

Multi-dimensional Project Breakdown Structures to Ensure Efficient Delivery of Hospital Construction ¹

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ABSTRACT

Health-care related spending is growing worldwide. To increase efficiency and control costs, health economics are applied by hospital management. The purpose of this case study is, therefore, to explore the best solution to integrate and standardise the WBS/CBS comparing different methods.

2D Standard WBS/CBS approach researched to define if this is the best solution to allow local governments to reach financial and social goals while still maintaining control of the estimate and applying the best international practices and the highest ethical standards², this from the tendering process as the country is considered the 101 most corrupt nation out of 179 countries³, and one of the two hospitals considered in this case study was stopped due to corruption and cost overruns or if we need to look to new solutions to guarantee efficient delivery of the projects.

KEYWORDS: WBS, CBS, Multidimensional WBS, Hospitals, Coding Structures, Best Practice, Government Agreements, BIM, 3D Coding Structures

INTRODUCTION

A new wave of agreement between European governments and the Peruvian government is taking place, after the successful implementation of this state-to-state agreement in the 2019 Pan-American Games ⁴.

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² International standards. (n.d.). <https://www.rai-see.org/international-standards/>

³ most corrupt countries 2020. (n.d.). 2020 World Population by Country.

<https://worldpopulationreview.com/country-rankings/most-corrupt-countries>

⁴ Mace celebrates Pan-American success in Lima and secures new role in Peru. (n.d.). Mace.

<https://www.macegroup.com/media-centre/190730-mace-celebrates-pan-american-success-in-lima-and-secures-new-role-in-peru>



Figure 01: Completed T30 building in Huna Province⁵

The challenge for the Peruvian economy, and with many economies and for other countries in the region, is to build the first-class infrastructure to bring growth and prosperity to their citizens reducing or eliminating public spending mistakes⁶ and corruption⁷ that many times in the past created wrong spending of public funds and personal enrichments, of which we have examples all around the world.

In this respect, the new model for developing local infrastructure paid by taxes will create an alternative approach to building high-quality public projects, on time and with extremely competitive costs. International experience and track record on programs like the Pan and Parapan American Games brings the capabilities to build the infrastructure that the local populations expect. Nevertheless, when it comes to project controls, budgeting and cost tracking, the Cost Breakdown Structure (CBS)⁸ carries out an integral role in the management of construction projects. For many organisations, designing a standardised CBS can present several challenges.

The reality is that many times we find ourself trying to define how to break down interdependent buckets to manage the finances properly.

⁵ (n.d.). Juegos Panamericanos y Parapanamericanos | Lima 2019. <https://www.lima2019.pe/>

⁶ The Oxford Olympics study 2016: Cost and cost overrun at the games. (n.d.). arXiv.org. <https://arxiv.org/abs/1607.04484>

⁷ Corruption perceptions index. (2019, December 4). Transparency.org. <https://www.transparency.org/en/cpi#>

⁸ BS (Cost breakdown structure). (2018, July 25). The Project Definition. <https://www.theprojectdefinition.com/cbs-cost-breakdown-structure/>

Many times the group that manages the finance will use its own Standard Code of Accounts that provides an initial point in preparing the CBS and other coding structures (such as resource codes) for labour, material or equipment. But accounting does typically not divide down the way the coding is done to the level of granularity that is needed today to manage projects, in particular, the more complex and big ones, so many times the Project Management Office team is left with designing how these coding structures are.

There are some significant differences between the coding system for accounting and the cost control systems for major projects and that is projects are work driven and the actual completion and delivery of activities and tasks to achieve the technical specification of the scheme. If we take into consideration all this element, it makes sense to prepare design cost codes in buckets that align with the actual work and those particular tasks. It makes sense, and there is a natural fit to assign a cost code to a task, this because the task is quantifiable in different ways, see materials, hours, and equipment that is needed to finalise the task, and this leads to being associated with the costs, budget, progress, and others. Considering that, it is inherent to map the hierarchy of the work breakdown structure (WBS)⁹ to a hierarchical cost breakdown structure.

