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EFFICIENT PROJECT MANAGEMENT: WORK BREAKDOWN STRUCTURE

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Abstract: This article discusses one of the tools of Project Management and defines the essence and significance of the Work Breakdown Structure (WBS), which helps to make detailed planning and measure the cost in the implementation of projects. By breaking down the entire product into several smaller sizes, management can verify that all activities identified with the work breakdown structure are attributed to efforts that contribute to the achievement of project objectives. The use of work breakdown elements for work planning is the basis for assessing and planning resource requirements.

Keywords: Work Breakdown Structure (WBS), WBS elements, planning tool, detailed planning, efficient management, resources

Introduction

Successful project implementation requires not only competent specialists, but also continuous research into various methods of effective project management. Among the various standards, methods and tools for good project management that exist, the Work Breakdown Structure (WBS) stands out as the fundamental building block for initiating, planning, executing, monitoring and controlling the processes that are used to manage projects.

There are many project management tools and techniques that use the work breakdown structure or its components as input. For example, the WBS uses the project charter as a starting point. High-level elements in the WBS must match verbatim with the nouns used to describe project outputs in the scope description. The network diagram is a sequential workflow defined by the WBS, and the WBS elements are the starting point for defining the activities to be included in the project timeline.

The function of management is to plan & direct project activities to achieve the program goals. A complex project is made manageable by first breaking it down into individual components in a hierarchical structure, known as the Work Breakdown Structure (WBS). Such a structure defines tasks that can be completed independently of other tasks, facilitating resource allocation, assignment of responsibilities, measurement & control of the project. Figure 1 below shows a typical WBS.

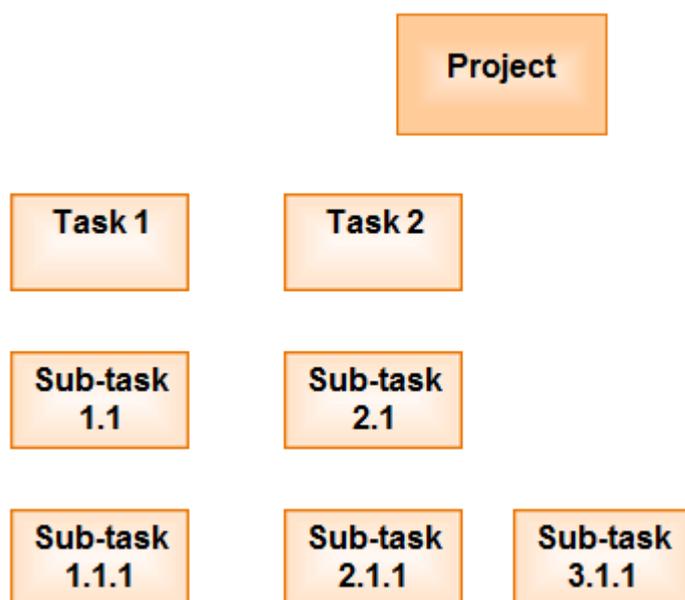


Figure 1.1: A typical work breakdown structure

The purpose of a WBS is to divide the program/project into manageable pieces of work to facilitate planning & control of cost, schedule & technical content. A WBS is written early in program/project development. It identifies the total work to be performed & divides the work into manageable elements, with increasing levels of detail.

The WBS is a project management tool. It provides a framework for specifying the technical aspects of the project by defining the project in terms of hierarchically related, product-oriented elements & the work processes required for each element's completion.

Each element of the WBS provides logical summary points for assessing technical accomplishments, for measuring cost and schedule performance. Because the WBS is a hierarchical structure, it may be conveyed in outline form as shown in Table 1.

Table 1

Work Breakdown Structure Outline

Level 1	Level 2	Level 3
Task 1		
	Sub-task 1.1	
		Work Package 1.1.1
		Work Package 1.1.2
		Work Package 1.1.3
	Sub-task 1.2	
		Work Package 1.2.1
		Work Package 1.2.2
		Work Package 1.2.3
Task 2		

	Sub-task 2.1	
		Work Package 2.1.1
		Work Package 2.1.2
		Work Package 2.1.3

In short, WBS is used for technical management, work identification and assignment, schedule management, status report, cost management and performance measurement.

