Valuation on the Intangible Benefits of EVMS using CVM

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Abstract
There has been a lot of controversy about whether the return on IT (Information Technology) is adequate. While the number of articles on IT evaluation has been substantial, limited attention has been given to the value of an intangible benefit. This paper aims to suggest an approach to putting a financial estimate on the intangible benefit of IT applications. The authors chose a sample system for the evaluation and utilized the contingent valuation method to quantitatively measure the intangible value. Then, a valuation and analysis model were suggested for the quantitative valuation of the intangible benefit from IT adoption.

Keywords: construction; project information management system; intangible value; contingent valuation method; quantitative analysis

1. Introduction
There has been a lot of controversy about whether the return on IT (Information Technology) is adequate (Brynjolfsson, 1993). Top managers always want to identify the benefit/cost of IT in order to see if IT investment delivers sufficient value. New technology in Information Systems is increasingly broadening its contribution to the effectiveness of organizations as a whole (Money et al., 1988). As a result, Information Systems may create not only tangible benefits but also intangible ones. A tangible benefit means one that directly improves the performance of the firm such as reducing costs, and increasing profits. An intangible benefit is one that might improve the general circumstances in an organization, but will not directly lead to identifiable effects on the organization's bottom line (company accounts). It is easy to identify and to quantify the value of tangible benefits, however, it is difficult to quantify the financial value of intangible benefits. Remenyi et al., (2005) points out that one of the major problems with IT benefit measurement and management is the intangible benefit. The traditional cost benefit approaches to evaluating effectiveness are now generally regarded as inadequate, especially when a holistic view of the firm is required (Remenyi, D. et al., 2005). This paper aims to suggest a more systematic approach to putting a financial estimate on the intangible benefit of IT systems.

This paper utilizes CVM (Contingent Valuation Method), which is a method to measure intangible value, to provide a valuation and analysis model for measuring the intangible significance of IT adoption. CVM has been well recognized in measuring the value of goods and services with an unfixed market price. EVMS (Earned Value Management System) was chosen as a sample to be evaluated. EVMS, which provides an integrated management environment for construction projects, reflects the biggest IT trend in the Korean construction industry recently.

2. Literature Review
Remenyi et al. (2005) provides a comprehensive framework of the main issues concerning the economics of IT investment and suggestions as to how a firm's IT efforts may be appraised both theoretically and practically. As a framework, they discuss the benefits to be derived from IT investment, approaches for evaluation of the IT function, guidelines concerning issues such as business case accounting, ranking and scoring techniques and user information surveys, etc. Remenyi et al. (2005) also suggests two approaches by negotiation and by imputation for the evaluation of an intangible benefit. However, the approaches are still inadequate in terms of the objective aspects.

Marsh and Flanagan (2000) point out that uncertainty concerning the identification and measurement of benefits associated with IT applications are significant barriers preventing construction organizations from investing in IT. They also review existing approaches to evaluating IT within these organizations and identify metrics in order to deliver the value of IT impact both on management and operational processes within construction organizations. The paper presents an evaluation methodology tailored to one specific IT application, high-density bar coding in maintenance management to illustrate the quantification of both the costs and benefits of applying IT. Marsh and Flanagan (2000) point out that difficulties in quantifying benefits
associated with improved information availability and decision making still prevent effective IT cost/benefit analysis.

To access the value of IT, Pena-Mora and coworkers (1999, 2002) suggest a process-oriented IT planning framework. This framework supports the identification of a value-adding mechanism of IT through business processes, which allow the direct measurement of IS/IT benefits. The studies utilize a set of metrics for measuring the IT business value, and promote our understanding of the relationship between IT and organizations. This study also does not deal with intangible benefits.

Thomas et al. (2004) provides a collaborative effort by industry, the government, and academia in evaluating the approximate economic benefits of using the technologies. They examined the relationship between the use of design/information technology (D/IT) and project performance (cost savings, schedule compression, safety performance) by utilizing statistical analyses and on-site interviews. This paper, however, does not try to put a financial estimate on the benefits.

In order to identify the impact of information technology on construction, El-Mashaleh et al. (2006) focuses on the firm level, and then examines the relationship between IT and firm performance as opposed to a project performance. Firm performance is evaluated as a composite score of several metrics of performance: schedule performance, cost performance, customer satisfaction, safety performance, and profit.

