

Effects of the Training Transfer Management on the Workers in Nuclear Power Plants

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Objective: The aim of this study is to enhance the efficiency of education and training through application and management of 'Transfer of Training' in nuclear power plants.

Background: Despite the sophistication and standardization of job-related skills and techniques of workers, accidents/incidents keep taking place due to human errors and unsafe actions and behaviors, which translates into the necessity to review and examine the effectiveness and influence of education and training on the workers of nuclear power plants.

Method/Results: This study drew the factors of 'Transfer of Training' through a review on the preceding studies and document research. In addition, through expert examination, this study explored the expected effects and possibility of application when managing the influencing factors of 'Transfer of Training' in nuclear power plants. And lastly, management priority order for nuclear power plants was drawn through an AHP analysis.

Conclusion: Among the 'Transfer of Training' factors, the training design factor was the most important. In addition, the design of the training and transfer and goal setting showed a high degree of importance among the influencing factors.

Application: The management of 'Transfer of Training' in nuclear power plants enhances the capability of workers and improves the operational integrity of nuclear power plants.

Keywords: Nuclear power plant, Worker's competence, Transfer of training, AHP analysis

1. Worker's Training Paradigm

As mechanical and technological development and system improvement throughout all industries have been made to date, various system errors, human errors or unsafe actions and behaviors have been reduced to some degree. Human errors may have a huge influence on the soundness of facilities and systems, according to the job characteristics and context combination (Lee, 2011). For a nuclear power plant with large scale and complex systems, trivial mistakes or unsafe actions and behaviors may cause unpredictable results, and incurred economic and social losses are immense. For this reason, very conservative standards are maintained for equipment operation and management in nuclear power plants and verification and research on the soundness of equipment, facilities, technologies and systems have been intensively

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conducted. Although, workers' job-related equipment and system technologies have been enhanced and standardized, the human errors caused by workers and unsafe actions and behaviors are not reduced to a certain level (Kim et al., 2012).

In this context, training for workers has emerged as a key method having core functions from a supplementary means to ensure nuclear power plant safety. Therefore, interest in what results are generated by human resource development activities such as education and training within nuclear power plants are increasing. The human resource development paradigm to improve a performance is called performance-based paradigm. Such a paradigm is on the rise globally (Holton, 2002; Guen, 2003).

Compared to the efforts inputted on the execution and management of education and training, the research and management of training transfer related with applicability of knowledge, attitude and technology to actual work through education and training are insufficient. According to a study of Holton and Baldwin, 10% of the learning transfer takes place through corporate education and training (Holton and Baldwin, 2003). For general industries, some studies on the transfer of learning emerging as a key factor for corporate education and training execution and performance improvement were carried out (Jung, 2006; Kim et al., 2010; Park et al., 2011). In the nuclear power industry, however, studies on education and training execution and performance improvement are lacking, except for a response evaluation according to education and training (Kim et al., 2013).

This study ascertained the factors influencing the transfer of training through preceding studies and literature review. This study also drew influencing factors of training transfer to be managed in order to ensure the effects and performance of the education and training for workers in nuclear power plants by reviewing the expected effects and applicability of transfer of training.

2. Management for Transfer of Training

Although, various definitions of transfer of training can be found, they contain similar meanings (Lee, 2008). Wexley et al. (1981) and Broad et al. (1992) defined the transfer of training as the degree to effectively apply the knowledge, technology and attitude acquired from training to job context. Baldwin et al. (1988) defined transfer of training as the generalization and maintenance of what has been learned and diffused through training programs. Park (1997) defined transfer of training as the degree to apply what has been learned from training to an actual job. Keum (2005) defined transfer of training as demonstrating changed actions and behaviors by applying the knowledge, skills and attitudes learned through training programs to an actual job, after the trainees return to actual work, to broader job domains, and then maintaining such behavioral changes.

Looking into studies on the functions, transfer of training plays an important role in education and training effectiveness by acquiring technology, knowledge and information and applying them, according to the education and training (Park et al., 2011). Through the transfer of training measurements, the results can be obtained, according to expectations on worker's job execution and performance (Colquitt et al., 2000).

