

# Correlation Study on Safety Culture Awareness and Accident Investigation Recognized By Railroad Staff

**Sangoh Lee**

*Department of Railway Safety Engineering, Seoul National University of Science and Technology  
232 Gongneung-ro, Nowon-gu, Seoul 01811, South Korea.  
Orcid: 0000-0003-3261-4886*

**Sungbong Chung**

*Professor, Department of Railway Management and Policy, Seoul National University of Science and Technology  
232 Gongneung-ro, Nowon-gu, Seoul 01811, South Korea.  
(Corresponding author)*

## Abstract

This dissertation is based on the results of study on awareness of railroad staff when the companies managing urban railroad conduct internal investigation, for which was employed the items of technological-level system required by Railroad Safety Management System. That is, an analysis was carried out to find what moderating effect the safety culture awareness of railroad staff has on their existing internal training, utilization of investigators' investigation method and their will to reflect their opinions. While previous studies on Railroad Safety Culture Awareness have been only for a rather superficial appreciation of railroad staff's safety culture awareness, this dissertation aims at creating desirable ways for the investigation of railroad accidents through analyzing their cognition of work process activities of those employees in charge of accident investigation. The railroad accident investigation inside railway companies is being conducted so that accidents may be analyzed for any problems to be found or deducted in the resolution-oriented way. The regressive analysis using the SPSS 18 Program was applied for the estimation of the correlation among the variables which were to be studied. The study analysis revealed that railroad staff thought their opinions were actively reflected to the procedures of railroad-accident investigation when those investigators executed internal checkup and training with positive attitudes in their organizations. Plus, railroad staff's cognition result was deducted that still more positive opinions of theirs would be reflected to those investigations in the condition where safety culture awareness and will for safety policy of railroad staff, managers and investigators were to be fostered in terms of Railroad Safety Precaution. Lastly, it was also revealed that the positive recognition of internal inspection will have a positive (+) effect on the rational procedures and utilizations resulting from investigation of accidents along with the fact that the higher management's awareness of safety culture is, the more positive (+) influence on them there is

**Keywords:** Railroad Accident Investigation, Railroad Safety Management System, Safety Culture Awareness, Internal Inspection, Education & Training

## INTRODUCTION

The analysis of railroad accidents in the recent 5 years shows that railroad staff's negligence and system failure (defective material quality of parts, manufacture defect) were major causes. To put it concretely, more than 96% of accidents were caused by personal errors, followed by technological causes (2.8%) and external ones (0.45%), where train accidents by personal errors of railroad staff were found to have been caused by personal errors of railroad operators, which is more than 80% of those train accidents by personal errors[1]. It indicates that business intervention of railroad staff is indispensable in exceptional conditions, which makes human errors inevitable.

So far, most of railroad-accident investigators have been found not try to determining any definite causes of accidents with desirable approaches to the clarification of various barriers and accidents but to hurriedly complete their perfunctory investigations in due degree only with some condescending attitude. The fundamental purpose of railroad-accident investigation is the very prevention of them. The duty of accident investigators is to play a key role in the process of business feed-back and feed-forward to other departments based on the problems which have been deducted from accident analyses for the purpose of preventing the same accidents, where the role of railroad staff, a challenge for railway companies to resolve for the very first time, is counteracting accidents while that of accident investigators is thoroughly determining the accident causes in order to develop and apply any desirable improvements for the prevention of the same accidents and then to make their investigation reports.

This study was launched with the necessity to improve the methods and procedures of future accident investigations through cognition survey with the subjects of railroad staff to find out if internal railroad-accident investigation procedure and their effort for its improvement are progressing in a desired direction. Furthermore, it was supposed to figure out what is the railroad staff's viewpoint about how much the railroad safety awareness, which have been researched very actively, influences the management. That is, this study, from

their standpoint, tried to find out if the management recognized the significance of safety culture awareness to make efforts for fostering safety culture and had any will and leadership to practice and enforce any safety policies. The outcomes from this study are expected to be utilized as fundamental material for creating a practical manual for railroad management to operate railroad system. In short, the ultimate purpose of this study is to achieve the result that the improvement of management’s safety culture awareness and of accident investigators’ work process in their organizations enables urban railway companies to suffer less railroad accidents.