Literature Review

Speaking about the hierarchical structure of work, Wikipedia defines it as “... a hierarchical breakdown of all the work that needs to be done to achieve the goals of the project into smaller activities and actions to such a level where the ways of performing these actions are quite clear and the corresponding work can be evaluated and planned. It also includes the definition of intermediate results of all the components of this structure of work”.

The term "work breakdown structure" arose as a result of the translation of the corresponding tool in project management from English, which sounds like Work Breakdown Structure. Although this concept exists in our country, the specific term defining this concept is not fully defined. That is why, in different literature, this concept is defined in different ways. In one literature you can find the term “hierarchical structure of work”, in another “structure of work decomposition” or “structure of work breakdown” and so on, but at the same time retaining its identical essence [7] [8] [9].

The 6th Edition of the PMBoK Guide states that the WBS organizes and defines the overall project scope and displays the activities identified in the current approved project scope statement. Planned activities are contained in the lowest-level WBS elements called work packages. They can be used to group activities at the level of which work is scheduled and evaluated, monitored and controlled. In the context of the WBS, “works” means products or deliverables that are outputs of operations, but not the operations themselves. PMBoK includes the creation of a hierarchical structure of work in the group of planning processes [4].

Doctor of Economics, Professor Razu M.L. in his book on the basics of project management believes that the hierarchical structure of work is one of the effective tools for project management, and also adds that this structure allows you to determine what work needs to be done to implement the project, and establish a single structure for managing these works [4].

When we talk about creating a hierarchical work structure, it means the process of dividing project deliverables and project work into smaller elements that are easier to manage. The author also emphasizes that this is a results-based hierarchical decomposition of the work that the project team must perform to achieve the project goals and desired results [5].

Anshin V.M. (2013) in his book "Project Management: A Fundamental Course" published at the Higher School of Economics shows the latest trends in the development of

project management, the impact of various methods and standards on the successful implementation of strategic projects. Particular attention is paid to aspects of the practical and theoretical functioning of the management staff, the methods used for planning work and the general principles of management. Priority is given to fundamental technical and graphical analysis of project management processes. The hierarchical structure of works is highlighted in a separate chapter and discussed according to the data of developed countries. The book shows and analyzes various cases of effective work planning [7].

Harold D. Kerzner (2017) believes that changes in the planning structure for project implementation can have significant implications for performance and the effectiveness of tracking. This is detailed in his book *Project Management: A Systems Approach to Planning, Scheduling and Control*. One of the most significant developments in project management in recent years is the growing importance of planning efficiency. In many countries, planning and control is increasingly carried out directly at the project initiation level by responsible managers, rather than through outsourced specialists and other consultants. In addition, the new WBS approach has increased the correlation between quality planning and outcome success [2].

Research Methodology

Implementation of the WBS system should be economically viable because this contributes to a more flexible solution to problems of distribution of tasks, which allows improving the conditions for performing tasks. Project customers can easily see the results of work in the form of a hierarchical structure of decomposition and increase the traceability of work. The most important criterion for the implementation of the WBS is its economic feasibility from the point of view of the process as a whole. The main prerequisite for the successful introduction of transformations is the constructiveness of the position and the understanding of the need by the relevant leaders, since the market economy is not able to adequately regulate this area.

The main goal is to develop a methodology for assessing the functioning and improving the efficiency of the WBS, which means continuous improvement of the enterprise's activities to ensure measures for planning activities. This process should include the step-by-step development of the necessary implementation activities, subsequent performance evaluation and identification of areas for improvement. The functioning, maintenance of the WBS is carried out by the employer through compliance with legal and regulatory requirements, taking into account the specifics of their activities, the achievements of modern science and best practices, the obligations assumed and on the basis of international and national standards, guidelines, as well as recommendations of international project management associations on the project management system. The WBS should be compatible with other management systems operating in projects, clearly stated and formatted so that it is understandable to those who need to use it and periodically reviewed, updated if necessary and be easily accessible to all members of the organization.

