Why Adopt a Standardized 3D Work Breakdown Structure for Tangible Drilling Cost in Indonesia?

By Gideon Wibowo

Abstract

This paper offers a solution to create a reliable database of drilling activity by standardizing the Work Breakdown Structure (WBS) through Budget Schedule (BS) 19 and BS 20 that are submitted to Indonesian Government Agency by the Production Sharing Contract (PSC) Contractors.

By standardizing WBS, it can give some advantages to Indonesian Government Agency i.e. provide reports on the use of materials and costs consistently and in a standard format, provide the material needs and the cost of a project, and develop a database for consolidate data to determine where the variances that exist between functional areas, project areas and projects during a specific time period. The database will provide an insight to how an improvement will be made to the need of material and the cost of drilling and workover project in the future.

Standardization of WBS models designed should also be multi-dimensional, because the ability of three-dimensional model allows stakeholders to view the data from three different perspectives.

1. Introduction

Indonesian Government Agency (henceforth called "IGA") has responsible to supervise and control the activities of upstream oil and gas under the Production Sharing Contract (PSC). In supervising and controlling the activities of the upstream oil and gas, IGA will evaluate and approve the Authorization for Expenditure (AFE) and close out AFE proposed by the PSC Contractors. AFE system is designed to provide the information necessary to analyze, evaluate, approve and monitor the project expenditure by PSC Contractors. AFE proposals are submitted in the form of a document package where AFE Budget Schedule (BS) is part of the AFE package document.

IGA has a role to approve and control the annual capital budget, including the budget approved and drilling activities. Based historical data on the approval of the Work Program and Budget (WP&B) of the year 2014, IGA has approved the drilling development wells with a total number of 1,358 wells with total budget of around US$ 3.8 billion. Of the total amount of the budget, the allocation of costs for tangible cost is approximately US$ 188 million.

Budget Schedule (BS) used for drilling activities is BS 19 and BS 20. For other activities, Budget Schedule used is as follows:

BS	Description
18	Aero/Land/Marine Survey, Data Processing, Exploitation and Exploration Study
19	Drilling and Workover
20	Drilling and Workover Material List
21	Offshore Platform Facilities
22	Other Offshore Facilities
23	Onshore Facilities
24	Component List Facilities
25	Platform Certification
26	Certain Other Project

Table 1: AFE Budget Schedule[1]

What happens now is the lack of standardization in the Work Breakdown Structure (WBS) introduced into PSC Contractors, where each PSC Contractor has the freedom to determine their own level of standards and definitions. Of course this makes it difficult to enter the data into the database system, so the data becomes less accurate. As a result, the new AFE proposal evaluation process that relies on historical data becomes inaccurate as well.

In this paper, the author want to build a Work Breakdown Structure (WBS) in BS 19, with restrictions on the components of the tangible cost topics, which are detailed in BS 20, which is a list of material or tangible components of drilling activity. With the WBS components of tangible drilling costs, it is expected will be obtained an accurate input of data in a database system and ease the process of input, so that the database can be used for further analysis.

2. Why the IGA needs to standardize the WBS?

Building and having a reliable database has always been a big issue for every company, no exception the IGA. To obtain a reliable database, of course, also required the accurate data input. What will be inputted should match the criteria or specifications of the input data.

Standardizing the WBS is the best way to get a reliable database. By standardizing the WBS, the company can collect and share data between programs. By standardizing the WBS, it will produce a better estimate of the cost, allowing the data to be shared across the company and lead to a more efficient project execution.

The IGA needs to standardize the WBS in order to build and has a reliable database. With the standardization of WBS, then the IGA can compare the costs of the PSC Contractor with the others that can be used to evaluate or assess the costs of a project as well as the magnitude of the risks to be faced. Without standardization of WBS will cause tremendous difficulty in comparing costs between PSC Contractor, and can cause great expense to the IGA when using a third party to collect and reconcile the cost and technical data PSC contractors in a consistent format.

It is expected that by using standardized WBS, all PSC contractors will adopt this standard in their submitting AFE, because WBS is actually a part of the AFE supplements determined by the various types of projects and budgets.

3. 3D Work Breakdown Structure (3D WBS)

The success of a project depends on careful and thorough planning. It begins by setting project goals with detailed enough information. WBS is used to define the scope of a project to ensure delivery of project objectives and outcomes, so that the WBS is a foundation of any project, because it stipulates in detail the work necessary for the achievement of project deliverables.

Jean-Yves Moine has developed a concept of 3D Work Breakdown Structure (3D WBS). There are three tree structures that compose the WBS:[2]

1. **The ZBS (Zone Breakdown Structure).**
   ZBS is hierarchical tree structure of zones. It is physic-functional areas, functional zones or topographical locations. In EPC (Engineering, Procurement, and Construction) project, ZBS is group of functional system for the design and the commissioning phases. For construction phase, ZBS is geographical area.
2. **The PBS (Product Breakdown Structure).**
   PBS is hierarchical tree structure of products. Generally PBS is equipment, material, deliverables, civil works components; and functional systems at the higher levels of the tree.
3. **The ABS (Activity Breakdown Structure)**
   ABS is hierarchical tree structure of activities. An activity is an action, in process point of view. Activities are deployed on products. It is the processes that build products. For example: studies, design, purchase, construction and installation.

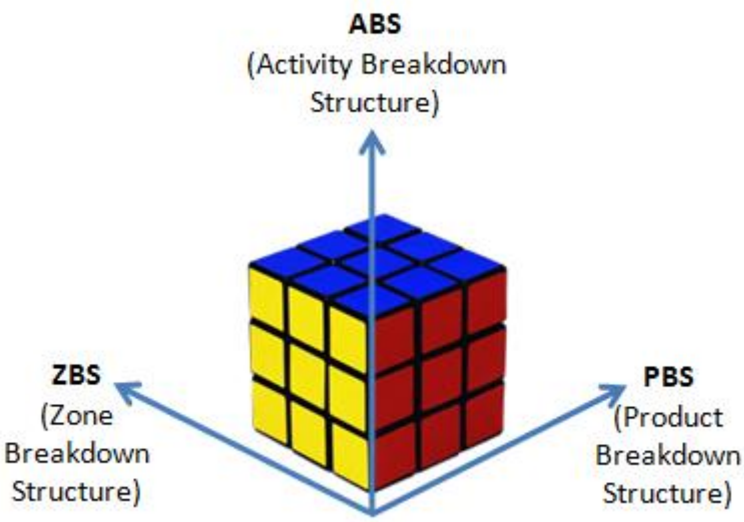

Figure 1: Illustration of 3D WBS[3]

A WBS can be read: in all projects, in the construction phase for instance, products (**PBS**) are constructed or installed (**ABS**) somewhere (**ZBS**). It forms the WBS. There are three dimensions to describe a WBS. Jean-Yves Moine writes that WBS is a crossing between ZBS, PBS and ABS:[4]

WBS = ZBS x PBS x ABS

Standards Norway has published Z-014 Standard Cost Coding System (SCSS) edition 2, May 2012. This NORSOK standard defines a system for cost coding and weight estimates and as-built or experience data. The system consists of 3 sets of complementary sub-coding systems namely:[5]

- **PBS (physical breakdown structure)**
  PBS sets the coding structure for physical or functional components of the project at the phase of development for each configuration scheme of production and processing facilities of oil and gas. The structure of code is separate from the area, modules and sub-projects classification systems.

- **SAB (standard activity breakdown)**
  SAB sets a timescale attribute that expenditures and activities occur during the project. The structure of code apart from the project specific WBS or Activity Breakdown Structure (ABS) and is used in all phase of projects from the exploration phase to the dismantling facility.

- **COR (code of resources)**
  COR also called the Code of Accounts (COA) classifies all project resources and categories based on the level of primary, secondary and tertiary. This structure of code classifies the scale of resources involved in the development of offshore and onshore installations.

