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Can multidimensional WBS be the solution
for IT Project Issues?
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Abstract

From small organization to large, IT projects are growing rapidly with the revolution of technology and expansion of systems. They worth the companies a lot and become very important while most of the organizations are moving toward digitizing and automation. Consequently, the need of good project management is necessary to achieve the goal without wasting time and cost.

Work Breakdown Structure WBS has proven to be a powerful control, plan and monitor tool for projects. It decomposes the projects to manageable components. This helps to execute the project very well, estimate the cost and schedule, allocate and assign resources and track the project progress and performance. The result of all of these outcomes can hit the heart of the project success.

Through this short paper, different models of WBS will be explored including a 3D WBS. 3D WBS was first introduced by Moine where he projected 3 types of tree structure and combined them together to form one cube model that make effective different in the project management field. The paper will also suggest, based on comparison and evidence, for IT project managers to adopt the 3D model as it proves its efficiency in other industrial fields.

Keywords: *WBS, Building Information Modeling, Multi-Dimensional WBS structure, Business Intelligence System, components, tasks, tree structures.*

1. Introduction

From small to large organizations, IT projects exist in almost all the companies. The success of these projects reflects highly in the performance of the organization in general. Implementing Enterprise Resources Planning (ERP) systems, Document management systems (DMS) and others have lots of potential challenges in each and every implementation step and activity. One of the tools used to implement the project successfully and overcome the challenges is Work Breakdown Structure (WBS).

Work Breakdown Structure WBS is a tool to decompose the project into smaller components (tree structure). It's a project management tool that is important to establish a framework for better management control over the projects budget, schedule and scope. It is also defined as "an enumeration of all work activities in hierarchic refinement of detail which organizes work to be done into short manageable tasks with quantifiable inputs, outputs, schedules, and assigned responsibilities" [1]

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[1] See Tausworthe in the Journal of Systems and Software Vol. 1, pages 181-186.

PM World Journal
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The WBS has been developed from being flat and covers only one perspective of the project to be multidimensional and more comprehensive by combining different types of tree structure. Construction projects are using multidimensional models since almost 50 years and these models are standardized for the construction and civil projects and can be up to 4 dimensions. Recently, Moine[2] developed an 8 dimensional model by combining many types of tree structures.

The 8 dimensions model developed by Moine is basically based on the famous theory of Lisi: The unified theory of universe[3]. The theory was developed by a young scientist called Garrett Lisi who presents in this theory an 8 dimensional model of elementary particles which can answers all the big questions of the universe. Lisi said: "All fields of the standard model and gravity are unified as an E8 principal bundle connection"[3]. This claim can have a positive effect on WBS by assuming that the tasks (lowest component of multidimensional WBS) can have common fractals repeated from bottom to upper level building up a full project. The repeated fractal here is the star tetrahedron shape shown below which has the 8 questions: What, Where, How, When, Who, Why, How much and For What. The answers of these questions can be derived from a multidimensional database and they are the same questions repeated for each component in each level of the project and program. One note about the Lisi theory is that it's not yet completed nor finalized.
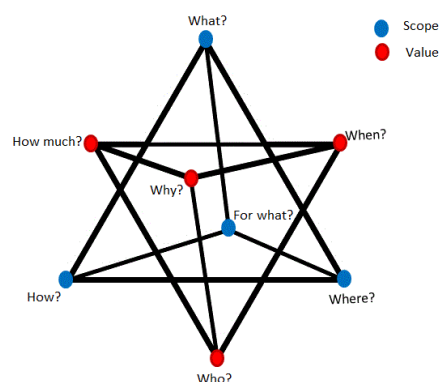

Figure 1 – Star tetrahedron project [4]

Oil and gas field has also created and used a multidimensional standard coding model – Norsok – since 25 years ago. NORSOK Z-014 cost coding system consists of 3 set of sub-coding systems: physical breakdown structure, standard activity breakdown and code of resources.

