

A Feasibility Evaluation on the Outsourcing of Quality Testing and Inspection

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Abstract

The purpose of this research is to evaluate the feasibility of outsourcing test/inspection activity in construction work. This research conducted a questionnaire of interested parties as well as a survey by Analytic Hierarchy Process (AHP) with experts on quality control. For the evaluation by AHP, five criteria were adopted and a number of pair-wise comparisons were conducted through two stages. Finally, the weighting coefficient to approve the outsourcing was calculated at 0.606 and it therefore appeared more reasonable to permit rather than prohibit outsourcing. According to the AHP result, it was found that outsourcing would be necessary to enhance the objectivity and specialties of quality testing and inspection, even though somewhat undesirable in terms of enhancing a sense of responsibility and systemically conducting the testing and inspection.

Keywords: Outsourcing, Testing and Inspection, AHP, Testing Agency, Quality Control

1. INTRODUCTION

The quality control activity in construction work is very important to assure the quality of construction structures and to prevent defective work. In general, the quality control activity includes planning for quality management, examining design drawings, checking specifications, purchasing, inspecting, testing, etc.(Davis 1987). Inspections and tests are fundamental units that form the central core of the quality management activity (Battikha 2002).

As the scale of construction works becomes larger and restrictions for quality control are more strictly enforced than before, the tasks related to quality control have increased recently. As a result, the number of specialized testing agencies and cases that contractors outsource for labor-intensive testing and inspection has increased.

Outsourcing quality control is not a rare practice in many countries (Williams 1996, Schexnayder 2003). According to the case studies of major countries such as the United States, Japan, Singapore, and Taiwan, although the quality control (QC) manager is employed by a prime contractor, most quality testing and inspection activities tend to be outsourced to outside testing agencies. In case of a large project, a project owner sometimes engages another independent quality testing/inspection agency just for quality assurance (Choi, 2005).

Nevertheless there is a lot of disagreement about this type of outsourcing because quality testing and inspection is a core part of quality control activity. Accordingly, the necessity and effectiveness of the outsourcing need to be verified through an objective evaluation for it.

The purpose of this research is to evaluate the feasibility, effectiveness and necessity of outsourcing the test/inspection activity by Analytic Hierarchy Process

(AHP) with the help of the experts in quality management. Also, this paper proposes some policies to support the outsourcing through discussions with experts and a questionnaire of interested parties, such as constructors, project owners, supervisors and testing agencies.

2. THE FEASIBILITY EVALUATION OF OUTSOURCING BY AHP

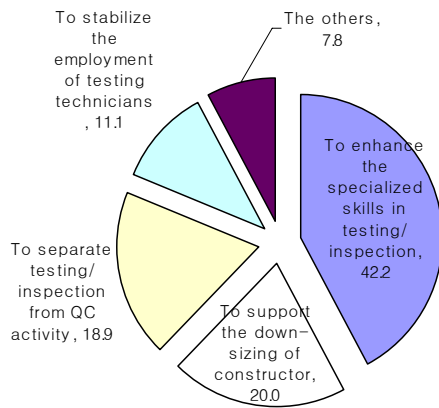
(1) Review of arguments for and against the outsourcing

According to the survey result (Choi, 2004), as a reason to approve the outsourcing of testing/inspection activity, the argument that it is possible to enhance the specialized skills of testing technicians and inspectors was given by 45.8% of the participants and ranked first, as shown in Fig. 1. Subsequently, the argument that outsourcing is needed in order to separate testing/inspection from quality control activity was given by 23.5% of the participants. To examine the results according to the kind of respondents, constructors relatively tended to emphasize the importance of downsizing on job sites. On the contrary, project owners and testing agencies tended to emphasize the separation between testing/inspection and quality control activity. As an argument against outsourcing, 'possibility of decreasing a tester's sense of responsibility' received 34.6% and ranked first, as shown in Fig. 1. The reply that there is a possibility that a testing agency would be subordinated to constructors, like subcontractors, obtained 24.2%.