For the research, the employees in operating headquarters of A Urban Railway Company were surveyed on the technological level of railroad safety management system from Dec 1 2016 to Dec 30 2016. Those questioned were all railroad staff. 170 sheets of questionnaire were collected from them, 147 of which were employed for final estimation with the exclusion of 23 unfaithfully answered sheets. Likert 5-point Scale was applied to those questions, whose format was for higher-numbered ones to be estimated as more positive cognition of relevant questions. This survey was aimed to accomplish the study purpose by appreciating railroad staff’s overall awareness of safe railroad management, accident investigation and report, internal checkup, education and training and safety culture all of which are required for railroad safety management system.

**REVIEW OF RELEVANT LITERATURE**

**Over view of Railroad Safety Management System**

“Railroad Safety Management System”, composed of SMS, train operation system and maintenance system, means an organic system for safety management by manpower, facility, equipment and emergency response plan with which railroad corporations should be equipped for operation of urban train and management of railroad facilities [2]. Among them, SMS (Safety Management System) means an organic system of organizational structure of safety management, role and responsibility, procedure, preparation, management and regulation. It is made up of the total 11 programs, which are program overview, railroad safety management, documentation, risk management, observation of requirements, accident investigation and report, internal checkup, emergency response, education and training, safety information and safety culture.

The rationale of experiment in the questionnaire was focused on the above-mentioned Railroad Safety Management System, for which were quoted Notification #20151033 Technological Level of Railroad Safety Management System of Ministry of Land, Infrastructure and Transport and Article # 82 (Measurement of Safety Culture Level) “Safety Culture Program” of Railroad Safety Management System of A Urban

Railroad Corporation [2]. As research tools were selected and applied requirements and safety culture out of 4 fields of safety policy, responsibility assignment, requirements and safety culture from management realm, internal checkup and education/training out of 3 fields of risk management, internal checkup and education/training from prevention realm and accident/fault management out of 2 fields of accident/fault management and emergency response. Table 1 shows details of variables at survey.

**Table 1: Questionnaire items**

Classification		Total number Of existing items	Number of items For real research
Management realm	Awareness of safety culture fostering	17	12
	Responsibility assignment		0
	Requirements	20	0
	Intention for safety policy		14
Prevention realm	Education/training	7	7
	Internal checkup	7	7
	Risk management	13	0
Fulfilment realm	Accident/fault management	8	2
	Emergency response	12	0

Note: Quoted form Technological Level Provision, Railroad Safety Management System

The concrete contents of questions at Table 1 indicate that there are two fields of measurements of safety culture applied as moderator variables. One field has 12 questions including “safety management policy”, “management’s will for and awareness of safety management policy” and “knowledge on SMS” related to their safety management awareness and the other 14 questions including “managers’ contribution level”, “awareness of safety goal by department”, “possibility of safety goal achievement by department”, company-wide awareness of safety goal”, “awareness of detailed plan for enforcement of safety goal”, “post of safety management policy”, “management’s will for enforcement of safety management policy” and “appreciation of safety management policy” related to the will for fostering safety culture. For the measurement of education/training, an independence variable, were applied the seven items of “education/training for prevention of safety accident”, “appropriateness of education/training hours for safety regulation”, “routine checkup of demand for education/training”, “effort for appreciating the necessity of frequent educations/trainings “, “will for application of requirements”, “will for improvement effort after estimation” and “level of feedback after education/training”. For the measurement of internal checkup were 7 items of “recognition of routine inspection”, “awareness of accident prevention efficiency by internal

inspection”, “awareness of significance of internal inspection”, “acknowledgement level of inspectors’ qualification”, “necessity of monitoring safety activity”, “efficiency of monitoring result” and “will for review of results from procedure monitoring”. The questions related to awareness of railroad accident investigation, which is a dependent variable, were for determining what they think about “Procedure and method for accident investigation are ready and utilized practically” and “Workers’ opinions are reflected enough for fairness and correctness to be secured during investigation procedure”.