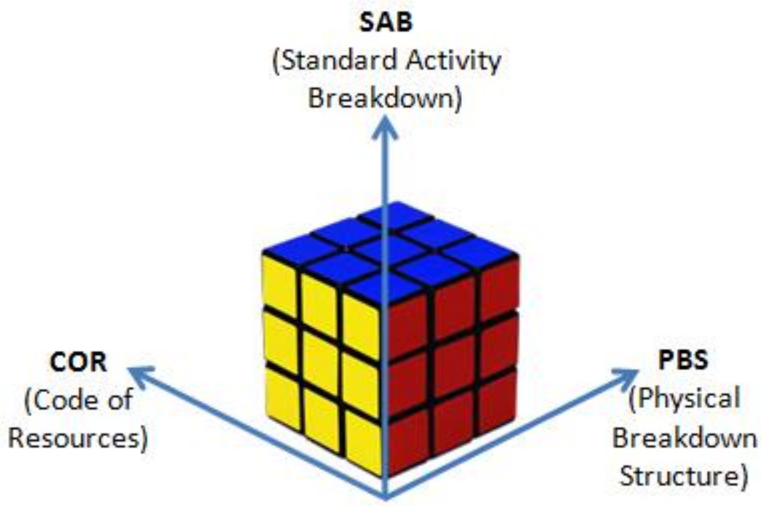

Figure 2: Illustration of NORSOK Standard Z-014[6]

The value or importance of a multi-dimensional WBS as a "best tested and proven practices" can be evidenced with Norsok Z-014 which is a three-dimensional model. The ability of three-dimensional Norsok Z-014 allows stakeholders to view the data from three different perspectives.

The recently evolving OmniClass WBS offers 15 dimensions. OmniClass has 15 hierarchical tables in which each of these tables carries different construction information. Each table can be used separately to compose a particular subject or combined with other tables to construct a more complex subject.[7] On his article, Jean-Yves Moine has showed that OmniClass and 3D WBS model are compatibles.[8]

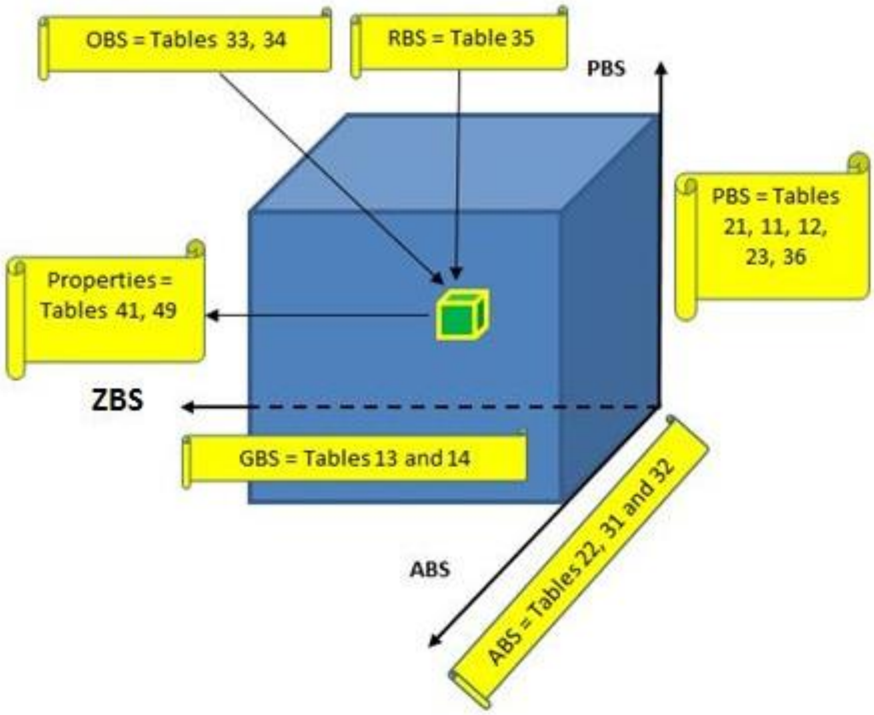

Figure 3: OmniClass and 3D WBS[9]

Therefore, by looking at the value and importance of a multi-dimensional WBS, the IGA should not only standardize WBS, but also designing that the standardized models should be multi-dimensional.

4. BIM (Building Information Modeling)

An article states that a company can reduce costs and risks through BIM (Building Information Modeling)[10]. BIM identifies potential issues before construction begins; provide a level of detail construction materials, reducing unnecessary transportation activities and costs. By identifying issues before the time of construction, they were able to save construction time by ensuring that the design can be done according to the plan without variation.

BIM is a sharable collection of building data, including a three-dimensional (3D) computer model of the entire project. The model can also include information related to time (adding a 4th dimension to the BIM), cost (a 5th dimension), and all aspects of managing the project lifecycle (a 6th dimension).[11]

Currently research BIM is developed through OmniClass. OmniClass can be applied in the field of Building Information Modeling (BIM) for many applications, from managing reports and object libraries to provide a way to explore and browse through the data to obtain the required information.[12]

Levels of BIM:

- 3D BIM: Building Information Models in 3 Dimensions/ volumetric geometric
- 4D BIM: 3D + Time/ phasing
- 5D BIM: 4D + Cost/ money
- 6D BIM: 5D + all aspects of project life-cycle management information/ facilities management

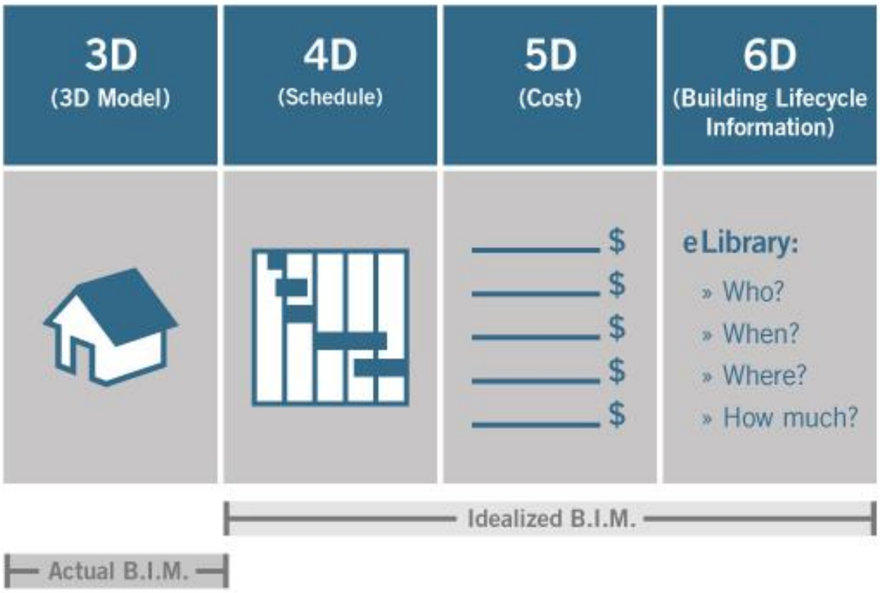

Figure 4: Levels of BIM[13]

Below is illustration of the BIM process:

Figure 5: Illustration of BIM process (step 1 to step 3)[14]