Toward WBS standardization, construction industry started using a Building Information Modeling since the last decade. Building Information Modeling is the process of creating and developing virtual design and construction illustrating the whole project's life cycle. Hence, Building Information Model (BIM) –produced by the building information modeling process – is a 3D digital representation of the building components and functional characteristics using consistent types of data and information. The BIM helped the construction industry to come over serious challenges like the increasing demand of labors versus the hourly cost.

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[2] See *Moine, J.Y.* http://3d-wbs.blogspot.fr
[3] See Lisi paper http://arxiv.org/pdf/0711.0770v1.pdf
[4] See *Moine, J.Y.* http://3d-wbs.blogspot.fr

PM World *Journal*
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However, one of main issues that have been sorted out by BIM is scheduling. BIM can be used for scheduling and cost estimates, in fact 4D BIM is a schedule integrated BIM where you can see multiple dimension of Gantt schedule and instance drawings.[5]

Illustrating the whole life cycle of an IT project is very useful achieving the project. In the early 2000s almost most of the biggest countries with the biggest construction projects has adopt BIM. However, this tool is still shy in IT field; the BIM along with WBS can build a very powerful multidimensional schedule. Imagine what useful information the project managers, project team and informed parties can get when WBS is used to build BIM – along with other information. One for instance and as mentioned previously is the multidimensional schedule. What WBS offers for BIM is a standard WBS codification.

BIM is out of this paper scope however continuing with WBS and specifically what called 3D WBS (multidimensional) model. Other than the ordinary "flat" WBSs which are currently used in IT projects, 3D WBS shapes a cube out of many tree structure types crossed each other and gives 6 faces or sides of views. How we are seeing the project from 6 different perspectives. A 3D WBS combines activities, zones and products so standardization can be generated from activities vs. products for any product line. The zones however will be different from project to another.

IT projects are still without known standard codification system and didn't publish any multidimensional model for WBS. The other business fields have been running projects successfully for their projects with standardization and in order to build one we need first to find the most appropriate model.

The author in this paper is going to try to answer the following questions:

1. Is a multi-dimensional WBS approach suitable or appropriate for use in software development and IT projects?

2. Is there any comparison or analogies that can be drawn from the architecture and engineering of buildings using Building Information Modeling (BIM) to the architecture and engineering of software projects?

2. Tree structure types

There are many types of tree structure as following:[6]

- ZBS (Zone Breakdown Structure) or GBS (Geographical Breakdown Structure)
- PBS (Product Breakdown Structure)
- SBS (Systems Breakdown Structure) or FBS (Functional Breakdown Structure)
- ABS (Activity Breakdown Structure)
- OBS (Organization Breakdown Structure)
- RBS (Resources or Risks Breakdown Structure)

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[5] Review Hergunsel, M. F. (2011) thesis *BENEFITS OF BUILDING INFORMATION MODELING FOR CONSTRUCTION MANAGERS AND BIM BASED SCHEDULING*
[6] See *Moine, J.Y.* http://3d-wbs.blogspot.fr

PM World *Journal*
Vol. III, Issue XI – November 2014
www.pmworldjournal.net

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Featured Paper   by Asma AlFadha

- CWBS (Contract Work Breakdown Structure) and many others.

In IT projects, manager are mostly used ZBS, PBS and ABS and in this paper particularly we will concentrate on these types for flat WBS types.

