The Journal of Korean
Institute of CALS/EC
Vol 6, No. 1, April 2001

대규모 정보시스템 개발 프로젝트를 위한 개념적 작업분담구조도의 모형화에 관한 연구

이남용*

Conceptual WBS Model for a Large-Scale Information System Acquisition Project

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Abstract

Over the past decade, the topic of work breakdown structure (WBS) has gained an increasing amount of attention from information technology professionals as an effective tool for managing the complexity of a large-scale information system development project. It is a method for planning and controlling a large-scale information system development. A WBS provides the basis for project organization, cost estimation, task scheduling, and contract management. Based on the authors' practical experience, this paper discusses how to establish a specific WBS and some considerations for developing a well-defined WBS. The model of WBS suggested in this study will provide useful insight and guidelines for establishing the spec-ific WBS for a large-scale information systems development.

Keywords: Work Breakdown Structure, Project Management, Information Systems Planning and Controlling

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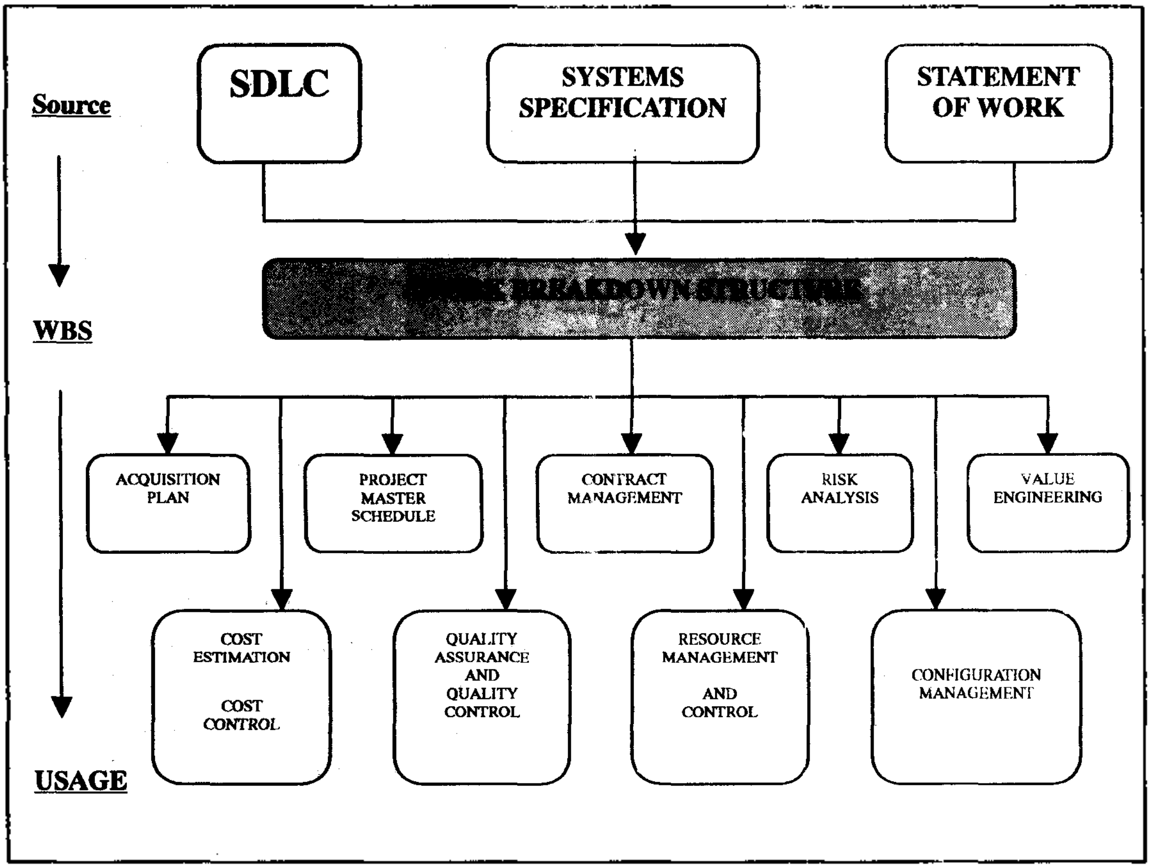
1. Introduction

Over the past several decades, numerous information systems development methodologies have been developed in the field of information systems. These include planning and controlling methods, software analysis and design methods, various programming languages, and software development tools. Among these methodologies, project planning and controlling methods have received the greatest attention in the field of information systems [4] [8] [30] [32] [43]. In today's dynamic information technology environment, the continual announcement of new information technologies often exacerbates the complexity in the role of project management [13]. For the reason, the role of project managers has become more important. Generally, the project manager has overall responsibility for the development and implementation of information systems in an organization. For example, the project manager's responsibility may include hardware and software acquisition, application development, system integration, facility construction and engineering, communication, life cycle configuration control, rationalization, standardization and interoperability, and users' requirement satisfaction [32]. Therefore, the role of the project manager is to coordinate, plan, and work with his or her staff to obtain the most economical and effective information systems within the budget and time constraints.

