Work Breakdown Structures (WBS) For Software Development Projects

Preprint · November 2015

DOI: 10.13140/RG.2.2.31554.02240

1 author:

Liza Wikarsa
Universitas Katolik De La Salle Manado
14 PUBLICATIONS **28** CITATIONS

Work Breakdown Structures (WBS) For Software Development Projects

Liza Wikarsa, BCS, MComp
Program Studi Teknik Informatika
Universitas Katolik De La Salle Manado

Abstract

Many people have mistaken WBS as a list of tasks, a schedule or an organization chart. In reality, WBS is a simple and easy visual breakdown of deliverables for product, result, or service. It does not elaborate about individual tasks or the order of execution in detail. Instead, WBS provides useful inputs for cost estimating and budgeting, scope control, activity definition, and more. Unfortunately, developing a WBS can be a painstaking process because it is not easy, time consuming and requires efforts. The larger the project scopes the larger and more complex the WBS will be. Inputs from all involved parties and their approvals are essential. The WBS requires continual refinement throughout the development. Hence, this study will address benefits of WBS, WBS process and common pitfalls. It will also try to demonstrate on how to develop a simple and easy WBS to implement for software development projects.

Abstrak

Banyak orang salah menganggap bahwa WBS adalah sebuah daftar dari kegiatan, jadwal atau gambar struktur organisasi. Pada kenyataannya WBS adalah sebuah perincian visual sederhana dari produk, hasil, atau servis. WBS tidak mengelaborasikan tentang kegiatan-kegiatan individual atau urutan eksekusi secara detil. Sebagai gantinya, WBS menyediakan masukan-masukan yang berguna untuk mengestimasi biaya dan pengeluaran, mengontrol ruang lingkup, mendefinisikan aktivitas, dan lainnya. Akan tetapi, pengembangan sebuah WBS merupakan suatu proses yang sulit karena sulit, memakan waktu dan membutuhkan usaha keras. Semakin besar ruang lingkup proyek maka semakin kompleks WBS tersebut. Input dan persetujuan dari semua orang yang terlibat di dalam proyek sangatlah dibutuhkan. WBS mengharuskan adanya perbaikan secara terus menerus sepanjang pengembangan. Studi ini akan menjelaskan keuntungan dari WBS, proses WBS, dan kekurangannya. Selain itu, studi ini akan mencoba untuk mendemonstrasikan cara pembuatan WBS sederhana yang dapat diimplementasikan untuk pengembangan proyek perangkat lunak.

Keywords: work breakdown structure, software, development, progress

1. Introduction

Many software development projects do not fail because of a single thing. Usually there are a number of smaller, often avoidable, failures that soon add up to a greater problem resulting in unsatisfactory outcomes and unaccomplished objectives. In addition to this, there are only very few organizations that have training or mentoring programs for new managers, especially in software developments. As a result, many questions were thus asked, including what we are supposed to do, where we can go for resources, how I can get off to the right start with my team, how I can get organized, and many more.

It is also difficult to keep track of the deliverables and the people who are supposed to get things done, all while staying within budget and time. Hence, the needs to learn about timelines and milestones, project phases, managing resources, monitoring the status of the project, and what to do if the project starts to fall behind are significant. Here is where WBS comes into play by which a software development project is broken down according to the different modules of the system in a hierarchical structure. WBS will also define tasks to be completed independently of other tasks, facilitate resource allocations, and assign responsibilities as well as measure and

control of the project. Therefore, it is notably important to pay attention to terminologies used for classifying WBS components accordingly to their levels in the hierarchy. This is to avoid confusion during the project development. For instance, some organizations refer to different levels as tasks, sub-tasks, and work packages. Others use the terms like phases, entries, and activities and while the rest distinguishes it as project, sub-project (optional), phase, sub-phase optional), layers of activities, and work package.

The WBS further aims to provide the project manager and team with the suitable framework of tasks going forward to create detailed cost estimates and project task scheduling. It is believed that by going through the WBS, the project manager and team will have a clear idea whether or not they have captured all the necessary tasks, based on the project requirements. In a way, WBS helps organize and define the total work scope of the project. Unfortunately, many software developers built their WBSs unsystematically and often without the involvement of their teams and without the support of other involved parties. This certainly creates problems for the teams to build and deliver the product or service in a timely and cost effective manner.