A. Zone Breakdown Structure (ZBS)

The term Zone Breakdown Structure (ZBS) refers to the tree structure of areas, sites or the geographical parts of the project generally. For IT projects the ZBS can be:

- **Functional:** System versions or releases. For each release, we add functionalities
- **Physical:** can be categorized as:
    1. Web applications
    2. Desktop applications
    3. Mobile, tablets applications
- **Environmental:** The operating system for desktop: Windows, Mac, UNIX or Linux. For the mobiles: iOS, Android, BlackBerry etc... For the websites the zones can be considered as the types of the browsers: IE, Firefox, chrome etc...
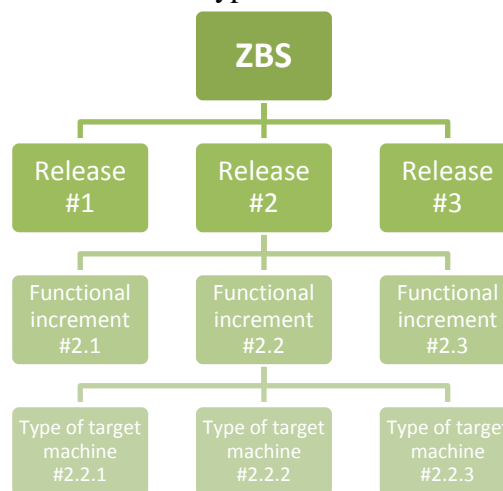

Figure 2 – ZBS[7]

B. Product Breakdown Structure (PBS)

The product breakdown structure breaks the project into physical elements, products, systems or sub-systems. The system or the software usually is divided into multiple applications, programs that together they form the final system. Each one of those programs and small modules form a release or, what developers like to call, version of a system.

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[7] See *Moine, J.Y.* paper titled 3D Work Breakdown Structure method. 2013, April

PM World *Journal*
Vol. III, Issue XI – November 2014
www.pmworldjournal.net

Can multidimensional WBS be the solution
for IT Project Issues?
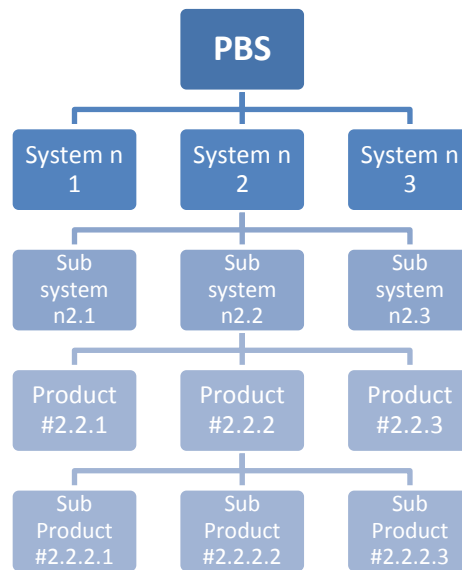Featured Paper   by Asma AlFadha

Figure 3 – PBS [8]

C. Systems Breakdown Structure (SBS)

PBS is part of system breakdown structure (SBS); some called it Function Breakdown Structure. Figure 2 explain how the product is part of a system.

D. Activity Breakdown Structure (ABS)

Activity breakdown structure is the hierarchy of activities, phases and sub-activities. The activities are linked together to form processes. Activities are not tasks rather than actions that can be described with verbs.
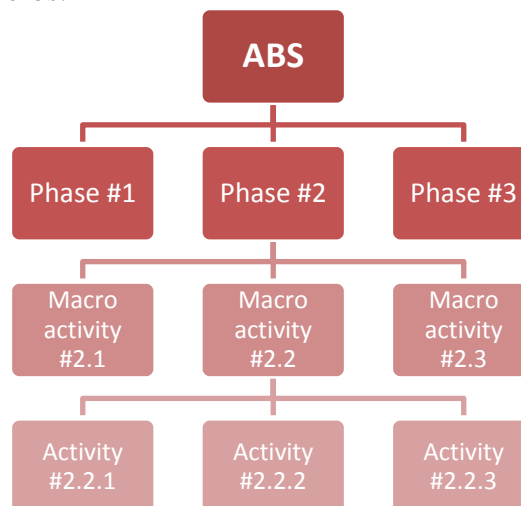
Figure 4 – ABS[9]