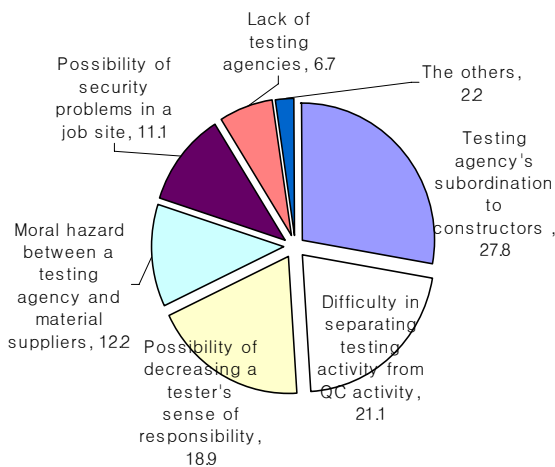
(2) Outlook of AHP

This study applied AHP (Analytic Hierarchy Process) to draw reasonable conclusions in coping with the above controversial points, particularly whether the outsourcing of testing/inspection activity is reasonable or not.

1) Reasons for approval



2) Reasons for disapproval



Source : Choi (2004), replied by 90 construction engineers.

Figure. 1. The reasons for and against outsourcing testing/inspection

The questionnaire for AHP was conducted in March of 2006, with the help of 22 experts on quality management in Korea. The experts were composed of public servants (2), professors (3), researchers (4), construction engineers (4), graduate students (3), building material makers (3), a project owner, a constructor, and a public testing institute. To ensure the objectivity of this survey, we excluded from the survey specialized testing agencies. Of all the experts, 16 (72.7 percent) have experience working for construction companies or quality control division as an engineer.

(3) Discussion of criteria

In order to evaluate the feasibility of outsourcing testing/inspection by AHP, first of all definite criteria should be determined. Then, the merits/demerits of outsourcing and its influence should be analyzed in advance. In order to determine the criteria, we had a discussion with 6 experts who would take part in the questionnaire for AHP. Finally, the criteria were classified by the following five items :

1) Can the testing and inspection be conducted

systemically?

Because quality testing/inspection is a core part of quality control activity, there are some disputes in relation to how the testing/inspection can be separated from quality control activity. In addition, some argued that when the testing/inspection is outsourced, there is some possibility of conflicts between testers/inspectors and the construction organization. If a testing agency applies excessive requirements in deciding whether the construction passes or fails, the conflicts will become larger and the construction period will inevitably be prolonged. Accordingly, provided that the testing/inspection is outsourced, we should examine whether or not the quality inspection and tests can be conducted systemically.

2) Is it possible to enhance the specialized skills of testing technicians?

There are many kinds and testing items that demand specialized skills and experiences in the testing and inspection of construction work. For those who are beginners or are unskilled, it is difficult to be fully aware of these. Therefore, it is desirable that quality control systems should be improved in terms of enhancing the specialties of testing technicians and inspectors. Accordingly, we should review whether or not the outsourcing can enhance their specialties.

3) Can it improve the objectivity of testing and inspection?

Basically, the purpose of quality testing and inspection is to determine whether supplies of services (including raw materials, components, and intermediate assemblies) conform to contract requirements. Therefore, objectivity is essential in conducting tests and inspections (Williams 1996). For conformance-oriented quality control, more attention is given to separating the responsibility for judging quality from those charged with carrying out the work (Barrie and Paulson 1992). Hence, test and inspection activity needs to be secured independently against the organization carrying out construction work. Accordingly, we should examine whether or not the outsourcing can improve the objectivity and independency of testing and inspection.

4) Can it enhance the sense of responsibility of testing technicians and inspectors?

It is important to secure reliability and responsibility in testing and inspection activity. Provided that the testing/inspection is outsourced, some argue that there is a possibility that the sense of responsibility as a testing technician may deteriorate if he is not attached to the prime contractor. On the contrary, some point out that the sense of responsibility hardly deteriorates because most tests/inspections are conducted under the supervision of a QC manager belonging to a constructor. Accordingly, we should examine whether or not the outsourcing can enhance the sense of responsibility of testing technicians.

