Practical Issues of Earned Value Management Systems (EVMS) for Nuclear Power Plant (NPP) Construction

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***Abstract:** Cost, schedule, and quality are the three major performance indicators for any construction project. Under the globalized competition in the nuclear industry, researchers and practitioners have also explored a systemized and integrated management system for cost, schedule, and quality. In order to address this issue, the concept of earned value management system (EVMS) has been often utilized. However, implementing EVMS for a mega-project of nuclear power plant (NPP) construction requires extensive overhead efforts. Though previous studies proposed structures and methods for effective NPP EVMS, there has been no legitimate study for data collection strategy for practical implementation. In this context, the purpose of this paper is to develop an effective data collection strategy for NPP EVMS. Firstly, the barriers to practical NPP EVMS were identified based on literature review and expert interviews. Strategies for data collection were then developed based on different phases of project life cycle. This study focuses on the 'life-cycle integrated progress management system' for NPP construction from an owner's perspective Therefore, results of this study can be used as a guide for preparing request for proposals (RFP) of an NPP owner organization.*

***Keywords:** EVMS, Nuclear Power Plant (NPP), Data Collection, RFP*

I. INTRODUCTION

The concept of earned value management system (EVMS) has been often explored in academia as well as in the industry in order to effectively integrate the management systems for cost, schedule, and quality in an integrated manner. Even though it is widely recognized that this integration offers significant benefits, implementing EVMS for a mega-project such as nuclear power plant (NPP) construction requires extensive overhead efforts to collect and organize data [1][2]. Nevertheless, there has been no legitimate study for data collection strategy for practical implementation.

In order to address this issue, the purpose of this paper is to develop an effective data collection strategy for NPP EVMS. EVMS requirements for project management organization (PMO) in NPP projects were identified first. Data collection strategies and methods were then developed focusing on the contractual relationships with engineers, equipment suppliers, and general contractors (GC). Finally, provisions for request for proposals (RFP) of an NPP owner organization were specified to collect general contractors' information during the construction phase for the purpose of NPP EVMS in an owner's organization.

II. REQUIREMENTS FOR NPP EVMS

In order to identify EVMS requirements, this study uses a case-company that constructs and operates nuclear power plants as an owner. The owner's PMO is specialized in managing NPP projects throughout the project life cycle including design, procurement, construction, operation, and decommissioning. This paper focuses on the construction phase.

A. EVMS Objectives

As the case-company has lately joined into international nuclear market as an EPC service provider, significant efforts to enhance PMO capability have been conducted. EVMS objectives were formulated to support this posture change. The objectives can be summarized into four major areas [1]; "integrating performance measures", "enhancing organizational capability" specifically in the planning phase, "optimizing EVMS workloads", and "augmenting cost engineering" processes.

B. EVMS Requirements for Data Collection

Based on the objectives identified above, EVMS requirements for data collection are defined. The first important requirement is to directly connect general contractors' (GCs') input with the owner PMO's systems in order to minimize the efforts in manipulating enormous data. It also requires to minimize the GC's data entry to PMO systems. The second requirement is to embed knowledge of previous projects into the database as much as possible. The form of knowledge could be either implicit or explicit. The last major requirement is to maximize the use of EVMS data not only for project control of on-going projects but also as the basis for scenario-based planning for the future projects.

C EVMS Structure

An EVMS structure with a systematic numbering method was developed to meet these EVMS requirements. The entire EVMS structure for this case-study consists of about 18,000 activities, those are grouped into 1,400 EVMS packages (control accounts, CAs) [1].