**Status of train accidents caused by human factors of railroad staff**

Table 2 below shows the numbers of railroad accidents by cause from 2011 to 2015, which clearly indicates that the accidents caused by personal errors take up more than 96%, much more than those caused by others.

Table 3 below shows the status of train accidents caused by human factors from 2011 to 2015. The ratio of accidents resulting from human factors is as high as over 90%, of which 50% was caused by a human factor of operator errors.

**Table 2:** Numbers of railroad accidents by cause

Classification	2011	2012	2013	2014	2015	Total	Average	Ratio
Human factor	272	242	224	200	132	1,070	214	96.75%
Technological factor	1	7	8	9	6	31	6.2	2.8%
External factor	4	1	0	0	0	5	1	0.45%
Total	277	250	232	209	138	1,106	221.2	100%

NOTE: Quoted from Data at Homepage of Korean Transportation Safety Authority

**Table 3:** Status of yearly train accidents by human factor

Classification	2011	2012	2013	2014	2015	Total	Ratio
Total	1	3	2	3	1	10	100%
Engineer	0	2	2	1	0	5	50%
Controller	0	0	0	0	0	0	0%
Operator	0	1	0	0	0	1	10%
Station employee	0	1	0	0	0	1	20%
Maintenance staff	1	0	0	1	0	2	20%
Others	0	0	0	1	0	1	10%

NOTE: Quoted from 2016 White Paper on Safety of Korean Transportation Safety Authority

**Introduction of preceding researches**

Bend, R. et al. (2011) conducted the research producing the dissertation of “Safety culture, Safety behavior and safety performance in Railway Companies” to get the results from real experiences by analyzing the correlation among safety culture, safety behavior and safety performance in railway companies. The analysis outcomes revealed that a positive safety culture surely had some influence on engineers’ awareness of safety behavior. In addition, they found out that safety culture was having a positive effect on expected safety

performance, that is, it was playing a positive role influencing such expected safety performance. A few outcomes from policy analysis played the role of providing useful information for those making decisions on railway operation and government policy who regulate and plan the safety management system [5].

Jongsuk Yi (2011) carried out “Study on Standard for Measuring Railway Safety Culture and Process Development” so as to examine the level of railroad safety culture in domestic railway operation agencies for estimating the examples of safety culture system applied by foreign railway-advanced countries and other transportation fields which would be compared with the domestic status. He, with the intention of stressing the sense of safety responsibility and leadership of management, carried out the examination of safety culture level in railway operation agencies according to the standard for measuring the level of railroad safety culture which was developed for domestic railway conditions [3].

Sikon Kim and another (2014) tried an evaluation development for executing an analysis of internal consistency and factors to figure out how well the questions by factor reflected individual factors [4]., which was a research aimed to finding out if the standard defined through structuring and grouping evaluation factors of questions for higher reliability of estimation had any other common properties. Two additional factors resulting from the study were added to the existing ones to be grouped by each of those seven ones and named appropriately so that they might be compared with those existing ones for estimation of reliability, which produced the data of considerably high figures. Consequently, it revealed that there was a difference between the structure of the first questions and the real appreciation by the subjects of questionnaire.

Seonchol Hwang and 2 others (2015) conducted the research of “Effect of Moderating Preventive Focus and Fatalism in Relationship between Safety Culture Cognition and Safety Behavior” to verify that the effect of safety culture cognition had much effect on safety behavior in order of information sharing, decision-making and fair culture [5]. In addition, they found out that those with lower preventive focus behaved more safely as their awareness of each factor to safety culture got higher. Lastly, they also deducted that fatalism enabled workers to adjust the relationship among such constituents of safety culture as leadership, organization capacity, fair culture and safety behavior. In short, their dissertation suggested that the continuous effort of management is very significant since there comes to be more employees’ safety behavior as the level of safety culture in an organization gets higher.