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[8] See *Moine, J.Y.* paper titled 3D Work Breakdown Structure method. 2013, April
[9] See *Moine, J.Y.* paper titled 3D Work Breakdown Structure method. 2013, April

PM World Journal
Vol. III, Issue XI – November 2014
www.pmworldjournal.net

Can multidimensional WBS be the solution for IT Project Issues?
Featured Paper
by Asma AlFadha

E. 3D WBS

Moine (2013) has developed a 3D WBS model after a railway project in Qatar. The model projects the flat types of WBS and combines them into one cube. Furthermore, Moine has figured out the activities (ABS) are deployed on products (PBS) which are constructed and deployed on geographical areas (ZBS) and came up with the 3D model.

The 3 types are mixed together to form a dimensional cube where the ABS is the x-axis, PBS is the y-axis and the z-axis is ZBS. Hence, a fourth dimension can be added which is the Organization Breakdown Structure, OBS, and this can be extended to Resources Breakdown Structure, RBS.

The three tree structures: ABS, PBS and ZBS crossed each other to build the 3D WBS cube producing small cubes inside the big one; these cubes are the project's tasks.
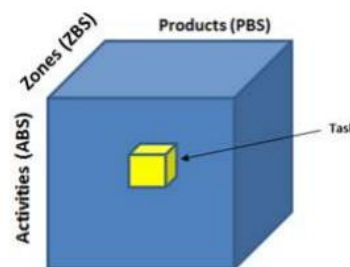

Figure 5 - 3D WBS cube [10]

For IT Projects this model is very powerful. Instead of having linear WBS with one dimensional, more components can be considered while breaking the projects. Most of the IT systems are in fact a collection of small programs and this is the reason behind why PBS is widely used in IT. More, there is an orientation toward "phases" and dividing the project into defined phases. However, all of these models have shortages as we will explore in later sections.

3. Develop WBS for IT Projects

There so many approaches used for WBS in IT projects. The project managers are usually mixing 2 types of tree structures to come up with a suitable one, a mixture of product and activities is often used to form 2D WBS. Here are two models of WBS:

1. Product – Activities model: Activities (ABS) are deployed for each product (PBS) where level 1 is PBS, level 2 is ABS. the figure below illustrate this model for Business Intelligence System (BI).

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[10] See *Moine, J.Y.* paper titled 3D Work Breakdown Structure method. 2013, April