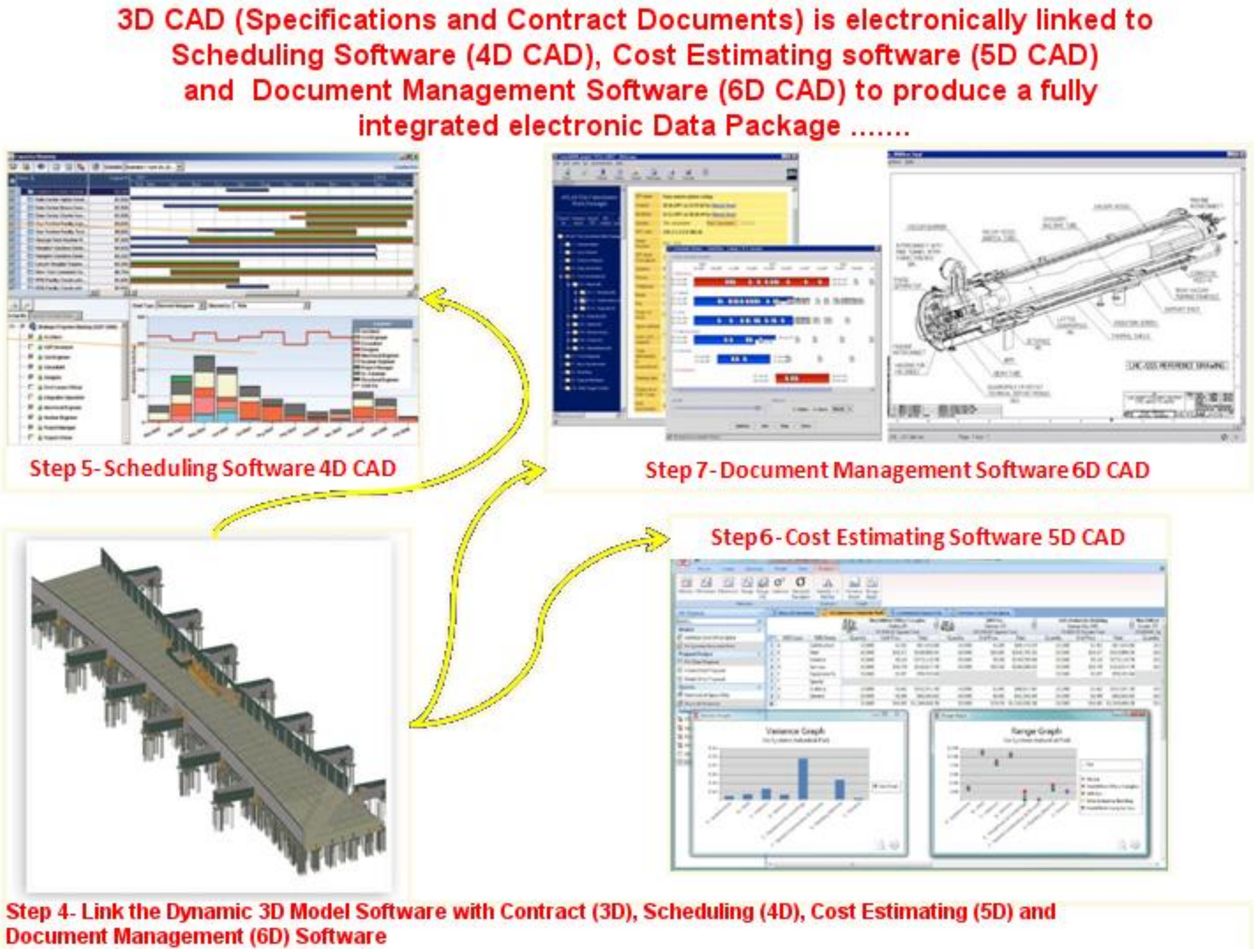

Figure 6: Illustration of BIM process (step 4 to step 7)[15]

From illustration Figure 5 and Figure 6 above, it is obvious that BIM is the common coding structure which enables the objects to be linked from the design database to the scheduling database, to the cost database, and to the document management database.

If the IGA will adopt BIM, it would require a reliable database. In order to be able to have a reliable database, the first thing to do is to standardize the WBS. Without standardized WBS, then fully integrated BIM (3D, 4D, 5D and 6D CAD) will not be realized.

5. Build the WBS

5.1. Choosing a method

The approach used to build the WBS is to use a top-down approach. WBS is constructed of AFE BS 19, and then the components in BS 19 are grouped or decomposed into more detailed sections.

5.2. Build the initial WBS

Using the concept of 3D Work Breakdown Structure (3D WBS), the system which is built consists of three sets of complementary sub-systems that compose the WBS:

1. ZBS (Zone Breakdown Structure). The hierarchical structure defines drilling area.
2. SAB (Standard Activity Breakdown). The hierarchical structure defines the activities carried out during the drilling of wells.
3. PBS (Product Breakdown Structure). The hierarchical structure defines the product, including tangible material components that will be installed in the drilling well.

5.3. Building down the WBS

In building the WBS; SAB and ZBS will be described to a Level 1 and Level 2 only, because the focus of this paper is to build a WBS on tangible drilling components. Whereas for PBS will be described in more detail. However, it should also be informed that although PBS will be described in detail, but will be limited to the components that are common in tangible material drilling activities.

5.3.1. ZBS (Zone Breakdown Structure)

Drilling projects are divided into several areas of work (ZBS), namely contract area and then field.

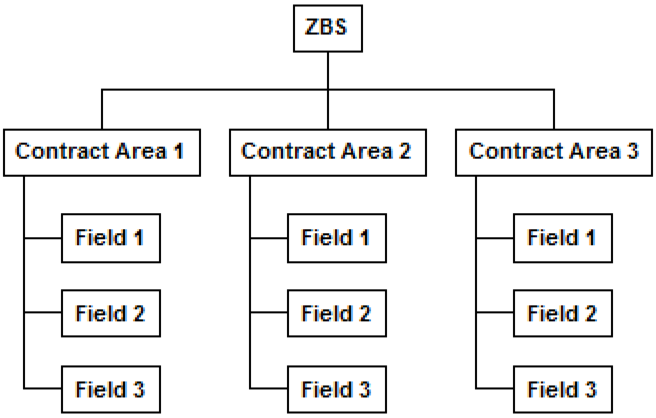

Figure 7: The ZBS drilling[16]

5.3.2. SAB (Standard Activity Breakdown).

Standard Activity Breakdown is divided into:

- 1 – Site Preparation
- 2 – Drilling operation
- 3 – Formation evaluation
- 4 – Completion
- 5 – Plug and Abandon
- 6 – General

1. Site Preparation
   Includes all activities carried out prior to drilling after drilling site selected and surveyed.
2. Drilling Operation
   This includes all activities drilling a hole in the ground to lift hydrocarbons, injecting fluid into the reservoir or for evaluation or monitoring of subsurface formations.

3. Formation Evaluation
   Includes all activity of measurements taken inside a wellbore to detect and quantify hydrocarbon reserves in the rock formation.
4. Completion
   This includes all processes to make the well ready for production or injection.
5. Plug and Abandon
   This activities are to prepare and close the well permanently.
6. General
   General activity in standard activity breakdown relates to activities carried out by PSC Contractors in drilling activities to organize, manage, plan and support drilling activities.

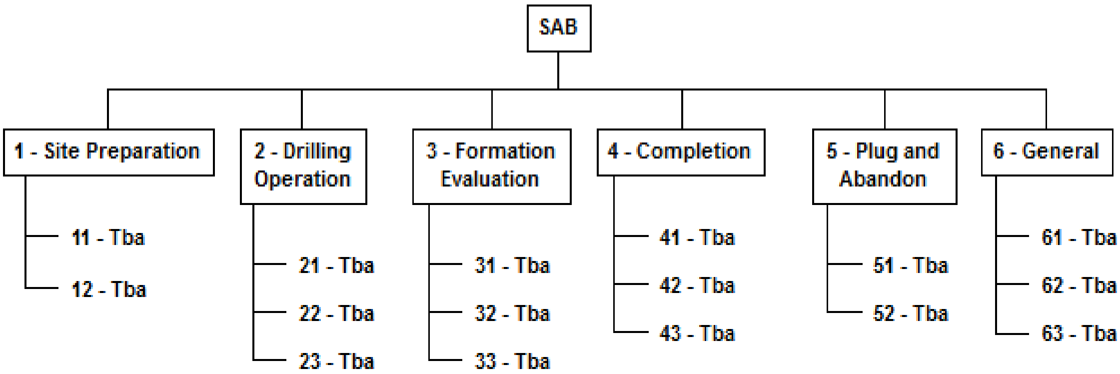

Figure 8: The SAB drilling[17]

5.3.3. PBS (Product Breakdown Structure)

As stated above Product Breakdown Structure which will be described below are only common tangible components or often used in drilling activity, will not be composed into details the needs of any material tangible in drilling activity.
PBS will be delivered in the form of the type of wells to be drilled, namely exploratory, delineation or development. Each of type of wells will consist of tangible component below:

a. Casing
b. Tubing
c. Casing Accessories
d. Well equipment – surface
e. Well equipment – subsurface

Detail of each tangible component can be seen on Appendix 1.

