Important Factors for Organizational Performance Evaluation through Implementation of Earned Value Management (EVM) in North Taiwan

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The trend of global outsourcing gradually virtualizes organizations. Because of the characteristics of its flexibility and agility, projectized organization may be the tendency. The growth of Taiwan economy is based on the successful development of Small and Medium Enterprises (SME). In order to verify the conditions for implementation of project control tool, Earned Value Management (EVM), as performance evaluation for projectized organizations in Taiwan, this research studied a government owned research and development organization (GORDO) over a two-year period and surveyed the project managers of northern Taiwan. The important factors for implementation of EVM in an organization were authority, incentives, office automation based on project management of information system, the degree of projectization of human resource, contract mechanism for employment, balance of cash flow, and project size.

Key Words and Phrases: Earned Value Management, Performance Evaluation, Project Management Information System, Performance Measurement Baseline

1. Introduction

In order to cope with the rapid changes in the world, enterprises utilize project management methodology to globally outsource their works and to evaluate their internal and external work performance. Of all the project management techniques, Earned Value Management (EVM) is the major one that provides a method to evaluate project performance by integrating schedule and cost of work packages. EVM establishes a performance measurement baseline (PMB) for a project. PMB displays the schedule for expenditure of the resources assigned to accomplish work packages and represents time-phased accumulation of the cost spent to the work subordinate elements. The performance of project evaluates by comparing with planned baseline. The variances between them are reported by Project Management Information System (PMIS). EVM also is capable to forecast project risk through regression analysis of the accumulated cost data on the time frame.

Nowadays, EVM has been effectively implemented in the large-scale project management for the project’s budget above two billion dollars among U.S.A., U.K., Canada, Sweden, Australia, and Japan, etc[4]. It has been recognized as a valuable tool for project management as well as a standard for measuring contract performance [5][6][7]. Recently, earned value management systems maturity model and the earned value management maturity model were developed. These efforts offer the specific goals for an organization to implement EVM for control and performance evaluation of a project step by step [8][9][10][11].

In 2003, Kim, etc. surveyed the key factors for implementation of EVM for project management in the United States. Based on their survey, 82% of project managers have adopted and are employing EVM concept or strongly accept the methodology [3]. However, some researches mentioned that cultural differences and project size are the two important factors for the implementation of EVM in an organization [12].

In order to understand whether that EVM can be used as a tool for performance evaluation and project control in Taiwan or not, this research tried to verify the important factors for implementing EVM methodology. The research effort includes a two-year period field study in a government owned research and development organization (GORDO) and compares the results with a survey of the project managers of the major industrial parks in northern Taiwan.

This GORDO, Chung Shan Institute of Science and Technology (CSIST), has about 10,000 employees and is one of the major R&D organizations in Taiwan for more than 35 years. Most of the projects in this GORDO are managed and controlled under a matrix structure with specific work breakdown structure (WBS) and functional objective breakdown structure (OBS). Most of the programs’ (or projects’) budget are controlled by the program management offices.

In 2003, CSIST considered adopting EVM as an alternative for organizational performance evaluation. Although some of American companies, e.g., Lockheed Martin, Raytheon, Northrop Grumman [5][6] have implemented EVM for their organizational performance evaluation in 2000, nevertheless, none of examples shows that EVM can be adopted for organizational performance evaluation in a public organization as well as SMEs in Taiwan. Therefore,
it is needed to verify the important factors for implementation of EVM and to understand what the differences of the conditions that may have in the other companies of Taiwan are.

2. The approach for the research

In order to define and verify the important factors for implementation of EVM in Taiwanese organizations, three phases were developed as shown in Table 1. Phase I determined the implementation stages and the necessary conditions for implementation of EVM in the GORDO. Phase II decided the important factors for implementation of EVM in the GORDO and experimented the performance of small, medium, and large projects. Phase III surveyed the important factors for implementation of EVM in the SMEs of North Taiwan and compared this results with the Phase II to find out the important factors for the implementation of EVM that occurred simultaneously in both profit and nonprofit organizations.

