theory of safety culture.

## II. LITERATURE REVIEW

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### A. Safety Culture

Accident caution theory goes through four sections since it was proposed by Heinrich in 1950<sup>[8]</sup>. The first stage called technology cause which emphasize the integrity and reliability of the equipment<sup>[9]</sup>. The second stage underlined man-made error<sup>[10]</sup>. The third stressed society technology. Safety culture accenting team corporation in the organization culture was put forward since nucleus accident in 1986<sup>[11]</sup>. Since then safety culture was taken the responsibility to be investigated for serious accidents.

In short, safety culture is considered much important from organization to industry. The original proposals regarding safety culture were proceeded in the dangerous traditional industries, soon afterwards unfolded to all others<sup>[12]</sup>.

### B. Leader-member exchange

Since the traditional theory and early contingency theory are hard to account for the validity of leadership, Graen transferred the research point of leadership interacting with members. And proposed the Leader-member exchange theory (LMX) in 1975<sup>[13]</sup>. Differ from any other theory, LMX lay stress on leader interacting with members<sup>[14]</sup>, so the correlation to organization behavior<sup>[15]</sup>.

As the association to both the process and conclusion of leadership, LMX has been the focal point for more than 40 years. From theory to practice, LMX consider a successful leader set up efficient relationship with members seriously<sup>[16]</sup>.

### C. Literature of the relation between LMX and Safety Culture

Tomas concluded the key of leadership to safety culture and the accident prevention<sup>[17]</sup>. Hofmann illustrated the relationship between leader and member impacting safety communication and forecasting safety performance<sup>[18]</sup>. In China, although most articles discussed safety culture

without scientific methods, it still gives the orientation to develop the safety research in the future.

### III. RESEARCH HYPOTHESES

The impact of LMX on safety culture is proposed as the Fig.1 followed.

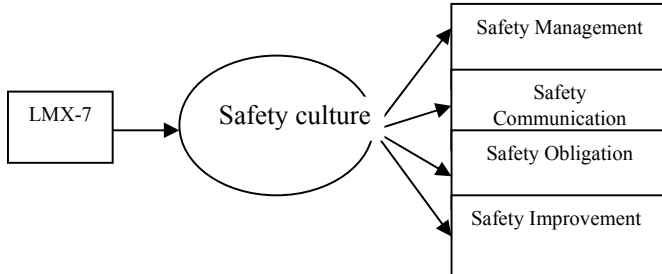


Figure 1. Model of the impact of LMX on each element of safety culture

Four hypotheses are put forward:

- H1 LMX-7 impact safety management positively
- H2 LMX-7 impact safety communication positively
- H3 LMX-7 impact safety obligation positively
- H4 LMX-7 impact safety improvement positively

### IV. RESEARCH METHODS

#### A. Questionnaire survey

Questionnaire survey was performed to collect data. 625 self-administered forms are distributed to the employees at coal mines with extent to the provinces all over China. Among the 531 feedbacks with completion anonymously, 333 are selected by standard with the valid ratio at 53%. Statistic methods including reliability, validity, correlation and the equation of structure model (SEM) are conducted data analyses.

#### B. Measuring Scales

LMX-7, the well-known one element scale developed by Graen, is selected to measure the degree of Leader and member interaction. The scale with 30 items developed by Cheyne is chosen to measure safety culture. Both scales adopt Likert5 style in this study. SPSS18.0 integrate with Amos18.0 is conducted for data analyses.

### V. RESULTS ANALYSES

#### A. Reliability

Reliability tests to the scales are conducted by SPSS18.0. Statistic results are showed as table 1 and table 2.

TABLE I. RELIABILITY STATISTICS OF LMX-7

$\alpha$	Items
0.821	7

Cronbach  $\alpha$  of LMX-7 is 0.821. And it is 0.845 of safety culture in this research on coal mines in China. Both data of results are greater than 0.7, which meet the reliability standard of social research.

TABLE II. RELIABILITY STATISTICS OF SAFETY CULTURE

$\alpha$	Items
0.845	30

Both scales which elected for data collection are according with the survey requirement in this paper.

#### B. Validity

Analysis results of factor loading with principle component extraction and max rotation indicate that LMX-7 is a single factor scale. And 5 elements are presented to the scale of safety culture. Confirmatory factor analysis is then conducted by Amos 18.0 to test discrimination validity. Four optimized factors which revised by the test are structured as safety management, safety communication, safety obligation and safety continuous improvement. The revised structure of safety culture is followed as Fig.2.

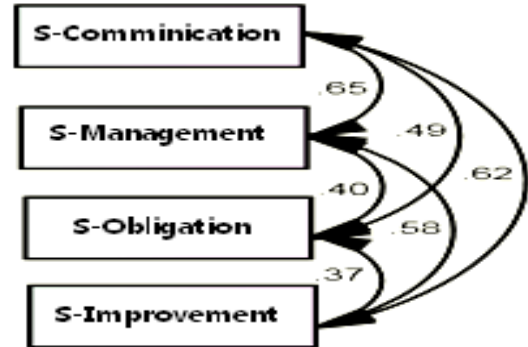


Figure 2. Revised structural model of safety culture

#### C. Correlation

Correlation analysis is subjected to verify the relationship between LMX-7 and safety culture. The result is showed as Table 3. The correlation coefficient is 0.300 with two-tailed at 0.01 level concomitant probabilities. This result proves LMX-7 positive correlating to safety culture significantly.