Many people have also mistaken and regarded WBS as a list of tasks, a schedule or an organization chart. In reality, WBS rather provides the basis on which a task list and a schedule can be constructed. Though, it does not elaborate about individual tasks or the order of execution in detail. In this regard, this study will address benefits of WBS, WBS process and common pitfalls. It will also try to demonstrate on how to develop a simple and easy WBS to implement for software development projects.

2. Statement of Purpose

The purpose of this research was to provide simple, easy to implement WBS to help software developers better manage or be part of a project team.

3. Research Objectives

1. To outline benefits of WBS, WBS process and common pitfalls.
2. To be able to develop a simple and easy WBS to implement for software development projects.

4. Research Question

How to develop a simple and easy WBS to implement for software development projects?

5. Literature Review

5.1 Definition Of WBS

WBS is a breakdown of the project or a piece of work into deliverables (Mathis n.d., Whitten, Bentley, and Kevin 2004). It describes planned outcomes instead of planned actions. Outcomes are basically the desired ends of the project that are a product, service, or result. Furthermore, Dym and Little (2000) pointed out that WBS helps the making of project baselines, cost estimation and budgeting, resource allocation, scheduling, risk analysis, and more. In this study, WBS is defined as a hierarchical structure that provides the basis for keeping track of the project's scope by carefully assigning necessary tasks, schedule, and resources as well as is used as a mechanism for performance measurement and control of the software development project.

5.2 WBS Roles

According Universityessays (n.d.) and Cho (2009), roles of WBS are as follows:

- Help define the project's scope
- Partition the major project deliverables into smaller components to improve the accuracy of cost estimates

- Provide a mechanism for cost estimating and budget formulating
- Provide a mechanism for performance measurement and control
- Organized around the primary products of the project (or planned outcomes) instead of the work needed to produce the products (planned actions).
- Help map requirements from one level of system specification to another.
- Design of high level algorithm for large scale and complex software products
- Provide project status reporting
- Provide product documenting

For new product development projects, the most common technique to ensure an outcome-oriented WBS is to use a **product breakdown structure** (PBS) (Taylor 2009). It serves to 'reduce a complex project, or product, into manageable components. As a result, teams can obtain a clear understanding of a product, its components, and what is required to provide those components' (productbreakdownstructure n.d.). Feature-driven software projects may use a similar technique which is to employ a **feature breakdown structure**. According to Taylor (2009), when a project provides professional services, a common technique is to capture all planned deliverables to create a **deliverable-oriented WBS**. He further pointed out that WBS 'subdivide work by project phases (e.g. Preliminary Design Phase, Critical Design Phase) that must ensure those phases are clearly separated by a deliverable also used in defining Entry and Exit Criteria (e.g. an approved Preliminary Design Review document, or an approved Critical Design Review document)' (2009:5).

5.3 WBS Structure

According to Whitten, Bentley, and Kevin (2004) and Dym and Little (2000), rules of WBS structure are as follows:

- There are two kinds of WBS views to select from that are tree structure view, tabular view.
- Must avoid having more than 7 immediate sub-elements below any given node of the WBS.
- WBS is a simple map of what is to be produced and therefore has no duration.
- Starts with a single box at the top which represents the whole project. The project is then partitioned into its components with lower level boxes.
- Each box must be given a number according to numbering system the WBS developer chose to use.
- Work percentage and budget can be assigned for each node.
- Work percentages should add up to 100% at the root for the whole project

Samples of WBS are shown in the figures below:

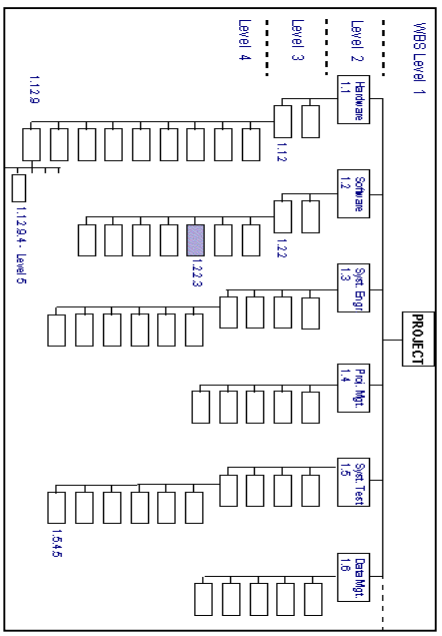


Figure 1: WBS for Software Development Projects (Bocij *et al.* 2003)

Table 1: Tabular Structure View of WBS (Netmba n.d.)