In order to achieve the goals effectively, the project manager should identify work for the project and make a statement of work which shows the role and responsibilities of all participants at the initial stage of a project.

As shown in Fig. 1, the project manager should develop a specific work breakdown structure (WBS) for organizing the project based on the systems development life cycle (SDLC), the statement of work and the user's requirements. Traditionally, the project managers have used one of various SDLC to establish the WBS. The SDLC may be tailored to comply with the features of information systems in an organization [12]. Establishing the WBS for a large-scale project becomes the major task in the early stage of the project. However, it is very difficult to develop a specific WBS because users' requirements are not well defined at the initial stage. Consequently, the project manager needs to use one of the existing WBS and the SDLC when attempting to develop the WBS in his or her organization.

This study discusses how to develop the WBS in an organization and suggests a model of WBS for a large-scale project, i.e., the Theater Automated Command Control Information Management System Development Project [21] [51] [52]. This model of WBS may provide useful insight for developing the WBS for a large-scale information system development project in an organization.



<Fig. 1> function of the WBS

2. Work Breakdown Structure (WBS)

Over the past decade, the topic of the WBS has gained an increasing amount of attention from project managers. A bibliographic survey was conducted by the authors, limited to analyses of the ABI/INFORM database. Table 1 shows the subject areas in which there have been published applications. This data implies that the number of work breakdown structure applications has been increased in management and related fields for the past five years. As presented in Table 1, the WBS can be utilized in various areas such as acquisition planning, project master planning, configuration management, contract and subcontract management, cost estimation and control, resource management and control, project team organization, risk analysis and value engineering, and work package development. Among numerous applications of work breakdown structure, cost estimation and control have been the most dominant application area.

Table 1. WBS Applications by Subject Classification

[illegible]	[illegible]
Acquisition Plan & Project Master Plan	[2][6][22][28][39][40] [42] [54]
Configuration Management	[25][29][34][37][53]
Contract Management	[5][7][18]
Cost Estimation & Cost Control	[15][17][19][23][24][27] [38][44][48] [50]
Resource Management & Resource Control	[47][56]
Responsibility Matrix & Organization Chart	[1]
Risk Analysis & Value Engineering	[31][46]
Work Packages	[41][55]
Others	[16][30][36]

Also, work breakdown structure has been widely used in acquisition and project master planning.

The WBS is a mixture of work, products, systems, and techniques required to carry the project to successful completion. Also, the WBS can be a graphic depiction of the project. Therefore, the WBS can be defined as a product-oriented and organized task plan formulated by the project manager for effective planning and control [26]. In fact, the WBS is a hierarchical definition of all work to be performed in the entire course of the project and products at various levels. The WBS is the primary method of organizing and allocating work throughout an organization and the basis for planning and defining the structure for a project and allocating work to individuals and organizational elements in a coordinated manner. At the same time, the WBS relates to various products such as hardware, software, services, and other tasks that organize, define, and represent work elements of the project.

As a graphic portrayal of the project, the WBS can be described in a level-by-level fashion down to a level of detail needed for effective planning and control. Also, its configuration, content, and level of descriptions may vary according to the project in an organization. Developing the WBS is the foundation for planning and controlling the project [6] [8] [10] [32] [43]. For planning and controlling each element of the WBS, all of its components should be quantified [33]. The WBS may be generally developed by starting at the top level, which provides the project definition. Through an interactive procedure, the work can be decomposed until all of its levels have been satisfied. The number of the levels required is a function of the following factors:

a. the size and complexity of the project
b. the number of milestones in the project
c. the cost accounts and work package dollar size
d. the personnel requirements for the project and for individual task areas
e. the development cost, the management's

confidence
f. the organizational structure of participating organizations
g. the number of sites associated with information systems, and
h. the information systems development approach selected to be applied to the project.