5) Is it possible to enhance the status of testing technicians?

Most testing technicians and inspectors tend to be employed by a project-oriented temporary worker than a

Table 1. Criteria for AHP.

Criteria	Major considerations in evaluation (In case of outsourcing or not)
C1 Possibility of conducting tests/inspections systemically	Which is the more effective way to easily harmonize the testing/inspection activity with construction work? Which is a better way to minimize the conflict between the constructor and testing technician? Is it possible and reasonable to separate testing/inspection activity from QC activity? Is it possible to harmonize test/inspection with the QC activity of constructor? Are there plenty of specialized testing agencies, and if so, are they able to provide a high-quality service?
C2 Enhancement of the specialties of the tester/inspector	Which is a more efficient way to raise the specialized skills of testing technicians? Which is more useful for training the testing technicians systematically? Which is more useful to improve the specialties in testing/inspection activity?
C3 Improvement of objectivity	Which is more desirable for conducting the testing and inspection with objectivity and independence? Can the testing organization conduct their testing/inspection duty on an equal footing with constructors? Which is effective to minimize moral hazard with material suppliers?
C4 Securing a sense of responsibility	Which is more effective for conducting the testing/inspection activity sincerely and faithfully? Which is more effective for raising the testing technicians' sense of responsibility and pride?
C5 Improvement of the testing technician's status	Which is more useful for stabilizing the employment of testing technicians? Which is more effective for improving working conditions of testing technicians? Which is more effective for promoting the joining of a well-trained employee as a testing technician and inspector? Which is more useful for managing the career of testing technicians?

regular worker. Therefore, well-trained QC personnel tend to avoid conducting quality testing and inspection or to change their occupations easily. Because this leads to lower quality control of construction sites, the systemic training of testing technicians and the enhancement of their status should be taken into account.

(4) Decision of criteria and hierarchy

In order to conduct evaluation by AHP, a total of 5 criteria were adopted finally after discussions with experts on quality control. The criteria finally adopted in this research were: a) the possibility of conducting tests/inspections systemically; b) the enhancement of the specialties of the tester/inspector; c) improvement of objectivity; d) securing a sense of responsibility; and e) improvement of the testing technician's status. Here, except for a), we could find that the criteria b) - e) were

connected with the qualitative improvement of testing/inspection activity. A hierarchy of the problem was designed as two levels, as seen in Fig. 2. The five criteria for AHP and major considerations in their evaluation are shown in Table 1.

(5) Pair-wise comparison

In order to determine whether outsourcing should be permitted, a number of pair-wise comparisons were necessary through two stages. First, each pair of criteria was mutually compared with respect to the goal. Second, each pair of alternatives was compared with respect to each criterion at the upper level of the hierarchy.

Comparisons of all elements of the hierarchy, that is, Criteria with respect to goal and alternatives with respect to criteria, were made on both levels of the hierarchy by using Saaty's scale of pair-wise comparisons. Weighting