In this research, firstly, it spent one year to find the necessary conditions and the stages for implementation of EVM in GORDO. A baseline review team including 15 experts assigned by the president office was formed. They developed a questionnaire and sent to 433 managers and vice managers in GORDO. 256 of them submitted their results. The rate was about 59%. After the analysis of those data, the research team categorized the issues that may cause the difficulties for implementation of EVM. The implementation process of EVM was developed into eight stages after their discussion and system analysis of these experts for piloting EVM. Secondly, a pilot run for observing the feasibility of EVM was hold in following six months. In order to understand the influences of the size effect of a project for the implementation processes, information, and interfaces in the organization, three projects with different sizes were selected. In this phase, the Delphi method was used through an Integrated Baseline Review (IBR) team to decide the conditions to adopt EVM in GORDO. The IBR team included the technical, logistic, cost analysis, and important path method experts. The other IBR members came from the representatives of the accounting department, planning as well as information centers. Totally, there were seventeen members. They monitored the pilot run of the implementation of EVM and graded the performance of the three selected projects at the beginning, midterm, and final stages. They also answered the similar questionnaires as the managers did before. These results offered GORDO to decide the conditions for implementation of EVM for its organization. In order to compare and verify the existence of important factors for implementation of EVM, a survey in the small and medium enterprises of Taiwan through distributing 140 questionnaires to the project managers in north Taiwan was developed. There are 117 project managers returned their answers. The return rate is 83.5%. The tested important factors in the questionnaires were based on Kim’s model [3] and modified to fit the Phase I investigation results. The hierarchical structure of the tested important factors is shown in Table 2 of Section 6.

3. The perspectives for implementation of EVM

In order to understand the feasibility of EVM, key factors or conditions for GORDO are found after the survey of the managers in GORDO. We categorized into four issues that may cause the difficulties for implementation of EVM in GORDO as follows:

- The characters of the nonprofit organization
  The characters of nonprofit organization are different than the characters of private companies. The main strategic objective for the nonprofit organizations is effectively fulfilling its obligations for the society. Some of these organizations may be monopolies without any competitors in the market. Their major stakeholders are taxpayers, auditors, and supervisors. For the finance issues, the nonprofit organizations focus on how efficiently using the budget and reducing the unnecessary cost in a project. The priority of budgeting for nonprofit organizations may depend on the leadership of project managers.

- The accuracy of reporting the work from subsystems
  When an organization adopts EVM system, one of the major problems that may happen in the baseline management is that the project managers may manipulate the periodical report of project performance to fit the project baseline that is planed in advance. This is so called Over Target Baseline (OTB) [5]. This situation will generate a bias from the real
The status (or performance) of a project.

- The integration of PMIS from subsystems
  Subsystems in GORDO may have their own PMIS. Some of the data structures of those PMIS systems for project management offices are not standardized. The difficulty of automatic data transaction and information flow might happen between subsystems and project management offices, if the intranet system is without capable software integration. Therefore, the unsuccessful integration of the information for material flow and cash flow of a project into a PMIS system may be a hurdle for implementation of EVM.

- The feasibility of the performance management baseline (PMB)
  Usually, a PMB is designed by project manager before the project starts. The baseline is built up by accumulating the predicted Cost Breakdown Structures (CBS) in the time frame of the project life. Each CBS is related to a Work Breakdown Structure (WBS). If the contents of WBS can be clearly specified, then the forecasting of CBS probably is accurate. However, especially, for the activities in research and development, WBS may not be evidently defined in the first time. Therefore, project managers need to develop Work Dictionary by themselves to plan projects and to establish a feasible baseline before implementation of EVM.

  The above first two items are related to the fields of human resources management and performance evaluation. Generally, the nonprofit organization may lack the flexibility to adaptively arrange personnel from one department to the other, the incentives to motivate employees, and an efficient system to accurately report the results of their assignment. Especially, a standardized and automatic control flow for management of the project information is needed to be constructed before implementation of EVM. Otherwise, there are a lot of interfaces between centers and program management offices that may cause complexity for information data accumulation, if the PMIS of an organization is not well integrated. The above last item needed to be considered in this investigation is the requirement of rational cost and schedule system for a program or project plan to evaluate the program baseline and make the program reasonable.

  Based on the above results of the investigation of the directors in GORDO, the pilot experiment for implementing EVM as an infrastructure program performance evaluation tool was developed. The research team specified eight milestones for implementation of EVM in GORDO and modified our PMIS control processes into a plan-do-check-action close loop. The details will illustrate in the following paragraphs. Separately, they are: the stages that are needed for implementation of EVM and the specific control processes for PMIS.

4. The stage for implementation of EVM

Because EVM are usually used for large program, in terms of project scope management, the implementation of EVM system in an organization needs to consider how many employees will be appropriately involved in the project. In order to understand what the suitable size of a project is needed for GORDO to adopt EVM methodology, three projects for different levels in the organization were selected. GORDO’s hierarchy has three layers. From top to down, it includes an institute, eleven centers, and about two hundred departments. The first selected project utilized the resources across the whole three layers. About two thousand employees involved in this project. The second project contained two layers of organization, i.e., one center and several departments under this center and involved hundreds employees. The third project was designated to a department only and included dozens of members. These pilot projects were periodically evaluated by seventeen Integrated Baseline Review (IBR) team members. These IBR team members are all experienced experts in managerial accounting, project planning, logistics, and systematic analysis as well as management.

In order to separate the processes for implementation of EVM for GORDO into several necessary steps, eight milestones for project management by evolutionally using EVM methodology are specified and listed as follows:

Based on systematic analysis of CBS, OBS, and WBS of a project, project manager needs to define working packages (WP) for evaluation of their earned values.