If we design the work breakdown structure correctly, it can serve a dual purpose of representing not only how work is organised, but also how cost and progress are broken down and organised.

While it might seem obvious to sync all these things together, there are many aspects to consider when coordinating cost codes with the work breakdown structure. Usually, the WBS on complex and significant projects traditionally created by the planners and schedulers in specific software and often includes activities and milestones that are not relevant in the cost management of the project. This will result in the work breakdown structure we will find in the cost management system will be significantly smaller in the size of the work breakdown structure that can be found in the scheduling system. Project Controls professionals that find themselves in this situation will many times take one of two approaches:

Try to create a unique work breakdown structure that can be of use for cost management. This leads to the program work breakdown structure not to be synchronised and will change independently from the CBS.

Then we should sync the programme WBS with the cost controls work breakdown structure, but at the same time mark the unneeded activities, and WBS levels in the schedule to not be synchronised

We should also consider that the cost breakdown structure typically needs code elements, one or more, to map to the accounting system's code of accounts that we are using. Usually, these 'mapping' code elements will often have little connection to the WBS and only serve the purpose of synchronising data between project cost controls and accounting.

⁹ Work breakdown structure. (n.d.). [workbreakdownstructure.com. https://www.workbreakdownstructure.com/](https://www.workbreakdownstructure.com/)

As the objective of our assignment is to support the Peruvian Minister of Health¹⁰ and its operational arm PRONIS¹¹ to build and reconstruct hospitals in various regions of the country, from greenfield developments to demolition and reconstruction to finalisation of hospitals blocked due to misuse of public funds, one of the goals of the PMO¹² is to set up a standardised WBS/CBS. With the goal to achieve timely completion of the project, completing the deliverable of the technical specifications and the social benefits to the involved population.

To ensure this, the PMO team needs to create a standardise WBS/CBS that will ensure we include all deliverables, will allow us to verify and update the cost estimates while creating a reliable CPM schedule that will minimise the risk while still maximising opportunities at the early stages of the Assets development life span and guarantee proper communication to the numerous stakeholders to ensure the ethical and anticorruption standards are met. So what are our goals? What do we want to achieve? To respond to this, we need to respond to the following questions?

Do the current integrated, standardised WBS/CBS solutions align to the needs of our projects?

What is the recommended solution from the PMO for an integrated WBS/CBS solution?

As we are working on live projects, we will be able to monitor our decisions in regards to the standardise WBS/CBS and provide even better feedback and lessons learned, while still making the necessary changes to the chosen structure, that has an even more significant complication of being, by contract, fast track projects.

METHODOLOGY

Step 1

Across the world, many governments are now under heavy pressure for improving services of health care during this ongoing Covid-19 pandemic¹³ whilst always attempting to use their scarce resources efficiently. Hospital buildings are basically one of the essential elements of health care systems. Developing the scope of the project as the outset is the correct method of mapping the features of the project and keeping internal consistency with the project objectives. All project work is broken down into deliverables and activities in which resources are allocated, scheduled, budgeted, and later, controlled. This process is formalised under the creation of the work breakdown structure (WBS), as summarised in Figure 2.

¹⁰ Ministerio de Salud. (n.d.). Gobierno del Perú. <https://www.gob.pe/minsa/>

¹¹ Programa Nacional de Inversiones en Salud. (n.d.). Gobierno del Perú. <https://www.gob.pe/pronis>

¹² Project management office. (2005, October 25). Wikipedia, the free encyclopedia. Retrieved September 28, 2020, from https://en.wikipedia.org/wiki/Project_management_office

¹³ Coronavirus disease (COVID-19) – World Health Organization. (n.d.). WHO | World Health Organization. <https://www.who.int/emergencies/diseases/novel-coronavirus-2019>