PM World *Journal*
Vol. III, Issue XI – November 2014
www.pmworldjournal.net

Can multidimensional WBS be the solution
for IT Project Issues?
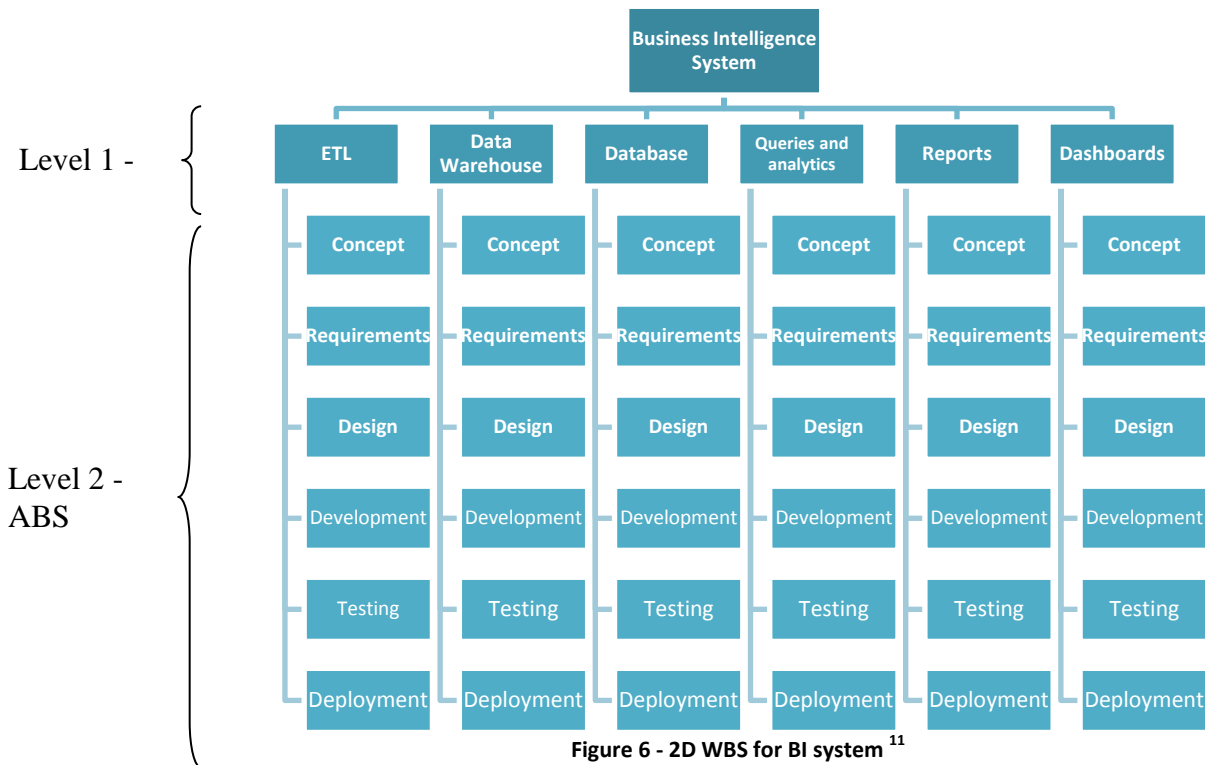Featured Paper   by Asma AlFadha

Figure 6 - 2D WBS for BI system [11]

2. Phases model (ABS): The second is the purely activities group by phases. This one is commonly used in IT projects, activates are set as the highest level of the structure and they are applied to each product and version. The same previous example –BI system – will be used for this model also.
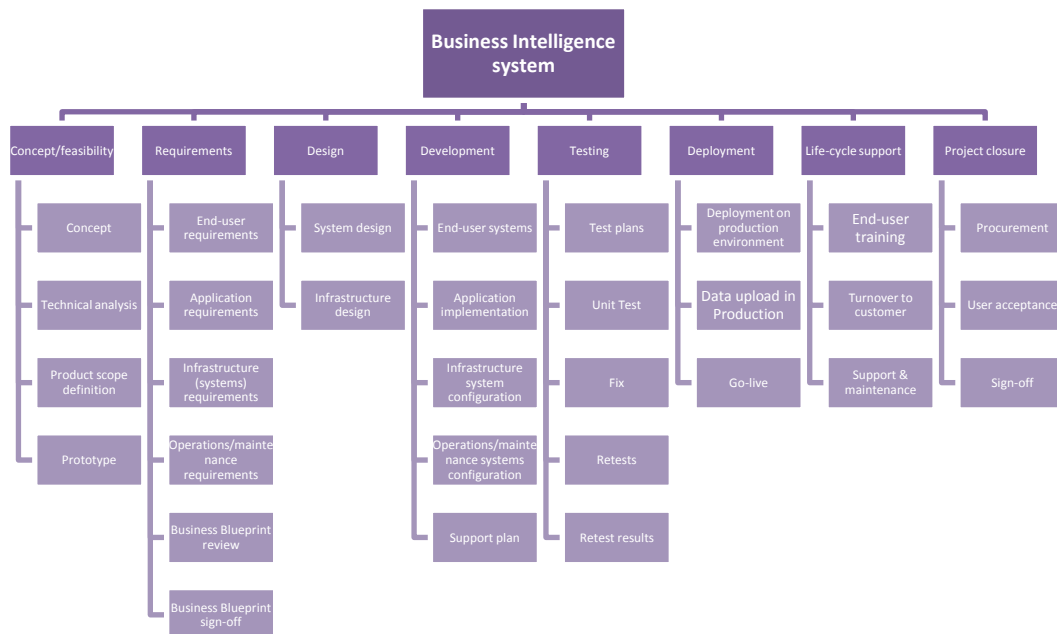

