

Ways of Overcoming Inadequate Incentives for the Engineers in Fire Protection Systems

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Abstract: In this study, we derived ways to improve incentives for the engineers in fire protection systems based theoretically on the principal-agent problem from a perspective to provide a system of incentives which could reduce the uncertainty about the principal's decisions on choosing their agents. In order to reduce question design errors in the exams for the engineers in fire protection systems, we suggested three points. First, it is necessary to reinforce the system for controlling the processes of designing the exam questions by introducing the processes in accordance with the procedures of designing exam questions for the College Scholastic Ability Test such as a review of the exam questions and the exam question designer's final confirmation of the exam questions. About second, it is necessary to select firefighting majors as the researchers at the Human Resources Development Service of Korea in charge of the engineers in fire protection systems, readjust their job descriptions into similar job fields and enhance their professionalism by means of various education programs such as regular compulsory refresher education, training programs and in-house education programs. Finally, we raised the need for evaluating merely basic qualification requirements by the written exams for the engineers in fire protection systems but conducting the actual qualification by interview as well as introducing the real-name system for the exam question designers and the exam question reviewers.

Key words: Engineers in fire protection systems, principal-agent problem, question design errors, human resources development service of Korea, national technical qualification

INTRODUCTION

The qualification system of the engineers in fire protection systems focuses on what is more effective for fire protection. As buildings are increasingly getting larger, higher and denser, it is more effective to focus on prevention and early suppression of fire than post fire extinguishment in order to protect the life, body and property of the people. The qualification system of the engineers in fire protection systems is a qualification system established to train professional human resources in fire protection systems.

There are few studies on the qualification systems of the engineers in fire protection systems. Instead, we intend to analyze studies on National Technical Qualification part of which are qualifications. The reason is that we can hypothesize about the qualification systems the engineers in fire protection systems by analyzing studies on National Technical Qualification. In one of the existing studies on National Technical Qualification (Gi *et al.*, 2013) intended to investigate the effectiveness of the admission criteria of National Technical Qualification. In order to do this, they carried out a survey of applicants for National Technical

Qualification and National Technical Qualification holders and compiled statistics. As a result, it showed that there were currently existing admission criteria for National Technical Qualification to strongly promote. It also showed that there were some criteria that it was necessary to review and other criteria desirably to abolish. There were also criteria that needed to be newly established. It was the result from the survey of applicants for National Technical Qualification and National Technical Qualification holders and the statistics based theoretically on the relevant laws of admission criteria, functions and operating systems.

Kim *et al.* (2006) sought a plan to expand the contracting certification of National Technical Qualification out to private institutions in order to overcome the structural limitations of the existing government-led National Technical Qualification system and ensure customer-oriented implementation of the qualification system. They examined the status of applicable certification agencies and the specific survey of these institution's managerial and operational capabilities. Based on this, they presented effective measures for contracting out certification of National Technical Qualification. It was the result from the analysis

of the National Technical Qualification system based theoretically on the survey of certification agencies. Kim (2009) examined occupational regulation effect of preferential treatment in statutes for National Technical Qualification. After classifying the statute into four types, this study analyzed the effect of statutes on the pass rate by multiple regression analysis. As a result, the statutes of preferential treatment for certificate or license practitioner in National Technical Qualification are playing the function of occupational regulation. It was the result from the analysis of the National Technical Qualification system by means of utilizing a multiple regression analysis based theoretically on preferential treatment in statutes.

Kim (2012) applied the technique of Human Performance Technology (HPT) to select an effective management plan of two different qualifications. Analyzing characteristics of the qualifications and the differences between them, he suggested the improvement plan for management process. This was analysis theoretically based on the current state of qualifications by using HPT. Na (2012) found the model to utilize current National Competency Standards (NCS) practically in respect of redesigning of the grade and the category of National Technical Qualification and National Professional Qualification. In result, they developed the category as 8 levels by utilizing literature research, interview with the persons concerned, development research and expert conference. This was the analysis of qualifications theoretically based on the related law (NCS) by using the examples of other countries such as Australia and England.