On the other hand, major elements and constraints in developing the WBS may be:

a. organizational budgeting procedures
b. management structure
c. segregation of recurring costs from nonrecurring costs
d. reflection of certain types of activities such as analysis, design, coding, testing, etc.
e. collection of costs by tasks relative to end items or deliverable products
f. size of a work package, and relationships between elements of the WBS and people in charge of each element.

As described above, the WBS is highly coupled with the project management composed of a series of activities directed toward the accomplishment of a desired objective which usually results in the delivery of an information system. In order to effectively develop an information system, an organization should use a specific work breakdown structure when the project management is adopted. The WBS is designed to provide the effective mechanism of planning and controlling the project. The WBS is very useful when the project management form is a team approach to problems. For example, although there are varying degrees of authority and responsibility that are assumed by the project participants, participants can be managed and controlled efficiently by the mechanism of the WBS [20] [45].

3. Work Breakdown Structure and the SDLC

Among numerous methodologies for information systems development, rapid throwaway prototyping, incremental develop - ment, evolutionary prototyping, and automated synthesis might be widely used in information systems development [11] [26]. Developers of these methodologies have a variety of motives, but are primarily looking for a possible solution for rescuing the software industry from what appears to be a problem commonly known as the software crisis. The software crisis is identified by several explicit symptoms. First, software development projects are always more expensive and delivered later than expected. Second, software systems are often unreliable. Last, software systems often fail to meet the ultimate user's needs.

Although there are a variety of different names for each of the milestones and phases, most SDLCs used in industry, academia, and government follow some basic variations of the waterfall model originated by Royce and developed by Boehm [3] [35]. There is not a single model that perfectly describes the entire development process from all points of view. As a result, project managers may often bypass phases or take shortcuts for solving the problem. Unplanned and inconsistent alterations of the SDLC make the software even more expensive, more unreliable, and less productive. Unfortunately, project managers must select and tailor one of various versions of the SDLC. Although the traditional SDLC has been criticized because of the nature of emphasized sequence, project managers need to understand the meaning of the SDLC in order to identify work and intermediate products.

In short, the SDLC is a set of activities that serve as the foundation on which project planning, management, and controlling are based. Several baselines are established at the completion of each phase during the project [13]. According to the US DoD-STD-2167A("System Software Development Life-Cycle")[12], each phase of the SDLC produces some documents, software configuration items and hardware configuration items, as well as results in a formal review or an audit. The project management for a large-scale information system development requires a cohesive, well-planned, and rigorously controlled process of the SDLC [10] [14]. In other words, the project management must be scientific and disciplined to consistently produce the high quality of information systems within the planned schedule and budget. Therefore, fitting the SDLC to a problem is essential to develop the best WBS for a problem [4].

4. How to Establish WBS

As mentioned earlier, the WBS illustrates how each piece of the project is tied to the whole in terms of performance, responsibility, budgeting, and scheduling. The thirteen steps can be used to design the WBS for a large-scale project. For small or moderate-size projects, some steps might be skipped or combined [26] [33].

First step is to set up the acquisition strategy for deciding how to acquire an information system. The second step is to break project tasks down into successively finer levels of detail by using information obtained from the users and engineers who will perform the work. The third step is to decompose work until all meaningful tasks have been identified and each task can be individually planned, budgeted, monitored, and controlled. The fourth step is to make up a statement of work. The fifth step is to list any vendors, contracts, and subcontractors. The sixth step is to identify detailed end item specifications for each work element by using the guidelines for data item description. The seventh step is to establish cost account numbers. The eighth step is to identify the resource needs. The ninth step is to describe the personnel and organizations responsible for each task. The tenth step is to estimate time required to accomplish each of the tasks in the WBS. The eleventh step is to review the WBS, budget, and time for accomplishing or supporting the work to verify the accuracy of the

WBS, schedule, and to check interdependency of tasks, resources, and personnel. The twelfth step is to revise the WBS as necessary, but the project manager must be sure to check significant revisions with all individuals who have previously made contributions or comments. The final step is to integrate the WBS into a project master plan and continue to refine the WBS in compliance with the change of the situation of the project.

After the WBS is documented, it should be reviewed by those who have an interest in the project and their criticisms should be considered by the project manager for incorporation into the WBS in the project master plan.

5. Model of the WBS

In this section, a model of the WBS for a large-scale project is suggested and discussed. The model of the WBS provides useful insight regarding how to establish a specific WBS and what to include in it. Based on a case of the project, "Theater Automated Command Control Information Management System Project", jointly conducted by the US Department of Defense and the Ministry of National Defense of Korea, the model of the WBS comprises management, logistics and training, engineering, material and services acquisition, and test and evaluation.