Regarding the other aspect of evaluation - the prioritization of the construction management processes on which IS will be implemented - Yu et al. (2006) suggests an evaluation model for Information Systems benefits in construction management processes. The model is based on the evaluation of the benefits at the construction management task level, and the benefits are evaluated by the effect and possibility of IS implementation with a 0 to 10 scale. Ten, for example, represents an extremely high increase in efficiency. This paper provides a base for the strategic planning of IS implementation.

As reviewed above, while the number of articles on IT evaluation has been substantial, limited attention has been given to the value of an intangible benefit. Remenyi et al. (2000) points out that IT investment benefits are much more difficult to evaluate than IT investment cost because some benefits are intangible such as providing better information, or improving the decision-making capability of an individual. As a result, it is harder to directly link the end benefit to an increase in profitability for the firm. This study suggests an approach directly linking the intangible benefits to monetary values.

3. CVM (Contingent Valuation Method)

For tangible goods and services, the fair market price is the value. For intangible assets or public goods (e.g.: patents, new technology, the environment), however, prices cannot be determined in the market. Therefore, special techniques are required to measure the value. There are several methods to measure intangible value such as the HPM (Hedonic Price Method), TCM (Travel Cost Method), and CVM (Contingent Valuation Method). Of these, CVM has been in the widest use recently.

CVM is a method that measures willingness-to-pay (WTP) based on a hypothetical, not a real, market. In other words, contingent valuation is a survey-based economic technique for evaluating non-market resources through questionnaires, measuring WTP to protect the goods and the willingness to accept compensation for the loss of the resource. The questionnaires use various methods of elicitation for CVM such as open-ended/direct questions, payment cards, bidding games, dichotomous choices (take-it-or-leave-it offer), and so forth. However, CVM may lead to hypothetical bias. Because the willingness to pay/accept is asked directly through use of the questionnaire, there is a possibility of bias. Bias is the difference between the actual value and the answer on the questionnaire. When CVM is used, therefore, special attention should be paid to the design of the questionnaire to minimize possible bias.

The CVM was first suggested by Ciriacy-Wantrup (1947) and actively promoted by Davis (1963). Mitchell and Carson (1989) found that CVM is useful in encouraging WTP in environmental goods both theoretically and methodologically. In the U.S. the Water Resources Council (1979, 1983) published "Principles and Standards for Water and Related Land Resources Planning." This set forth the guidelines for federal participation in project evaluation, which specified that CVM was acceptable for use in determining project benefits. In 1986, the U.S. Department of State allowed CVM as a method to measure the benefits and losses of CERCLA (Comprehensive Environmental Response, Compensation, and Liability Act, 1980, 1986). The most famous case in the use of CVM was the Exxon Valdez oil spill in Alaska. The CVM was used to estimate the economic damages of the oil spill. Although there was some controversy over the use of CVM, it was concluded to be the most reliable method to assess the damages. In fact, the Exxon Valdez oil spill put CVM in the spotlight. As a result, CVM has been widely used for assessing the value of non-market resources.

In Korea, CVM has been used in the Assessment of the Environmental Value of Cheongcho Lake (Park 2001), the Assessment of Benefits from the Adoption of the Express Subway (Ko, 1999), and the Assessment of the Economic Value of the Cheongggyecheon (Stream) Restoration (Yoon, 2004).

4. EVMS

EVMS is "a performance-based management system through criteria setting and the measurement of the progress of project cost, schedule, and goal (OMB: the Office of Management and Budget, 1997)." In other words, it is a management technique to estimate the rate of progress, profit & loss, and future business schedule & cost by analyzing the progress and cost input in light
of the original plan based on process planning and management. Recently, a PIMS (Project Information Management System) which aims to support EVMS has been adopted in several public and private sectors (especially in the construction sector) in Korea. This paper has investigated "K" corporation, as a case to assess the value of the IT system, which adopted EVMS as a PIMS.

5. Design of Valuation

The Contingent Valuation Method (CVM) utilizes survey questions to elicit consumer preferences for public goods. In the survey, respondents are basically presented with the following material and questions (Mitchell and Carson, 1989):

1. A detailed description of the good(s) being valued and the hypothetical circumstance under which it is made available to the respondent.
2. Questions which elicit the respondents' willingness to pay for the good(s) being valued.
3. Questions about respondents' characteristics (for example, age, income), their preferences relevant to the good(s) being valued, and their use of the good(s).

Based on the requirements above, a scenario of a hypothetical market was formed in this study to assess the value of intangible benefits from EVMS. Then, a questionnaire survey on the career, job title, depth of awareness of EVMS, project management technique, contribution of EVMS, and WTP was performed and the results were analyzed using SPSS. Fig. 1. shows the systematic approach for the valuation on the intangible benefits of EVMS using CVM. The details will be described in the following sections.