Yujeong Kwon and another (2009) analyzed safety culture evaluation programs in each industry to consider establishment of railroad safety culture, which led to the dissertation of “Review of Railroad Safety Culture”. They revealed that the major causes of safety accidents were not any problems to safety regulation or system or any devices but such human factors of managers and operators like lack of responsibility for safety and ignorance of safety awareness and attitude [6]. They also mentioned that the interest in railway safety culture is not only less than that in other high-

risk industries but also the evaluation program is rather insufficient. Accordingly, they asserted that for settlement and spread of right railroad safety culture it is indispensable to adopt a systematic and comprehensive evaluation program which can effectively evaluate the status of safety culture and its settlement so that all concerned in railway operation in government, regulating agencies and industries may exert themselves consistently.

Myoungson Son and two others (2015) carried out an examination on safety culture level of railway companies to conclude that as with safety culture the atmosphere is necessary where employees prioritize safety in the communication system reflecting their freely expressed opinions on the ground of established safety management system. Plus, they asserted that for higher level of railroad safety culture the management's sense of safety should be stirred up and that there is the need for incentive in order to reinforce employees' safety activities [7]. They, lastly, mentioned the necessity for Safety Management System based on Risk Evaluation System to be constructed first in Korea where railroad safety culture has not settled completely yet.

### Distinctiveness and implications of this study

This study has a considerable distinctiveness when compared with any other studies or dissertations on the theme of safety culture since it has tried to appreciate the correlated effect by employing the answers to diverse questions about awareness of railroad safety culture in Railroad Safety Management System with the research subjects of railroad staff. That is, while preceding researches on railroad safety culture were of the simple type of arithmetic statistics report with the application of only the results from the analysis of answers to questions, this dissertation contains the outcomes from in-depth approaches enabling to understand the correlational cause and effect and appreciate the moderating effect among specific variables by a regressive analysis on the items for technology level system which are required by railroad safety management system.

## RESEARCH MODEL & HYPOTHESIS ESTABLISHMENT

### Research model

With the application of safety culture awareness, internal checkup and education/training and accident investigation as moderator variable, independence variable and dependent variable for basic research establishment respectively, the analysis was executed to find out what effect there is between independence variable and dependent variable. First, this study, with the premise that the railroad staff's cognition of and opinions on internal education/training and checkup would be aggressively reflected in accident investigations, tried to find out how the management's safety culture awareness and its will for safety policy, which have been continuously paid attention to recently, play the role of adjusting the relativeness between railroad staff's cognition of education/training and internal checkup and their recognition on accident investigations in which the staff's opinions were reflected by accident investigators. Second, it figured out what adjusting effect the management's safety culture awareness

and safety-policy would have on fostering fairness and accuracy when investigation methods familiar to railroad staff are employed. Figure 1 below shows its summary as an overall chart.

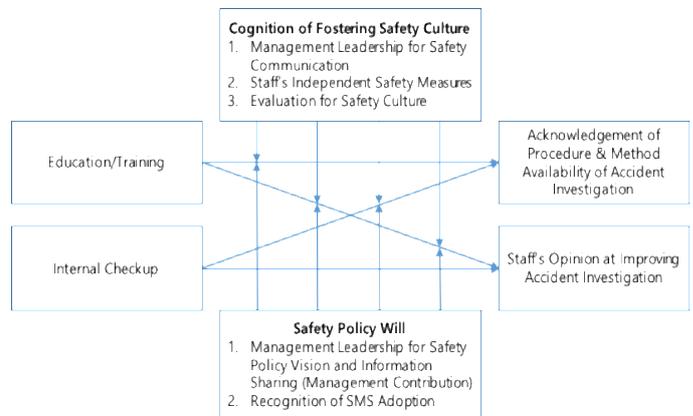


Figure 1: Schematic diagram of study

### Hypothesis establishment

Based on the review of preceding researches, this study established the below research hypotheses in order to figure out the casual relations among the following major constructs with the focus on research models which were to be verified by this study.

Preceding researches have emphasized the most the significance of management's sense of safety responsibility and leadership for the materialization of higher level of safety culture in railway companies and consequently verified that the degree of effect of safety culture awareness on safety behavior gets higher in order of information sharing, decision-making and difference in fair culture. Accordingly, this study established the following hypotheses based on the facts, considerable part of which had been confirmed.

