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An Empirical Study on Safety Culture in Aviation Maintenance Organization

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Abstract

Research on the safety culture of aviation maintenance organization is weak compared to one of the aviation flight organization. This reality is a situation that worked the effort systematically to reduce the risk factors that are caused by the aircraft maintenance actions and thus it is true that it is a situation where the environment is concerned and can be causing more accidents and serious incidents. The aim of this study was to derive improvement strategy by evaluating the safety culture of aviation maintenance organization and by analyzing the poor part of it. Made on the basis of the five aspects of safety culture, the reliability of the questionnaire by Cronbach's Alpha coefficients of .92 is very high and the results of the evaluation of the safety culture level of aviation maintenance organization evaluated by the bureaucratic level.

Keywords*: Aircraft Maintenance, Safety Culture, Aviation Safety, Aviation Maintenance Safety Culture, Informed Culture, Learning Culture, Reporting Culture, Just Culture, Flexible Culture*

1. Introduction

The knowledge and skills of individual maintenance personnel are important in the aircraft maintenance organization. However, aircraft maintenance organization is composed of a complex structure because the aircraft maintenance organization requires the close working cooperation and coordination among the job skills such as airframe, engine, electrical, electronic and instrument.

According to a Normal Accident Theory of Perrow(1984), it claims that the accident of complex organization is apt to occur inevitably[1]. However, hopefully being able to overcome the gloomy outlook for the normal accident theory is that the problem of complex organization such as aircraft maintenance organization can be overcome through a device called a safety culture. In other words, the integrative system that can create a more secure management and operation, can be built by combining safety culture with intentional manipulation of various organizational characteristics that affects safety [2].

According to the International Air Transport Association safety report(IATA Safety Report, 2013), 29% of aviation accidents that occurred in 2009 to 2013 is that aircraft malfunction was threats, 80% of the causes of accidents caused by maintenance pointed out there were problems in maintenance standard operating procedures and inspection [3]. In the case of Korea, according to the data of the Ministry of Land and Transportation in October 2014, it shows that a total of 141 cases of aviation accidents occurred for last three years. Those were mostly minor defects such as emergency warning light malfunctions but some caused air turn backs or take-off rejects. Even though these are

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minor defects, these maintenance malfunctions give a heavy burden on the pilot and so the heavy workload of the pilot is the cause of lowering the reasonable judgment of pilots and eventually it may lead to airplane accidents. Maintenance defects also result in flight delay, cancel, divert, flight schedule change as well as threat of flight safety and it will lead to significant economic losses to airlines. For example, if B747-400 aircraft flight is canceled due to maintenance problem, the cost of USD $140,000 is generated. And the flight delay results in the cost of USD $ 17,000 per hour [4]. This shows that the effect of the wrong maintenance and inspection may threaten flight safety and high cost.

Accordingly, this study reviewed safety culture measurement methods and tools of the aviation maintenance organization. And it also assessed the level of safety culture in the aviation maintenance organization by the developed methods and tools. Among the evaluation results, the analysis of a poor safety culture factors was done. And finally it proposes the strategies for a positive safety culture in aviation maintenance organization and it can contribute to the implementation of safety management systems.

2. Aviation Maintenance Job Characteristics

Technological advance for the aircraft maintenance has continued and the state-of-the-art equipment is introduced but the mechanics' operational error is inevitable as long as the technology is beyond the mechanic's capability. Thus, accidents caused by human factors in aviation maintenance organization will occur continuously [5]. Especially with regard to aircraft maintenance, the term, "safety" commonly implies two meanings. One meaning is to emphasize the worker's safety and health because there have been sporadic risk factors such as machinery moving the heavy parts, toxic and hazardous substances and aerial work platforms around the workplace. The other meaning is the procedure to ensure that the aviation mechanic provides the reliable aircraft with airworthiness for aircraft flight safety [6]. Aircraft maintenance job types can be divided into line maintenance, base maintenance, and technical support.