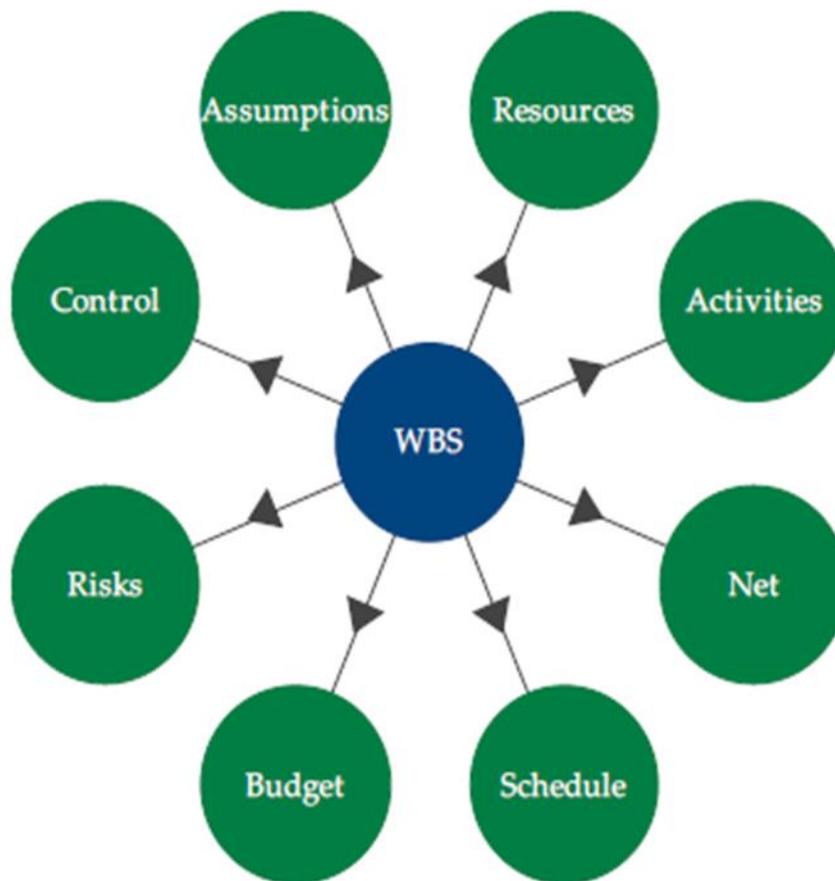


Figure 02: Relationship of the work breakdown structure with the project¹⁴

Regarding the level of detail of the decomposition, there is no uniform criterion either. Still, depending on the industry, organisational culture, and type of contract, a series of guidelines can be provided. For example, for effective project planning and control, the WBS must reflect an appropriate level of detail, reflecting the extent of decomposition and the sizing of the WPS. Generally, in a project in general but especially for construction projects, stakeholders need/want the answers to the following eight questions or criteria.

1. Who
2. What
3. Why
4. Where
5. When
6. How
7. How Much
8. For What Purpose

¹⁴ (PDF) Integration of cost and work breakdown structures in the management of construction projects. (2020, February 19). ResearchGate. https://www.researchgate.net/publication/339353789_Integration_of_Cost_and_Work