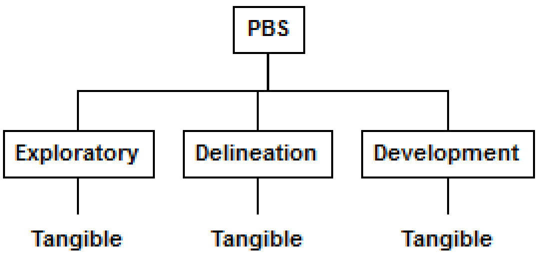

Figure 9: The PBS Drilling[18]

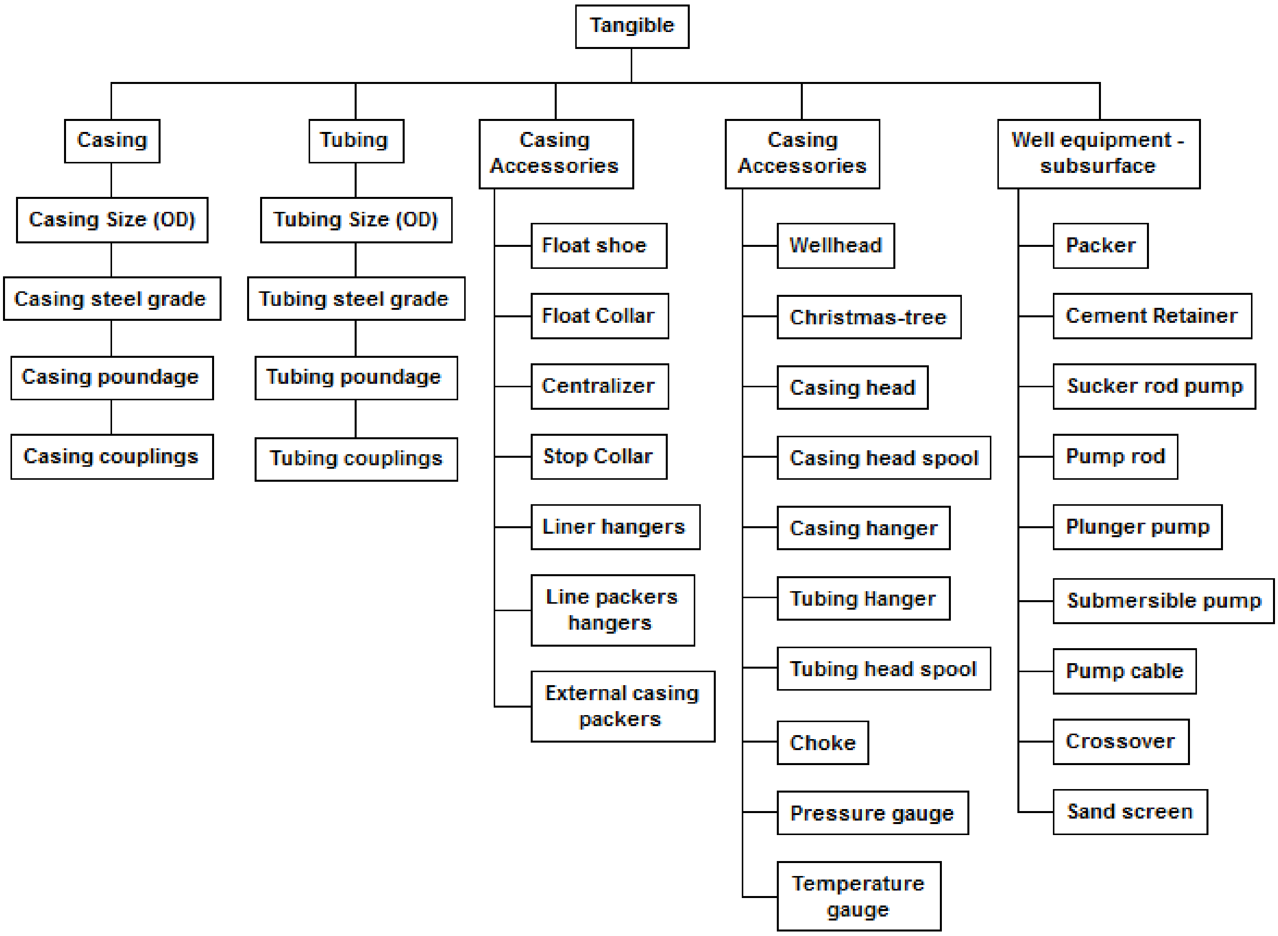

Figure 10: The tangible drilling[19]

6. Standardizing WBS in BS 20

BS 20 is a list of supporting materials for AFE drilling and workover projects (BS 19) and a summary of the material expenditures. Referring to BS 20 in Appendix 3, BS 20 is an empty form of BS which the PSC contractors can decide what will be filled into the form. Thus the PSC contractors can decide on each line of the form BS 20:

- Description of materials to be used , and
- Unit materials to be issued.

As explained earlier that actually WBS is part of the AFE supplements, and then it is actually no WBS was made in BS 20. In fact there should be a WBS created and sufficient detail that can be used as a tool to organize project tasks. So in BS 20 will be found quite a lot of variations on the description of the materials used in a project from each BS 20 submitted by the PSC contractors as well as units of the material used, whether will be used the type of unit meters, feet or joint. Even sometimes from the BS 20 submitted by the same PSC contractors is quite varied. There is no standard format in the submitting of BS 20.

That is why in BS 20 is quite important to standardize how to fill in the BS 20 with certain formats. Standardize WBS format is an important part in providing repeatability and consistency.

With standardize the WBS in BS 20 will give some advantages to the Indonesian Government Agency (IGA):

1. Provide reports on the use of materials and costs consistently and in a standard format to the entire drilling and workover project in Indonesia.
2. This capability also provides the level of management to acquire the material needs and the cost of a project up to the overall drilling and workover project in Indonesia.
3. Due to material needs and costs reported are consistent, then the IGA can develop a database for consolidate these data to determine where the variances that exist between functional areas, project areas and projects during a specific time period. It will provide an insight to how an improvement will be made to the need of material and the cost of drilling and workover project in the future.
   With the growth and development of the database, it will be able to provide the ability to accurately estimate material requirements and costs relating to drilling and workover projects in the future.

7. Applying 3D WBS on Drilling and Workover Project

BS 19 is used to summarize the expenditures budget drilling and workover project by type of wells. Description of the type of wells to be drilled is such as exploratory, delineation or development. The following will do the selection of the most optimal WBS by comparing the WBS in the BS 19 existing with alternative 3D WBS.

Drilling and workover projects are divided into several areas of work (ZBS), namely contract area and then field. In each area there is a product (PBS) that will be delivered in the form of the type of wells to be drilled, namely exploratory, delineation or development. Each product has several activities to be composed as ABS. The following table shows the available WBS option in BS 19. Option 1 and option 2 is the WBS used in BS 19.

Option	Type	WBS Level		
		Level 1	Level 2	Level 3
1	2D	Area (ZBS)	Product (PBS)	Activities (ABS)
2	2D	Product (PBS)	Area (ZBS)	Activities (ABS)
3	3D	Product (PBS) X axis	Activities (ABS) Y axis	Area (ZBS) Z axis

Table 2: Feasible option of WBS[20]

Option 1

In the following figure, WBS level 1 is ZBS and level 2 is PBS. In each of PBS, there will be related activities (ABS), which forms WBS Level 3.

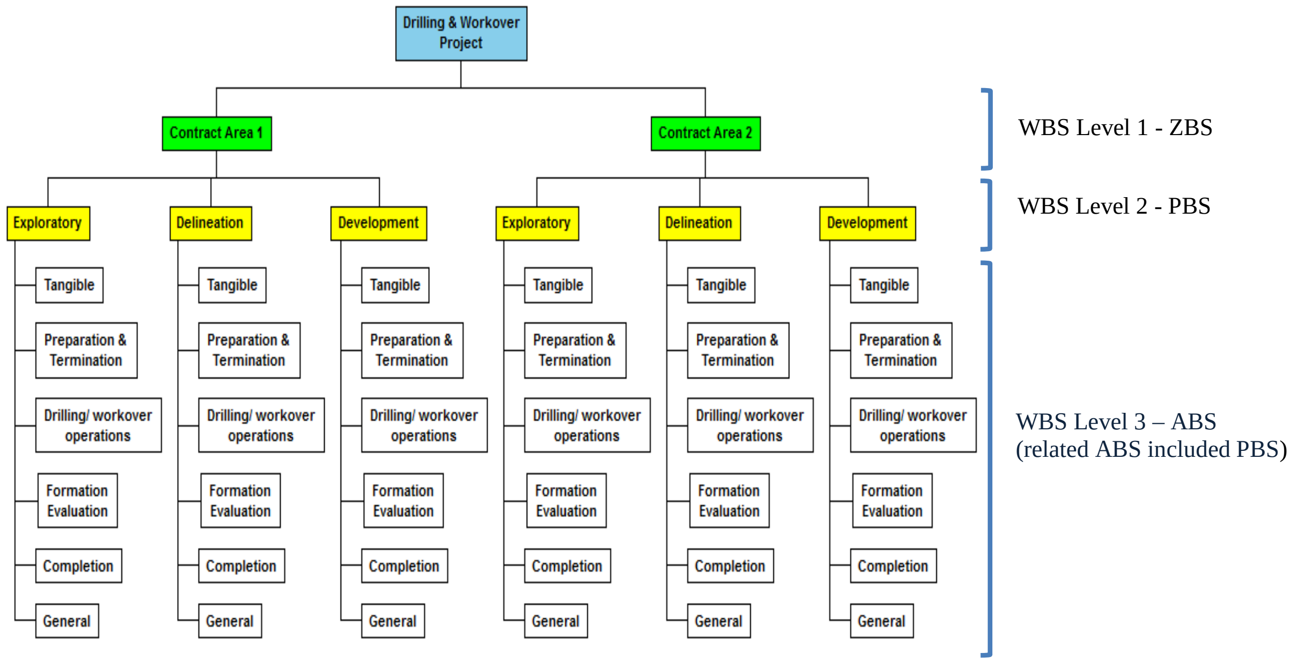

Figure 11: Option 1 of WBS[21]

Advantages:

- Roll up schedule and cost for each contract area (start to completion) is capable.
- Visible to analysis productivity by contract area
- Easier to produce project report by area.

