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The Risk Management in New Technology Deployment to Nuclear Power Plant

Kil-Young Jung*, Myung-Sub Roh,
KEPCO International Nuclear Graduate School, 1456-1 Shinam-Ri, Seosaeng-Mueon, Ulju-Gun,Ulsan
**Corresponding author: magicjky@email.kings.ac.kr*

1. Introduction

It has been requested to upgrade and replace equipment in Nuclear Power Plant (NPP) with new technology because of obsolescence and spare parts issues, and demands for higher performance. The processes for the new technology deployment to NPP, however, may have risks causing the unpredictable outcomes leading to the degradation of performance or operation. Therefore, the proper risk management is essential for ensuring safety and performance of NPP since it provides means to identify risks and minimizing their impacts.

For these reason, this paper aims at investigating how the risk is managed and presents the proper risk management in project for the deployment of new technology to NPP.

2. Research Methodology

The research methodology selected for this paper consists of comprehensive literature review, questionnaire survey, and a statistical analysis of the survey result.

2.1 Data Analysis method

The risks are primarily identified by survey and literature review [1]. In addition, the survey data includes the likelihood of occurrence of each risk and their impact on project objects such as cost, time, scope, and quality. Based on these data, all risks are calculated through Equation (1)

$$r_{xy}^{z} = p_{xy} i_{xy}^{z} \quad (1)$$

Where x=ordinal number of risk; y=ordinal number of valid respondent; z=ordinal number of project objective; r_{xy}^{z} =significance score assessed by respondent y for the impact of risk x on project object z; p_{xy} =likelihood of occurrence of risk x, assessed by respondent y; i_{xy}^{z} =impact of risk x on project objective z, assessed by respondent y.

The average score (Equation (2)) for each risk is used for risk significance score. All identified risks are ranked in accordance with this average score.

$$R_{xy}^{z} = \frac{1}{n}\sum_{y=1}^{n} r_{xy}^{z} = \frac{1}{n}\sum_{y=1}^{n} p_{xy} i_{xy}^{z} \quad (2)$$

Where n=total number of valid respondent; R_{xy}^{z} =significant score for risk x on project object z.

Probability and Impact Matrix is used for prioritizing the identified risks. In the matrix, risks are classified as high risk, moderate risk, and low risk. The red area (with the largest numbers) represents high risk; the green area (with the smallest numbers) represents low risk; and the yellow area (with in-between numbers) represents moderate risk [2].

Table I: Probability and Impact Matrix

Impact / Probability	Very Low 0.05	Low 0.10	Moderate 0.20	High 0.40	Very High 0.80
0.90	0.05	0.09	0.18	0.36	0.72
0.70	0.04	0.07	0.14	0.28	0.56
0.50	0.03	0.05	0.10	0.20	0.40
0.30	0.02	0.03	0.06	0.12	0.24
0.10	0.01	0.01	0.02	0.04	0.08

3. Survey result and analysis

3.1 The Familiarity with risk management

All respondents consider risk as negative terms causing negative impacts on project objectives even if positive risk called opportunity can also give positive impact. Only 27% of respondents are familiar with risk or risk management as shown in the following figure.

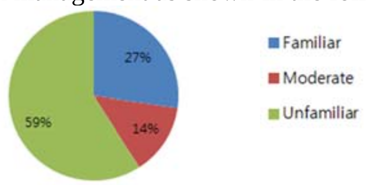

Fig. 1. Familiarity of risk or risk management

Another interesting finding is that the more experienced the workers are, the more familiar they are with risk or its management. It shows that risk management has been learned through work experience in NPP industry.

3.2 The risk identification

In the individual level, the lessons learned from the working experiences and the review of similar cases are most frequent risk identification method. In this case, factors causing schedule delay, design error, error during commissioning, etc. should be considered. Another common way of identifying risk is a systematic review of documents. Brainstorming, SWOT, and expert judgment are also used.

Similarly, identifying risks within the workers' organizations is mainly performed by a systematic review of the document followed by brainstorming. For the proper systematic review, every document should be reviewed and approved by reviewers, an independent reviewer, and approvers. In addition, the respondents answered that project teams usually perform brainstorming with members involved in the project to identify risks. Knowledge including know-how and know-why through the past experience and review of similar cases is also a commonly used method to identify risks.