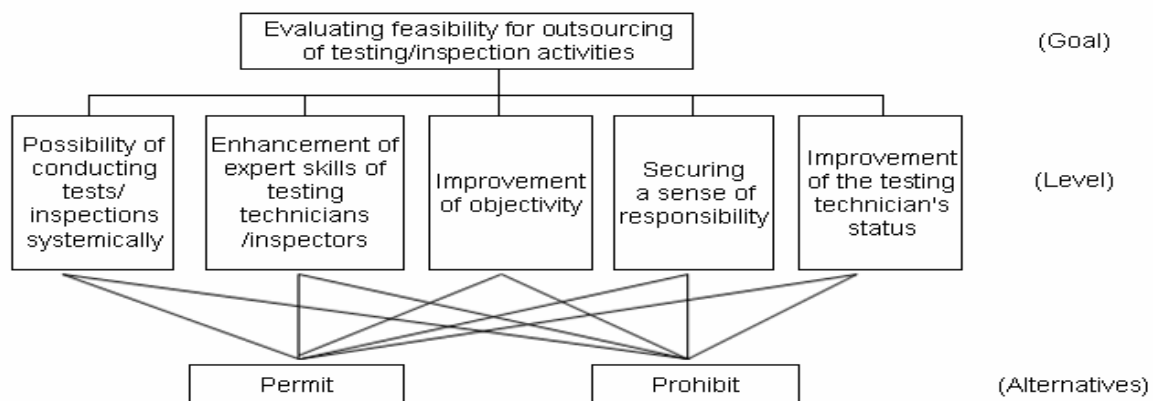


Figure 2. Hierarchy of the problem for AHP

coefficients for all criteria with respect to the goal were derived in turn as a sub-result of the procedure. Weighting coefficients for two alternatives were derived by AHP with respect to the goal.

After 10 comparisons, $(5 \times 4) / 2 = 10$, a comparison matrix shown in Table 2 was obtained. The results were the value of each matrix calculated by integrating the answers of 10 experts of the quality control field and by using the geometric mean instead of arithmetic mean to avoid being affected by outliers (Doune 1995). After the comparison matrix for criteria vs. goal was completed, weighting coefficients and ranks of criteria were calculated on the basis of the procedure described in Saaty(1995). The results are given in Table 2. Weighting coefficients represent the relative importance of each criterion in making a decision.

As a measure of inconsistency, AHP uses an originally defined method of calculating the inconsistency index (Saaty 1995). It is deduced that the values of the inconsistency index lower than 0.10 are acceptable (10% of inconsistency). The inconsistency index obtained here was 0.028 and was considered acceptable.

From the evaluated results, the element of 'improvement of objectivity' was ranked as the relatively most important criterion. Judging from the results, it could be concluded that experts on quality control attached greater importance to the inherent role of testing technicians and inspectors than to stable employment or specialization of skills.

Table 2. Comparison matrix and weighting coefficients.

	C1	C2	C3	C4	C5	Weighting coefficient	Rank
C1	1.000	1.463	0.530	1.568	1.139	0.205	2
C2	0.683	1.000	0.460	0.350	0.877	0.122	5
C3	1.887	2.176	1.000	1.397	1.822	0.302	1
C4	0.638	2.657	0.716	1.000	0.981	0.203	3
C5	0.878	1.140	0.549	1.020	1.000	0.168	4

Note: $\lambda_{max} = 0.0251$, inconsistency index = 0.028

(6) Decision of alternatives

As a second step following the same procedure, AHP computed weights for two alternatives (permit outsourcing activity or prohibit it) with respect to the five criteria shown below. After $5 \times 2 = 10$ comparisons, the five matrices were generated as shown in Table 3.

Here, each vector consists of the alternatives' weights. In other words, for each element (here criterion) at a higher level, there is one vector of weighting coefficients for each of the alternatives. The overall vector of alternatives' weighting coefficients is the final result of comparisons made on both levels of hierarchy.

As a final step, the final weighting coefficients of the alternatives can be calculated using the following two results: a) the relative weight through pair-wise comparison with respect to each element (criteria), and b)

Table 3. Comparison matrices: alternatives vs. criteria.

C1) Possibility of conducting tests systemically

	Prohibit	Permit	Weights
Prohibit	1	1.0385	0.509
Permit	0.9629	1	0.491

C2) Enhancement of the specialties of the tester/inspector

	Prohibit	Permit	Weights
Prohibit	1	0.3154	0.240
Permit	3.1706	1	0.760

C3) Improvement of objectivity

	Prohibit	Permit	Weights
Prohibit	1	0.3626	0.266
Permit	2.7577	1	0.734

C4) Securing a sense of responsibility

	Prohibit	Permit	Weights
Prohibit	1	1.1885	0.543
Permit	0.8414	1	0.457

C5) Improvement of the testing technician's status

	Prohibit	Permit	Weights
Prohibit	1	0.7127	0.416
Permit	1.4031	1	0.584

weights for the two alternatives (i.e., permit or prohibit) with respect to the five criteria. The result was summarized in Table 4. In conclusion, by means of AHP, the weighting coefficient that was required to permit outsourcing testing/inspection activity was calculated 0.606 and appeared more reasonable than prohibiting it.