Disadvantages:

- Not able to roll up schedule and cost by product and activities.
- Difficult to track progress for activities and procurement (procurement deliverable by product).

Option 2

In the following figure, WBS level 1 is PBS and level 2 is ZBS. In each of ZBS, there will be related activities (ABS), which forms WBS Level 3.

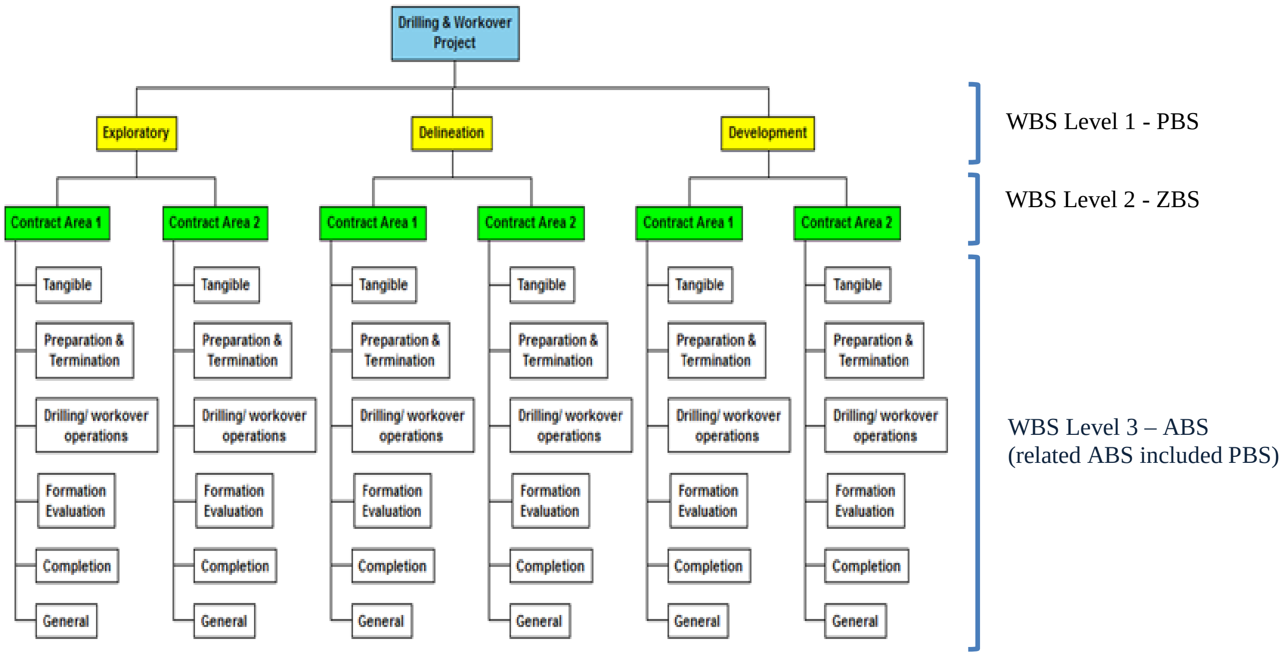

Figure 12: Option 2 of WBS[22]

Advantages:

- Able to roll up schedule and cost by product.
- Easier to control procurement that focus on each contract area
- Able to progress reporting by product (well type).

Disadvantages:

- Roll up of schedule and cost for each contract area is not available.
- Difficult to produce project report by area

Option 3

A 3D WBS model is shown on Figure 12 below. PBS is applied as X-axis, ABS is applied as Y-Axis and ZBS is applied as Z-Axis. This model can visualize the well type as 2D model of 1 particular area (PBS and ABS) and then applied the same for other contract area (ZBS) in the third dimension within the project scope of work.

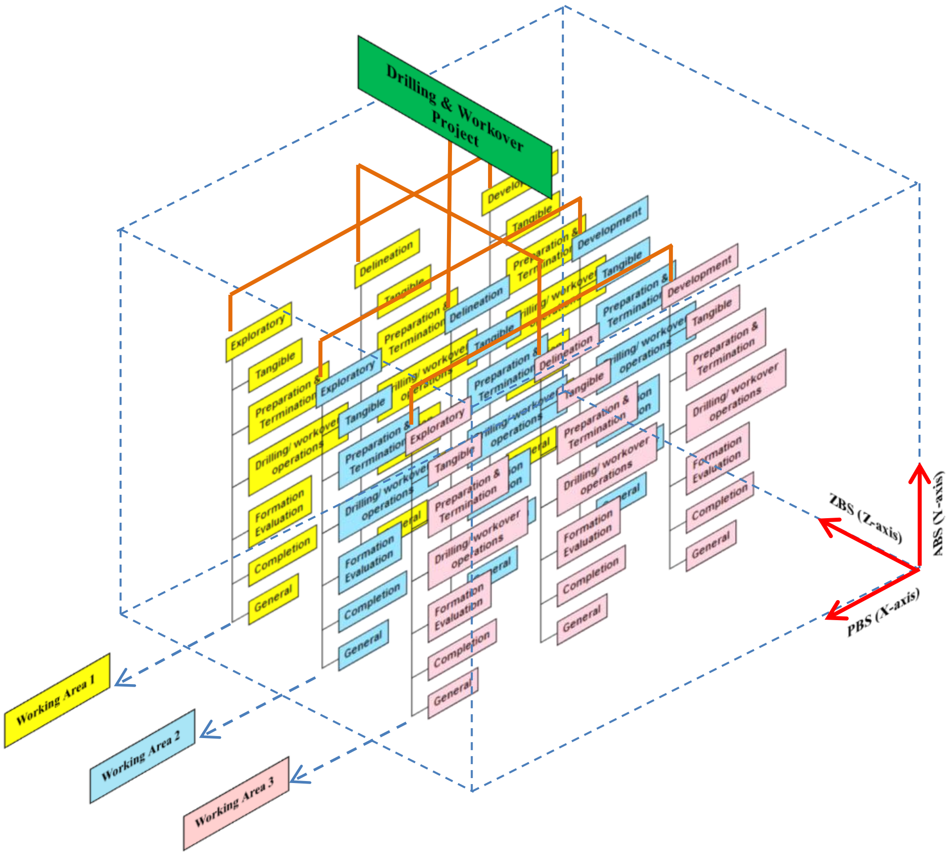

Figure 13: Option 3 of WBS[23]

Advantages:

- Roll up by level of WBS is flexible.
- Preparing progress reporting by requirements is flexible.

Disadvantages:

- More complex activity on coding structure.

From each of these options will be tested based on the following criteria:

a. Flexible roll-up of cost and schedule.
b. Best flexibility and visibility for project reporting and analysis, including cost and schedule.

Based on the criteria, option 3 (3D WBS) is the best meet the criteria. 3D WBS model is suitable for drilling and workover project, because there will be a similar PBS and ABS in a lot of number of contract area (ZBS).

8. The advantages of using 3D WBS

Jean-Yves Moine explains some of the advantages of using 3D WBS.[24] It is shown by the use of Cubix 360.[25] These are some of the advantages of using 3D WBS:

1. Saving time and effort

2. Detection of possible synergies
3. Coherences of the durations and the costs
4. A better understanding of projects
5. A better structuring of projects
6. The more the project is huge and complex, the more the 3D model brings added-value
7. Capitalization of the discipline data and the processes.