Na and Lee (2015) analyzed the design units and employment units for craftsman items of National Technical Qualification. In this study, it was analyzed 1st whether the standards of the qualification design or the actual recruitment of the qualification holder could be categorized as either occupational categories or occupation components. This study implied that it was necessary to adjust excessive segmentation, categorization and mismatch of items between design units and employment units and to consider qualification design criteria which was suitable for employment units in the business field in order to ensure the compatibility and the applicability of the craftsman qualification in the actual field. It was based theoretically on the relevant law, i.e., the craftsman items provided in the National Technical Qualifications Act. Park and Kim (2004) suggested a need and the role of the operation system of the current National Technical Qualification system, the grades and the application requirements at the personal, corporate and national levels and also suggested an

improvement plan on the government, public corporations and qualification acquirers. It was the improvement plan of qualification system based on related laws about the operation system, the grades and the application requirements as its theoretical basis.

Park and Kim (2004) analyzed the current state of management and operation of the National Technical Qualification system and examined the limitations of operation of the qualification system on a national focus. A plan on division of roles of the nation and people about this was suggested through collection and analysis of related data, surveys targeting qualification managers at work in a company and associations by industry in a group of business owners, holding conferences with experts and interviews about associations by corporation and industry. This was an analysis of frequency through surveys, interviews and meetings with experts based on the current state of management and operation of the qualification system as its theoretical basis.

When analyzing existing research, they developed their studies based theoretically on the related laws, the current state, surveys and the examples of other countries with comprehensive research about NCS. This study attempted research about the qualification systems of the engineers in fire protection systems which has never been attempted yet in Korea and this is meaningful in regard to approaching the systems based theoretically on the principal-agent problem unlike existing directions of research on National Technical Qualification.

MATERIALS AND METHODS

The principal-agent problem: The principal-agent Problem is that discordance of the object due to observation and supervision and impossibility of observation on an agent's action (Park and Kim, 2004). Meanwhile, the solutions of the Principal-Agent problem are suggested: clarification of contractual relationships (Tatsuro and Kim, 2004; Kang, 2005) for facilitation of regulatory agencies' command and supervision, reduction of uncertainty on the principal's decisions on selection of the agents by means including the merit system, the efficiency wage and co-insurance at the insurance market, fulfilling provision of incentives (Kim, 2008, 2010; Kwon, 2009; Son, 2007) and construction of competition systems (Lim, 2001) by means of multiple agents and so on. Kwon and Park (2007) suggested maintenance of neutrality, professionalism and efficiency and Shin suggested maintenance of propriety as a solution of other principal-agent problem, however, these are excluded in this study since they are minor opinions).

RESULTS AND DISCUSSION

Incentive structure of exam design for engineers in fire protection systems: To facilitate the regulatory agencies' command and supervision which is the main solution of the principal-agent problem, we have arrived at conclusions of clarifying contract relations, preparing an incentive structure for less uncertainty about the principal's decision of choice on the agent and building a competitive structure through multiple agents. Among these, we plan to analyze the main problems of National Technical Qualification for engineers in fire protection systems shown in current state.

Therefore, we intend to approach at the viewpoint of preparing an incentive structure for less uncertainty about the principal's decision of choice on the agent. There is an incentive structure that gives incentives or penalties through composing a commission about exam question design errors in the exams for the engineers in fire protection systems, however, exam question design errors are not reducing because the structure is not working well. When examining the process of setting questions on engineers in fire protection systems, method of setting questions by computer based on previous setting method of the question bank and method of setting questions directly by test organizers are run parallel as seen in Figure 1. Among all, the method of setting questions from the question bank has a bigger importance than the direct method of setting questions. About 3 test organizers from the outside set questions that take effect in next year and 2 or more different experts from the outside review the questions set. If there is no problem, the questions are stocked in the question bank.