Level 1	Level 2	Level 3
Task 1		
	Subtask 1.1	
		Work Package 1.1.1
		Work Package 1.1.2
		Work Package 1.1.3
	Subtask 1.2	
		Work Package 1.2.1
		Work Package 1.2.2
		Work Package 1.2.3
Task 2		
	Subtask 2.1	
		Work Package 2.1.1
		Work Package 2.1.2
		Work Package 2.1.3

5.4 WBS Tools

The larger the software development, the more deliverables, and the more steps required to produce them. Hence, developers may acquire to have what suitable WBS tools to use. Fortunately, they have various WBS tools to choose from, like PERT chart dan Gantt Chatt (Microsoft Project), Critical Path Method (CPM), Microsoft Excel, MindView, WBS Tool, WBS Chart Pro, and many more (Bocij *et al.* 2003, Dym and Little 2000, netmba n.d., matchware 2012). Developers can even build their own WBS tools to best suit the needs of software development projects.

According to Whitten, Bentley and Kevin (2004), Mathis (n.d.) and Matchware (2012), WBS tools enable software developers to:

1. input and track resources and budget information for the project
2. enables resources to be allocated to specific tasks
3. identify and resolve over allocated resources (people, materials, equipments, and more)
4. create and save a baseline schedule
5. create and track milestones
6. update and track project progress
7. generate reports about the project progress

6. Discussion

It is essential to know the basics of realistic project management in order to better monitor tasks, resources and your budget with the help of WBS. Within this context, this section will discuss benefits of WBS, WBS process, and common pitfalls. It will also attempt to demonstrate how to create a simple and easy to implement WBS for software developments.

6.1 Benefits of WBS

a. Attention to details

The WBS forces the development team and other involved parties, including customers, to delineate the steps required to build and deliver the product or service. Good communication between these people will certainly help 'clarify ambiguities, bring out assumptions, narrow the scope of the project, and raise critical issues early on' (Egeland 2011). It also allows the team development to double check all the deliverables' specifics with the stakeholders and make sure there is nothing missing or overlapping pieces of each deliverable.

It is strongly urged for developers to take a holistic rather than a reductionist approach to software development projects. Instead of breaking up a project into individual pieces (planning, budget) and managing it by understanding each part, a systems perspective focuses on trying to understand how relevant project factors collectively interact to produce project outcomes. The key to success ten becomes managing the interaction between different parts and not the parts themselves.

b. Establish the groundwork for schedule and budget

It is important to carefully plan schedule and budget so that deliverables are more precise and concrete. By doing so, it helps the project team to know exactly what has to be accomplished within each deliverable. A well-defined WBS allows for better estimating of cost, time, and risk as the team can work from the smaller tasks back up to the level of the entire development with ease and efficiency.

c. Create accountability

The size and complexity of a task vary widely. Therefore, it is necessary to carefully assign resources and individual responsibilities when creating the WBS. This particular individual is then responsible for the completion of the assigned tasks. Nevertheless, Netmba (n.d.) explained that activities in higher levels are normally done by groups since they tend to get more complicated and time consuming. These activities may also become too large and complex to manage effectively. On the other hand, activities in the lowest level in the structure are usually performance by specific individuals who will see them through completion.

d. Breed individual and team commitments

IT projects, especially software developments, are not really about hardware and software but are more about people that have so much influence over whether a project will be a successful or a failure. As a result, team participation is highly recommended even though it is the project manager who often develops the high-level WBS. He/she will seek participation of this team to fill in the detailed WBS to ensure that the development can be completed within time and budget. Nevertheless to say, team involvement and commitment is vital to the life of the project. WBS breeds team commitment as well as individual commitment as WBS will assign tasks to specific individuals who are responsible for their completion as instructed. The project deliverables are more precise and concrete by letting the team know what has to be achieved within each deliverable.

6.2 WBS Process

Before explaining WBS process, it is important to know what inputs, techniques, and outputs of WBS as shown in the table below.