6. Design of Contingent Valuation Scenario

6.1 Definition of Object Material to Measure

This paper presents the results of an investigation of the adoption of EVMS in the Korean construction industry. Specifically, the investigation was conducted to assess the value of the intangible benefits resulting from the adoption of EVMS, such as improved quality of decision-making based on improved quality of information, data accessibility, improved decision-making capability of an individual, improved image of the company, etc.

In order to make the target material in a hypothetical market clearly recognizable, a questionnaire survey was conducted for the employees of "K" corporation, which in turn increased the reliability of the value assessment.

6.2 Design of the WTP Encouragement Method and the Price

In terms of the method for encouraging the willingness-to-pay, a take-it-or-leave-it offer was used. Under this method, a respondent was asked to answer only "YES" or "NO" concerning the randomly suggested price. In this way, the bias which is found in open-ended questions or bidding games can be overcome (Cameron, 1994). In order to implement the take-it-or-leave-it method, an initial bid price should be set. Therefore, a questionnaire survey was administered to the primary professionals through open-ended questions. Based on the result, the amount at 20%, 40%, 60%, and 80% in a cumulative distribution of WTP as shown in Table 1. was set as the bid price for the 2nd questionnaire survey.

6.3 Structure of Questionnaire

In order to acquire the data needed for this study, the questionnaire included general information, how much they are interested in project management techniques, how much awareness there is of EVMS, how much EVMS contributed when adopted, and the advantages and disadvantages of EVMS and WTP. General information on EVMS and a full description of WTP were added for a better understanding on the part of the respondent.

6.4 Revision of Questionnaire

In order to remove the bias from CVM, the questionnaire was revised with easy words and simple structure on the advice of an expert. Furthermore, by accepting the feedback from the 1st questionnaire for the professional group, the result was reviewed and the bid price was analyzed. The price was set as the bid price of this questionnaire.

7. Sampling

7.1 Population and Sample

For the study, the population and sample were chosen from the employees of "K" corporation. The profile of the sample is designed to reflect the profile of the population in terms of job roles. A total of 140 questionnaires were distributed and one hundred surveys (71.4%) were returned.

7.2 Questionnaire Method and Period

The questionnaire was distributed via the Internet of "K" and collected through e-mail. If any questions
about the questionnaire arose, they were explained by telephone or e-mail. The 1st questionnaire survey was performed from Jan. 15 through Jan. 22, 2006 (8 days) and the 2nd from Feb. 1 through Feb. 13 (2 weeks)  

### 7.3 Analysis of Respondent and WTP

The response to WTP can be affected by a person's position and responsibilities in the company. Therefore, each respondent's personal information was investigated before empirical analysis. In terms of distribution by job title, assistant managers (30%) and section chiefs (39%) were the highest in the sample, followed by deputy general managers, staff, general managers, and branch office managers (Table 2.).

#### Table 2. Characteristics of Respondent

| Job Title          | Frequency | Percentage | Cumulative Percentage |
|--------------------|-----------|------------|-----------------------|
| Staff              | 8         | 8.0        | 8.0                   |
| Assistant Manager  | 30        | 30.0       | 38.0                  |
| Section Chief      | 39        | 39.0       | 77.0                  |
| Deputy General Manager | 16   | 16.0       | 93.0                  |
| General Manager    | 6         | 6.0        | 99.0                  |
| Branch Office Manager | 1   | 1.0        | 100.0                 |

| Total              | 100       | 100.0      |                       |

88 respondents (88%) said 'yes' and 12 (12%) said 'no' (Table 3.).

#### Table 3. Are You Willing to Pay?

| Response | Frequency | Percentage | Cumulative Percentage |
|----------|-----------|------------|-----------------------|
| No       | 12        | 12.0       | 12.0                  |
| Yes      | 88        | 88.0       | 100.0                 |

| Total | 100 | 100.0 |         |

To the question 'Are you willing to pay for the intangible benefits from EVMS application?', 88 respondents (88%) said 'yes' and 12 (12%) said 'no' (Table 3.).

8. Analysis of Results

The respondents were questioned about how much interest they have in project management technique and how informed they are concerning EVMS and its contribution to the company, projects, and individual work.

#### 8.1 Interest in Project Management Technique

According to the survey on how much interest respondents have in project management techniques, 87% (24%: somewhat) responded that they are interested in it (Fig.2.).