- 1-1 There will be a control action of the consciousness to foster railroad safety culture in the relation between railroad staff's positive cognition about education/training and procedure/method of railroad accident investigation.
- 1-2 There will be a control action of Safety Policy Will between positive cognition about education/training for railroad safety precaution and procedure/method of railroad accident investigation.
- 2-1 There will be a control action of the intention to foster railroad safety culture between railroad staff's positive cognition about education/training for railroad safety precaution and acknowledgement of their opinion reflection at accident investigations.
- 2-2 There will be a control action of will for safety policy between railroad staff's positive cognition about education/training for railroad safety precaution and acknowledgement of their opinion reflection at accident investigations.
- 3-1 There will be a control action of positive cognition about internal checkup between procedure/method of railroad accident investigations and consciousness of fostering railroad safety culture.

- 3-2 There will be a control action of positive cognition about internal checkup between procedure/method of railroad accident investigations and will for safety policy.
- 4-1 There will be a control action of positive cognition about internal checkup between consciousness of fostering railroad safety culture and staff's acknowledgement of their opinions reflected in improving procedure/method of accident investigation.
- 4-2 There will be a control action of positive cognition about internal checkup between will for safety policy and staff's acknowledgement of their opinions reflected in improving procedure/method of accident investigation

**Operational definition of variables**

The operational definition of the major configuration variables in this study are seen at Table 4 below.

**Table 4:** Major configuration variables

Research variables	Operational definition of variables
Safety culture	Cooper (2000) defined safety culture as a sub-factor to organization culture which has effect on members' attitude and behavior toward continuous health and safety activities of the organization [8].
Education/ Training	Sikula (1979) asserted that education/training, generally having effect on the improvement of organizational effectiveness, is for productivity increase, quality improvement, human resource improvement, morale boosting, enhancement of indirect compensation, promotion of employees' health hygiene and growth of self-development [9].
Internal Check	Cooper (2001) defined internal checkup as a process for members to continuously beef up and expand safety policies and procedures in their organization [10]. The internal checkup based on railroad safety management system features inspection and preventive monitoring, and accordingly each railway company is to execute routine internal checkup along with the construction of internal inspection organization.
Railroad accident & investigation	A railway accident causes human death or injury and damage to objects used or installed for railway operation and railway facility management [11]. The purpose of railroad accident investigation is to determine the cause of failure or fault of the system by analyzing accidents and to plan safe and rational measures for prevention of the same type of railroad disaster.

**RESEARCH ANALYSIS & VERIFICATION**

**Descriptive statistics**

Over 55%, 33.3%, 10.2% and 0.7% of survey respondents were in their 30's, 20's, 40's and 50's or others respectively. Due to the property of organizational rank system, relatively young employees were at lower ranks, which led to the response configuration with rank-and-files of 42.9%, deputy

section chiefs of 32%, section chiefs of 16.3%, deputy department heads of 6.8 and department heads and higher of 2%. One thing to be paid attention to was that those in their 20 ~ 30's responded more negatively than those in their 40's and over.

The statistics program of SPSS PASW was employed to produce the following analysis outcomes.

First, descriptive statistics analysis was adopted for figuring out respondents' demographic configuration.

Second, the reliability coefficient of Cronbach's Alpha was applied for testing the reliability of used scales.

Third, a factor analysis was implemented for the estimation of key factors, which produced factor scores.

Fourth, a regressive analysis was executed to figure out what effect the moderator variable of safety culture awareness has on dependent variables.

Based on the response data from 147 respondents, the descriptive statistics by question were produced as seen at Tables 5 and 6.