We analyzed data on different methods of effective project management in different countries. Project management activities have been carefully studied and a database has been compiled. Methods such as observation and comparison of economic analysis, systems approach and logical approach were effectively used on the basis of the

collected data. The search, collection, processing, analysis and systematization of information on the research topic for the preparation and adoption of managerial decisions was carried out. Also, an analysis of existing forms of management organization was carried out, as a result of which proposals for their improvement were developed and substantiated.

Analysis and Results

Technical Management

The WBS provides the framework for defining the technical objectives, establishing a specification tree, defining configuration items, providing integrated logistic support (ILS), preparing and executing a test as well as act as an evaluation plan for a project. Since each of them has its own specifics, let's consider them separately:

First. A specification tree developed by system engineering structures the performance parameters for the system or systems being developed. It subdivides the system(s) into its functional constituent elements and identifies the performance objectives of the system(s) and its elements. The performance characteristics are explicitly identified and quantified.

The completed specification tree represents a hierarchy of performance requirements for each element of the system for which design responsibility is assigned. Because specifications may not be written for each WBS element, the specification tree may not map the WBS completely. Administrative tasks associated with system engineering & development of the specification tree is normally treated as a support services WBS element.

Second. Configuration management is the process of managing the technical configuration of elements being developed. In establishing the requirement for project configuration management, designated contract deliverables are subject to configuration management controls.

A contract deliverable designated for configuration management is called a configuration item. Configuration management involves defining the baseline configuration for the configuration items, controlling the changes to that baseline, accounting for all approved changes and verifying that all changes have occurred. The WBS is the framework for designating the configuration items on a project. Thus, the WBS needs to be extended sufficiently to clearly define all elements subject to configuration management. Configuration management tasks are normally associated with a support services WBS element.

Third. Integrated logistic support (ILS) includes all supports necessary to assure the effective and economical support of a project, system, or equipment for the project's life cycle. ILS efforts include:

- Spare and repair parts inventories, warehousing, & control
- Preventive and scheduled facilities & equipment maintenance
- Reliability and maintainability data
- Transportation and handling systems
- Test equipment

- Training
- Related publications

ILS efforts require detailed definitions of the systems or components being supported down to the individual spare part or individual component receiving preventive maintenance. The WBS provides a hierarchical basis for such detailed definition. ILS tasks are usually associated with a support services WBS element. For example, planning and analysis tasks may be performed under system engineering.

Fourth. Many projects require a formal test and evaluation plan to ensure the procured systems satisfy the project's objectives as defined by the project technical baselines. Test plans may be developed for individual WBS elements. The effort associated with conducting and evaluating those tests may become part of the work defined for the appropriate WBS element.

Since tests may involve entire systems, parts of systems or individual components. They may not be uniquely identifiable to a single WBS element, but may span two or more of the elements going into one higher-level WBS element. Such integrated test work may be planned in conjunction with other work on the higher-level element that incorporates the elements being tested. Another alternative would be to establish a lower-level "test & evaluation" element for planning & controlling all tests.

Work Identification and Assignment

People performing work are organized to facilitate effective management, whether the organization is designed along project, functional, or matrix structure. To assign specific work responsibility to a specific organization, the WBS and organizational structure should be integrated with each other (i.e., functional responsibility is established for managing specified work to produce defined products). This integration can occur at any level of the WBS, but certainly occurs at the top project level and whichever level responsibility that has been assigned to manage the work. Other natural points of integration may occur as a result of how the scheduling, budgeting, work authorization, estimating and cost management systems interface with each other, with the WBS and with the organization.