2.1. Line Maintenance

The Line maintenance is the routine and limited maintenance action which is performed on the aircraft without removed parts at the line of airport. In other words, the Line maintenance can be referred to as the first-line maintenance methods. For it is to modify the various defects in the aircraft that occurs in the course of flight and to maintain the punctuality of flight operations, and so it can make flight plan without problem and can be ready to departure of aircraft. Therefore, because the line mechanic should finish operation ready within a short period of time for the regular operation of the aircraft, he is under stress due to time pressure. The job as a line mechanic, is to perform such the transit check, before and after flight check (PR·PO check), weekly check and so on. Since most line maintenance is done outdoors such as at ramp, the line mechanic is exposed to both extreme cold and heavy snowfall in winter, extreme heat and heavy rainy monsoon season in summer and so on.

2.2. Base Maintenance

The Base maintenance can be classified into the airframe maintenance checks are performed at hangar, the engine maintenance which disassembles and repaired the removed engine at the engine maintenance shop and the accessory & shop maintenance which repairs and tests the components. The base maintenance fixes the faults which were accumulated during flight operation and line maintenance, performs the preventive maintenance of the potential flight risk, verifies the airworthiness and performs maintenance beyond the capacity of line maintenance. In other words, the detailed checklist or repair, and sheet metal for the airframe are performed. Even though the base maintenance is relatively less time pressure than the line maintenance gets, and also it gets

less environmental side effects, the base maintenance mechanic are exposure frequently to hazardous working area such as chemicals, inside of the fuel tank and paint. In particular, since the aircraft maintenance check is made 24 hours to increase the operating rate of the aircraft, shift work should be done.

2.3. Technical Support

Technical support includes the Engineering Service and the Inspection. The engineering service job is to support the troubleshooting to the field mechanic by providing a range of technical resources to field mechanic or by finding and supplying a rapid solution in consultation with aircraft manufacturers, if any mechanic face any technical problems that do not match the maintenance manual while working with manual, by providing a range of technical resources to field mechanic. The inspection sector checks and judges the maintenance process such as initial, intermittent and final step in all process and determines whether the final quality is suitable to the standards described in maintenance manual. In addition, the special inspection is to support the field maintenance by performing various test processes or special process inspections (*eg.* non-destructive testing, bore-scope inspection). In particular, the inspector's reliability can be described as a key to efficient maintenance and inspection. Therefore, because the inspection work should strictly apply to the standardized technical quality standards stipulated in manufacturer's standard and flight technology standards, all maintenance data should be carefully and rigorously managed and all working process should be carried out in accordance with the specified criteria.

3. Aviation Maintenance Safety Culture

In terms of culture, safety culture may be often defined independently from a variety of perspectives as a multiple terms consisting of safety and culture. For example, regulatory authorities and insurance companies tend to emphasize safety in terms of acceptable risk stage, technicians tend to highlight the failure modes and effective aspects and psychologists tend to emphasize the contribution factors aspect which are leading individual, group, and organization causality and error or failure [7-8].

The trend of close study more comprehensive approach is emphasized by the safety culture concept can be found in studies of the safety climate developed in the 1980's. The Safety Climate concept implies a recognition that workers have about their work environment, in particular, the management's concern for the safety and their recognition for action, and their recognition of participation in risk management in the workplace [9].

Marcel Simard (1998) has defined that the safety culture includes beliefs, principles and values that act as the foundation of safety management systems, and it is the concepts including a set of customs and behaviors that present and enhance these basic principles [10]. These beliefs and customs are meant to be created in the process of finding a strategy on issues such as a risk of accident and an occupational safety in the workplace. These meanings act as a major source of motivation and coordination act on safety issues in the workplace as well as to some extend be shared among members of a workplace.

Positive safety culture is the organizational characteristics that help you learn to discover the potential hazards as well as norms and attitudes to safety [11], and provides a framework of recognition for guiding the behavior suitable to the work environment which workers share the work environment [9]. The formation of a positive safety culture enables workers to act safely in high-risk facilities [12].

To apply a safety culture in the aviation maintenance organization, necessary is to define conceptually that the aviation maintenance safety culture is generally acceptable behavior during the aircraft maintenance. Aviation maintenance organizations should ensure the safety of the aircraft and shall provide a comfort to customers while maintaining the punctuality of air transport services based on airworthiness. The tendency

to act on the behavior of mechanics caused value and attitude for achieving the objectives of this organization can be understood by the concept of aviation maintenance safety culture.