**Table 5:** Ranks of employees

Classification		Frequency	Percent	Valid percent	Cumulative percent
Valid	Rank-and-file	63	42.9	42.9	42.9
	Deputy section chief	47	32.0	32.0	74.8
	Section chief	24	16.3	16.3	91.2
	Deputy department head	10	6.8	6.8	98.0
	Higher than department head	3	2.0	2.0	100.0
	Total	147	100.0	100.0	-

**Table 6:** Classification by age

Classification		Frequency	Percent	Valid percent	Cumulative percent
Valid	20's	49	33.3	33.3	33.3
	30's	82	55.8	55.8	89.1
	40's	15	10.2	10.2	99.3
	50's & older	1	.7	.7	100.0
	Total	147	100.0	100.0	-

**Factor analysis**

42 questions which were employed as investigation variables for this study through factor analysis were reviewed to find out if they were categorized as one group with validity and reliability to represent railroad safety culture as seen at Table 6 according to the responses, which was to figure out whether the questions suggested for the appreciation of railroad safety culture awareness level with the objects of requirements on technological system level in Railroad Safety Management System properly corresponded to the classification of factor analysis in this study or not. Factor analysis of the variable, safety culture policy, led to the classification of Factor 1 with managers' contributiveness, department awareness of safety goal, probability of achieving safety goal in department, company-wide cognition of safety goal, acknowledgement of

detailed initiative-plan for safety goal, post of safety management plan, management's will for safety management policy, cognition of safety management policy and of Factor 2 with SMS education, level of SMS acquaintance, recognition of SMS adoption and education for safety management policy. It was found to have a proper reliability with Cronbach's Alpha Index 0.917 and a validity of 0.889, which means there was no problem since they are higher than reference values. It was found that Factor 1 was classified as safety policy vision and information sharing while Factor 2 as the level of cognition about SMS adoption, which made it clear that the questions applied for this study corresponded to the categorization standard of questions about railroad safety management system.

The factor analysis of the variable of safety culture fostering recognition led to the classification of Factor 1 as Communication and Leadership for management's safety improvements such as communication among one another, management's will for enduring the payment of safety cost, easy communication with managers, management's effort to listening for safety improvement, opportunity for communications among departments and management's will for improvement through safety check. While Factor 2 was classified as railroad staff's autonomous safety activities such as effectiveness of information related to safety, cooperativity for information relevant to safety, railroad staff's aggressive improvement activities, business association for safety and necessity for observing the procedures of safety regulations. Lastly, Factor 3 was categorized as the evaluation of safety culture level such as limitation to procedure or regulation of safety management, cognition of the presence of tools for evaluating safety culture level and department's volition for making effort to improve safety culture.

**Verification of hypotheses and analysis result**

1-1 It was rejected since there was no adjusting action of awareness about fostering railroad safety culture between

railroad staff's positive cognition about education/training on railroad safety precaution and procedure/method of accident investigation.

1-2 It was rejected since there was no adjusting action of will for safety policy between railroad staff's positive cognition about education/training on railroad safety precaution and procedure/method of accident investigation.

2-1 It was supported since there was the adjusting action of awareness about fostering railroad safety culture between railroad staff's positive cognition about education/training on railroad safety precaution and employees' acknowledgement of staff's opinions reflected in improving railroad accident investigation.

2-2 It was rejected since there was no adjusting action of will for safety policy between railroad staff's positive cognition about education/training on railroad safety precaution and their recognition of their opinions reflected in accident investigation.

3-1 It was supported since there was the adjusting action of awareness about fostering railroad safety culture between positive cognition about internal check and procedure/method of accident investigation.

3-2 It was rejected since there was no adjusting action of will for safety policy between positive cognition about internal check and procedure/method of accident investigation.

4.1 It was rejected since there was no adjusting action of awareness of fostering railroad safety culture between positive cognition about internal check and railroad staff's acknowledgement of their opinions reflected in improvement of accident investigation procedures.

4-2 It was supported since there was the adjusting action of will for safety policy between positive cognition about internal check and railroad staff's acknowledgement of their opinions reflected in improvement of accident investigation procedures.