#### 8.2 Awareness of EVMS

To the question 'How aware are you of EVMS?', almost all respondents (97%) reported having an awareness of EVMS. Most respondents (80%) had some knowledge about EVMS (Fig.3.). It can be said, then, that the respondents were well aware of EVMS. This was, therefore, a good subject for the survey.

#### 8.3 Contribution and Efficiency of EVMS

When the contribution of EVMS is categorized into company, project management, and individual work, it turns out to be high for company and project management. Eighty-six point seven percent (very
helpful: 29.6%; helpful: 57.1%) responded that EVMS is helpful for the company while 88.8% (very helpful: 27.6%; helpful: 61.2%) said that EVMS is helpful in project management. Therefore, in terms of the contribution of EVMS, project management (88.8%) was the highest, followed by company (86.7%) and individual work (59.2%) (Fig.4).

8.4 Willingness to Pay

In order to identify the quantitative amount each employee estimates concerning the value of the intangible benefits resulting from the adoption of EVMS, the respondents were questioned about "Are you willing to pay for the adoption of EVMS and how much are you willing to pay (WTP) monthly for the intangible benefits?". In terms of WTP, a slight difference was found between the mean value (US$ 73.85) and the adjusted mean which trimmed off 5% from the bottom and 5% from the top (US$ 48.71). The problem with the mean as a measure of central tendency is that it can be greatly influenced by a few extreme values. One very large value can make the mean much larger than it would be if that value were excluded, and similarly for an extremely small value. One way around this problem is to exclude very large and very small values before calculating a mean. The resulting measure of central tendency is called a trimmed mean. To calculate a 5% trimmed mean, the authors' exclude the largest 5% and the smallest 5% of the values and calculate the mean of the remaining values. In general, for an x% trimmed mean the authors' exclude the smallest x% and the largest x% of the values and calculate the mean of remaining (100 - 2x)% of the values. Typical values for the percent x excluded from each end are integers from 1 to 15 (Rasmussen, 1992). Therefore, in order to obtain a reliable WTP, US$ 48.71 was chosen, excluding the extremes. The adjusted mean does not greatly differ from the median (US$ 41.86) (Table 6.).

Table 6. Monthly WTP to Intangible Benefits from EVMS

| Statistical Measures          | Amount  |
|-------------------------------|---------|
| Mean                          | US$ 73.85 |
| 95% Lower Confidence Interval | US$ 41.02 |
| 95% Upper Confidence Interval | US$ 106.69 |
| 5% Adjusted Mean              | US$ 48.71 |
| Median                        | US$ 41.86 |
| Variance                      | US$ 24,016.73 |
| Standard Deviation            | US$ 154.97 |
| Min.                          | US$ 10.47 |
| Max.                          | US$ 1,046.56 |

Assessing the value of the benefits resulting from the adoption of the EVMS is based on the monthly and personal benefits. Annual company wide value of the adoption of EVMS is as follows. Considering the 550 employees of "K" corporation, the annual value of EVMS can be calculated as US$ 48.71 x 12 (months) x 550 (persons) = US$ 321,486. The amount is the annual value of the intangible benefit from the application of EVMS.

9. Estimation of the WTP Analysis Model

In order to estimate a WTP model, variables were chosen and basic statistics were stated as in Table 7. below. It turned out that the variables correlated highly with each other (Table 8.). Due to a lack of independence between variables, therefore, it was difficult to conduct regression analysis. In performing multiple linear regression analysis, multi-collinearity among independent variables produces large variance in regression coefficient estimates. It is important to remove multi-collinearity among independent variables. This is why factor analysis was conducted for each correlation after the questionnaire survey. A factor analysis is a statistical technique used to provide a way of condensing the information contained in a number of original variables into a smaller set of factors with a minimum loss of information (Hair et al., 1992). For factor sampling, PCA (Principal Component Analysis) was used. In terms of rotation method, furthermore, VARIMAX (Varimax rotation that is an orthogonal rotation criterion that maximizes the variance of the
squared elements in the columns of a factor matrix) was used. In order to estimate the WTP model, regression analysis was conducted with the grouped principal factor scores as independent variables and WTP as the dependent variable.