A combination of organizational learning, reporting, justness, and flexibility is emphasized in aviation safety culture [13]. In a learning culture, there exists both will and competence to learn from experience and readiness for improvements. In a justness culture, there are just consequences following the reporting of an incident or an anomaly. This can enhance the willingness to forward information about work and safety, which is a fundamental element of a reporting culture and a proactive approach to safety. The flexible culture enables to transform the work organization to manage changing demands under heavy workload and also respects the individuals' skills and experiences [13].

With this background concerning safety culture, the following five aspects of safety culture; information, learning, reporting, justness, and flexibility were included in the assessment of the safety culture.

4. Method and Material

4.1. Method

This paper has evaluated the safety culture of aviation maintenance organization in the biggest airlines in Korea which has a lot of maintenance personnel, the ability to perform aircraft scheduled inspection and heavy maintenance such as overhaul of parts including the engine. In order to minimize the bias that may occur in the evaluation process, this safety culture assessment was performed after explanation of the concept and research of safety culture to the maintenance personnel in course of in-house regular safety training and site managers who participated in maintenance safety supervisor training course.

Measuring Tool were extracted measurement variables (assessment questions) suitable to research purpose from a questionnaire package used by Asa EK in order to evaluate the safety culture of airline ground handling, air traffic controllers and the shipping industry [14] and the safety culture score sheets of the GAIN (Global Aviation Information Network) being operated by alliance of international airlines and the aviation safety score sheet of International Civil Aviation Organization(ICAO), Federal Aviation Administration(FAA), *etc.*

The 64 questions, excluding the demographic questions, were classified as informed culture, reporting culture, just culture, learning Culture and flexibility culture which are element of five kinds of safety culture. 60 items in the questionnaire were composed of a Likert scale of 5 points and 4 that requires additional question items is composed of the nominal scale. At the end it was free to describe the proposals on safety.

4.2. Material

A total of 300 questionnaires were distributed to Full Service Carrier, 249 of them were recovered. 236 survey responded, except 13 parts of insincere survey responded, were used in the analysis section. The average age of the respondents is 45.2 years (range = 25 to 59), the job career is 18.9 years (range = 1 to 38) and the line maintenance is 141 people (60%), the base maintenance is 64 (27%) and the technical support are 31 participants (13%) respectively.

4.3. Properties of the Five Safety Culture Aspects (Scales)

The internal consistency of the five aspects (scale) of safety culture in the questionnaire was evaluated by using the Cronbach's alpha coefficient. Alpha for each of the 5 aspects of scale in the questionnaire is shown in Table 1. The internal consistency of 60 questionnaire except multi responses 4 items among the whole questionnaire for aviation

maintenance safety culture is very high as .92 and in the five of safety culture aspects, an alpha value of at least four of the five is above .83 and only the just culture is .72.

Table 1. Internal Consistency (Cronbach's α), Mean Score, and Standard for the Five Safety Culture Aspects

Safety Culture Aspect	*n of Items*	*Cronbar's a*	*Mean Score*						
			Total Group M	*Total Group SD*	*Manager M*	*Mechanic M*	*Line Maint M*	*Base Maint M*	*Tech' Support M*
Information	13	.89	3.50	.50	3.65	3.49	3.48	3.55	3.54
Learning	15	.83	3.88	.39	4.02	3.87	3.86	3.87	3.98
Reporting	12	.85	3.45	.57	3.59	3.44	3.43	3.47	3.52
Justness	10	.72	3.13	.47	3.22	3.12	3.11	3.15	3.20
Flexibility	10	.83	3.53	.50	3.64	3.52	3.55	3.49	3.50
Total	60	.92	3.50	.41	3.62	3.49	3.49	3.50	3.55

4.4. Statistical Analysis

As the statistical methods used to analyze the data, Frequency Analysis, reliability tests between items (Cronbach's Alpha coefficients determined by) and Parameter test (t-test, Pearson correlation, analysis of variance [ANOVA]) were used in this analysis. Items to select two or more of the items from the questionnaire response were treated as multiple dichotomy method of the multi-response scheme.