To examine the results of AHP closely, it could be found that most experts recognized that outsourcing was quite necessary to enhance the objectivity and specialty of quality testing and inspection, even though outsourcing was a little undesirable in terms of enhancing a sense of responsibility and conducting it systemically.

Putting the opinions of the experts together, when the testing/inspection is outsourced, though the testing agency may be subordinated to constructors, it is expected that the objectivity can be improved far more than when constructors carry out testing/inspection by themselves. Also, when outsourced, testing technicians and inspectors can be continually engaged in testing/inspection activity belonging to specialized testing agencies. Thus, it is anticipated that their specialized skill may be more enhanced and employment status also more stabilized. In addition, though the quality testing/inspection is a core part of quality control activity, there is little influence to conduct quality control activity because it has a characteristic of being labor-intensive, provided that a quality manager belongs to a constructor.

Table 4. Weighting coefficients for alternatives with respect to the goal.

Alternatives	C1 (0.205)	C2 (0.122)	C3 (0.302)	C4 (0.203)	C5 (0.168)	Weighting Coefficient	Rank
Prohibit	0.509	0.240	0.266	0.543	0.416	0.394	2
Permit	0.491	0.760	0.734	0.457	0.584	0.606	1

Note: The values in () are the weighting coefficients of criteria with respect to the goal

3. PRACTICAL CONSIDERATIONS FOR OUTSOURCING

(1) Summary of practical considerations for outsourcing

Judging from the AHP results, it is concluded that the outsourcing was appropriate, there are practical considerations for permitting outsourcing. The principal arguments as derived from the discussion with experts in quality control are summarized below :

a) In order to outsource tests/inspections, isn't it necessary to legally separate a tester/inspector from quality management personnel?

b) Who would be the most appropriate person to make decisions about the outsourcing and selecting a testing agency, the project owner or the contractor?

c) Is it necessary to restrict the scale and kinds of construction work that can be outsourced for testing/inspection? Which aspects of quality control activity can be outsourced?

d) If outsourced, are there any measures that can be taken against anxiety about deterioration of a sense of responsibility in testers and inspectors? Moreover, are there any ways to control the testing agencies and to support them?

To cope with the argument points, this study surveyed the opinions of interested parties in Korea (131 construction engineers, 26 project owners, 30 supervisors and 24 testing agencies). Major policies deduced from discussions with experts in quality control are based on the results of the survey as shown below :

(2) Separation of inspector/tester from quality manager

It is desirable that QC/QA managers of job sites be tied to a prime contractor, considering that a prime contractor should be held responsible for quality control in the long run. In order to support outsourcing, there is a need to separate testing and inspection activity from quality control activity on job sites.

Quality control manpower should also separate the testing technician and inspector from the quality manager. According to survey result, 68.3% of respondents replied that testing technician and inspector should separate from QC manpower, as shown in Table 5.

(3) The decision maker of outsourcing and selecting a testing agency

There are different opinions between constructors and project owners about who shall decide whether to

outsource or not. According to the survey results, the majority of project owners, supervisors, and testing agencies replied that the project owner should decide whether or not to outsource. But 56.2% of construction engineers replied that constructors should make the decision, as shown in Table 5.

Provided that a constructor selects a testing agency, the agency is apt to be subordinated to the constructor; thus, it becomes difficult to maintain objectivity. Accordingly, in order to improve the objectivity and independence of test/inspection activity, it is desirable that a project owner decides the outsourcing and selects a testing agency. Otherwise, granted that the constructor may decide the outsourcing with a project owner's consent, it is desirable that the project owner has the authority to select the testing agency.