Transfer of training comprehensively means that information acquired through education and training is applied to actual work by trainees and can be seen as a medium connecting education and training with applicability.

2.1 Influencing factors of transfer of training

Studies on the factors influencing transfer of training have been actively conducted. As a result, the factors influencing transfer of training can be classified into three factors: trainee characteristics, training design, and organization environment (Baldwin et al., 1988; Broad et al., 1992; Holton et al., 2003; Noe, 2008).

Trainee characteristics refer to the attitude, motivation, interest, value, expectation and personality. Training design refers to the

characteristics that trainees can experience by inputting the training design factors in the training process (Bell et al., 2008). Organization environment means the support of supervisors or colleagues or organization culture that may cause a transfer of training.

This study summarizes the detailed factors of a transfer of training through a review of the preceding studies (Park et al., 2011) shown in Table 1.

Of the three influencing factors of transfer of training, a training design can be a relatively important factor, because management is possible by inputting intentional factors to adjust the transfer effects (Kim et al., 2013). Training design is the factor positively influencing training effects by near transfer and nuclear power plants. Actually, studies proving the influences of training design characteristic on learning and transfer have been conducted (Komacki et al., 1980; Quinones 1995; Rever et al., 1984).

Table 1. Influencing factors on transfer of training

Factors	Influencing factors
Trainee characteristics	Career planning (TC.01), Expectation (TC.02), Ability (TC.03), Motivation (TC.04), Meta-cognition (TC.05), Achievement & Desire (TC.06), Self-competence (TC.07), Efficacy (TC.08), Self-regulated Learning (TC.09), Perceived Usefulness (TC.10), Similar Training Experience (TC.11), Work Experience (TC.12), Job Involvement (TC.13), Ability of Control (TC.14), Learning Readiness (TC.15)
Training design	Instructor (TD.01), Design (training or transfer) (TD.02), Contents (TD.03), Goal setting (TD.04), Educational facilities (Environment) (TD.05), Environmental Similarity (TD.06), Media Richness (TD.07), Ease of Use (TD.08), Quality of System (TD.09), Feedback (TD.10)
Organization environment	Support of Colleagues (OE.01), Support of Supervisors (OE.02), Support of Organization (OE.03), Culture (Climate) (OE.04)

2.2 Assessment for transfer of training

Transfer of training is difficult to measure and assess within the short-term, and thus, a pre-management point of view is necessary. Looking at preceding studies on the transfer of training, a questionnaire survey by a self-report, objective evaluation method by supervisors, subordinates or colleagues, behavior assessment method and in-depth interview method are used. Although, the questionnaire survey by a self-report, which is the most frequently used measuring method (Kim et al., 2006; Bae et al., 2009; Lee et al., 2012), is equipped with convenience of measurement, a problem of common method bias may arise. This means that a possibility of exaggerated results being drawn is high when a respondent who has participated in training answers transfer of training, which is a dependent variable, based on his/her own perception (Podsakoff et al., 2003). Behavior assessment refers to assessing behavioral change taking place through the participation in the training by the firm's trainees. In general, companies regard an evaluation on the transfer of training to be the same as behavior assessment. Scholars related to corporate transfer of training explain the concept of transfer of training in linkage with behavior assessment (Park et al., 2013). An example of application includes a study on transfer measurement through BOS (Behavioral Observation Scale) that assesses a change and performance through an observation of trainee behaviors (Brown et al., 2013).

According to a study of Park and Jang (2011), as a result of survey on 250 staff members in charge of training at large, middle standing and small and medium-sized companies, 1/3 of the surveyed companies did not consider anything on applicability to actual work. Small and medium-sized companies were surveyed, and 50% of them did not make any effort to improve the transfer of training. They said that the main reason is difficulties in measuring applicability to actual work.

3. Application of Transfer of Training

A nuclear power plant shows a special organization culture and job characteristics and has the environment of transfer of training different from general industries. A nuclear power plant has huge risk and diffusion upon accident/incident occurrence, and thus, a conservative approach is taken through a sufficiently verified method for all decision making and job performance related to safety. Also, job, based on procedures having strong binding force over job performing actions and behaviors, is performed. Procedures related to all operations, tests and maintenance are equipped with procedures and cyclical modification and supplementation are conducted.