A researcher in charge organizes questions that will be carried out in a set from the stocked question bank and confirms the final questions at a restricted situation before implementation. Although the questions are set by test organizers from the outside, confirmation of final questions is done not by firefighting experts but by researchers in charge. Accordingly, errors occur due to plural selection of similar type of questions in final check process or without properly checking if the new law on the questions has been reflected. Furthermore, there are cases of selecting a test organizer without accurately check detailed major of the test organizer from the outside due to lack of professionalism of a researcher in charge, resulting in cases of setting fragmentary questions because the major the test organizer is in and the subject do not match each other. In case of firefighting theory, several test organizers should set questions by detailed majors because of its wide range. However, only one test organizer is requested to set the questions.

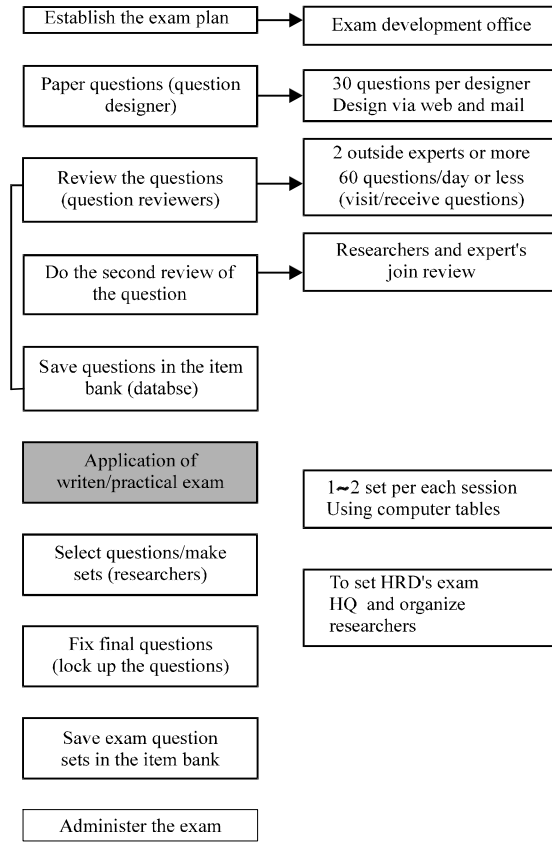


Fig. 1: (Existing) exam design procedure for engineers in fire protection systems (Kim, 2012)

Table 1: The number of exam question errors for engineers in fire protection systems

| Years | No. of exam question errors | Types of exam question errors |
|---------|-----------------------------|----------------------------------|
| 2011 | 3~5 questions | Not applicable to new laws |
| 2012 | 5~7 questions | Simply wrong/dubious answers |
| 2013 | 3~5 questions | True or false typo/miscalculated |
| 2014 | 2~4 questions | Miscalculated or dubious |
| 2015 | 2~4 questions | Not applicable to new laws |
| Average | 3~5 questions | - |

This way of procedure is considerably poor compared to the one of College Scholastic Ability Test. Meanwhile, a problem about the errors in setting questions which had been under the surface in the meantime, was brought up as questions from written test were opened to the public under the purpose of aiming convenience for the examinees. As seen in Table 1 as errors of 3-5 questions consistently occur yearly due to non-reflection of new law, simple wrong answers, duplicated answers, calculation errors and questions that correct ones and incorrect ones are directly opposed, public corporation has implemented a system that gives incentives or penalties through composing a commission as a measure for decrease of the errors. However, the errors in setting questions are not reducing because the

incentive structure is not working well. In the United States, there are various education programs provided for reinforcement of professionalism of qualification subjects in order to reduce errors in setting questions which results in improvement of professionalism of researchers in charge of qualification subjects, leading to less errors in setting questions compared to the case with South Korea. Also, in Japan, firefighting exam research center only manages firefighting qualification such as engineers in fire protection systems in order to raise professionalism. There are self-education and training to make this happen, therefore, errors in setting questions barely occur. In Australia, qualification is given in the condition of completing education training because education training is considered important. Therefore, errors in setting questions are not brought about.