5. Results

5.1. Overall Picture

As shown in Table 1, the analysis of the safety culture in the aviation maintenance organization showed $M = 3.50$. The average value from all aspects was perceived as more positive than the average of 3.00 over the middle position in the 5-point scale. For five aspects of safety culture, positive rate was calculated. Learning culture received the highest mean value ($M = 3.88$), and just culture received the lowest ($M = 3.13$). However, according to the 'Individual Safety Survey Tools' GAIN (2001), which consists of 25 questions, it is recommended to measure the airline safety culture with measurement of the degree of agreement or disagreement with a 5-point scale and total score of 125 points (25 items x 5 points) by dividing into three areas; 25-58 points are poor safety culture, 59-92 points are bureaucratic safety culture, and 93-125 points are positive safety culture [15]. Accordingly, up on the basis of GAIN's safety research tool, in case of analyzing the safety culture level by assuming that 1.0-2.32 poor level, 2.33-3.71 bureaucratic level and 3.72–5.00 positive level by conversion of 25-125 point to 1-5 point, the only learning culture is determined by level of positive safety culture and the rest are evaluated to bureaucratic safety culture level as 3.13 ~ 3.53.

5.2. Summaries of the Safety Culture Aspects

It showed a learning culture ($M = 3.88$) was highest, flexibility culture ($M = 3.53$), informed culture ($M = 3.50$), reporting culture ($M = 3.45$), just culture ($M = 3.13$) in safety culture aspects.

5.2.1. Informed Culture: In this research topic, it was evaluated the informed culture status by the recognition of knowledge, skills, acquisition of job-related information and communication for seeking necessary changes to overcome the safety treats. The average of evaluation result showed M = 3.50 in the bureaucratic level. The base maintenance (M = 3.55), technical support (M = 3.54) and line maintenance (M = 3.48) were in the order in each job. In each item, the questionnaires about whether to spread the experience of accident which might lead aircraft damage and injury to his fellow showed M = 3.73 as a positive level while the remaining items were all bureaucratic level. The items shown in lower average, the questionnaire about information delivery (M = 3.39) needed during work performance, communication with other workers (M = 3.33) in the same work place or aircraft, open communication about safety risk with managers (M = 3.14), the work shift details (M = 3.45) and the manager's information transfer (M = 3.46) were assessed as lower.

5.2.2. Learning Culture: In the evaluation items of learning culture, the whether the airline mechanics have developed and applied the skills and knowledge to enhance organizational safety, and whether they have acquired safety lessons through safety encourage among co-workers, were evaluated. As a result of evaluating the awareness of the learning culture, it showed a positive safety culture as an average level of 3.88 as shown Table 1. Technical support (M = 3.98), base maintenance (M = 3.87) and line maintenance (M = 3.86) were in the order in each job. Item 13 of 15 (M > 3.72) were evaluated in a positive level and only the remaining two items were evaluated in this investigation bureaucratic level. In particular, training for safe work performance (M = 4.31), information of risk to colleagues in case risk of work(M = 4.03), attention to safety or encourage you to carefully work from managers or colleagues (M = 4.02), encourage each other to work safely among their peers(M = 3.97) were shown higher while the mechanic's improvement will for safe enhancement(M = 3.66) and implementation status of the document such as maintenance improvement instruction (M =3.60) was evaluated by bureaucratic level.

5.2.3. Reporting Culture: In this research topic, the reporting culture such as whether the aviation mechanic can report safety risk and items related safety without fear of punishment was investigated. The result of evaluation of the awareness of reporting culture was bureaucratic level as an average of 3.45. In the job, technical support (M = 3.52), base maintenance (M = 3.47) and line maintenance (M = 3.43) were in the order. The item evaluated in a positive level of 12 items is only one reporting question about damage to the equipment (M = 4.04) and the remaining of 11 items were approved to be bureaucratic level. Especially, satisfaction (M = 2.99) was evaluated in the reporting system is below a normal level.