As shown in Table 2, the model shows the essential elements because the real WBS is tremendous. The model of WBS consists of five levels because the project has large size and high complexity. Although a variety of the WBS exists, the most common is the fifth indentured structure. Each element of the WBS may be the responsibility of a single individual. As shown in the WBS, it is important that the project manager and his or her staff keep the balance between products, services, resources, and schedules within it. The model of WBS not only provides project manager and his or her staff with a structural view of project activities, but also assists them in monitoring and controlling the progress of the information system development project.

6. Conclusion and Implications

An information system development project must be planned and organized by a well-defined WBS so that the project can be effectively managed and controlled. Although the WBS is established at the stage of a project initiation, it needs to be reviewed in light of the real-world data revealed during the phases of the SDLC. Projects are dynamic and inevitable problems may be encountered that require changes to accommodate them. The WBS cannot be static and it must provide management with a current picture of what is happening. Properly conceived, the WBS resembles the product-oriented structure, and provides a basis for work assignments and cost accounting.

Table 2. Model of the Work Breakdown Structure

0	Information System
1.	Management
1.1	Project management
1.1.1	Executive management
1.1.2	Resources management
1.1.3	Contract and subcontract management
1.2	Business management
1.2.1	Project master schedule
1.2.1.1	Scheduling
1.2.1.2	Documentation management
1.2.2	Master budget
1.2.2.1	Administration
1.2.2.2	Finance
1.3	Quality assurance
1.3.1	Configuration management
1.3.1.1	Plan
1.3.1.2	Functional configuration audit
1.3.1.3	Physical configuration audit
1.3.1.4	Engineering change documents
1.3.2	Quality assurance
1.3.2.1	program
1.3.2.2	Inspection of hardware
1.3.2.3	Data and services
1.3.2.4	Acceptance testing
1.3.2.5	Final report
1.3.2.6	Certificate of compliance
1.3.3	System safety
2.	Logistics and Training
2.1	Logistics
2.1.1	Maintenance
2.1.1.1	On-call/on-site
2.1.1.2	Plans
2.1.1.2.1	Project administration
2.1.1.2.2	Operational logistics planning
2.1.1.2.3	Off-site backup
2.1.1.3	Software
2.1.1.4	Test equipment
2.1.2	Supply and services support
2.1.2.1	Parts stockade procedures
2.1.2.1.1	Support material planning
2.1.2.1.2	Alternate facilities
2.1.2.2	Maintenance/ and logistics administration
2.1.2.2.1	Services
2.1.2.2.2	Facility activation
2.1.2.3	Contractor Personnel training
2.1.2.4	Site access coordination
2.1.3	Durable and expendable supply list
2.2	Training
2.2.1	Management overview course
2.2.1.1	Develop training material
2.2.1.2	Develop video tape
2.2.1.3	Conduct training
2.2.2	Formal training
2.2.2.1	Information processing system course
2.2.2.1.1	Develop training material
2.2.2.1.2	Conduct training
2.2.2.2	Database management system course
2.2.2.2.1	Develop training material
2.2.2.2.2	Conduct training
2.2.3	On-the-job training
2.2.3.1	Information processing systems and database management systems classes
2.2.3.1.1	Develop training material
2.2.3.1.2	Develop handbook
2.2.3.1.3	Conduct training
2.2.4	Training conferences
2.2.5	Training and training equipment plan
2.2.6	Training supplies
2.2.7	Embedded training
2.3	Technical manuals
2.3.1	Operation manuals
2.3.1.1	Evaluate and develop
2.3.1.2	Validate and verify

Table 2. Model of the Work Breakdown Structure(Continued)