Plans to improve incentive structure of engineers in fire protection systems: Based on critical analysis on the principal-agent problem, we suggest the following points in order to reduce the errors in setting questions on certificate applicants. 1st, it is necessary to reinforce the management system of setting questions by adopting process of review on questions and confirmation of final questions by a test organizer following the procedures of setting questions for College Scholastic Ability Test. While error rate of College Scholastic Ability Test is 0.5~1% having 1~2 questions out of 180 questions, error rate of engineers in fire protection systems is 1~2% having 3~5 questions out of 240 questions which is more than 4 times in maximum compared to the one of College Scholastic Ability Test.

Consequently, by benchmarking part of the process of setting questions in College Scholastic Ability Test, the content is redelivered to a test organizer after a primary review of questions, the test organizer corrects or resets the questions and delivers to a secondary reviewer, then the questions are finally confirmed through repeated primary and secondary reviews. If the improvement scheme of the procedure of setting questions of the exams for engineers in fire protection systems is suggested, it is same as shown in Fig. 2.

At 1st, test organizers of each subject camp and set 30 questions, then go through process of correction, supplementation and reset of the questions through meetings. A set of 30 questions completed through this procedure becomes a primary review. Referring to the opinions of the primary reviewers, the set is reviewed again by the secondary reviewers and the revised 30 questions are delivered to test organizers and go through correction and supplementation process again. It is a system that reduces problems by increasing the

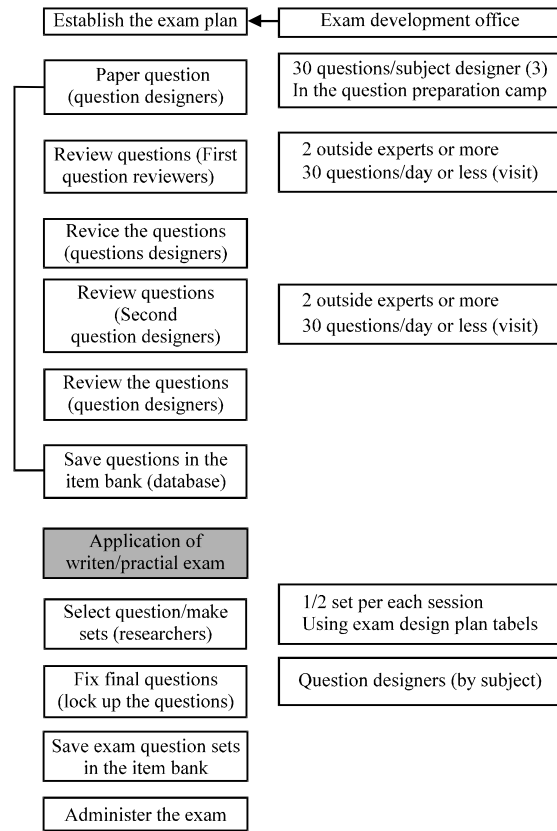


Fig. 2: (Planned) exam design procedure for engineers in fire protection systems

number of reviews on questions from twice in previous way to <4 times. Confirmation of final questions is also done by test organizers. Therefore, errors are checked until the last. Secondly, it is not easy to secure professionalism in that there is a limitation on comprehension and application of the subject the researcher is in charge of if the subject goes over the similar job field of the researcher. There is a limitation on understanding and applying the field in charge because a researcher in charge from public corporation, a qualification manager, has a job range which goes over the similar job field or is huge.

In other words, professionalism of a qualification manager is weakened. A researcher is in charge of 11 subjects in maximum per person. A researcher in charge of engineers in fire protection systems (mechanical) is also in charge of plate can manufacturing technician, electronic publishing technician and construction safety engineer which are not related to firefighting qualification and most of researchers in charge can affect as a cause of generating errors when conducting qualification test because they are not

professional personnel having majored in firefighting. In Japan, most of the researchers in charge working at firefighting exam research center where firefighting qualification is managed and operated are majoring in firefighting or are professional personnel who acquired firefighting qualification.