Table 2: Inputs, Tools & Techniques, and Output of WBS Process

Inputs	Tools & Techniques	Outputs
Project Scope Statement (PSS)	Decomposition (PMBOK Guide)	WBS
The Project Scope Management		Project Scope Management
Requirements documentation	Product analysis	WBS dictionary
	Inspection	Project document update
Organizational process assets	Alternative identification	Scope baseline
	Facilitated workshops	Project document

		updates
Approved Change	(PMBOK Guide)	Change requests

a. *WBS Process Inputs*

In order to create an effective WBS process, there are at least three major set of inputs required that are project scope, requirements, and organizational process assets. Project scope statement will describe the full scope of the project and product, including the project's boundaries, exclusions, and constraints, in detail which is very useful input for the creation of WBS. Meanwhile, requirements document is a key document that shows the link for each requirement back to the specific user and business needs. Any reference to project methodologies, WBS templates, or examples from previous similar software development projects are considered as valuable inputs to creating applicable WBS. Other organizational process assets may also be the use of software tools needed to create the graphical WBS diagram. For example, Microsoft Project has features to view stimulating WBS that leads to the next steps of defining the activities and tasks for the development.

Of note here that WBS is actually a PBS as it shows that first the products or deliverables must be first identified, and only then, it can determine the necessary activity to create such particular products. A useful tip for developer is to use a noun to describe the product or deliverable, while using a noun and verb for an activity. For example, 'installed wi-fi' or 'new help desk', while activity examples would be 'create project progress report' or 'design user interface'.

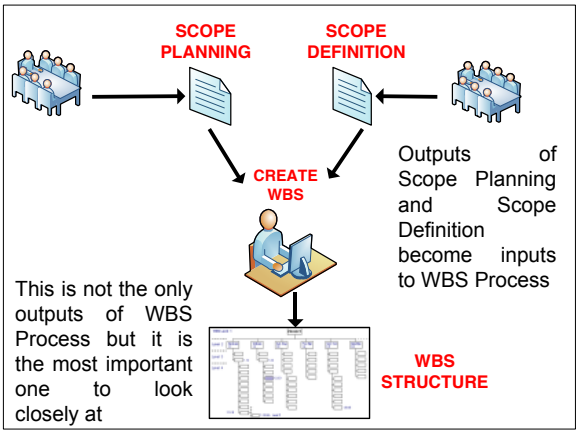


Figure 2: Inputs to WBS Process

b. WBS Process Outputs

WBS process has numerous tools and techniques that can be used to evaluate work performance as listed in Table 1. Using those tools and techniques, WBS process will produce at least four outputs such as the finalized WBS, WBS dictionary, the scope baseline, and updates project documents (i.e. Project Scope Management Plan Update, Project document updates, Change requests)

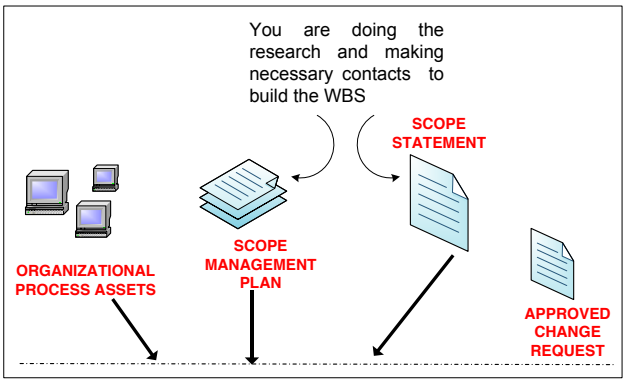


Figure 3: Outputs to WBS Process

Finalized WBS will outline all necessary works required to complete a project. It is also important to create control accounts at strategic points to overview performance. Alongside this, WBS dictionary must be developed to explain details of each component that does not fit into the WBS. It has a separate form for each WBS component that entails information about its work and requirements. Scope baseline contains

the detailed description of the software development, requirements, assumptions, and project constraints. It further includes all elements of the Project Scope Management planning processes and inputs from other knowledge areas. Do not forget to always update project documents. While creating the WBS, you may find out that some projections made as project progresses are not entirely realistic. Therefore, you need to make some justification to the WBS accordingly. The scope baseline is basically created using three other outputs the scope statement, finalized WBS, and WBS dictionary

First of all, you need to create requirements documentation during the collect requirements process. Later during the define scope process, you will use the requirements documentation to produce the PSS. After that, you use this PSS and stakeholder requirements to produce the WBS. You finalize the WBS by creating control accounts at strategic points. Using the finalized WBS, you create the WBS dictionary. From the finalized WBS, the WBS dictionary, and the PSS, you compile the scope baseline. Eventually, you update project documents with any approved changes that may have resulted from the create WBS process.