5.2.4. Just Culture: In this research, it evaluated the just safety culture status whether to encourage the mechanic to report the important information for safety risk without fear of punishment at the maintenance shop. The evaluation of the process was bureaucratic culture level (M = 3.13). There was no item in poor or positive factor but the total of 10 items were proved to be bureaucratic level. In the job, technical support (M = 3.20), base maintenance (M = 3.15) and line maintenance (M = 3.11) were in the order. If not working in a safe way, the most exciting item which got the caution and warning from surrounding was the highest as M = 3.61, the item which accepted as positive when making the worker remind the caution was 3.59, the clarity of the work-sharing during work is 3.49, the fair assessment of the task done with a safe way is 3.29 but the recognition of work with safe way was 3.24 in order. However, the allowance for error that occurs during the operation (M = 2.54), Non-application of penalties to a simple

mistake caused by negligence (*M* = 2.45), clarity of criteria for acceptable behavior and unacceptable behavior (M = 2.97), were at normal levels or less.

5.2.5. Flexibility Culture: It evaluated the flexible adjustment possibilities of the maintenance of human resources, the flexible working forms and the working value. In the Job, line maintenance (*M* = 3.55), technical support (*M* = 3.50) and base maintenance (*M* = 3.49) were in the order. According to the itemized analysis, turning over the pending task to the following workers (*M* = 3.79) and cooperation among co-workers (*M* = 3.72) were shown as a positive. However, the recognition of work value (*M* = 3.36), the recognition of knowledge and experience (*M* = 3.17), and acceptability of the proposed changes to the work (*M* = 2.97) were below average.

5.3. Individual Characteristics' Effect on Safety Culture

5.3.1. Career: Against the hypothesis that there are differences in the level of safety culture according to the aviation mechanic careers, if the their career is classified into four groups, Less than 10 years, 11-20 years, 21-30 years, more 30 years, as a result of verification of hypotheses by One-way ANOVA, *F* value is 1.36, *p*-value is .25, because the *p*-value has greater value than α level of 0.05, That, there was no difference in the level of safety culture recognition in career. However, because the learning culture (F = 2.98, p< .03) and reporting culture (F = 2.73, p < .04) have smaller *p*-value of α level of .05, it can be said that there are differences between the types of career service personnel group.

5.3.2. Position: *T*-test Analysis has conducted whether their positions (manager, n=18; mechanic, n=218) affect the level of safety culture. Statistically, there was no difference in the safety culture recognition level. However, although not statistically significant, the management group showed a higher level of recognition than all five aspects of mechanic safety culture (Table 1).

5.3.3. Aviation Maintenance Job: As a result of verifying if there is any difference in safety culture level according to different maintenance job with One-way ANOVA, because *F* value is .28, *p*-value is .75 and so has greater value than .05 of α level, it shows that there is not difference in recognition of safety culture among maintenance job groups. In addition, it also shows that there is no difference in five safety culture type as p > .05. However, at the item of the learning culture of safety culture aspects, one item asking whether to work with safe way has a significant different between line maintenance and base maintenance same as Table 2.

Table 2. Safety Working-Analysis of Variance Classified by Job

Job	*N*	*Mean Score*	*SD*	*df*	*F*	*Sig.*
Line Maintenance	141	3.85	.70	Between Groups=2 Within Groups=233	4.27	.01
Base Maintenance	64	4.14	.61	Between Groups=2 Within Groups=233	4.27	.01
Technical Support	31	4.03	.65	Between Groups=2 Within Groups=233	4.27	.01
Total	236	3.95	.68	235		

5.4. Aviation Mechanic's Suggestion for the Safety Culture

59 respondents out of 236 responded for proposal about the aviation maintenance safety culture which the respondents freely answered to the question. In summary to the proposal content, there were feedbacks such as the difficult to follow the safety procedures due to lack of work time, issues of recognition for the safety of managers and punishment policy, the old safety facilities and lack of safety protective equipment, the organization which emphasized the efficiency rather than safety, the big difference between safety policy and on site work place, *etc.*

5.5. Correlations between Safety Culture Aspects

In order to verify the relevance of five safety culture aspects, Pearson's correlation analysis was carried out as in Table 3. Analysis results were output as a positive and statistically significant relationship between the five types of the safety cultures (p <.01, two-tailed). Pearson's correlation coefficient r is pronounced arranged from 0.468 to 0.762, or shows a strong quantitative linear relationship. Especially, the strong quantitative line relationship is appeared between the learning culture and the reporting culture.