**9.1 Factor Analysis**

According to the correlation-based factor analysis of 8 questions, which were acquired from the questionnaire survey, 3 categories were observed. Regarding annual salary among the variables, many respondents did not answer the question. Therefore, a factor analysis was done with 7 items without annual salary. The factor rotation converged in 4 iterations. According to the factor analysis, the 1st group was about job title and career and the 2nd group was about awareness of EVMS and contribution to company/project management/individual work. The interest in project management techniques was classified as the 3rd group. The results of the factor analysis are stated in Table 9. below:

**9.2 Regression Analysis**

The WTP model was estimated through multivariate regression analysis with the factor scores of three groups as independent variables and WTP as the dependent variable. In regression analysis, a backward elimination method, which stops the elimination of independent variables and sets regression equations when certain stopping criteria are met, was used. According to the multi-variant regression analysis through the backward elimination method, the final regression model was found as shown in Table 10. With 0.302 as R squares, it can be estimated that the independent variables influence WTP by 30.2%. Furthermore, the Durbin-Watson statistic is a test statistic used to detect the presence of autocorrelation in the residuals from a regression analysis with a range of 0 through 4. The risk of autocorrelation decreases as the value is closer to 2. The Durbin-Watson value of the regression model turned out as 1.391, which seems relatively low in terms of the risk of autocorrelation because the model was used with the correlation of the independent variables sufficiently excluded.

When the goodness-of-fit of variables in the WTP model is considered, constant term, career factor

Table 10. Summary of WTP Analysis Model

| Variables   | Mean (Standard Deviation) | Number of Samples |
|-------------|---------------------------|-------------------|
| How much interest do you have in project management technique? (PMCN) | 7.60 (2.03) | 100 |
| How aware are you of EVMS? (EVMSKN) | 7.94 (1.49) | 100 |
| Contribution to the company (COMCONT) | 8.33 (1.27) | 98 |
| Contribution to project management (PMCONT) | 8.29 (1.32) | 98 |
| Contribution to individual work (INDCONT) | 7.14 (1.32) | 98 |
| Annual salary (INC; Unit: US$) | US$ 50,978.01 | 49 |
| Career (CAREER; Unit: years) | (US$ 10,507.48) |
| Job Title (CLA) | 10.15 (4.36) | 97 |
| 1: Staff 2: Assistant Manager 3: Section Chief 4: Deputy General Manager 5: General Manager 6: Branch Office Manager |

Table 8. Correlation between Independent Variables

| Variables | CLA | INC | PMCN | EVMSKN | COMCONT | PMCONT | INDCONT |
|-----------|-----|-----|------|--------|---------|--------|---------|
| CLA       | 1.00 | -    | -0.76 | 0.111  | -0.115  | 0.076  | -0.159  |
| INC       | -    | 1.00 | -0.315 | -0.016 | -0.139  | -0.091 | 0.173   |
| PMCN      | -    | -    | 1.00  | 0.246  | 0.446*  | 0.304* | 0.284** |
| EVMSKN    | -    | -    | -     | 1.000  | 0.396*  | 0.446* | 0.306** |
| COMCONT   | -    | -    | -     | 1.000  | 0.405** | 0.529* | 0.412** |
| PMCONT    | -    | -    | -     | -      | 1.000   |       |         |
| INDCONT   | -    | -    | -     | -      | -       | 1.000  |         |

* Correlation Coefficient is significant at the 0.01 level (2-tailed).
* Correlation Coefficient is significant at the 0.05 level (2-tailed).

Table 9. Result of Factor Analysis

| Principal Factor | Impact Factor | Factor Loading |
|------------------|---------------|----------------|
| F1               | Q1) Job title | 0.920          |
|                  | Q2) Career    | 0.913          |
|                  | Q4) Awareness of EVMS | 0.562 |
| F2               | Q5) Contribution to the company | 0.642 |
|                  | Q6) Contribution to project management | 0.817 |
|                  | Q7) Contribution to individual work | 0.664 |
| F3               | Q3) Interest in project management technique | 0.944 |
and assessment of the contribution of EVMS (F2) turned out to be significant at 95% confidence intervals while the interest in project management techniques (F3) was not significant. It can be said that interest in the project management techniques has nothing to do with WTP. As shown in the results of the questionnaire survey, this kind of result is due to the fact that the interest in project management techniques is pretty much the same overall. The non-standardized coefficient “B” shall be as follows (Table 11).

