A Study of the IT Project Management Using EVM & Real Options
— Proposal of an Abandonment Option Integrated into EVM for Decision-making —

Hiroyuki Takagi, Masatoshi Mori
Chiba Institute of Technology, Japan

Abstract: It is important for project management of IT (Information Technology) development in Japan to carry out early detection of a problem by schedule management and cost management. EVM (Earned Value Management) is an effective method of performance by comparing planned to actual results. Unless a next action to its project is clear, the effective method may not function. Therefore, application of real options is considered that the action to performance should be clarified. Furthermore, in this article, we have proposed a simple real option model of IT project by EVM & an abandonment option.

Key Words: Project Management, EVM (Earned Value Management), Real Options, Information System Development, Decision-making support, Risk management,

1. Introduction
In recent years, as IT system is evaluated in the enterprise company, the amount of IT investments is going to be huge. However, there are no abandonment guidelines in the project of IT system development. In a new business project, an abandonment guideline is not mentioned in the project of IT system development. Moreover, an abandonment is determined after starting the project, and the relevance of the schedule and cost is not related. Under such a situation, IT control is strongly required. We propose an abandonment option integrated into EVM for Decision-making.

2. Critical issues in IT development projects
It is characteristic that IT project itself has lots of uncertain requirements and scarp. Therefore, it is necessary to make the trial calculation of many tasks, which held the risks in the budget plan. There are also time restrictions; it is necessary to make the trial calculation of two or more tasks, which have the risk in a budget plan. A bad risk is an uncertainty, and a plan is made by the buffer (it usually adds 10 to 20%) for uncertainty. This kind of plan has a possibility to increase the project cost. This cannot be integrated by WBS (Work Breakdown Structure) plentifully. In the budget plan stage, it is decided in the requirements of the priority by a decision tree for changes of requirements. So by a decision tree, expenses and its investment effects are not clear. This cannot be calculated by WBS as well. The requirement's change means the quality and the quantity change. And a lot of risks are included in the requirement definition of the system. Assumptions are necessary at the plan stage, but they are greatly different on the development environment. At the budget plan stage, it is not clear to be permitted the cost overrun and the schedule delay. It is a big subject in IT system development project that the trial calculation of a risk is made easily, and it is necessary to decide the guideline (standard) before the problem is found. Furthermore, it is more important to relate the guideline with actual project management.

3. Approach of the solution to critical issues
3.1 Explanation and the subject of real options
Various techniques are used for the calculation method of IT system development project until now. The relation between this value evaluation technique, "enterprise uncertainty", and the "pliability of management judgment" is shown by flexibility & uncertainty. Real Options describe High Flexibility & High Uncertainty.

Figure 1 shows a simple conceptual picture of the drivers of project value. IT project is characterized by its lead-time, its cost over time, and the resulting performance.
Formally, we could find out this as follows: A project’s value $V$ is a function of three or four “value drivers” which is defined in EVM.

$$V = f(\text{performance: } \text{EV (Earned Value)}, \text{cost: } \text{AC} \text{ (Actual cost)}, \text{time: } \text{SPI (Schedule Performance Index)}, \text{project requirement: } \text{EAC (Estimate At Completion)},$$

$$V = f(\text{EV, AC, SPI, EAC}). \quad (1)$$

Although Real Options represent the value by performance Variability, EVM presents the value as the Earned Value. Also, performance of EVM shows not only Earned Value but Actual cost, Schedule Performance Index (SPI), and Estimate At Completion (EAC) as shown in equation (1).

Therefore, in this paper, real options and EVM express the standard for IT project management. And we tried IT governance with Cost & Schedule Control.

Five typical patterns of real options are as follows:

1) Option to Postpone (Delay): When the market potential of a project is unknown, managers strive to delay decisions in order to be able to react to new market information.

2) Expanding Option: When it is judged that a merit will be in investment in the future at the time, the scale of an investment project is expanded by performing additional investment.

3) Option to Contract: When environment gets worse besides assumption, it is the option which can reduce a scale.

4) Abandonment Option: According to environmental aggravation, it is the option, which can be completely abandoned from the enterprise.

5) Switching Option: It allows changing the mode of operation of an asset, depending on factor prices.

IT project manager has the case where the delay option and the contract option are used, without being conscious of the real options. Until biggest problem of the budget over and the schedule delay occurs, the abandonment of the project is not considered. In other words the management of the project cannot be taken, it is necessary to clarify abandonment and the standard clear in both the IT control reinforcement of the company and the IT project.

3.2 Explanation and the subject of real options

Earned Value technique in its various forms is a commonly used method of performance measurement.