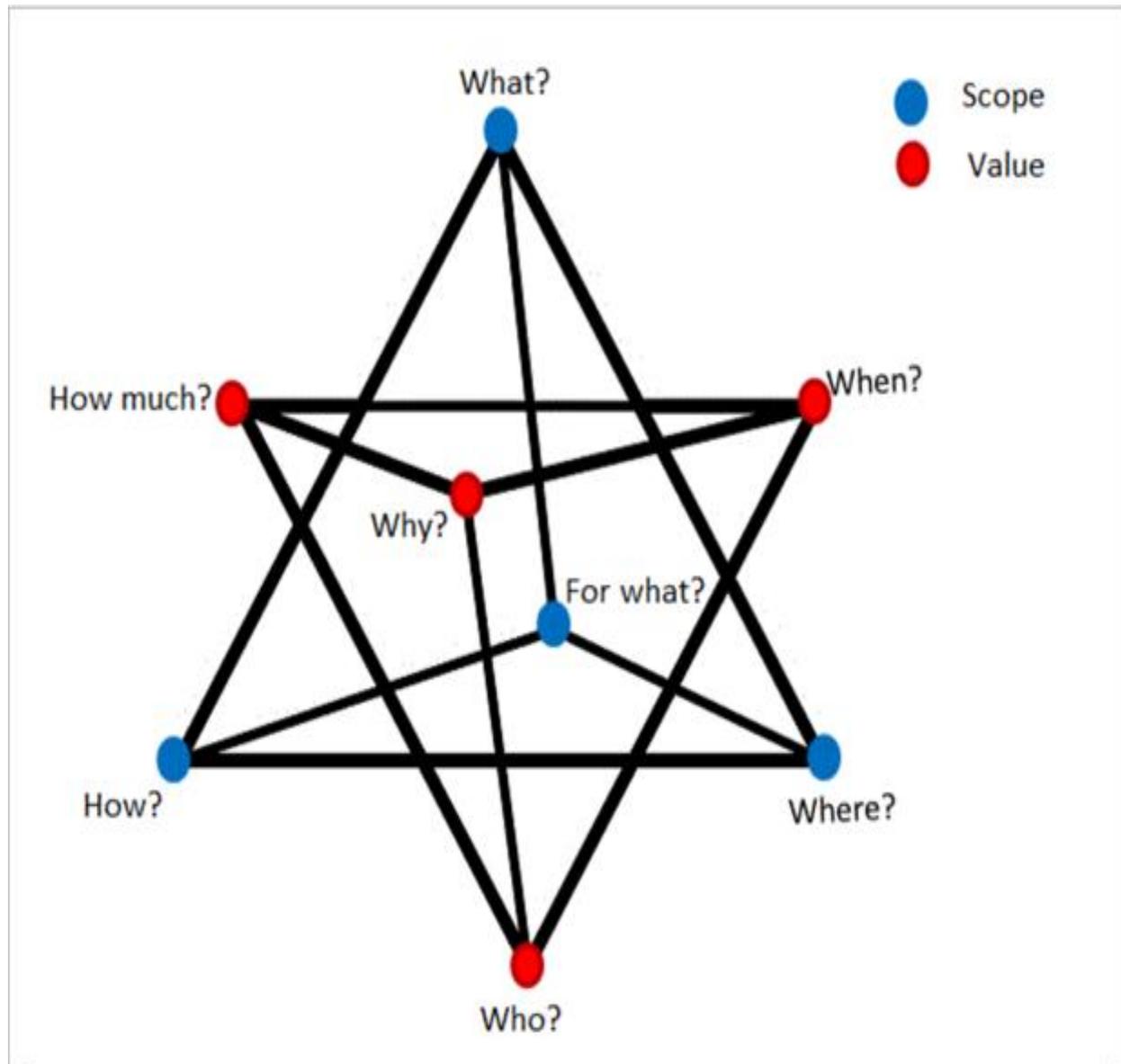


Figure 03: The 8 High-Level Questions for Stakeholders ¹⁵

Based on this, we define the work content through the WBS, but to classify all this information, the coding system needs to be set up. This will allow us to use the WBS for archiving and retrieving project information. Hence, choosing an adequate classification system (aggregated) is the first step when preparing the WBS.

¹⁵ The 8 Questions for Stakeholders to the right based on research by Garrett Lisi adapted to project management by Moine, Jean Yves, Leynaud, Xavier, Giammalvo, Paul

Also, it needs to be taken into consideration that we are shifting from a flat-file¹⁶ or hierarchical structures towards relational or object-oriented coding structures that allow for greater flexibility to filter and sort the available data and that better complies with our requirements. Therefore, we need to have both standardised structures but also multi-dimensional coding structures to allow for the required flexibility and integration.