Schedule Management

This section discusses using the WBS to help plan, revise and update status schedules. The WBS provides a framework for detailed work schedule information based on technically verifiable product completion. A network of events (e.g., start, complete) and activities (e.g., design, develop, operate) must take place. There is logic to the relationship of the activities needed to produce and complete the WBS products. Resources (e.g., labor, finance, plant, materials) and responsible organizations (e.g., mechanical and electrical engineering department, fabrication department, sub-contractor) can then be identified for each of the activities.

The scope and complexity of the work and the needs of management for schedule visibility dictate the number and type of schedules. Schedule levels and management levels need not coincide with WBS levels. There is no requirement for separate schedules for each WBS level. Although scheduling methodologies may vary, it is important that

schedule events require completion of a tangible product in accordance with predefined specifications and that completion is verified by test or inspection by persons other than those responsible for performance of the activities leading to completion of the product.

When work is underway, the impact of schedule changes may be readily assessed if a network of events is used. This is because each WBS element's completion date is integrated with the schedule for completion of other elements and the schedule for all supporting activities. In other words, all elements going into a higher-level element must be completed before the higher-level element itself can be completed and in some cases, before work on the higher-level element can even begin.

Status reporting

Product-oriented schedules allow owners, consultants and builders to monitor the schedule baseline for the project's outputs to ensure that the project objectives are completed on time. Owners or consultants may require builders to file the following reports to monitor schedule progress and to manage the project such as:

- a. Periodic Milestone Schedule Status Reports - to provide schedule status information in terms of duration
- b. Cost Performance Report - to assess schedule performance in terms of earned value
- c. Status Report - to provide a narrative description of the schedule

Cost Management

The WBS assists management in measuring cost. By breaking the total product into successively smaller entities, management can verify that all work identified to the WBS, hence charged to the effort that contributed to the project objectives. Using WBS elements to plan the work serves as the basis for estimating and scheduling resource requirements.

Using the WBS to help with cost estimating facilitates project and contract management. The WBS provides a systematic approach to cost estimating that helps ensure that relevant costs are not omitted. An estimate based on WBS elements helps owners and builders to plan, coordinate and control the various project activities that clients and builders are undertaking. The WBS also provides a common framework for tracking the evolution of estimates (e.g., conceptual estimates, preliminary design estimates and detailed design estimates). The WBS can also provide a framework for life cycle cost analysis. As periodic project cost estimates are developed, each succeeding estimate is made in an attempt to forecast more accurately the project's total cost. Basically, the estimates may be organized in two ways, i.e., by WBS element or by code of accounts. Both support owners' on-going efforts in preparing budgets and evaluating contractor's performance.

In general, funds management involves periodic comparison of actual costs with time-phased budgets, analysis of variances and follow-up corrective actions (as required). When WBS elements and the supporting work are scheduled, a solid base for time-phased budgets is ready-made. Assignment of planned resource cost estimates to scheduled activities and summarization of each WBS element by time period results in a time-phased project/contract budget, which becomes the performance measurement baseline.

Analysis & Control

If budgets are based on WBS elements and time phased with scheduled accomplishment, the accounting process must similarly be able to cost WBS elements over time (i.e., costed transactions must be coded in such a way that they can be identified to the WBS element which incurred the transaction cost and to the time period when the transaction occurred).

An accounting process or system that can accommodate the WBS has some advantages. The accounting system can be programmed to accept or reject charges to relatively small increments of work with the planned time schedule for the work and this helps to minimize unauthorized charges. Also, the accounting and financial organizations can better ensure that they have achieved what they paid for since a product is accepted as complete only when a third party (e.g., work inspector, quality controller, project manager) agrees that it meets the specified objectives. As a result, periodic accounting and financial variance analyses become more meaningful. Also, project performance measurement, with its dependence on cost and schedule variance analysis is then possible.