It integrates project scope, cost (or resource) and schedule measures to help the project management team assess project performance.

EVM technique using “work in progress” will happen to work in the future. Earned Value is an enhancement over traditional accounting progress measures. Traditional methods focus on planned accomplishment (expenditure) and actual costs. According to Graphic Performance Report (e.g. Figure 2.), managers can create risk mitigation plans based on actual cost (AC), schedule and technical progress of the work. It enables managers to identify and control problems before they become insurmountable. It allows projects to be managed on budget and on schedule.

EVM relies on three key data points:

1) Planned Value (PV),
2) Earned Value (EV),
3) Actual Cost (AC).

Three quantities are based on cost performance measurement using EVM. The above quantities are defined below. (Cf. Table 1.)

From these three quantities we can determine our total program budget, schedule and cost performance and provide an estimated cost of the project at its completion. Additional terms are defined to record cost and schedule performance.
Without the next action, which is decided in the guideline (standard), even if "early warning" is issued for a manager by EVM, it needs extra costs.

4. Proposal of the decision-making method using EVM & Abandonment Option

In the IT project, the cost deficit grows big without guidelines because it decides on the abandonment too late. In order to make this negative spiral minimal, we propose the abandonment decision-making method, which unified an abandonment option and EVM.

When we set abandonment standard (Abandonment Option) based on experience, we can avoid the problem of the project.

Cost Performance Index (CPI): The ratio of cost of work performed (BCWP) to actual cost (ACWP). CPI of 1.0 implies that the actual cost matches to the estimated cost. CPI greater than 1.0 indicates work is accomplished for less cost than what was planned or budgeted. CPI less than 1.0 indicates the project is facing cost overrun.

Schedule Performance Index (SPI): The ratio of work accomplished (BCWP) versus work planned (BCWS), for a specific time period. SPI indicates the rate at which the project is progressing. Table 1 shows what EVM performance measures indicate about a project in regard to its planned work schedule and resource budget. We took notice CPI (Over Budget) and SPI (Behind Schedule).

Figure 3 shows a lower performance compared to an estimated WBS, which is over possible performance range. In this model (Figure 3), three patterns of abandonment option is described by transition of the performance at the time of a plan with the risk. Each EVM drivers (Figure 3) are typically characterized by uncertainty, which is graphically represented in Figure 3. Performance Variability corresponds to uncertainty in the performance of EVM. As shown in Figure 2, Schedule Variance (SV) is considered with Cost Variance (CV). Therefore, we decided to control the final decision-making by the cost.

<table>
<thead>
<tr>
<th>Name</th>
<th>Interpretation</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planned Value (PV)</td>
<td>PV is the budgeted cost for the work scheduled to be completed on an activity or WBS component.</td>
<td></td>
</tr>
<tr>
<td>Earned Value (EV)</td>
<td>EV is the budgeted amount for the work actually completed on the schedule activity or WBS component.</td>
<td></td>
</tr>
<tr>
<td>Actual Cost (AC)</td>
<td>AC is the total cost incurred in accomplishing work on the schedule activity or WBS component.</td>
<td></td>
</tr>
<tr>
<td>Budget At Completion (BAC)</td>
<td>The sum of all the budgets allocated to a program.</td>
<td></td>
</tr>
<tr>
<td>Cost Variance (CV)</td>
<td>The cost variance at the end of the project will be the difference between the budget at completion (BAC) and the actual amount spent.</td>
<td>CV = EV - AC</td>
</tr>
<tr>
<td>Schedule Variance (SV)</td>
<td>Schedule variance will ultimately equal zero when the project is completed because all of the planned values will have been earned.</td>
<td>SV = EV - PV</td>
</tr>
<tr>
<td>Cost Performance Index (CPI)</td>
<td>The ratio of cost of work performed (BCWP) to actual cost (ACWP). CPI of 1.0 implies that the actual cost matches to the estimated cost. CPI greater than 1.0 indicates work is accomplished for less cost than what was planned or budgeted. CPI less than 1.0 indicates the project is facing cost overrun.</td>
<td>CPI = EV/AC</td>
</tr>
<tr>
<td>Schedule Performance Index (SPI)</td>
<td>The SPI is used, in addition to the schedule status, to predict the completion date and is sometimes used in conjunction</td>
<td>SPI = EV/PV</td>
</tr>
<tr>
<td>Estimate to Complete (ETC)</td>
<td>ETC is the estimate for completing the remaining work for a schedule activity, work package, or control account.</td>
<td>Method 1: ETC = (BAC - EV) Method 2: ETC = EAC - AC</td>
</tr>
<tr>
<td>Variance at Completion (VAC)</td>
<td>The difference between Budget At Completion and Estimate At Completion (EAC). This is the dollar value by which the project will be over or under budget.</td>
<td>VAC = BAC - EAC</td>
</tr>
<tr>
<td>Estimate at Completion (EAC)</td>
<td>EAC is the projected or anticipated total final value for a schedule activity, WBS component, or project when the defined work of the project is completed. Method 1: AC + ETC Method 2: AC + BAC - EV Method 3: AC + [(BAC-AC)/cum CPI]</td>
<td></td>
</tr>
</tbody>
</table>