**Table 7:** Results of analyzing factors to safety culture policy cognition

Classification	Component		Cronbach's Alpha	KMO and Bartlett's Test
	1	2		
Managers' contributiveness	.798	.068	.917	.889
Department awareness of safety goal	.798	.208		
Probability of achieving safety goal in department	.753	.220		
Company-wide cognition of safety goal	.749	.198		
Acknowledgement of detailed initiative-plan for safety goal	.703	.258		
Post of safety management policy	.648	.407		
Management will for safety management policy	.603	.510		
Cognition of safety management policy	.574	.537		
SMS education	.186	.864		
SMS cognition	.232	.824		
Recognition of SMS adoption	.142	.805		
Education for safety management policy	.573	.600		

**Table 8:** Analysis Result of Factors to Variable of Safety Culture Fostering Awareness

Classification	Component			Cronbach's Alpha	KMO and Bartlett's Test
	1	2	3		
Communication interexchange	.820	.145	.268	.905	.864
Management's will for enduring payment of safety cost	.793	.128	-.014		
Easy communication with managers	.767	.229	.193		
Managements' effort for listening to safety improvement	.744	.387	-.041		
Opportunity for communications among departments	.742	.240	.238		
Management's will for improvement through safety check	.511	.504	.102		
Effectiveness of information Related to safety	.213	.760	.121		
Cooperativity for information Relevant to safety	.331	.760	.083		
Aggressive improvement activities	.233	.751	.077		
Business association for safety	.120	.747	.299		
Necessity for observing procedures of safety regulations	..131	.736	.240		
Limitation to procedure or regulation of safety management	-.039	.174	.781		
Cognition of presence of tools for evaluating safety culture level	.344	.156	.720		
Department's volition for making effort to improve safety culture	.365	.432	.507		

Hypothesis 3-1 was that there would be the adjusting action of safety culture level evaluation between positive cognition on internal inspection and procedure/method of railroad accident investigation. The analysis found that the acknowledgement on availability of investigation procedure/method and internal inspection had the adjusting effect at the significant level of 0.019 as seen at Table 10. That is, the railroad staff's positive cognition of internal inspection means that they are aware of the importance of evaluating safety culture level through recognizing the limitation to current organizations' procedures or regulations for safety management. A positive cognition was deducted that the more the managers' will for enhancing safety culture awareness is, the higher their volition for

effective application of accident investigation procedure and method gets.

Hypothesis 4-2 was that the organization's awareness on the adoption of railroad safety management system included in the will for railroad safety policy would play the adjusting role between the positive cognition of internal inspection for promoting safety activities in organizational level and the procedure/method of railroad accident investigation. The analysis results indicated that the cognition of the internal inspection and the procedure/method of railroad accident investigation had the adjusting effect at the significant level of 0.042 as seen at Table 11.

**Table 9:** Verification result of adjusting effect (hypothesis 2-1)

Variable		Independent variable: Reflection of staff's opinion in accident investigation					
		Model 1		Model 2		Model 3	
		Value f	Sig	Value f	Sig	Value f	Sig
Independent	Education/training	63.493	0.000	12.652	0.001	3.706	0.056
Adjustment	Cognition of safety culture fostering (management's leadership for safety communication)						
<b>R<sup>2</sup></b>		0.305		0.352		0.364	

**Table 10:** Verification result of adjusting effect (hypothesis 3-1)

Variable		Dependent variable: cognition on availability of accident investigation procedure/method					
		Model 1		Model 2		Model 3	
		Value f	Sig	Value f	Sig	Value f	Sig
Independent	Internal check	43.838	0.000	7.407	0.007	3.706	0.019
Adjustment	Awareness of fostering safety culture (evaluation of safety culture level)						
<b>R<sup>2</sup></b>		0.227		0.259		0.282	

**Table 11:** Verification result of adjusting effect (hypothesis 4-2)

Variable		Dependent variable: acknowledgement on availability of railroad accident investigation procedure and method					
		Model 1		Model 2		Model 3	
		Value f	Sig	Value f	Sig	Value f	Sig
Independent	Internal inspection	43.818	0.000	1.713	0.193	3.706	0.042
Adjustment	Will for safety policy (cognition of SMS adoption)						
<b>R<sup>2</sup></b>		0.227		0.231		0.247	

Railroad staff's acknowledgement of internal inspection means that they recognize the importance of evaluating safety culture level along with the appreciation of limitation to current organizations' procedure/method of safety management. Railroad staff's viewpoint was deducted that the more the management's will for enhancing safety culture awareness is, the higher their volition for effective application of accident investigation procedure and method gets.