Table 3. Pearson Correlation among the Five Safety Culture Aspects

Safety Culture Aspect	*1*	*2*	*3*	*4*	*5*
1. Informed Culture	1	.649**	.705**	.621**	.601**
2. Learning Culture	.649**	1	.762**	.468**	.542**
3. Reporting Culture	.705**	.762**	1	.585**	.537**
4. Just Culture	.621**	.468**	.585**	1	.537**
5. Flexible Culture	.601**	.542**	.537**	.581	1

Note. *N = 236*. All correlations are significant at $p < .01$, two-tailed.

6. Discussion

If the safety management systems are physical systems consisting of safety policies, procedures, various safety engineering techniques, *etc*., the safety culture is the spirit of a person who operates a safety management system, that is, the spiritual world including the members' recognition level for the safety, attitudes, beliefs, aggressiveness, *etc.* Therefore, to the settlement of aviation safety management systems, it will be active participation followed a positive aviation safety culture of the entire organization. So, this is to derive a strategy for the safety culture enhancement by analyzing empirically the perceived level of safety culture type based on the components of aviation safety such as information, learning, reporting, a just and flexible culture, targeting the full service carrier aviation maintenance organization, as a study for settlement of positive safety culture for the aviation maintenance organizations.

6.1. General Findings

The questionnaire which was created on the basis of the five safety culture aspects showed very high reliability with Cronbach Alpha coefficients of .92, also showed statistically apparent significant relationship by the correlation between safety culture type and also the Pearson correlation coefficient value r is spread from .468 to .762. Additionally, the safety culture evaluation method used in this study showed that it was

possible to measure the safety culture level of the individual and organization and it could show the features within aspect of safety culture required improvement by finding the difference of relative attitude and recognition of individual and organization within sample.

6.2. The Level of Aviation Safety Culture Maintenance Organization

The safety culture consciousness of aviation mechanic is a bureaucratic level. The results of the evaluation of the safety culture (M = 3.50) in the aviation maintenance organization shows a bureaucratic level by conversion of 25-125 points equivalent into 1-5 points per items based on a safety research tool of the GAIN and by analyzing with hypothesis that the level of 1~2.32 is a poor, 2.33~3.71 is bureaucratic, and 3.72 to 5 is positive cultural level. At the aspects, the only learning culture is positive level (M = 3.88), flexible culture (M = 3.53), informed Culture (M = 3.50), reporting culture (M = 3.45) and just culture (M = 3.13) are in the order and all but the learning culture shows in the bureaucratic level. It is estimated that this aspect should be further strengthened with respect to the safety culture of aviation mechanic. In particular, the perception of the just culture among the safety culture element was the lowest. The distinction for the error and violations was not clear and it showed that fear of punishment for the simple error.

6.3. Safety Culture Level Depending on Job, Position and Career

There are partly difference in perception of safety culture depending on mechanic's job, position and career. The base maintenance job is very positive as 4.14 for what job you are working in a safe way, but line maintenance jobs shows a significant difference between the job as 3.85. This can be interpreted as due to the nature of the line maintenance job working while receiving pressure on punctuality. Learning culture (M = 3.88) shows a positive level but less than 10 year experience (M = 3.67) is lower in bureaucratic level. It shows that there is a difference in career-specific awareness. In also reporting culture, the significant difference is found in career low mechanics in reporting methods for injuries and risk factors as well as counseling on safety issues. It can be seen that suggests that there is a need to strengthen safety training for the new employees. There is a significant difference in reporting culture among the mechanic with over 20-year-career too. The reason is their distrust toward the reporting system which could not improve the problem which they reported, and also their attitude to solve by themselves.

6.4. The Relationship between Mechanic and Manager

It is lack of trust between the mechanic and the managers. Compared to the level of safety culture in the relationship between himself and his fellow mechanic, the level of safety culture in relationship between the company and the managers was evaluated as insufficient. Although the CEO declared that safety is the most important value of the company as a safety policy, the middle management or the executives with decision-making within the company do not participate in the safety training course and so a lot of aviation workers tend to judge that the safety training is not significant. Also, in the informed culture aspects, the communications with the manager in the workplace (M=3.14) shows the lowest level, and it can be seen that the information would not be transmitted to the satisfactory level during the work shift.