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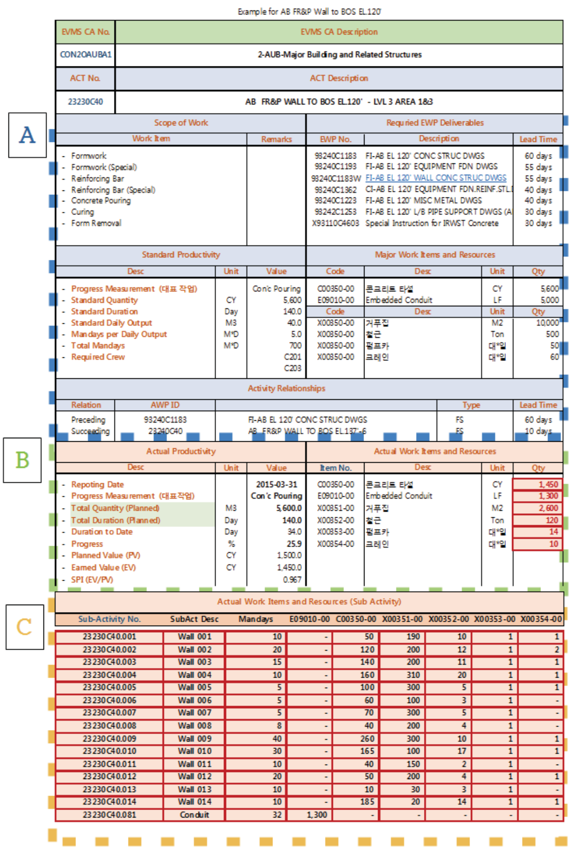
FIGURE I
DATA STRUCTURE OF EVMS COMPONENTS



III. DATA STRUCTURE AND COLLECTION STRATEGY

The 1,400 EVMS packages (CAs) with CPM activities were carefully organized to accommodate previously defined EVMS requirements, especially focusing on the data sharing with other management systems including scheduling, cost engineering, and scenario-based planning. Figure I illustrates one of the 18,000 activities for the purpose of discussing the practical issues for EVMS. Characteristics of the proposed data structure are briefly discussed.

A. Direct Integration with GC's Minimized Data Entry

The example shown in Figure I is a construction activity for a concrete work package (5,600 cubic yard of concrete pouring with reinforcing bars and forms). Even though this activity is sizable, data entry requirements are relatively simple. The general contractor (GC) is only required to input the quantities of major work items (form, rebar, pouring) for fifteen areas as shown in the block 'C' in Figure I. After GCs fill out the block 'C', the system automatically generate block 'A' (showing planned data) and block 'B' (analyzing progress and productivity). The input data from GC are also directly connected to the cost management system for progress payment. Due to the fact that many GCs' capability for EVMS has been significantly improved over the decade [3], more complex data entry by GCs would make it possible to have highly sophisticated system. However, this study minimized the data entry in order to have the most efficient system.

B. Embedding Knowledge into EVMS Database

One of distinct features of proposed system is that the EVMS packages incorporate construction experiences from the historical database. Block 'A' in Figure I shows the 'scope', 'required documents', and 'standard productivity'. By combining block 'A' and block 'C', the system can analyze current status of this activity in terms of progress, productivity, variances, and indices.

C. Linking and Supporting Relevant Functions

The primary function of EVMS is to analyze the cost and time. In addition to this basic function, this study put an emphasis on accumulating historical data into the EVMS system. The accumulated historical database can automatically update critical information for future projects. In this sense, EVMS data structure and Block 'A' were designed. Thus, the proposed EVMS system directly provides historical experiences to the automated front-end planning systems [4][5].

III. CONCLUDING REMARKS

This paper addressed the issues of practical EVMS implementation in terms of effective data collection strategy. An organization-wide perspective for EVMS throughout the project life cycle was discussed first. A case-company with examples of its construction activities were introduced in order to explore the practical issues.

Three major requirements were discussed including 1) minimized and directly linked data entry from the contractors based on optimized objectives, 2) embedding experiences into the EVMS in a structured manner, 3) maximizing the use of EVMS database for relevant functions (e.g. preliminary estimating and scheduling). It is stressed that automated and systemized applications to attain EVMS objectives can be more viable by identifying practically feasible solutions from the organizational perspectives.

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