1) In order to accumulate project data directly from members in a project, information center needs to construct the intranet of PMIS including the functions of automatic generation of project baseline and control account management.

2) Project managers are authorized to assign the new control account after the old one was finished by specific OBS. Without approval through the authorization process, the functional OBS cannot use the new control account.

3) Micro-structure managers are assigned to evaluate the earned value of the working package.

4) Project managers can utilize PMIS involving financial flow for the performance evaluation of both schedule and cost of the total budget.
5) Project managers can analyze the variances of the planned baseline and monitor both the schedule variances through Schedule Performance Index (SPI) and the cost variance through Cost Performance Index (CPI).

6) After the performance evaluation system is successfully established, the IBR team audits each project and calls for actions.

7) Finally, the PMIS can offer a visualized project performance evaluation function in the infrastructure of organization information system. CEO and managers can transparently and promptly understand the performance of each project and obtain Contractor Cost Data Report (CCDR) from the functional department, Cost Performance Report (CPR) from the project managers, and Contract Funds Status Reports (CFSR) as well as Cost / Schedule Status Reports (C/SSR) from the information center.

5. Control process for PMIS

In change management of business process reengineering (BPR), the importance of information management of an organization is like the mind management of a person. The information flow for PMIS of EVM in our case is developed and depicted in Figure 1. Control account managers in a subsystem have the responsibility to periodically report the direct labor hours and the direct material spending in a work package of WBS to the information center. Information center automatically transfers these data as the direct cost spending for a project and sends these data to the account department.

The account department calculates the overhead that should be shared by this project for the annual financial report. The data also automatically transmits to program office through organizational information infrastructure. At this moment, the micro-structure project manager in the program management offices plays an important role in evaluating work package (WP) performance and decides the EV for this WP. Once this WP is finished, a new WP will be assigned to subsystem in the functional organizations. If the subsystem postpones finishing the WP, then it can only report the used account. Therefore, the delay or variance that differentiates from the planned baseline will be found and transferred to SPI. The information center also accumulates other costs for all WPs with their direct cost as a total cost spending for a project and posts the results as a visualized Cost/Schedule Status Reports (C/SSR) to the platform of information system for authorized staff’s references. Meanwhile, it is worth mentioning that IBR team plays a role as an auditor in solving the problems happening in a program and accelerating the review process for approving the WBS/OBS/CBS structure that is needed to be revised.

After project management methodology is clearly defined, the control process for the activities of EVM can be depicted as Figure 2.

6. Important factors for implementation of EVM

At the end of the pilot experiment of EVM implementation, the conditions needed for this implementation were found through the investigation
of all members in the IBR team, project managers, and MIS managers. The results were verified through a survey of the small and medium enterprises in the industrial parks of northern Taiwan. The $\chi^2$ test presents $p=98.8\%$ and shows that the existence of the important factors in not only nonprofit organizations but also SMEs in Taiwan.

The five-point Likert scale was utilized for weighting the factors. Those results can be categorized into four perspectives as we found before the experiment. The details of the important factors that need to be improved for the successful EVM implementation after the pilot experiments are shown in Table 2 and discussed as follow:

- **The characters of organization**
  The problem that may usually happen in an organization which adopts matrix management and concurrently precedes several programs is that who owns the authority for allocating and controlling the resources. If the centers’ authority is superior to programs’, the program managers cannot efficiently manage their subsystem managers. The reason is that their performances are mainly evaluated by chiefs of center not by program managers. This situation also weakens the management capability for the programs. Moreover, incentives drive the motivations of employees to work hard. Essentially, nonprofit organizations do not have sufficient flexibility for employees’ salary and the adjustment of organizational structure. Lack of incentives and the flexibility for the arrangement of human resources hinder the re-engineering of project process when using EVM methodology as the interior performance evaluation tool.

- **The integration of PMIS from subsystems**
  Most of the program offices and subsystem managers may utilize commercial off-the-shelf software products (COTS) to produce desired results. According to the past reports, the spending for implementing of EVM usually increases up to four percent of the total program cost[3][12]. Most spending locates in the field of the extra activities, such as, defining the works and integrating PMIS for the organization as an interior performance evaluation system.

- **The accuracy of the work reports from subsystems**
  In order to match the budgets obtained from several programs, the directors of department might adjust all final cost performance reports in advance. Therefore, the cost will almost fit the budgets obtained with less variance. This is also a typical problem that frequently happens in EVM, leading to inaccuracy of the work reports from subsystem.

- **The feasibility of the performance management baseline**
  EVM needs a database which contains sufficient definitions of each WBS. When the program initiate, it is difficult to appropriately evaluate Earned Value (EV) from the vague work. The other reason that causes baseline infeasible is that the program office cannot control obtaining budgets on time. The delay in obtaining budgets obtained from the demand side forces the departments to transfer budgets from other existing programs to make up the insufficiency for department operations.