6.5. Aircraft Maintenance Job Environment

Aviation Mechanics are exposed to an unsafe work environment. Since most line maintenance is done outdoor such as ramp, the line mechanics have been exposed to the

extreme cold and heavy snowfall in winter, as well as extreme heat and heavy rainy season in summer, the safety facilities are outdated in technology for the safety, and safety and protective gear are described as incomplete. Further, essential is the systematic channel which the mechanic can report the hazards with respect to his workplace and can verify the improving process but the reporting system has the lowest satisfaction with 2.99 in this research.

7. Conclusions

Of 60 evaluation items except for the multiple response questions, 17 questionnaires were a positive level and the remaining 43 questionnaires were bureaucratic level. Accordingly, on the basis of the results discussed based on the result of factor analysis for the items which were evaluated as poor or bureaucratic level and the multi-response analysis, for the establishment of a positive safety culture in the aviation maintenance organization, the strategies to improve safety culture by a specific component derived as follows:

First, it must establish an efficient and positive learning culture for safety enhancement. Education and training cannot solve all the safety problems but the positive learning culture in the organization should be a prerequisite in order to become active. In other words, all personnel shall understand the organization's safety philosophy, policies and procedures throughout the study because they must fulfill their roles and responsibilities within a framework of safety management. For that, by moving away from simple list for past statistic data as well as managers aggressive participation of safety training course, the safety training should be improved with the case study, safety scenario training and exercises. Also, it is necessary to cultivate the mind skill of mental ability to predict failure with strengthen the training for the safety of new mechanics, and it should include the repeated training so that the organization members can predict the error and take an appropriate measures to restore

Second, for the effective safety reporting system, the positive reporting culture should be followed. Prevention of aircraft accidents is the complex activity requiring a lot of skill and effort. Effective accident prevention activities increase the efficiency of flight, as well as improve aviation safety. In order to prevent such an aircraft accident, the effective safety reporting system should be built. In order to facilitate reporting, it shall create an atmosphere that can be reported without fear of punishment, the reporting system based on user-friendly and simple, should be improved to ensure anonymity, and are to be avoided or improved measures for the reported latent factors, and required is the improvement of the reporting process which includes the feedback to re-evaluate the results of measures.

Third, the positive just safety culture should be spread in the workplace. In order to spread the rational just safety culture, the punishment due to safety issues should be based on agreed criteria for the non-punishment and punishment subjects. And also, the nature of the action than action itself should be the standard to determine the punishment. The deliberate action of reckless risks and the act to produce avoidable risks only should be subject to punishment, for a simple error, it should be recognized that safety-related errors may occur, and therefore, it shall operate a rewards program on working safely.

Fourth, it should enable the information culture for effective information delivery system. Since safety is one that can be based on communication, it can be considered the first step of efficient information delivery system to enable inter-organizational communications within organization. Because its value is recognized only when time information is reflected in the decision to get any useful results, various kinds of required information should be provided at the right time. Therefore, front-line field managers shall summary, fabricate and convey the information easily in accordance with the site conditions. And also, it is necessary to check whether the mechanic know well the

relevant information and perform the task properly through its feed-back. With overall information activity, the information should be collected, fabricated and stored so that the maintenance personnel may refer easily the useful information only whenever he needs

Fifth, safety culture should be oriented positive and flexible culture. At peak season for airlines, there are lack of line maintenance personnel enough to support the line maintenance, and also the base maintenance mechanics temporary shortage may occur when un-schedule works such as airworthiness directives are assigned. Lack of personnel or manpower makes time pressure and then it may cause human error. Therefore, the maintenance organization should have the flexibility to adjust the maintenance personnel in a short period of time. For that, the maintenance personnel should cultivate the ability to do their jobs as well as the ability to perform various maintenance tasks of different job. In addition, the company should respect the knowledge, experience and value of the maintenance personnel and promote the morale of mechanic through incentives such as training for multi-skilled and induce the commitment of the mechanic. And also flexible maintenance management is required.

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