3.3 The risk assessment

According to the result of survey, the most widely used tool for accessing risks is lesson learns from past experience and review of similar case. Failure Mode Effect Analysis (FMEA) is also used since it is commonly used to identify significant single failures and their effects or consequences on the system's ability to perform its functions and shows that no single failure will prevent the systems from performing their intended functions. Besides, risk is assessed by expert judgment by experienced professionals.

When it comes to prioritization of risks, lessons learned from past experience and review of similar case are mainly used criteria. Impacts on safety of NPP and license are also important factors to prioritize risks since the safety is very import and licenser heavily weighs on safety. It is also found that main difference of priority criteria from other industries is "Safety First", that is to say, safety is the most important factor.

All risks are prioritized according to data analysis method in section 2.1. Among them, the key risks, which are classified as high risk on cost, time, scope, or quality, are listed in Table II.

Table II: The key risks classified as high risk

No.	Abbreviations	Identified risks	Time	Cost	Scope	Quality
1	PSEW	(Proper) personnel shortfalls, Excessive workload	0.27	0.14	0.17	0.24
2	LSKT	Lack of sufficient knowledge of the introduced technology	0.25	0.17	0.14	0.23
3	LSET	Lack of sufficient experience including technical know-how in performing the project for introduction of new technology.	0.24	0.21	0.14	0.24
4	LUS	Lack of understanding the system which new technology is introduced to (Configuration, interfaces, operation history, and requirements of the system)	0.22	0.17	0.15	0.20
5	DME	Design mistake or error	0.19	0.20	0.09	0.21
6	PSR	Poor specification of requirement (Uncertain requirement)	0.16	0.15	0.14	0.23
7	DSD	Delayed submission of deliverables	0.18	0.12	0.08	0.11
8	PRIT	Potential risks from incompleteness of new technology	0.19	0.17	0.13	0.20
9	IVST	Insufficient verification system for new technology (or its applied system)	0.15	0.16	0.12	0.28
10	EL	Effects on licensing (The uncertainty of obtaining permits)	0.26	0.21	0.19	0.16

"Design mistake or error" can give a significant effect on three project objectives; "Proper personnel shortfalls and Excessive work load", "Lack of sufficient knowledge of the introduced technology", "Lack of sufficient experience including technical know-know in performing the project for introduction of new technology", and "Potential risks from incompleteness of new technology" can give a significant effect on time and cost of project; Lack of understanding the system which new technology is introduced to", "Poor specification of requirement", "Delayed submission of deliverables", "Insufficient verification system for new technology (or its applied system)", and "Effects on licensing" can give a significant effect on one project objective.

3.4 The risk response

As emerged from the survey, there is no systematic risk response to enhance opportunities and to reduce threats to project. It means that most actions for risk response are performed in the individual level. In the individual level, lessons learned from past experience and the review of the similar case are primarily used technologies as well as sharing them to colleague. Avoiding the use of technologies not verified, sharing knowledge with workers, and working with experienced professionals are also used. Moreover, it is recommended to build system to share data and experience about risks in enterprise level.

4. Conclusions

This paper investigated how the risk is managed in the NPP industry. Risk is perceived as a negative term that brings negative impact on project objectives. 10 key risks are identified and classified as high risk on cost, time, scope, or quality in compliance with the criteria seeking "Safety First". "Design mistake or error" can significantly influence three project objectives while the rest risks can significantly influence one or two project objectives. However, it is also found that there are neither structured ways nor a systematical approach to perform the proper risk management. As a result, risk management such as identification, assessment, and response is mostly performed in the individual level laying much weight on experience since the most common methods are past experience and review of similar case. In conclusion, this paper figures out that it is required to build the structured and integrated risk management system in enterprise level. By means of it, the accumulated data and experience of work can be shared and transferred effectively among workers, and consequently design mistake or error can be reduced.

REFERENCES

[1] TIMEA CZIRNER, Risk management in new technology deployment projects, AALBORG UNIVERSITY, Aalborg, 2010
[2] Project Management Institute, A guide to the project management body of knowledge (PMBOK® guide), Fifth edition, 2013