8.1.1. Study comparison of WBS, WBS OmniClass and 3D WBS models by Mohammed Elrashid.[26]

Mohammed Elrashid has conducted a study on the use of non-standard current WBS used in the projects and compares it to the standardized WBS. To analyze and choose some alternative of existing WBS, it is used a decision making technique: lexicography which is one of the noncompensatory models for selecting an option when multi attributes are present.
The following table is the result of the application of various alternatives WBS with techniques lexicography.

Application of Lexicography		
Attributes	**Rank (a)**	**Alternative (b)**
WBS level of details	3	**3D WBS** = **OmniClass** (Table 31-Phases) > Current WBS
Complexity	2	**Current WBS** > OmniClass (Table 31-Phases) > 3D WBS
Number of design activity phases	1	**3D WBS** = **OmniClass** (Table 31-Phases) > Current WBS
Work flow of activities	0	**3D WBS** > OmniClass (Table 31-Phases) > Current WBS

Note:
(a) Rank of 3 = most important, rank of 0 = least important
(b) Selection is based on the highest-ranked attribute

Table 3: Decision making technique using lexicography[27]

Based on the Table 3 above, the selected alternative is 3D WBS model, because the level of accuracy of the WBS and the number of design activity phase are the highest ranking attributes. The 3D WBS model is the best among other two WBS models.

8.1.2. Managing project by using Norsok standard Z-014 3D WBS[28]

Fahmi Syafri uses Norsok standard Z-014 3D WBS to manage Water Pre Treatment Package project. The results of the study concluded that Norsok Standard Z-014 gives a more detailed and valuable WBS that can help project teams to develop better cost and schedule.

9. Conclusion

Work Breakdown Structure (WBS) standardization is required to obtain a reliable database of drilling activities in Indonesia. WBS is a part of the Authorization for Expenditure (AFE). The database input data were obtained from AFE which is submitted by the PSC Contractor after approval; and the results AFE close-out. It is expected that by using standardized WBS, all PSC contractors will adopt this standard in their submitting AFE.

The Indonesian Government Agency (IGA) should not only standardize WBS, but also designing that the standardized models should be multi-dimensional. The value or importance of a multi-dimensional WBS as a "best tested and proven practices" can be evidenced with Norsok Z-014 which is a three-dimensional model. The ability of three-dimensional model allows stakeholders to view the data from three different perspectives.

Here are the reasons why WBS standardization on drilling activities in Indonesia recommended to be applied by the IGA:

1. WBS is expected to create a reliable historical cost database, which can be used as a basis for recommending approval of AFE.

2. It can be used as a checklist to help identify the tangible material that required for drilling and workover projects in Indonesia through the Work Program and Budget (WP&B) meeting every year, so that the material procurement process can be carried out collectively, so it can suppress the price.

3. Forming a reliable historical cost database that can be used to determine the value of rough Owner Estimate (OE)/ Conceptual Estimate to forecast a budget need in the near future for oil development.

References

[1] *Pedoman Tata Kerja Authorization For Expenditure (AFE)*. (2010). Jakarta.
[2] Moine, J.-Y. (n.d.). Retrieved from 3D Work Breakdown Structure: http://3d-wbs.blogspot.com/
[3] By Author
[4] Moine, J.-Y. (n.d.). Retrieved from 3D Work Breakdown Structure: http://3d-wbs.blogspot.com/
[5] *NORSOK standards*. (n.d.). Retrieved from standard.no: https://www.standard.no/en/sectors/energi-og-klima/petroleum/norsok-standard-categories/z-stand-cost-coding/z-0142/
[6] By Author
[7] *About OmniClass*. (n.d.). Retrieved from OmniClass: http://www.omniclass.org/about.asp
[8] Moine, J.-Y. (2012, April 12). *Part #47: OMNICLASS and 3D WBS*. Retrieved from 3D Work Breakdown Structure: http://3d-wbs.blogspot.com/2012/04/part-48-omniclass-and-3d-wbs.html
[9] Moine, J.-Y. (2012, April 12). *Part #47: OMNICLASS and 3D WBS*. Retrieved from 3D Work Breakdown Structure: http://3d-wbs.blogspot.com/2012/04/part-48-omniclass-and-3d-wbs.html
[10] *Reducing Cost and Risk through Building Information Modelling (BIM)*. (2014). Retrieved from Aecom: http://www.aecom.com/Where+We+Are/Australia+-+New+Zealand/Oil+Gas/_projectsList/Reducing+Cost+and+Risk+through+Building+Information+Modelling+%28BIM%29
[11] Pete Fowler Construction Services, Inc. (2014, March 26). *Building Information Modeling: What is B.I.M.?* Retrieved from Pete Fowler Construction Services, Inc.: http://www.petefowler.com/2014/03/26/building-information-modeling/
[12] *About OmniClass*. (n.d.). Retrieved from OmniClass: http://www.omniclass.org/about.asp
[13] Pete Fowler Construction Services, Inc. (2014, March 26). *Building Information Modeling: What is B.I.M.?* Retrieved from Pete Fowler Construction Services, Inc.: http://www.petefowler.com/2014/03/26/building-information-modeling/
[14] Giammalvo, P. D. (2012). Slides from Short Courses.
[15] Giammalvo, P. D. (2012). Slides from Short Courses.
[16] By Author
[17] By Author
[18] By Author
[19] By Author
[20] By Author
[21] By Author
[22] By Author
[23] By Author
[24] Moine, J.-Y. (2013, January 22). *Part #59: Advantages and benefits of the 3D WBS*. Retrieved from 3D Work Breakdown Structure: http://3d-wbs.blogspot.com/2013/01/part-60-advantages-and-contributions-of.html
[25] Cubix360. (2014). *Contributions and benefits*. Retrieved from Cubix360: http://cubix360.fr/contributions-and-advantages-2/?lang=en

[26] Elrashid, M. (2013, January 2). *W10_Mohammed_ Our Current WBS Vs OmniClass and 3D model*. Retrieved from Mahakam preparation Class of AACE 2012: http://aacemahakam.blogspot.com/2013/01/w10mohammed-our-current-wbs-vs.html
[27] Elrashid, M. (2013, January 2). *W10_Mohammed_ Our Current WBS Vs OmniClass and 3D model*. Retrieved from Mahakam preparation Class of AACE 2012: http://aacemahakam.blogspot.com/2013/01/w10mohammed-our-current-wbs-vs.html
[28] Syafri, F. (2013, Oktober 8). *W7_AFS_ Managing Small Project: NORSOK Standard Z-014 3D WBS*. Retrieved from Simatupang AACE 2014: http://simatupangaace2014.wordpress.com/2013/10/08/w7_afs_-managing-small-project-norsok-standard-z-014-3d-wbs/
[29] Society of Petroleum Engineers. (2013, August 31). *Casing and tubing*. Retrieved from PetroWiki: http://petrowiki.spe.org/Casing_and_tubing
[30] American Petroleum Institute. (2002). Specification for Casing and Tubing (Metric Units). Whashington, D.C.
[31] Schlumberger. (n.d.). Well Services Field Data Handbook.
[32] Schlumberger. (n.d.). Well Services Field Data Handbook.