A construction project involves a series of processes, from design to planning, construction, maintenance, and disposal. The CBS, the cost breakdown structure identifies all relevant cost categories in all project life cycle phases. Hence, the cost breakdown structure supports a breakdown of project costs.

The cost breakdown structure classifies all types of expenses (e.g., equipment, preparation, wages, welfares, maintenance, energy consumption, depreciation, taxes, fees, and others). The CBS allows for costs to be collected, during the planning and construction phases, then analysed and reported for every item that was cost generated.

This cost, as it happens for the WBS, can be consolidated similarly, and it might happen that the codes from both systems appear to be similar. A fundamental difference is that the lowest level of CBS is known as cost Account (CA). We can compare the cost account to the work package of the WBS.

The CA is considered the apparent management focal point where the costs of each work to be done are integrated. We usually also include the costs in relation to the organisational structure to support the development, while allowing singular accountability and responsibility to undertake it. It is easy to notice that all these different functions relate to management functions like control, planning, work definition, estimating, managing change, cost definition, expenditure, information analysis and reporting.

Activity-based costing (ABC) is a costing method that assigns overhead and indirect costs to related products and services. This accounting method of costing recognises the relationship between costs, overhead activities, and manufactured products, assigning indirect costs to products less arbitrarily than traditional costing methods¹⁷.

¹⁶ Difference between a flat-file and relational Database(Comparison). (2020, February 23). Relational DB Design (Database Design and Analysis). <https://www.relationaldbdesign.com/basic-sql/module3/relational-versus-flatfile.php>

¹⁷ Activity-based costing (ABC). (n.d.). Investopedia. <https://www.investopedia.com/terms/a/abc.asp>

However, some indirect costs, such as management and office staff salaries, are challenging to give to a product. We can see an exact representation of activity-based costing in Figure 3. So, we can break down the result of our projects into WPs.

These, in turn, can be divided into activities, which are the ones that generate costs. Once activities are defined, indirect costs can be allocated to activities through their cost-drivers