Table 1. Earned Value Management Interpretation and Formula
5. The method of application

Abandonment Option (AO) is integrated by the addition equation with our experience. It is general to calculate the risks with taking a buffer in budget planning. It is not a buffer after carrying out total trial calculation. It proposes to add WBS individual task like a Figure 5. Concretely, it is possible to exceed for Planned Value (PV) recalculated based on the budget planning which is task of WBS.

1) Analyze WBS and classify into the following three.
   (1) HP (Highly Possible): There is an Actual Result, Risk is low.
   (2) MP (Middle Possible): Similar Actual Result Which are Expected. Risk is Middle.
   (3) ABP (Aggressive But Possible): No Actual Result. Risk is High.

2) Add budget to PV at the time of the budget plan of classified WBS as follows.
   (1) HP uses PV using WBS.
   (2) MP uses the budget of 10-30% of PV value is added.
   (3) ABP uses the budget of 20-50%* of PV value is added.

   (4) Re-total the budget after each addition and compute AO (Abandonment Option) which is the Abandonment Option value of Fig. 5.

   The rate of (2) and (3)* computes the frame which does not conflict with a listed indication standard and which can be ranged (not influenced by 30% of profits) invested in consideration of the cash flow of a company, and computes the proper premium ratio of the company.

   Example)
   The rate of premium of the project in case of and (2) PV at the time of an example) budget plan was 300, and by which WP (Work Package) where WP (Work Package) of (1) is the whole 1/3 and (2) is the whole 1/3 and (3) was whole 1/3, when the rate of premium of the 30% and (4) is assumed 50%. When it's 100 + 130 + total of 380 for 150, AO (Abandonment Option) which is the withdrawal option value is set in 380.

   Figure 4. Re-calculation for Abandonment Option

   The real option value of managerial flexibility can be evaluated using contingent claims analysis, developed. Figure 3. means Earned Value (EV) of EVM, so the upper side is positive and the lower side is negative.

   Figure 5. Abandonment Option Line
6. **Expected Effect**

The expected effect of the introduction of the abandonment decision-making method that integrates an Abandonment Option and EVM of the real option is said in a single phrase, the effect of EVM can be strengthened further. It is concretely as follows.

1) It integrates work, schedule and cost using a work breakdown structure (WBS) & Re-calculated Budget.
2) It is a single management control system that provides reliable data using an abandonment option.
3) The associated database of completed projects is useful for comparative analysis using Value & Performance.
4) Cumulative cost performance index (CPI) provides an early warning signal.
5) The schedule performance index (SPI) provides an early warning signal.
6) The "to-complete" performance index allows evaluation of the forecasted final cost.
7) The abandonment option is a predictor for the final cost of the project.
8) The management by exception principle can reduce information overload.

"Exact information" and the "exact standard" are indispensable to decision-making support.

By introducing an "Abandonment Option" from the time of a budget plan, the above effects are assumed also in budget management. "Abandonment Option" considering in IT project should become the natural thing like the loss cut in the Abandonment in new business, the withdrawal in war, and stock dealing.

7. **Conclusion**

In this paper, we have described the subject on the practice in the validity and the enterprise company of the Abandonment decision-making method which the Abandonment Option of the real option using EVM which coils round project management of IT system development. Introduction of the thorough base line as "an abandonment decision-making method using the Abandonment Option of a real option & EVM" was proposed. This real option is effective in project management not only as an "Abandonment Option" but as the risk-management technique.

Therefore, "each option" and "EVM" cooperation has studied further from now on, we want to embody advance research of the "abandonment option value" trial re-calculation method.

We expect this method as following applications;
1) Fund accommodation condition at financial organization
2) Meeting of stockholders (pursuit of responsibility and accountability)
3) Clarification of the responsibility of management executive and CIO

The subject of our future task is additional research of use in business, and other real options than Abandonment Option.

**References**


**Biography**


Masatoshi Mori was born in 1956. Doctor of Engineering of the University of Tokyo. Professor of Chiba Institute of technology. Member of the Japan Society for Production Management, The Japan Society for Management Information, Business Model Association.