3.	Engineering	3.3.3	System support
3.1	System engineering	3.3.3.1	Man and machine interface
3.1.1	System analysis	3.3.3.2	System monitoring and management
3.1.1.1	Update System specification	3.3.3.2.1	System security
3.1.1.2	Complete system specification	3.3.3.2.2	Statistics
3.1.2	Plans, requirements and specify	3.3.3.4	Operating system
3.1.2.1	System engineering management plan	3.3.3.5	Support software
3.1.2.2	System/design trade study report	3.3.3.5.1	Software for hardware test
3.1.2.3	System security plan	3.3.3.5.2	Other interface
3.1.2.4	System allocation documents	3.3.4	Communications
3.1.2.5	Data Communication Network master plan	3.3.4.1	Interactive message handling system
3.1.3	Design reviews	3.4	Site engineering
3.1.3.1	Preliminary design review	3.4.1	Site activation planning
3.1.3.2	Critical design review	3.4.1.1	Site surveys
3.1.3.3	In-progress review	3.4.1.2	Installation plans
3.1.4	Certificate of compliance	3.4.2	Cutover plan
3.2	Hardware engineering	3.4.3	Site activation
3.2.1	Hardware configuration items	3.4.4	Installation and checkout
3.2.1.1	Workstations		
3.2.1.1.1	Engineering	4.	Material and services acquisition
3.2.1.1.2	Drawings	4.1	Hardware acquisition
3.2.1.2	File server	4.1.1	Hardware
3.2.1.2.1	Engineering	4.1.2	Furnishings
3.2.1.2.2	Drawings	4.2	Software acquisition
3.2.2	Communication configuration items		
3.2.2.1	Local Area Net	5.	Test and evaluation
3.2.2.2	Data links	5.1	Vendor acceptance test
3.2.3	Transportable equipment	5.1.1.	Hardware
3.2.3.1	Engineering	5.1.2	Commercial-off-the-shelf software
3.2.3.2	Drawings	5.1.2.1	Procedures and criteria
3.2.4	Hardware and software test bed design	5.1.2.2	Tests and reports
3.2.4.1	Engineering	5.2	Software test in-plant
3.2.4.2	Drawings	5.2.1	In-plant demonstration
3.3	Software engineering	5.2.1.1	Integration and Test support
3.3.1	Engineering	5.2.1.2	In-plant demonstration
3.3.1.1	Rapid prototype development	5.2.2	Developed software
3.3.1.2	System architecture	5.2.2.1	Plans and procedures
3.3.1.3	System design and transition	5.2.2.2	Tests and reports
3.3.1.3.1	Transition software	5.2.3	Software qualification test
3.3.1.3.2	Test database	5.2.3.1	Plans and procedures
3.3.1.4	Review support	5.2.3.2	Tests and reports
3.3.2	User support	5.2.4	Software acceptance test
3.3.2.1	Information management system	5.3	On-site system integration and test
3.3.2.1.1	Central database	5.3.1	Test bed
3.3.2.1.2	Cluster database	5.3.2	Test and evaluation support
3.3.2.1.3	Query and update	5.3.3	Integration
3.3.2.1.4	Reports and other outputs	5.3.4	Integration test plan and procedures
3.3.2.2	Integrated Office Automation	5.3.5	Integration test and report
3.3.2.2.1	Word processing	5.4	On-site acceptance test and quality assurance monitoring
3.3.2.2.2	Spread Sheet		
3.3.2.2.3	Business graphic	5.4.1.	Plans and procedures
3.3.2.2.4	Electronic mail	5.4.2	Test support
3.3.2.2.5	Mapping	5.4.3	Test report

Without the well-defined WBS, information systems development projects are often built piecemeal, resulting in incompatible, redundant and inflexible information systems. To put it another way, the lack of the well-defined WBS prior to the initiation of a project is failing to effectively organize, plan, and control the project. The better WBS we can establish, the more advantages we obtain for the project. In addition, great care must be exercised in establishing the WBS because the structure and elements of a specific work breakdown structure may be artificial [51] [52].

Therefore, this paper walks through a case of the WBS and discusses various aspects that project manager's address in preparing a large-scale project's master-plan. Also, some considerations are presented for developing a specific WBS in an organization. It is believed that the model of the WBS and guidelines be useful to make a specific WBS for a large-scale information system development project at the early stage of the project.

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1979 년 숭실대학교 컴퓨터학부를 졸업하고, 국군정보사에서 정보시스템 개발과장을 지내고, 한국국방연구원에서 18 년간 근무하였다. 한국국방연구원 해외장학위탁교육으로 미국 미시시피주립대학교에서 MIS 박사학위를 취득하였고, 현재, 숭실대학교 컴퓨터학부 교수로 재직중이며 한국정보통신기술사협회정책위원회 위원장, 한국전자거래학회 편집위원장, 국방부, 중소기업청, 서울시청 등의 자문위원으로 활동하고 있다.
주요 관심분야는 전자상거래, 소프트웨어공학(UML EJB, CORBA 등), 경영정보시스템(MIS, CRM, SCM, ERP, KMS 등) 이다.