TABLE III. CORRELATION BETWEEN LMX-7 AND SAFETY CULTURE

	Index	Safety culture
LMX-7	Correlation coefficient	.300**
	Concomitant probability	.000
	Sample size	333

#### D. Equation of structure model

Structural equation model relate to LMX-7 and safety culture is supposed based on the literature research. Fit measure investigating the reliability and validity of the model demonstrate the degree of consistency with the hypothesis and the practical data. 8 indexes with benchmarks which showed as table 4 are selected on the basis of the test criterion to verify the model. The model is advised to revise when the goodness of fit index being out

of the benchmark<sup>[19]</sup>.

Standardized fit summary of the hypothetical model is

showed as table 5.

TABLE IV. MODEL FIT INDEXES WITH BENCHMARKS

Index	Benchmark
$\chi^2$ (CMIN)	$P > 0.05$
GFI	$> 0.9$
AGFI	$> 0.9$
RMSEA	$< 0.08$
ECVI	hypothetical model < independent model, hypothetical model < Saturated model
CFI	$> 0.9$
NC	$1 < NC < 3$ (model meet a criterion) $> 5$ (model has to revise)
Significant level of estimate parameter	Absolute value of C.R. of $\lambda > 1.96$ , $P < 0.05$

TABLE V. STANDARDIZED MODEL FIT SUMMARY OF LMX-7 AND SAFETY CULTURE

Model index	CMIN	P	DF	CMIN/DF	RMSEA	GFI	AGFI	CFI
Hypothetical model	33.433	0.000	9	3.715	.090	0.966	0.922	0.824

TABLE VI. STANDARDIZED REVISED MODEL FIT SUMMARY BETWEEN LMX-7 AND SAFETY CULTURE

Model index	CMIN	DF	P	CMIN/DF	RMSEA	GFI	AGFI	CFI
Revised Model	7.81	5	0.167	1.562	.041	0.991	0.972	0.976

Freedom degree of this model is  $21 - 12 = 9$ . Chi-square of hypothetical model is 33.433 with  $P < 0.05$ . CMIN/DF is  $3.715 > 3.000$ . RMSEA =  $0.9 > 0.8$ , CFI =  $0.824 < 0.9$ , ECVI of hypothetical model is 0.173, ECVI of saturated model is 0.127, ECVI of independent model is 0.500. The results above define the reformulation to the hypothetical model. Re-inspect conduct with unreasonable items deleted in terms of conciseness principle and causal inference. Test results display as table 6.

SEM of revised model is manifested as Fig. 3.

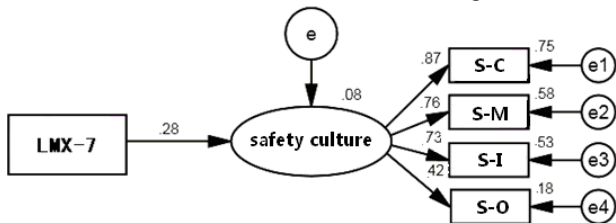


Figure 3. Revised standardized-model of the impact of LMX-7 on safety culture

Matching test of revised model indicates that the absolute value of C.R. of  $\lambda$  is greater than 1.96 with  $P > 0.05$ . Error variance is normal. ECVI of revised model is 0.084. It meets the standard of

the data is less than the ECVI of independent model (0.412) and saturated model (0.090). Chi-square value of the revised model is 7.81 with  $P = 0.167 > 0.05$ . Freedom degree is 5. CMIN/DF =  $1.562 < 3.000$ . RMSEA =  $0.041 < 0.08$ . GFI, AGFI and CFI are all greater than 0.9. All indexes meet the benchmarks requirements. Revised

standardized-model of the impact of LMX-7 on safety culture reflects the practical data with good adaptation degree.

R<sup>2</sup> of revised SEM model is 0.08 which denotes that LMX-7 accounts for 8% general variance variation. Influence coefficient of the impact of LMX-7 on safety culture is 0.28. According to the calculation with path coefficient, conclusions are showed that the impact coefficient of LMX-7 on safety communication is  $0.28 \times 0.87 = 0.24$ , the coefficient on safety management is  $0.28 \times 0.76 = 0.21$ , the coefficient on safety continuous improvement is  $0.28 \times 0.73 = 0.20$ , the coefficient on safety obligation is  $0.28 \times 0.42 = 0.12$ .

## VI. CONCLUSIONS

The fit tested and revised ESM of the impact of LMX on safety culture is proved by empirical study at coal mines in China. It shows LMX is the key to safety culture, impacts safety culture positively. In the same way, LMX as the independent variable influence on safety communication, safety management, safety obligation, and safety improvement positively.

Results of this study show that the improvement of safety culture can achieve though the LMX enhancement at coal mines. The verdict pushes the realistic purport to the construction of enterprise safety culture in China.

In conclusion, the findings of this research are not only to replenish empirical data but also to enrich the theoretical basis.

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