The WTP model estimated through multi-variant regression analysis is as follows (Eq. 1):

\[
- \text{WTP} = 50.06 + 13.42F1 + 20.07F2
\]

\[
(12.769)** (3.402)** (5.090)** \quad \text{(Eq. 1)}
\]

N: 100, F: 18.739, AdjR\(^2\): 0.302

( )**: t value is significant at 95%

When estimated using the mean of the explanatory variables, WTP turned out to be US$ 50.06. Because the mean of each value should be converted into a standardized value in the case of F1 and F2 factor scores, F1 and F2 are 0. Therefore, the constant term becomes WTP when explanatory variables are the mean. This value, which is very close to the 5% adjusted mean (US$ 48.71), is suitable for the design of the WTP model. Therefore, when the intangible value of EVMS was estimated in an annual value using the WTP model in consideration of the 550 employees of "K" corporation, it turned out as follows: US$50.06 x 12 (months) x 550 (persons) = US$330,396. That is to say that due to the adoption of EVMS, the value of intangible benefits is US$330,396 annually. Therefore, the benefit factor, which has been immeasurable in monetary values, can now be considered as a factor of economic benefit.

10. Benefit/Cost Analysis

The main cost items of the system are development and operation & maintenance cost. The initial cost of the system development and implementation was $350,000. Kim and Kim (2003) analyzed the cost and benefits in utilizing EVMS in Korea. For a company performing about 40 construction projects per year, the operation and maintenance cost was estimated as $825,910/(year) (Kim and Kim, 2003). The direct benefit through efficient work process (reduced time for paper work, budget approval, monthly report and application of payments, etc.) was $1,591,020 annually as shown in Table 12. (Kim and Kim, 2003). The annual indirect benefit was found to be 20.77% of the annual direct benefit. Its B/C ratio for just one year was larger than 1.

11. Lessons Learned

The estimation on the value of intangible benefits turned out to be lower than expected. It is assumed that, as shown by Remenyi et al. (2000), the intangible benefits of IT implementation do not show their full effects at the early stage of IT implementation. However, the benefits of IT implementation will increase over time accordingly. Furthermore, because many respondents regarded WTP as a personal expenditure, the WTP estimation seemed somewhat conservative.

CVM is a method investigating willingness-to-pay (WTP) based on a hypothetical market for non-market resources through questionnaires. Some people will be more willing than others to pay for the benefit. As a result, some variance in the WTP amount given for the benefit in a CV study is inevitable. However, the estimate in the CV study, having scenarios that respondents find unclear or unrealistic could obtain estimates which differ from a true mean by large amounts (Mitchell and Carson, 1989). It was found that it is important to design the questionnaire: its concepts, its wording, and its method of presentation, in a clear manner and to make best efforts to ensure respondents clearly understand it. In addition, further investigations concerning the approaches to improve the estimate are necessary.
12. Conclusion

In order to estimate the value of intangible benefits from IT application (EVMS), this study used CVM, which has been utilized in the valuation of environmental resources, and investigated the WTP for Korean construction companies in which an EVMS-based construction management system is implemented. This study has aimed to determine the value of the expected intangible benefit from EVMS implementation. As a result, it has aimed to make the benefits quantifiable in monetary terms by analyzing the correlation between a respondent’s features and WTP. Therefore, the significance of this paper is that the indirect benefits occurring from the adoption of EVMS have been quantified.

This paper can be summarized as follows:

First, respondents already had some basic knowledge of EVMS. Out of the total respondents, 88% showed a willingness to pay, and 94% of those were sure of their willingness-to-pay. Therefore, WTP was reliable. In terms of the contribution to the company and project, 86.7% responded positively. In terms of the contribution to individual work, however, the result turned out relatively low because the workload increased at the early stage that the system was implemented. Second, when analyzed by multi-variant regression analysis, the value of EVMS turned out to be US$50.06 per man-month, which is slightly higher than the 5% adjusted mean (US$48.71/month). Therefore, this is included in the 95% confidence interval. Furthermore, the value of intangible benefits of EVMS per man turned out to be US$600.70/year. However, this value was relatively low, considering the generally expected value from IT implementation because the respondents regarded WTP as a personal expenditure. This explains the conservative result of the responses. In particular, the variety of problems that occur in the early stage of EVMS adoption and shock and defensive retreat to the new system were the main reasons for the low assessment of the efficiency. Considering the usual confusion and hostile environment when a new system is adopted, however, it can be said that the result above is somewhat positive. Lessons learned are that the evaluator should be aware that the point in time in which the value of IT application is assessed can have an influence on the value of WTP and it is important for respondents to understand that WTP is not a personal expenditure but a personal assessment of value.

In addition, for a company performing about 40 construction projects per year, benefit/cost analysis in implementing and operating the system was analyzed. Its B/C ratio for just one year was larger than 1.

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