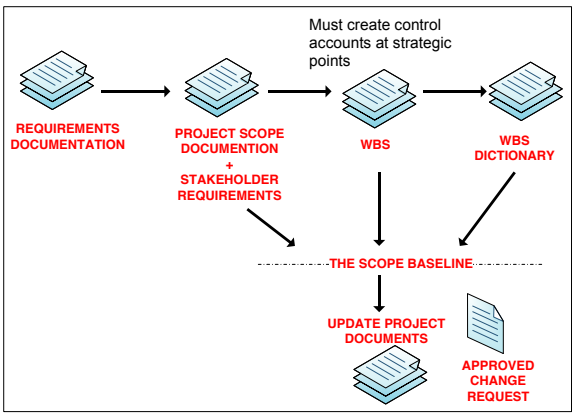


Figure 4: WBS Process

Other baselines, like those for the budget and schedule, typically have only one component. Although all of the components describe the deliverables and the work required to create them, each one brings unique and important information to the scope baseline.

6.3 Common Pitfalls

We also need to know common pitfalls of WBS as outlined below.

a. It is a painstaking process

Developing a WBS can be a painstaking process because it is not easy, time consuming and requires efforts. Having said that, it is believed that the larger the project scopes the larger and more complex the WBS will be. It therefore needs inputs from all involved parties and approval must be sought after for each task that is especially assigned to a specific individual who is then responsible to perform till completion. The WBS requires continual refinement throughout the development.

b. Level of detail for each work package

The project manager is advised not to get too detailed when making work packages as this will become difficult for him/her to manage as a whole. Hence, this will eventually slow down the project progress.

c. Deliverables Not Activities or Tasks

Many people treat WBS as a tool to define activities and tasks that are required to accomplish outcomes or deliverables. The WBS is in fact not a list of specific activities and tasks, but rather it contains a list of broken down deliverables. How the activities and tasks are completed can be vary widely by which changes can happen at any point in time during the development. Deliverables, however, cannot be changed without having a change request approved.

d. WBS is not a Plan or Schedule

WBS should not be used as a total replacement for the project plan or schedule. In addition, a WBS is not

required to be created in any type of order or sequence since it has no time scale attached to the structure. In fact, WBS is a simple and easy visual breakdown of deliverables. Once again, WBS is regarded as the product structure since it demonstrates the logical relationship among all product elements to a specific level. It also helps the project manager to define or manage the project and resources more efficiently.

e. Required continual refinement for change requests

Since a WBS is such an important formal project document, any changes to the WBS must first be requested and get approved before implementing them. It is because those changes can impact the deliverables and thus the project scope.

f. WBS is not an Organizational Hierarchy

Many people treat WBS and organizational hierarchy chart as the same thing due to the similar appearance these two documents have. Unfortunately, they are very different by which the organizational hierarchy shows things like communication lines and command chains. Meanwhile, WBS simply shows the breakdown deliverables based on the project scope.

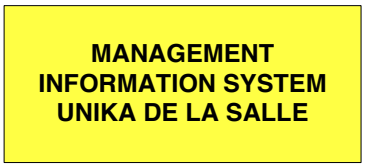
Those points above will help developers to have a better understanding on how to conduct software development projects in a timely and cost effective manner.

6.4 Create a WBS Template

A WBS template can be reused across development projects. WBS also enforces the project team to think through all the levels of the project. One thing to note here is that no task should be less than 8 hours or more than 80 hours **(8/80 rule for WBS** according to PMBok Guide). WBS provides useful inputs for cost estimating and budgeting, scope control, activity definition, and more.

Steps in creating a simple and yet easy to use WBS for software developments are as follows:

1. Define the end product of the software development project.



2. Define the main deliverables.

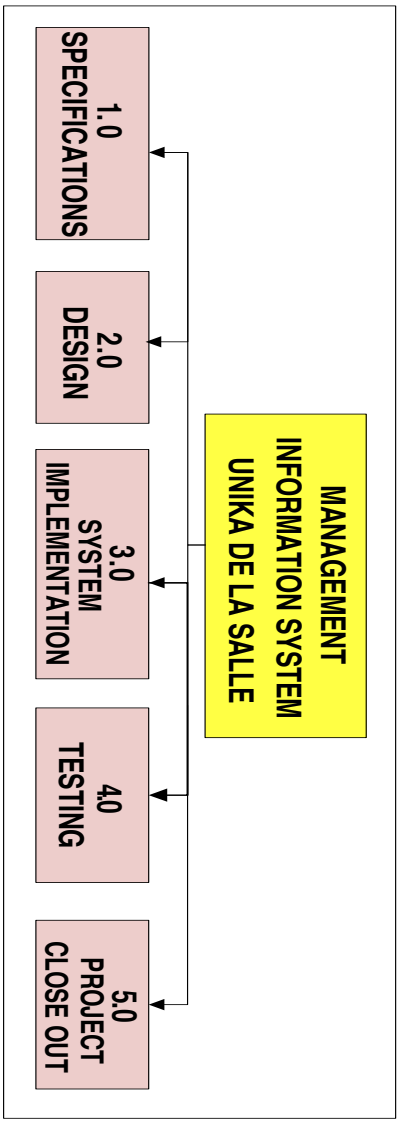


Figure 5: Main Deliverables of MIS

3. Break down the main deliverables into their sub-components using as many sub-branches as needed until you have manageable units of work that do not have to be further subdivided.