Figure 7 - ABS for BI system [12]

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[11] AlFadha, A. (2014)
[12] AlFadha, A. (2014)

PM World Journal
Vol. III, Issue XI – November 2014
www.pmworldjournal.net

Can multidimensional WBS be the solution
for IT Project Issues?
Featured Paper   by Asma AlFadha

4. Developing 3D WBS for IT projects

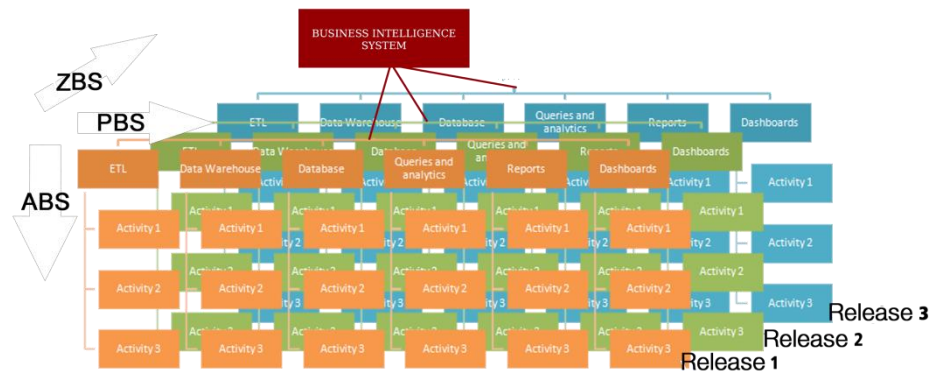The trend now is going toward the multidimensional structures.

Figure 8 - 3D WBS cube [13]

5. WBS Comparison

Comparing between the 3 above WBSs, below is a list with advantages and disadvantages for each model.

1. Product – activities breakdown structure (by products):

   Advantages:
   - o It gives quite comprehensive look about the project and what's required to be done by products
   - o The level of details is Fair
   - o Flexible cost estimate product wise

   Disadvantages:
   - o It doesn't give a comprehensive image by releases (ZBS)
   - o Easy to report the higher levels however it will become more difficult to report to the client when you go more deeply in work
   - o Difficult for resources assignment

2. Activities breakdown structure (by phases):

   Advantages:
   - o Easy for resources assignment
   Disadvantages:
   - o Un- comprehensiveness
   - o The level of details is bad
   - o Progress report is not optimal
   - o Not good for cost estimate

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[13] AlFadha, A. (2014)

PM World Journal   *Can multidimensional WBS be the solution*
Vol. III, Issue XI – November 2014   *for IT Project Issues?*
www.pmworldjournal.net   Featured Paper   by Asma AlFadha

3. 3D WBS

> **Advantages:**
> - o Excellent level of details
> - o Comprehensive, covers all aspects of the project structures
> - o Progress report can be easily prepared
> - o Optimal for cost estimate

6. Discussion: Multidimensional WBS (3D WBS) for IT project

This short paper discusses the WBS for IT projects in general however the author would like to highlight the 3D WBS and multidimensional models particularly. As previously defined 3D combines 3 types of WBS, this helps to better understand the projects and manage them more efficiently. Furthermore, the Responsibility Assignment Matrix (RAM) can be represented in the 3D WBS and this allows assigning the smallest components in the 3D cube, the tasks, to OBS (organization breakdown structure) and resources. Instantly where pure ABS (phase's structure) lacks of deep details of the project, 3D WBS gives an excellent details up to tasks and their resources assignment (this can extend 3D WBS to more dimension up to 8). Unlike flat WBS, 3D WBS has flexible report preparation by any aspects; progress report can be prepared by products, zones (versions) or activities which suit any decision makers and stakeholders from any discipline.