Historical Database Development

When cost information is accounted by WBS element, it can be used in cost estimations for pricing and negotiating contract changes and for follow-on procurements. Over time, owners and consultants will be able to accumulate a growing cost database of similar WBS elements from different projects. Such historical cost data can be used in conjunction with learning curves, regression and other techniques to estimate the cost requirements for similar elements of new projects. Subsequent cost data collected can be compared to the original estimates to establish their validity, identify trends and re-estimate future project needs.

Builders will similarly benefit from use of such databases. Builders are expected to periodically provide a current estimate of future costs and the total estimated cost for each reporting element. They are also expected to complete a detailed bottoms-up estimate periodically. The WBS provides the framework for summarizing detailed costs. Since builders tend to provide similar products on similar projects, the cost history that is accumulated can assist them in bidding future contracts and in budgeting new work.

Performance Measurement

Proper use of the WBS for technical, schedule and cost management accomplishes the performance measurement objectives of defining work and related resources, ensuring that all work is included and ensuring there is no duplication of effort. In addition, the WBS is used to accumulate performance data and associated variances. This permits the builders to evaluate progress in terms of contract performance. There is no need for separate contract performance assessments to be made at levels above the cost account because the WBS facilitates the summarization of data for successively higher levels of management. Significant variances will usually appear at summary WBS levels. Using the WBS, variances can then be traced to their sources.

Terminology for Different Levels

Each organization uses its own terminology for classifying WBS components

according to their level in the hierarchy. For example, some organizations refer to different levels as tasks, sub-tasks and work packages, as shown in the above outline. Others use the terms phases, entries and activities.

Organization by Deliverables or Phases

The WBS may be organized around deliverables or phases of the project life cycle. Higher levels in the structure generally are performed by groups. The lowest level in the hierarchy often comprises activities performed by individuals, though a WBS that emphasizes deliverables does not necessarily specify activities.

Level of Detail

The breaking down of a project into its component parts facilitates resource allocation and the assignment of individual responsibilities. Care should be taken to use a proper level of detail when creating the WBS. On the one extreme, a very high level of detail is likely to result in micro-management. On the other extreme, the tasks may become too large to manage effectively. Defining tasks so that their duration is between several days and a few months works well for most projects.

The size of the WBS should generally not exceed 100 to 200 terminal elements (if more terminal elements seem to be required, use sub-projects). The WBS should be up to 3-4 levels deep. Each level should be 5 to 9 elements broad. These suggestions are derived from the following facts:

- a. Short-term memory capacity is limited to 5 to 9 item
- б. Having fixed time to plan a project, the more terminal elements you have, the less time there is to pay attention to any single one of them. Consequently, your estimates are less thought-through.
- b. The more terminal elements you have the more there are potential dependencies among them. (see fact b above for consequences).

Conclusion

The WBS is the foundation of project planning. It is developed before dependencies are identified and activity durations are estimated. The WBS can be used to identify the tasks in the CPM & PERT project planning models.

The WBS is a tool that helps management measure technical and schedule performance as well as cost. By dividing the total product into successively smaller entities, management can ensure that all required products are identified in terms of technical performance goals. Management can also verify that all work identified to the WBS and then charged to the project, actually contributes to the project objectives. The planning of work based on WBS elements serves as the basis for estimating and scheduling resource requirements. Subsequently, the assignment of performance budgets to scheduled segments of contract work produces a time-phased plan against which actual performance can be compared.

Appropriate use of the WBS to manage technique, schedule and cost can help achieve performance measurement objectives in defining work and associated resources, ensuring that all work is included and avoiding duplication of effort. In addition, the WBS is

used to accumulate performance data and related variances. This allows contractors to measure progress in terms of contract performance. There is no need to conduct separate assessments of contract performance at levels above the cost account, as the WBS facilitates the generalization of data to successively higher levels of management. Significant deviations usually appear at the aggregate levels of the SRI. Using the WBS, deviations can be traced back to their sources. When performance deviates from the plan, appropriate corrective actions can be undertaken. Identification of potential cost and schedule impacts of proposed technical changes is simplified when this integrated approach to work planning is used.

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