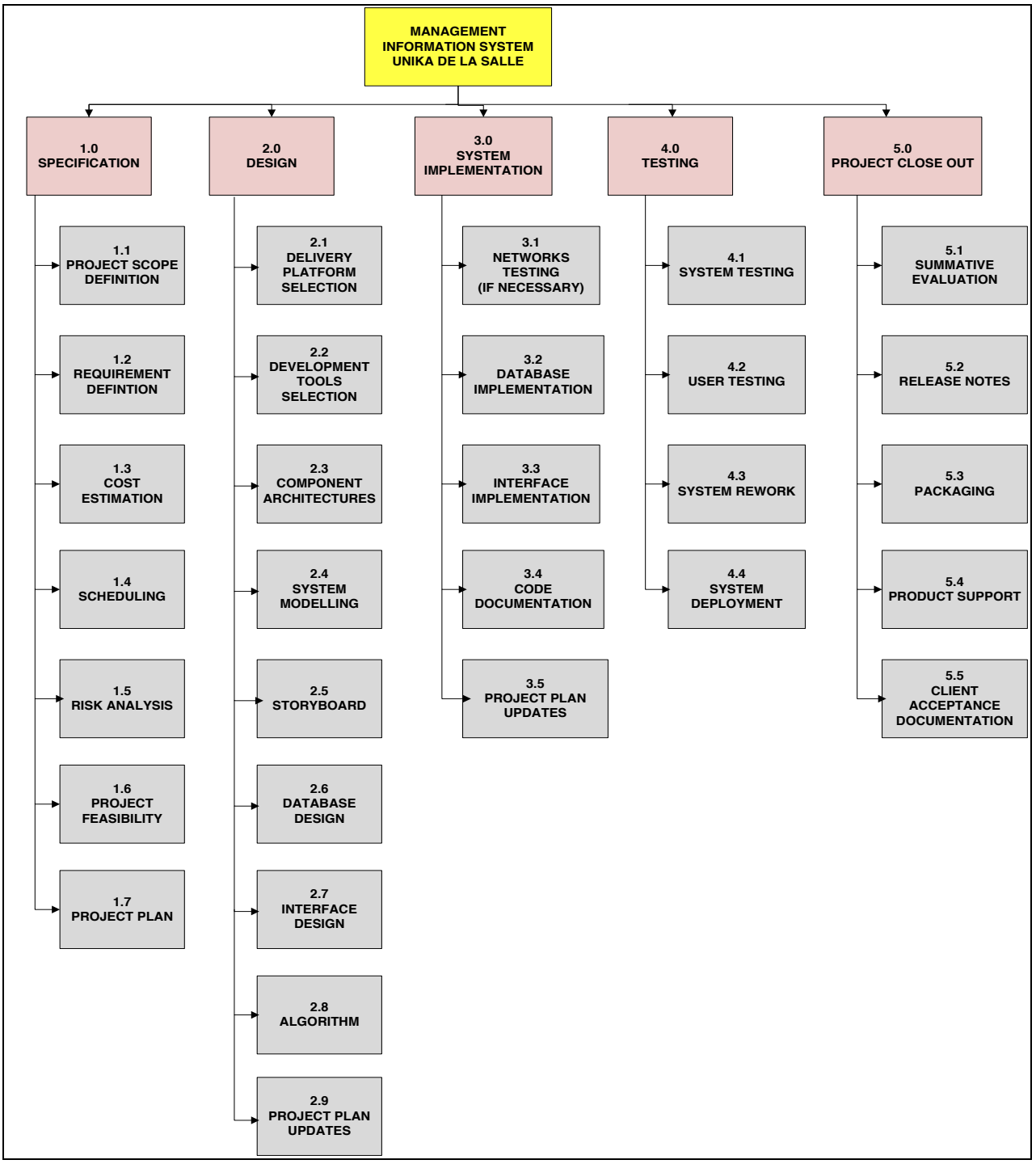


Figure 6: Sub-branches of MIS

4. Use various colors for sub-components for easy viewing.
5. Once the basic layout of the WBS is complete, numbers are added to show the percentage of the total work that the various elements of the project represent. These numbers should add up to 100% at the root for the whole project. Percentage work figures have mostly been added to the branches of the WBS that are lowest in the hierarchy.

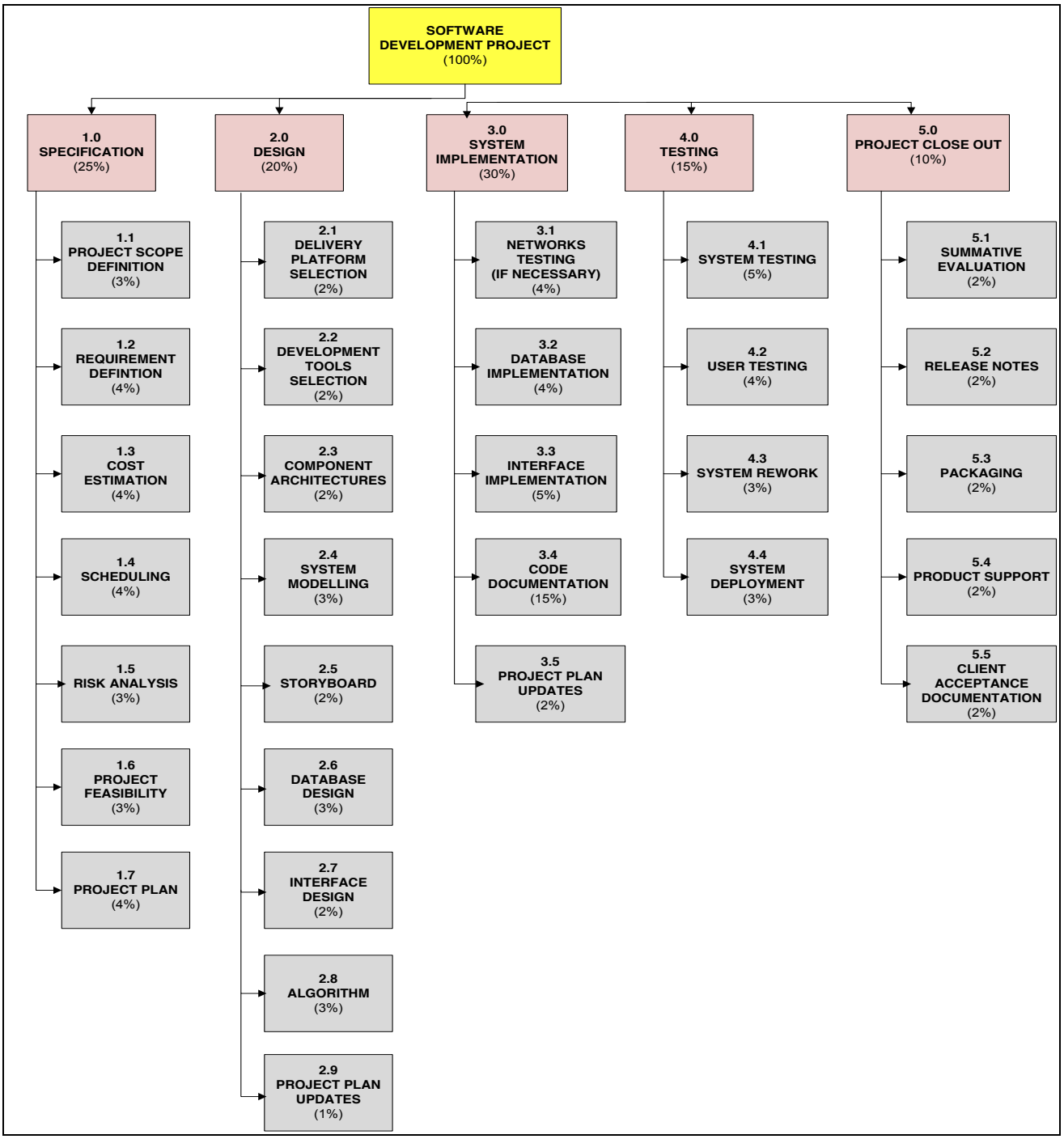


Figure 7: Sub-branches of MIS with Work Percentages

6. You can add cost figures in much the same way as the work percentages.
7. Product descriptions can be a useful component of WBS.