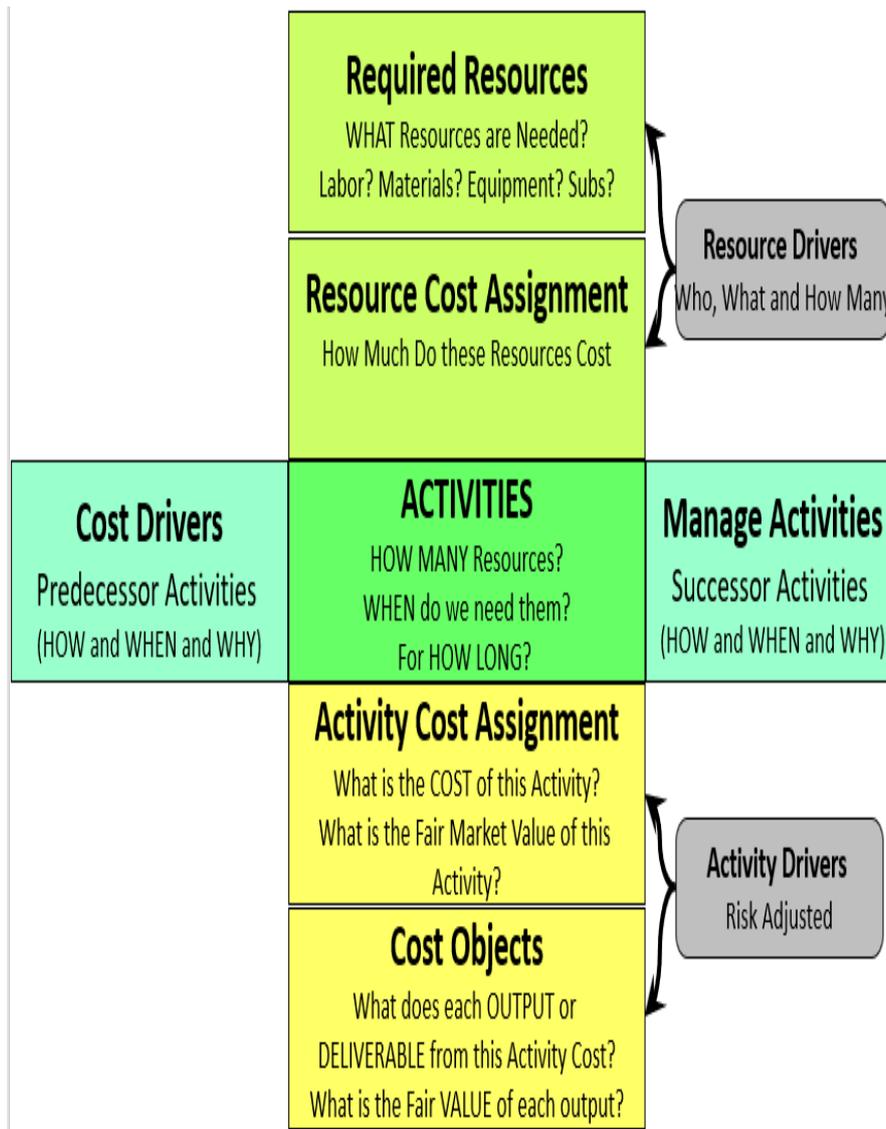


Figure 04 Adapting the information from the Cost Estimating Database into the Activity Based Costing¹⁸

¹⁸ Adapted from “Implementing Activity Based Costing” (n.d.) IMA and Gary Cokins <https://goo.gl/t39BzG> as published in the PM World Journal, Figure 10 page 21 of 28. <https://pmworldlibrary.net/wp-content/uploads/2018/04/pmwj69-Apr2018-Giammalvo-ERP-and-BIM-Omniclass-coding-marriage-featured-paper-1.pdf>

On the other hand, in figure 8 below, shows major coding system proposals aimed at standardising the cost structures of projects. With the advent of BIM, we need to process information automatically. It is fundamental to name all objects and their properties in a unique way, as a must, also using reference libraries when we have object-oriented information in others. This at the end All this has led to the development of a new standard: The ISO 12006-3. This standard is currently under review.

Code	Edition		Ref	Scope	Organization
	First	Last			
Masterformat	1963	2018	[103]		
Uniformat	1973	2010	[104]	USA ¹	Construction Specifications Institute
OmniClass	2006	2019	[105]		
DIN 276-1	1993	2008	[95]	Germany	Deutsches Institut für Normung
BSAB	1996	2005	[96]	Sweden	Swedish Building Centre
CoClass	2015	2018	[108]		
UniClass	1997	2019	[97]	UK ²	Construction Project Information Committee
TALO	2000	2017	[98]	Finland ³	Building Information Foundation
DBK	2006	2010	[99]		
CCS	2012	2017	[109]	Denmark	Building Information Technology, Productivity, and Stands (Dansk Bygge Klassifikation)
CMCP	2008	2014	[94]		
ICMS	2017	2019	[100]	Europe	European Committee of Construction Economists (International coalition)
ISO 12006-2	2001	2015	[106]		
ISO 81346-12	2018	2018	[107]	World	International Organisation for Standardisation

Figure 05: Comparison of the International Standards Evolution¹⁹

As we have discussed before we have defined our feasible alternatives as follows:

1. Uniclass²⁰, is a consistent classification structure for all disciplines in the construction industry. It contains tables classifying items of any scale from a large facility such a railway, down to products such as CCTV camera in a railway station. It is an important way of identifying and managing the vast amount of information that's involved in a project, and it is a requirement for BIM projects, as set by the BS EN ISO 19650 series of standards.
2. CSI Omniclass²¹ is a comprehensive classification system for the construction industry. Can be used for many applications, such as filing physical materials or organising project