Bibliography

1. *Pedoman Tata Kerja Authorization For Expenditure (AFE).* (2010). Jakarta.
2. *Reducing Cost and Risk through Building Information Modelling (BIM)*. (2014). Retrieved from Aecom: http://www.aecom.com/Where+We+Are/Australia+-+New+Zealand/Oil+Gas/_projectsList/Reducing+Cost+and+Risk+through+Building+Information+Modelling+%28BIM%29
3. *About OmniClass*. (n.d.). Retrieved from OmniClass: http://www.omniclass.org/about.asp
4. American Petroleum Institute. (2002). Specification for Casing and Tubing (Metric Units). Whashington, D.C.
5. Cubix360. (2014). *Contributions and benefits*. Retrieved from Cubix360: http://cubix360.fr/contributions-and-advantages-2/?lang=en
6. Elrashid, M. (2013, January 2). *W10_Mohammed_ Our Current WBS Vs OmniClass and 3D model* . Retrieved from Mahakam preparation Class of AACE 2012: http://aacemahakam.blogspot.com/2013/01/w10mohammed-our-current-wbs-vs.html
7. GAO. (2009, March). *GAO Cost Estimating and Assessment Guide: Best Practices for Developing and Managing.* Retrieved from http://www.gao.gov/new.items/d093sp.pdf
8. Giammalvo, P. D. (2012). Slides from Short Courses.
9. Humpreys, G. C. (2011). *Project Management Using Earned Value* (2nd ed.). Humpreys & Associates, Inc.
10. Miller, D. P. (2009). *Building A Project Work Breakdown Structure : Visualizing Objectives, Deliverables, Activities, and Schedules.* CRC Press.
11. Moine, J.-Y. (n.d.). Retrieved from 3D Work Breakdown Structure: http://3d-wbs.blogspot.com/
12. Moine, J.-Y. (2012, April 12). *Part #47: OMNICLASS and 3D WBS*. Retrieved from 3D Work Breakdown Structure: http://3d-wbs.blogspot.com/2012/04/part-48-omniclass-and-3d-wbs.html
13. Moine, J.-Y. (2013, January 22). *Part #59: Advantages and benefits of the 3D WBS*. Retrieved from 3D Work Breakdown Structure: http://3d-wbs.blogspot.com/2013/01/part-60-advantages-and-contributions-of.html
14. *NORSOK standards*. (n.d.). Retrieved from standard.no: https://www.standard.no/en/sectors/energi-og-klima/petroleum/norsok-standard-categories/z-stand-cost-coding/z-0142/
15. Pertamina - BPPKA. (1993). Section IV - Authorization For Expenditure. In *Financial Budget and Reporting Procedures Manual of Production Sharing Contract* (pp. 26-39).
16. Pertamina BKKA. (n.d.). *Manual of Drilling and Workover Expenditure and Control.*
17. Pete Fowler Construction Services, Inc. (2014, March 26). *Building Information Modeling: What is B.I.M.?* Retrieved from Pete Fowler Construction Services, Inc.: http://www.petefowler.com/2014/03/26/building-information-modeling/
18. Rossitha. (2012, August 16). *W#08_Ros_3D WBS for Mining Facilities Development Project*. Retrieved from Mahakam2012: http://mahakam2012.wordpress.com/2012/08/16/w08_ros_3d-wbs-for-mining-facilities-development-project/
19. Schlumberger. (n.d.). Well Services Field Data Handbook.

20. Sellappan, H. K. (2012, June 3). *W18_Hari_Applying 3D WBS To Telecommunication RAN Rollout*. Retrieved from Casablanca Q1-2012 AACE: http://aacecasablanca.wordpress.com/2012/06/03/w18_hari_applying-3d-wbs-telecommunication-ran-rollout/
21. Society of Petroleum Engineers. (2013, August 31). *Casing and tubing*. Retrieved from PetroWiki: http://petrowiki.spe.org/Casing_and_tubing
22. Syafri, F. (2013, Oktober 8). *W7_AFS_ Managing Small Project: NORSOK Standard Z-014 3D WBS*. Retrieved from Simatupang AACE 2014: http://simatupangaace2014.wordpress.com/2013/10/08/w7_afs_-managing-small-project-norsok-standard-z-014-3d-wbs/

Appendix 1

Detail of Tangible Components

A Casing

Based on the definition of the American Petroleum Institute (API) specification 5CT, casing is a pipe runs from the surface and intended to line the walls of a drilled well. Selection of the casing to be used in drilling activity divided by the order of the following criteria:

1. Casing size Outer Diameter (OD)
   Casing size used is as follows:
   AA Casing size OD 7 inches
   AB Casing size OD 9-⅝ inches
   AC Casing size OD 13-⅜ inches
   AD Casing size OD 18-⅝ inches
   AE Casing size OD 20 inches
   AF Casing size OD 30 inches

2. Casing steel grade.
   Steel grade is used to define the strength of the casing steel. This designation consists of a grade letter followed by a number, which determines the minimum yield strength of steel in ksi (103 psi). The following table summarizes the common grade of the standard API:

API STEEL GRADES				
API Grade	Yield Stress, psi		Minimum Ult. Tensile, psi	Minimum Elongation, %
	Minimum	Maximum		
H-40	40.000	80.000	60.000	29,5
J-55	55.000	80.000	75.000	24,0
K-55	55.000	80.000	95.000	19,5
N-80	80.000	110.000	100.000	18,5
L-80	80.000	95.000	95.000	19,5
C-90	90.000	105.000	100.000	18,5
C-95	95.000	110.000	105.000	18,5
P-110	110.000	140.000	125.000	15,0

Table 4: API Steel Grades[29]

3. Casing poundage
   Casing poundage is a casing or tubing weight per foot (pounds per foot). The following table is API casing specification for some casing size and nominal weight (pounds per foot):

Casing O.D (in)	Grade	Nominal Weight (lb/ft)	Casing Wall Thickness (in)	Inner Diameter (in)
7	H40	17.00	0.231	6.538
7	J55	23.00	0.317	6.366
7	K55	23.00	0.317	6.366

7	N80	23.00	0.317	6.366
7	L80	23.00	0.317	6.366
7	C95	23.00	0.317	6.366
7	J55	26.00	0.326	6.276
7	N80	26.00	0.326	6.276
7	L80	26.00	0.326	6.276
7	C95	26.00	0.326	6.276
7	P110	26.00	0.326	6.276
9 5/8	J55	36.00	0.352	8.921
9 5/8	K55	36.00	0.352	8.921
9 5/8	J55	40.00	0.395	8.835
9 5/8	K55	40.00	0.395	8.835
9 5/8	N80	40.00	0.395	8.835
9 5/8	L80	40.00	0.395	8.835
9 5/8	C95	40.00	0.395	8.835
13 3/8	H40	48.00	0.330	12.715
13 3/8	J55	54.50	0.380	12.615
13 3/8	K55	54.50	0.380	12.615
13 3/8	J55	61.00	0.430	12.515
13 3/8	K55	61.00	0.430	12.515
18 5/8	H40	87.50	0.435	17.755
18 5/8	J55	87.50	0.435	17.755
18 5/8	K55	87.50	0.435	17.755
20	H40	94.00	0.438	19.124
20	J55	94.00	0.438	19.124
20	K55	94.00	0.438	19.124
20	J55	106.50	0.500	19.124
20	K55	106.50	0.500	19.124
20	J55	133.00	0.635	18.730
20	K55	133.00	0.635	18.730

Table 5: API Casing Specifications [30]

Below table are physical properties of XLC casing based on XL Systems Inc. data:

Casing O.D (in)	Grade	Nominal Weight (lb/ft)	Casing Wall Thickness (in)	Inner Diameter (in)
30	K55	234.3	0.750	28.500
30	L80	234.3	0.750	28.500
30	N80	234.3	0.750	28.500
30	P110	234.3	0.750	28.500
30	P110	383.8	1.250	27.500
30	N80	456.6	1.500	27.000
30	K55	528.0	1.750	26.500
30	L80	528.0	1.750	26.500

Table 6: XLC Casing Specification[31]

4. Casing couplings
   Based on the definition of the American Petroleum Institute (API) specification 5CT, coupling is an internally threaded cylinder for joining two lengths of threaded pipe. Below are the common sizes of the couplings used for the casing:
   - Short Thread – Casing Couplings (STC)
   - Long Thread – Casing Couplings (LTC)
   - Buttress Thread – Casing Couplings (BTC)
   - Vam Top
   - Tenaris

B Tubing

Based on the definition of the American Petroleum Institute (API) specification 5CT, tubing is a pipe placed within a productive well to serve as an exhaust or delivery duct. Selection of tubing to be used in drilling activity divided by the order of the following criteria:

1. Tubing size Outer Diameter (OD)
   Tubing size used is as follows:
   BA Tubing size OD 2-⅜ inches
   BB Tubing size OD 2-⅞ inches
   BC Tubing size OD 3-½ inches
   BD Tubing size OD 4-½ inches
   BE Tubing size OD 5 inches
2. Tubing steel grade.
   Referring to Table 4: API Steel Grades above.
3. Tubing poundage
   The following table is physical properties of HD-L tubing base on Atlas Bradford data for some tubing size and nominal weight (pounds per foot):

Tubing O.D (in)	Grade	Nominal Weight (lb/ft)	Tubing Wall Thickness (in)	Inner Diameter (in)
2 3/8	H40	5.30	0.218	1.939
2 3/8	J55	5.30	0.218	1.939
2 3/8	N80	5.30	0.218	1.939
2 3/8	L80	5.30	0.218	1.939
2 7/8	H40	7.90	0.276	2.323
2 7/8	J55	7.90	0.276	2.323
2 7/8	N80	7.90	0.276	2.323
2 7/8	L80	7.90	0.276	2.323
3 1/2	H40	10.30	0.289	2.922
3 1/2	J55	10.30	0.289	2.922
3 1/2	N80	10.30	0.289	2.922
3 1/2	L80	10.30	0.289	2.922
4 1/2	H40	13.50	0.290	3.920
4 1/2	J55	13.50	0.290	3.920
4 1/2	N80	13.50	0.290	3.920
4 1/2	L80	13.50	0.290	3.920
5	H40	15	0.296	4.408
5	J55	15	0.296	4.408
5	N80	15	0.296	4.408
5	L80	15	0.296	4.408