3D WBS introduces what it called logical links which build interfaces between the structure's smallest components. Those interfaces get produced when two tasks are linked together building a network inside the WBS. The types of relationships -links- between the tasks are the classical: Finish to Start (FS), Start to Start (SS) and Start to Finish (SF) however the natures of these logical links are Zones, Products and Activities. For instant, FS can have the three coordinates - zones, product and activities - but each logical link will have one dominate coordinate. Each task has a start and finish dates off course and with these links a flexible and complete schedule can be created perfectly. Accordingly, the interfaces are the period or distance between each tasks in the WBS and this helps a lot in identifying the risks of the projects.

One of major issues with IT projects is expansion of functionality where the requirements goes beyond the scope and the customer requests and expects more from the software, system or application. Expansion of functionality will lead to cost overrun and delay in project schedule, one of the ultimate solutions to solve this problem is a robust and good WBS. 3D and multidimensional in general allows for better cost estimate based on products, versions or activates. For that the 3D WBS defines the tasks better than any models as it, in other words 3D WBS says: "activities for a product that is implemented in certain version of the system".

Looking at the other experience with multidimensional WBS, multidimensional models have been adopted from quite long time in construction and oil and gas projects. The different models including Omniclass and Norsok have up to 4 dimensions. Omniclass has developed to classify the information used in engineering and construction fields. This classification standardized all the organization information and it's contributing in building BIMs for constructions projects.

PM World Journal
Vol. III, Issue XI – November 2014
www.pmworldjournal.net

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for IT Project Issues?
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The Omniclass has defined tables to cover all projects' aspects. The struggling with the IT projects to find suitable model to breakdown the projects.

7. Conclusion

The paper showed different types of WBS and it presented the 3D WBS – type of multidimensional WBS- as a suitable model for IT projects. IT projects suffer from many issues starting from inaccurate cost estimation to insufficient master project schedule and WBS is one of the powerful tools to come over such issues. The advantages of 3D WBS showed how useful it is in the IT field and IT project managers need to start adopting this trend in order to practically evaluate it and cope up with other fields which already start using it.

Flat WBS (or flat file database) are used currently by many IT managers however they have deficiencies and people are still debating on what's the best to be used in IT. Multidimensional in this case can be a more suitable option to invest on. How multidimensional can link information together and facilitate reporting, will bring different stages of an IT project together. As discussed earlier in this paper, an ERP system – for example - will be more manageable if we link the phases of the project together.

The important of standardization in IT project becomes obvious day by day. To have one standard model for WBS is needed to end up the market mess in this significant field. Imagining that each company / contractor has their own model and method to carry out the projects will definitely results in difficulties in measuring the quality, carrying out the projects implementation and evaluates them.

One last note, All WBS types need dictionaries to briefly define the components of the structures. The dictionary can define many types of information like resources, component codes and contract references. It's an important enclosure with the WBS to have a common understanding and good communication between the project team.

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PM World *Journal*
Vol. III, Issue XI – November 2014
www.pmworldjournal.net

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Asma AlFadha is a senior developer in a Salalah Methanol Company subsidiary of Oman Oil Company (OOC), Sultanate of Oman. She worked previously with one of the biggest software company in the country and was involved with many huge projects for government and big companies. Ms AlFadha has experience in many programming languages and different platforms. Being part of the whole life cycle of the software provided the experience not only in dealing with computers and languages, but also in communicating with people and learning to understand them and analyze their thoughts for transforming into computerized codes. Asma has 5 years' experience in development. She graduated from Sultan Qaboos University with a bachelor's degree in Computer Science. Contact her on: asma.fadhah@smc.co.om or fadhaasma@gmail.com