Researchers in charge working at Australian firefighting association which manages qualification are also mainly composed of professional personnel majoring in firefighting or who completed educational training. It is necessary to reinforce professionalism of researchers, who are qualification managers, through various education programs such as selecting a firefighting major, readjusting the job range to the one similar to the job field of the researcher in charge of qualification management having an obligatory regularization of regular supplementary education for the researcher to understand the work and having training programs and education programs at work, from the principal-agent problem's perspective. Researcher in charge does not only have simple supporting duty but is also involved in meeting with expert related to certificate and selection of exam questions and in case there is an error in exam questions or type of question has a distance from the industrial site, he or she also conducts a role including new questions and confirming final questions. Therefore, since it can be found that professionalism of a researcher in charge is an important element, measures such as selecting a firefighting major and reinforcing professionalism through various education programs alike the ones in the United States are in need.

Finally, it is necessary to implement a method in which written test only tests about basic points and practical points are dealt during oral test. Errors occur during the process of twisting questions in order to have the assessment function. Therefore, it is recommended to select measures which decrease errors of setting questions and also raise assessment function by lowering its level of difficulty and evaluating the least points engineers in fire protection systems should prepare for the written test which does not reflect present sense of engineers in fire protection systems and deciding pass or fail through oral test.

There are various education programs, provided for reinforcement of professionalism of researchers in charge of qualification subjects in the United States. These results in improvement of professionalism of researchers in charge of qualification subjects which leads to less errors in setting questions compared to the case with South Korea. In Japan, most of the researchers in charge working at firefighting exam research center where

firefighting qualification is managed and operated are majoring in firefighting or are professional personnel who acquired firefighting qualification. Researchers in charge working at Australian firefighting association which manages qualification are also mainly composed of professional personnel majoring in firefighting or who completed educational training.

If professionalism of researchers in charge is secured, it is easy to select a test organizer from outside and also to match the major and subject of the test organizer. Hence, it would be able to select a test organizer suitable for the major of the subject regarding of setting questions.

In conclusion, in order to reduce the errors in setting questions on qualification applicants, it is necessary to reinforce the management system of setting questions by adopting a process of <4 times of repetitive reviews on questions and confirmation of final questions by test organizers, following the process of setting questions for College Scholastic Ability Test. Furthermore, we suggest that it is necessary to select a firefighting major, reinforce professionalism of researchers in charge through running various education programs only evaluate basic points in written test and conduct a practical evaluation through oral test. Additionally, adaptation of real-name system on the members who set questions and review is considered as an effective method in reducing errors (Kwon and Park, 2007; Choi, 2015; Lim, 2013).

CONCLUSION

This study approached qualification system of the engineers in fire protection systems based theoretically on Principal-Agent problem. Based on critical analysis on Principal-Agent problem, we proposed following 3 points in order to decrease the errors in setting questions on exams for the engineers in fire protection systems. First, it is necessary to reinforce the management system of setting questions by adopting process of question review and confirmation of final questions by the examiner, following the procedures of setting questions for College Scholastic Ability Test. Second, it is not easy to secure professionalism in that there is a limitation on comprehension and application of the subject the researcher is in charge of if the subject goes over the similar job field of the researcher.

IMPLICATIONS

It is necessary to reinforce professionalism of researchers in Human Resources Development Service of Korea who are qualification managers through various

education programs such as selecting a firefighting major, readjusting the job range to the one similar to the job field of the researcher in charge of qualification management, having an obligatory regularization of regular supplementary education for the researcher to understand the work and having training programs and education programs at work. Finally, it is necessary to implement a method in which written test on qualification system of the engineers in fire protection systems only tests about basic points and practical points are dealt during oral test. Additionally, we proposed the necessity of adaptation of real-name system on the members who set questions and review.

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