Table 7: HD-L Tubing Specifications[32]

4. Tubing couplings
   Below are the common sizes of the couplings for tubing used:
   - External Upset End – Tubing Couplings (EUE)
   - Non Upset End Tubing – Couplings (NUE)

C Casing Accessories

All accessories that are attached on the casing string in the well bore. Includes in casing accessories are:

- Float shoe for any size
- Float collar for any size
- Centralizer for any size
- Stop collar for any size
- Liner hangers
- Line packers hangers
- External casing packers

D Well equipment – surface

Includes in well equipment – surface are complete wellhead and Christmas tree attached to the well, i.e.:

- Wellhead
- Christmas-tree

- Casing head
- Casing head spool
- Casing hanger
- Tubing hanger
- Tubing head spool
- Choke
- Pressure gauge
- Temperature gauge

E Well equipment – subsurface

Includes in well equipment – subsurface are tubing accessories and fluid lifting equipment.

- Packer
- Cement retainer
- Sucker rod pump
- Pump rod
- Plunger pump
- Submersible pump
- Pump cable
- Crossover
- Sand screen

Appendix 2

Form BS 19

Indonesian Government Agency
PRODUCTION SHARING CONTRACT
AUTHORIZATION FOR EXPENDITURES - DRILLING AND WORKOVER

SCHEDULE NO. 19

OPERATOR :
CONTRACT AREA :
CONTRACT AREA NO. :
:

PROJECT TYPE : DRILLING / WORKOVER
WELL NAME :
WELL TYPE : EXPLORATION/DELINEATION/DEVELOPMENT
PLATFORM/TRIPOD :
FIELD/STRUCTURE :
BASIN :

AFE NO. :
DATE :

IN U.S. DOLLARS

LOCATION :
WATER DEPTH :
:
SPUD DATE :
COMPLETION DATE :
PLACED INTO SERVICE :
DRILLING DAYS :
CLOSE OUT DATE :

SURFACE COORDINATE LAT : ____________ LONG : ____________
ELEVATION : ____________ CONTRACTOR : ____________

COMPLETION TYPE : SINGLE / DUAL / TRIPLE

	PROGRAM	ACTUAL
RIG DAYS	: ________	________
TOTAL DEPTH	: ________	________
WELL COST PER FOOT S/Ft	: ________	________
WELL COST PER DAY S/DAY	: ________	________
WELL STATUS	: ________	

LINE	DESCRIPTION	WORK PROGRAM AND BUDGET	REVISED BUDGET	FINAL BUDGET	ACTUAL EXPENDITURES PRIOR YEARS	CURRENT YEARS	TOTAL	ACTUAL OVER/(UNDER) BUDGET	PERCENTAGE OVER/(UNDER) BUDGET
		1	2	3	4	5	6	7	8
1	TANGIBLE COST								
2	CASING								
3	CASING ACCESSORIES								
4	TUBING								
5	WELL EQUIPMENT - SURFACE								
6	WELL EQUIPMENT - SUBSURFACE								
7	OTHER TANGIBLE COST								
8									
9	TOTAL TANGIBLE COST								
10	INTANGIBLE COST								
11	PREPARATION AND TERMINATION								
12	- SURVEYS								
13	- LOCATION STAKING AND POSITIONING								
14	- WELLSITE AND ACCESS ROAD PREPARATION								
15	- SERVICE LINES & COMMUNICATIONS								
16	- WATER SYSTEMS								
17	- RIGGING UP / RIGGING DOWN								
18									
19	SUBTOTAL								
20	DRILLING / WORKOVER OPERATIONS								
21	- CONTRACT / RIG								
22	- DRILLING RIG CREW / CONTRACT RIG CREW								
23	- MUD, CHEMICAL & ENGINEERING SERVICES								
24	- WATER								
25	- BITS, REAMER AND CORE HEADS								
26	- EQUIPMENT RENT								
27	- DIRECTIONAL DRILLING AND SURVEYS								
28	- DIVING SERVICES								
29	- CASING INSTALLATION								
30	- CEMENT, CEMENTING AND PUMP FEES								
31									
32	SUBTOTAL								
33	FORMATION EVALUATION								
34	- WATER								
35	- MUD LOGGING SERVICES								
36	- DRILLSTEM TESTS								
37	- OPEN HOLE ELECTRICAL LOGGING SERVICES								
38									
39	SUBTOTAL								
40	COMPLETION								
41	- INSURANCE								
42	- CASING LINER AND TUBING INSTALLATION								
43	- CEMENT, CEMENTING AND PUMP FEES								
44	- CASED HOLE ELECTRICAL LOGGING SERVICES								
45	- PERFORATING AND WIRELINE SERVICES								
46	- STIMULATION TREATMENT								
47	- PRODUCTION TEST								
48	SUBTOTAL								
49	GENERAL								
50	- SUPERVISION								
51	- INSURANCE								
52	- PERMITS AND FEES								
53	- MARINE RENTAL AND CHARTERS								
54	- HELICOPTER AVIATION AND CHARGES								
55	- LAND TRANSPORTATION								
56	- OTHER TRANSPORTATION								
57	- FUEL AND LUBRICANTS								
58	- CAMP FACILITIES								
59	- ALLOCATED OVERHEAD - FIELD OFFICE								
60	- JAKARTA OFFICE								
61	- OVERSEAS								
62	- TECHNICAL SERVICES FROM ABROAD								
63									
64	- . . . . SUBTOTAL								
65	TOTAL INTANGIBLE COST								
66	TOTAL COSTS								
67	TIME PHASED EXPENDITURES				REMARKS				
68	- THIS YEAR								
69	- FUTURE YEARS								
70	TOTAL								

Operator : APPROVED BY
POSITION
DATE

Indonesian Government Agency APPROVED BY
POSITION
DATE

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Appendix 3

Form BS 20

Indonesian Government Agency
PRODUCTION SHARING CONTRACT
AUTHORIZATION FOR EXPENDITURES - DRILLING AND WORKOVER MATERIAL LIST

SCHEDULE NO. 20
ATTACHMENT TO SCHEDULE NO. 19

OPERATOR :
CONTRACT AREA :
CONTRACT AREA NO. :

PROJECT TYPE : DRILLING / WORKOVER
WELL NAME :
WELL TYPE : EXPLORATION/DELINEATION/DEVELOPMENT
FIELD STRUCTURE :

AFE NO. :
DATE :

IN U.S. DOLLARS

LINE	DESCRIPTION	UNIT OF ISSUE	BUDGET								ACTUAL			ACT. OVER/UNDER		SURPLUS MATERIAL	
			ISSUED FROM STOCK			NEW PURCHASE			GRAND TOTAL								
			QTY	U.P.	TOTAL	QTY	U.P.	TOTAL	QTY	AMOUNT	QTY	U.P.	TOTAL	QTY	AMOUNT	QTY	DISPOSITION
		2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1																	
2																	
3																	
4																	
5																	
6																	
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24																	
25																	
26	TOTALS																

Operator :

APPROVED BY ________________ Position ______________ Date _________

APPROVED BY ________________ Position ______________ Date _________

Indonesian Government Agency

APPROVED BY ________________ Position ______________ Date _________

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About the Author

Gideon Wibowo

Jakarta, Indonesia

Gideon Wibowo currently works at SKK Migas as a Cost Engineer on the upstream oil and gas business unit for evaluating and controlling capital project (Capex) and operating expense (Opex) for Oil & Gas Production Sharing Contractors as per PSC Agreement. He has five years of professional experience in electrical and instrumentation in offshore construction (supervising construction and mechanical completion) as E&I Construction Engineer for five EPCI projects and over two years of professional experience in electrical and instrumentation in mining operation/ maintenance as E&I Maintenance Engineer. Gideon has a Bachelor's degree in Electrical Engineering, Sub Option Instrumentation and Control, from the Universitas Gadjah Mada (UGM). He holds international credential from AACEI as a Certified Cost Professional (CCP). Gideon can be contacted at gideonde@gmail.com.