Such organization culture and job characteristics may become constraints for the occurrence and consolidation of transfer of training within a nuclear power plant, and therefore influencing factors of transfer of training different from those of general industries may be included. For a proper transfer of training to occur, the influencing factors of a transfer of training reflecting distinct characteristics of nuclear power plants need to be drawn and appropriate management is also necessary. This study actually conducted an expert examination to draw a nuclear power plant's unique influencing factors of transfer of training. The experts consisted of ergonomics experts with average age of 33.2 and average research career of 4.8 years. The expert examination was undertaken using a 5-point scale on the expected effects and applicability within nuclear power plants with regard to 29 influencing factors considered through existing studies.

3.1 Influencing factors of transfer of training in NPPs

First, this study reviewed the expected effects of 29 influencing factors of transfer of training in nuclear power plants (NPPs). The expected effects were reviewed on the basis of 4-step model of Kirkpatrick (1994). Kirkpatrick's 4-step model is a typical model focused on corporate training's results as a standard of corporate training program assessment.

The model assesses the reaction, learning, behavior, and results according to training by step and uses the assessed results for the assessment and performance measurement of training. The following studies on corporate training program assessment have been conducted on the basis of Kirkpatrick's assessment model, and his model is recognized as one of the most influencing assessment models. His model is widely used as a model to assess corporate training programs implemented by companies in reality (Phillips, 1991, 1999).

This study evaluated the expected effects predicted, when 29 influencing factors of transfer of training are managed in NPPs with a 5-point scale from the worker's reaction, learning, behavior, and resulting aspects. As a result, the mean value of and deviation on the 29 influencing factors were 3.41 and 0.4, respectively. Twenty-five factors showed 3 or more points in mean value except trainee's expectation (TC.02), mega-cognition (TC.05), similar training experience (TC.11) and ability of control (TC.14) of the 29 influencing factors (Figure 1).

3.2 The applicability review at NPPs

A review on whether the influencing factors of transfer of training influences an NPP's transfer of training is necessary. NPPs have environment and job conditions different from general industries, and thus sorting out the applicable influencing factors is required. This study conducted an examination of experts, based on indicators including shift work within the NPPs, geographical and security characteristics, organization and job flexibilities, and influence on NPP operations. In doing so, a 5-point Likert scale was used. Figure 1 shows the examination results.

The 11 influencing factors of an NPP worker's transfer of training evaluated as 3 points or higher in terms of expected effects and

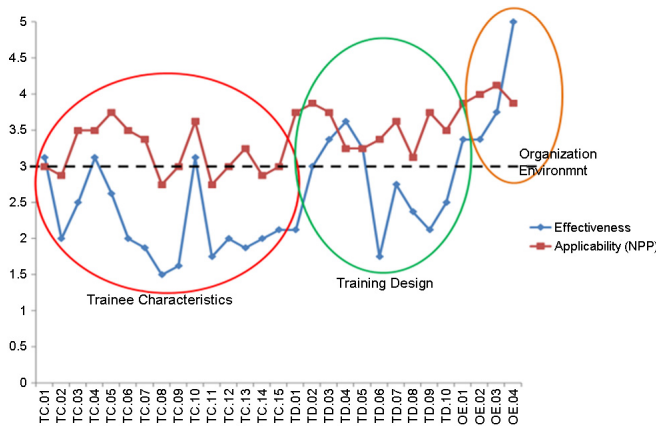


Figure 1. Expectation effectiveness and applicability for influencing factors

applicability were demonstrated as follows

Trainee characteristics factors (3)

: Career planning (TC.01), Motive (TC.04), Perceived usefulness (TC.10)

Training design factors (4)

: Design (transfer of training) (TD.02), Content (TD.03), Goal setting (TD.04), Educational facilities (environment) (TD.05)

Organization environment factors (4)

: Support of colleagues (OE.01), Support of supervisors (OE.02), Support of organization (OE.03), Culture (climate) (OE.04)

4. Management for Transfer of Training in Nuclear Power Plants

4.1 Priority according to the AHP analysis

This study drew weights through an AHP (Analytic Hierarchy Process) analysis to establish and execute more intensive and efficient management on the 11 influencing factors drawn with 3 or higher points in mean value in expected effects and applicability out of the influencing factors of transfer of training. AHP is a technique that can be very usefully utilized in the process of deciding importance by expert opinions. It is a mode used to conduct a pairwise comparison by bundling the items influencing the final decision making process by two items, evaluate each relative importance with the ratio scale, and then calculate each item's ultimate importance.