### Table 2. Important factors found for implementing EVM in GORDO vs. Survey of Taiwan*

<table>
<thead>
<tr>
<th>Phase I</th>
<th>Phase II&amp;III</th>
<th>GORDO</th>
<th>Survey</th>
</tr>
</thead>
<tbody>
<tr>
<td>The characters of organization</td>
<td>Center’s control is superior to program’s (Authority)</td>
<td>3.6</td>
<td>3.7</td>
</tr>
<tr>
<td>Lack of incentives</td>
<td>4.5</td>
<td>3.6</td>
<td></td>
</tr>
<tr>
<td>Lack of flexibility for the arrangement of human resources</td>
<td>3.8</td>
<td>3.5</td>
<td></td>
</tr>
<tr>
<td>The integration of PMIS from subsystems</td>
<td>Information and financial processes are not fully standardized.</td>
<td>3.8</td>
<td>3.5</td>
</tr>
<tr>
<td>The accuracy of the work report from subsystems</td>
<td>Performance report is planned in advance (contract mechanism for employment)</td>
<td>4.3</td>
<td>3.2</td>
</tr>
<tr>
<td>The feasibility of the performance management baseline</td>
<td>Cannot control budgets obtained on time. (balance of cash flow)</td>
<td>3</td>
<td>3</td>
</tr>
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</table>

*p=98.8% for $\chi^2$ test for GORDO and Survey*

Based on the pilot for the implementation of EVM in GORDO and the comparison with the survey of the project management in the north Taiwan, the results for the important factors were found and shown in Table 2.
The important factors for implementation of EVM in an organization were authority (3.6/3.7), incentives (4.5/3.6), office automation based on project management of information system (3.5/3.8), the degree of projectization of human resource (3.5/3.8), contract mechanism for employment (4.3/3.2), balance of cash flow (3/3).

7. The project size effect

From the past experiences of project management, EVM is considered to be used for large size projects. This is a tradeoff between avoiding the project risk and increasing the project cost with the implementation of EVM. For instance, the Department of Defense (DoD) of U.S.A. usually implements EVM for Research and Development projects greater than $73M, and for the production projects greater than $315M. The Ministry of Defense of the United Kingdom uses EVM for the project size great than £10M. However, in EunHong Kim’s investigation [3], the project size effect is not the key factor for the implementation of EVM.

In order to understand the size effect in GORDO’s pilot experiments of EVM, three different projects were selected. The first project recruited two thousand employees from several centers. The second project involved hundreds employees contained several departments in a center. The third project was designated dozens of members in a department. These pilot projects were periodically evaluated by seven Integrated Baseline Review (IBR) team members. There were three check points in this experiment. They were hold at the beginning, in the middle, and at the end of the experiment period. The evaluation results are shown in Figure 3.

The five point Likert scale was used for grading 17 items of these projects. Five point means strong agree. One point means strong disagree. For the overall performance among the three projects, the medium project presents better than the other two projects. The reason is that the medium project obtained fully support from the chief of the center who also supervised the chief director of this project. Small project shows low motivation at the beginning because it might be not necessary for small projects to implement EVM. Large project improves robustly. Its project managers need to conquer the hurdles from interfaces between centers. The experiment results present that medium or large projects may be more suitable than small project to implement EVM for project management.

8. Conclusion

The survey in the northern Taiwan showed that only one company has implemented EVM for the organizational performance evaluation. The most SMEs in Taiwan did not use EVM as the major management tool in their organizations. Balanced Scorecard seems more popular based on these project managers’ responses. The important factors for implementation of EVM as organizational performance evaluation tools in Taiwan comprise authority in an organization, incentives for the employees, robust PMIS, the degree of projectization of human resource, contract mechanism for employment, balance of cash flow, and project size. This research findings for implementation of EVM in Taiwan society need: (1) the accounting for the implementation of budget need to offer the sufficient incentives for promotion of programs; (2) the hierarchical structure of human resource need to be flexible enough for project management; (3) project management information system (PMIS) need the agility to concurrently upgrade; and (4) in order to evaluate earned value, the planning of baseline for a project must be accountable.

For the future works, an advanced survey sampling for the field study of this research is needed, since the sampling size issue for the representation of the population of north Taiwan organizations was not discussed during the survey period.

References


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Dear Dr. Wang,

We are pleased to inform you that your paper which entitled "Important Factors for Organizational Performance Evaluation through Implementation of Earned Value Management (EVM) in North Taiwan" is accepted for publication in The Journal of SPM International.


Yours sincerely,

Tetsurou Seki, Dr.
Editor in Chief of JSPMI and Secretary General
The Society of Project Management