(4) Scope of work to be outsourced

In general, QC activity includes planning for quality assurance, examination of design drawings, checking of specifications, purchasing, inspection, testing, management of incongruent items, recording of quality control, etc. (Davis 1987). Some experts argue that all types of QC activity, including testing and inspection activity, can be outsourced, as seen in Table 5. But the outsourcing of all types of QC activity tends to be against the ISO system (Voehl 1994). Moreover, it is a little difficult for testing agencies to understand constructors' internal quality management systems and access their computerized network. Accordingly, the scope of QC activity that can be outsourced should be limited to tests and inspections connected with operating a laboratory at the job site.

In general, the quality control system of a small construction company is non-systematic and of low-grade. Therefore, it is desirable that all types of QC activity may be outsourced in such a small construction work.

On the other hand, some are of the opinion that though testing activity may be outsourced, it is desirable that the outsourcing of inspection activity should be prohibited. But there are some cases in which it is difficult to distinguish inspection activity from testing activity, because inspection activity is also a kind of technical service like testing activity. Accordingly, we concluded that it is unreasonable to separate them.

(5) Supervision of testing agencies

Provided that outsourcing is allowed, disqualified testing agencies might be flooded with requests. Accordingly, there is a need to ensure that companies conducting test-

Table 5. Opinions on practical considerations for outsourcing

(Unit: %)

		Total	Constructor	Owner	Supervisor	Testing Agency
Separation of tester/inspector from QC manager	Agree	59.3	57.3	69.2	40.0	70.8
	Partially agree	9.0	10.7	7.7	13.3	4.2
	Disagree	27.6	26.7	15.4	43.3	25.0
	No comment	4.1	5.3	7.7	3.3	0.0
Decision maker of outsourcing and selecting a testing agency	By owner	51.1	30.7	66.7	43.3	63.6
	By constructor	28.8	56.2	33.3	16.7	9.1
	By supervisor	20.1	13.1	0.0	40.0	27.3
The scope of QC activity that can be outsourced	Testing/Inspection only	62.3	52.7	66.7	73.3	56.5
	All types of QC activity	28.9	29.5	33.3	26.7	26.1
	Others	8.8	17.8	0.0	0.0	17.4

Note: The % value is a weighted mean calculated by giving weights 3,2,1 to the responses that are ranked first, second and third, respectively.

ing/inspection activities register after being equipped with testing technicians and equipment. A large-sized testing agency needs to be increased to secure independence in testing/inspection activity.

Administrative penalties should be enforced against defective tests/inspections, to cope with anxiety about the deterioration of the sense of responsibility of testing technicians. Also a career development program for testing technicians and inspectors should be established.

If necessary, testing agencies may be classified according to their capability. In the case of Japan, testing agencies that are officially recognized by the government are classified into five grades from A to E (Ishido 1996). In the long run, there is a need to introduce an accreditation system for job site laboratories. For instance, in the case of Taiwan it is stipulated that all sampling and tests shall be conducted in a laboratory that is accredited by CNLA (Chinese National Laboratory Accreditation); thus, laboratories in job sites shall also be accredited from the CNLA.

4. CONCLUSION

From the AHP and survey results, it could be found that outsourcing is quite necessary for enhancing the objectivity and specialty of quality testing and inspection, even though outsourcing may be undesirable in terms of enhancing a sense of responsibility and conducting it systemically. By means of AHP, the weighting coefficient that is required to permit outsourcing testing/inspection was finally calculated at 0.606. Hence, it could be concluded that the outsourcing was appropriate.

In order to permit outsourcing, there is a need to separate the testers/inspectors from the quality manager, on condition that the quality manager of a job site should be attached to the prime contractor. Moreover, it is desirable that a project owner has authority to decide the outsourcing and to select a testing agency. The scope of QC activity that can be outsourced should be limited to test/inspection activity, except for small job sites.

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