Things to remember about WBS are such as:

1. WBS is a product structure that visualized breakdown of deliverables for product, result or service.
2. It does not elaborate about individual tasks or the order of execution in detail.
3. Must have coding scheme to show the breakdown of deliverables.
4. Use various colors for levels or paths.
5. Add numbers (cost and work percentage) for each product component.

8. Summary

WBS is a simple and easy visual breakdown of deliverables. It is not a plan or schedule, but rather is about the product structure of the project, especially in software developments. It also does not say anything about individual tasks or the order of execution. However, it is believed that a solid WBS can help to ensure proper project baselines, cost estimation and budgeting, resource allocation, scheduling, risk analysis, and more.

It is important to know what inputs, techniques, and outputs of WBS process in order to achieve desirable outcomes within the allocated time and budget. Also, the size and complexity of a task vary widely. Therefore, it is vital to be able to assign resources and individual responsibilities when creating the WBS. Finalized WBS will outline all necessary works required to complete a project by demonstrating the logical relationship among all product elements to a specific level. It also helps the project manager to define or manage the project and resources more efficiently. However, it is necessary to have control accounts at strategic points to overview performance.

In summary, the finalized WBS, WBS dictionary, the scope baseline, and updates project documents are important documents to keep track of the project progresses from beginning to an end. They can be used as templates for similar projects to undertake in future.

9. Recommendations

There are several recommendations made as outlined below:

1. It is strongly urged that a project manager creates a stronger WBS using practical methods to decompose human resources required to execute all tasks into different competence areas and then into project roles, independently of the number of individuals that will be assigned the specified role.
2. WBS should be able to help the project manager reduce the incidence of and the impact of scope creeps. It should be able to further identify, prioritize and actively manage the risks that the project may face.
3. It is also important to create a communication plan that sends just adequate and up-to-date information to all involved parties at the right time.
4. It is essential to create a simple, structured method to reveal what went well and what could be improved on similar software development projects in future.

7. References

Bocij, P., Chaffey, D., Greasley, A., and Hickie, S. (2003). *Business Information Systems: Technology, Development, and Management for e-Business*. England: Prentice Hall.

Cho, Sangwoo. (2009) *NASA Systems Engineering Handbook Work Breakdown Structure (WBS)* [online] available from <http://www.stanford.edu/class/cee320/CEE320B/WBS.pdf> [1 Mei 2012]

Dym, C. L., and Little, P. (2000) *Engineering Design: A Project-Based Introduction*. USA: John Willey & Sons, Inc.

Egeland, B (2011) *Benefits of the Work Breakdown Structure* [online] available from <http://pmtips.net/benefits-work-breakdown-structure/>[2 Mei 2012]

Matchware. (2012) *WBS Software* [online] available from <http://www.matchware.com/en/products/mindview/mindview2_be/WBS.htm> [2 Mei 2012]

Productbreakdownstructure. (n.d.) *What is a Product Breakdown Structure*? [online] available from < *http://productbreakdownstructure.com/*> [1 Mei 2012]

Mathis, M. (n.d.) *Work Breakdown Structure (WBS): Purpose, Process and Pitfalls* [online] available from <http://www.projectsmart.co.uk/work-breakdown-structure.html > [1 Mei 2012]

Taylor, M.D. (2009) *How To Develop Work Breakdown Structures* [online] available from <www.projectmgt.com/Files/Article-WBSHow.pdf> [1 Mei 2012]

Universityessays. (n.d.) *The Project Planning* [online] available from <http://www.universityessays.com/example-essays/education/the-project-planning.php > [1 Mei 2012]

Whitten, J. L., Bentley, L. D., and Kevin, C. D. (2004) 6th edn. *Metode Desain & Analisis Sistem*. USA: McGraw- Hill Companies, Inc.