This study carried out AHP analyses on transfer of training factors and influencing factors in NPPs.

The expert examination for an AHP analysis was conducted by 7 experts in the nuclear power and ergonomics fields (5 men and 2 women). Each expert applied a pairwise comparison in which points are entered with regard to the relative importance of two comparison subjects. As a result of the pairwise comparison, 7 experts judged that consistent evaluation was made with less than 0.1 of consistency index and consistency ratio. For the integration of each expert's average score, geometric mean was used. Table 2 demonstrates the AHP analysis results:

Table 2. AHP-weight for transfer of training

Factors	Weight	Influencing factors	Weight
Trainee characteristics	0.137	Career Planning (TC.01)	0.119
		Motive (TC.04)	0.357
		Perceived Usefulness (TC.10)	0.524
Training design	0.531	Design (training or transfer) (TD.02)	0.518
		Content (TD.03)	0.166
		Goal Setting (TD.04)	0.241
		Educational Facilities (TD.05)	0.075
Organization environment	0.332	Support of Colleagues (OE.01)	0.087
		Support of Supervisors (OE.02)	0.235
		Support of Organization (OE.03)	0.197
		Culture (climate) (OE.04)	0.481

The weights were drawn in the order of training design factor (0.531), organization environment factor (0.332) and trainee characteristics factor (0.137) as a result of AHP analysis. The weights of perceived usefulness (TC.10), design of transfer of training (TD.02) and organization culture (climate) (OE.04) were 0.524, 0.518, and 0.481, respectively, and they were the influencing factors with higher weights of all factors. The results show the factors to be considered preferentially, when economic feasibility and efficiency aspects are taken into account in terms of management in the searching and selecting stage of measures to respond.

The analysis above showed ensured consistency by exhibiting less than a 0.1 consistency index and consistency ratio, as demonstrated in Table 3.

Table 3. Consistency index and ratio

Index	Factors	Influencing factors
Consistency index	0.162	0.055
		0.032
		0.052
Consistency ratio	0.046	0.094
		0.055
		0.090

5. Conclusion

This study carried out research on influencing factor identification, application of those influencing factors to nuclear power plants (NPPs) and their management to enhance the effects according to nuclear power plant worker education and training.

This study was undertaken in the following step-by-step process:

- (1) Review of transfer of training factors through an examination of proceeding studies and a literature review
- (2) Investigation of the applicability of transfer of training factors to nuclear power plants and expected effects
- (3) Measures to manage the influencing factors of transfer of training through AHP analysis

The findings of this study are presented below:

- (1) 29 influencing factors of transfer of training were identified through a qualitative analysis based on preceding studies and a literature review.
- (2) Expected effects and applicability were investigated in the case of management of influencing factors of transfer of training in NPPs through an examination of experts. Consequently, 25 influencing factors were predicted to show the effects on the improvement of transfer of training in NPPs. To apply the influencing factors generating transfer of a training to NPPs, careful consideration of nuclear power plant characteristics is needed. Therefore, this study reviewed the applicability of the influencing factors of transfer of training from the four preferential aspects of work type, geographical/security characteristics, flexibility and influence on NPPs. The number of influencing factors of transfer of training, through which the effects are expected when they are applied to nuclear power plants and also an application is possible, was 11.
- (3) This study computed the weight of each influencing factor through expert examination through the AHP analysis. The weights were the highest in the order of training design factor (0.531), organization environment factor (0.332) and trainee characteristics factor (0.137).

A more efficient transfer of training enhancement can be inferred by devising measures to manage the factors with higher weights and influencing factors and with efficient cost investment. The pre-management of the factors of transfer of training that determine education and training's applicability to actual work, rather than improvement and supplementation according to education and training results assessment, is expected to contribute to enhancing the required competences of NPP workers and ensuring the soundness.

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