## CONCLUSION & PROPOSAL

### Conclusion

This study examined railroad staff's thought about technology system required by railroad safety management system including education/training of railroad operators, internal inspection, safety culture awareness and accident investigation procedure/method of investigators with the subjects of employees working at A Railway Company, which enabled the deduction of the followings.

First, there was adjusting effect of management's recognition of fostering railroad safety culture between the railroad staff's positive cognition of education/training and their acknowledgement of how faithfully accident investigators reflect employees' opinion in improving investigation procedure or method.

Second, there was adjusting effect of the recognition of fostering railroad safety culture between the railroad staff's positive cognition of education/training and accident investigation procedure/method.

Third, there was adjusting effect of the will for safety policy between the railroad staff's positive cognition of internal inspection and the acknowledgement of their opinion reflected by accident investigators in improvement of investigation procedure/method.

### Proposal

This study could reveal that the volition for communication tried for enhancing railroad staff's sense of safety has a very significant effect on their positive awareness of railroad safety. In contrast, when engineers decide that their management ignores safety, railroad staff comes to think their management is seeking for other goals than safety, which eventually causes them to assume that it will be difficult for railroad safety culture to be settled. Even though railroad staff thinks that management are making lots of effort for improvement through systematic and preventive monitoring in the organizational level, they have a relatively negative viewpoint that the management, in reality, are good neither at effective application of accident precaution by internal inspection nor at appreciation of its significance. Accordingly,

the management and railroad accident investigators should exert themselves even more to improve the systematic and preventive monitoring. While those problems noticed at railroad accident investigations are being reflected aggressively in future emergency response training and plan for its manual revision, there is still a challenge to be resolved that the effort for improving systems through active collection of the staff's opinion and for preventing accidents from being repeated is not sufficient. Railway companies may have a desirable way to encourage the staff to voluntarily participate in various safety activities such as Safety Contest and Contest of Preventing Accidents by Momentary Ignorance so that their mindset toward safety may be promoted. Finally, the management will have to do their utmost for free communication with one another by offering regular communication opportunity so that any information for accident prevention may be efficiently delivered to railroad staff. Furthermore, when investment of safety cost in workplace is decided to be necessary, the volition for daring investment of safety cost should be persistent.

### REFERENCES

- [1] <http://www.railsafety.or.kr/web/por/pageflow/board/PORBoardL.jsp>
- [2] SL9(2016): Internal report, SMS requirements, "20151033-notification", MLIT.
- [3] J.S.Lee et al, "A Study on the Development of the Safety Culture Inspection Standards and Process in Korea Railway", the Korean Society for Railway 2011 Annual Meeting, pp.2548~2556, 2011
- [4] S.G.Kim et al, "Designing Questionnaires for Better Reliable Survey : Case Study of Using Railway Safety Culture Survey Data", Journal of the Korean society of civil engineers, Vol.34(6), pp.1837-1844, 2014
- [5] S.C.Hwang et al, "The impact of Safety Culture on Safety Behavior : Moderating Effect of Prevention Focus and Fatalism", Korean Journal of Resources Development, Vol. 18(4), pp.153-175, 2015
- [6] J. Y .Kwan et al, "Consideration on safety culture of railway", the Korean Society for Railway 2009 Annual Meeting, pp.2417~2420, 2009
- [7] M.S.Son et al, "Research of the safety culture level on Korea Railway Corporations", journal of the Korean Society for Urban Railway, Vol.3(3), pp.389~397, 2015
- [8] Cooper .M.D, "Towards a model of safety culture, safety science", Vol.36(2), pp.111-136, 2000
- [9] Sikula, a. f., "Rethinking present appraisal system; Super Manage Publication", Sikua JP, 1979
- [10] Cooper M.D, "Improving safety culture", pp.144~148, 2001
- [11] SL9, "Internal report, SMS program", L91-SAF-SA-PRO-150005, pp 9~12, 2015
- [12] Bend, R. et al, "Safety culture, Safety behavior and safety performance in Railway Companies"
- [13] Sarah Sharples et al, "Contemporary Ergonomics and Human Factors", pp.66~73, 2015