¹⁹ (PDF) Integration of cost and work breakdown structures in the management of construction projects. (2020, February 19). ResearchGate. https://www.researchgate.net/publication/339353789_Integration_of_Cost_and_Work

²⁰ Uniclass, 2015. (n.d.). NBS. <https://www.thenbs.com/our-tools/uniclass-2015>

²¹ OmniClass® - Construction specifications institute. (n.d.). Construction Specifications Institute. <https://www.csiresources.org/standards/omniclass>

information, but its chief application is to provide a classification structure for electronic databases and software, enriching the data used in those resources. It incorporates other extant systems currently in use as the basis of two of its Tables – MasterFormat for Table 22 - Work Results and UniFormat for Table 21 - Elements.

3. ISO 12006-2:2015 defines a framework for the development of built environment classification systems. It identifies a set of recommended classification table titles for a range of information object classes according to different views, e.g. by form or function, supported by definitions. It shows how the object classes classified in each table are related, as a series of systems and sub-systems, e.g. in a building information model.²²
4. COClass is a Swedish classification system for the built environment, it gives all parties access to a common language, i.e. the same concept and terminology at all stages, in all parties, in all software and in all information deliverables²³
5. ISO 81346-12 This document establishes rules for the structuring of systems and the formulation of reference designations and provides classes for courses in the field of construction works and building services. This document also specifies a classification of objects and corresponding letter codes for use in reference designations of object occurrences.²⁴
6. Norsok Z-014, Standard cost coding system (SCCS)²⁵. The NORSOK standards are developed by the Norwegian petroleum industry to ensure adequate safety, value-adding and cost-effectiveness -for petroleum industry developments and operations. Furthermore, NORSOK standards are as far as possible intended to replace oil company specifications and serve as references in the authority's regulations. The NORSOK standards are developed according to the consensus principle, generally applicable standards work and according to established procedures defined in NORSOK A-001. This NORSOK standard describes a system for coding of cost and weight estimates and as-built/experience data. The method comprises three sets of complementary sub-coding approaches named:
 - a. PBS (Physical Breakdown Structure)
 - b. SAB (Standard Activity Breakdown)
 - c. COR (Code Of Resources)

²² ISO 12006-2:2015. (n.d.). ISO. <https://www.iso.org/standard/61753.html>

²³ CoClass. (n.d.). CoClass - Sveriges nya digitala klassifikationssystem. <https://coclass.byggjtjanst.se/login>

²⁴ ISO 81346-12:2018. (n.d.). ISO. <https://www.iso.org/standard/63886.html>

²⁵ Norsok Z-014. (2012, May 18). Techstreet -Technical Information Superstore. https://www.techstreet.com/standards/norsok-z-014?product_id=1904582

Step 2

As this is a publicly funded work, even if managed with a Turn-Key contract based on the FIDIC Silver Book, we need to define how our attributes respond to our eight high-level criteria, Who, What, Where, When, How, How Much, and for What Purpose based on which we will be able to make our decisions. Our objective is to allow the contractor to be able to create an activity-based costing, a level4/5 cost and resource loaded schedule, and what are the feasible alternatives based on the main international standards and if we need to integrate these standards to achieve our objectives, we think, as Covey's suggests with the end in mind²⁶.

Before we can do this, we need to create our MADM scoring model using “Key Words” analysis to match the different attributes from our selected international standards, see appendix 1²⁷, to rationalise and establish for each international standard if it complies with the attributes and has a summary table to compare the different standards.

Figure 6 shows how we created our MADM analysis using keyword analysis starting from appendix 1, and the result of this analysis is figure 7 and 8.

²⁶ Covey's seven habits: Begin with the end in mind | Art of manliness. (2020, October 5). The Art of Manliness. <https://www.artofmanliness.com/articles/the-7-habits-begin-with-the-end-in-mind/>

²⁷ Definition of attributes for each standard, by Author and Dr Paul D. Giammalvo

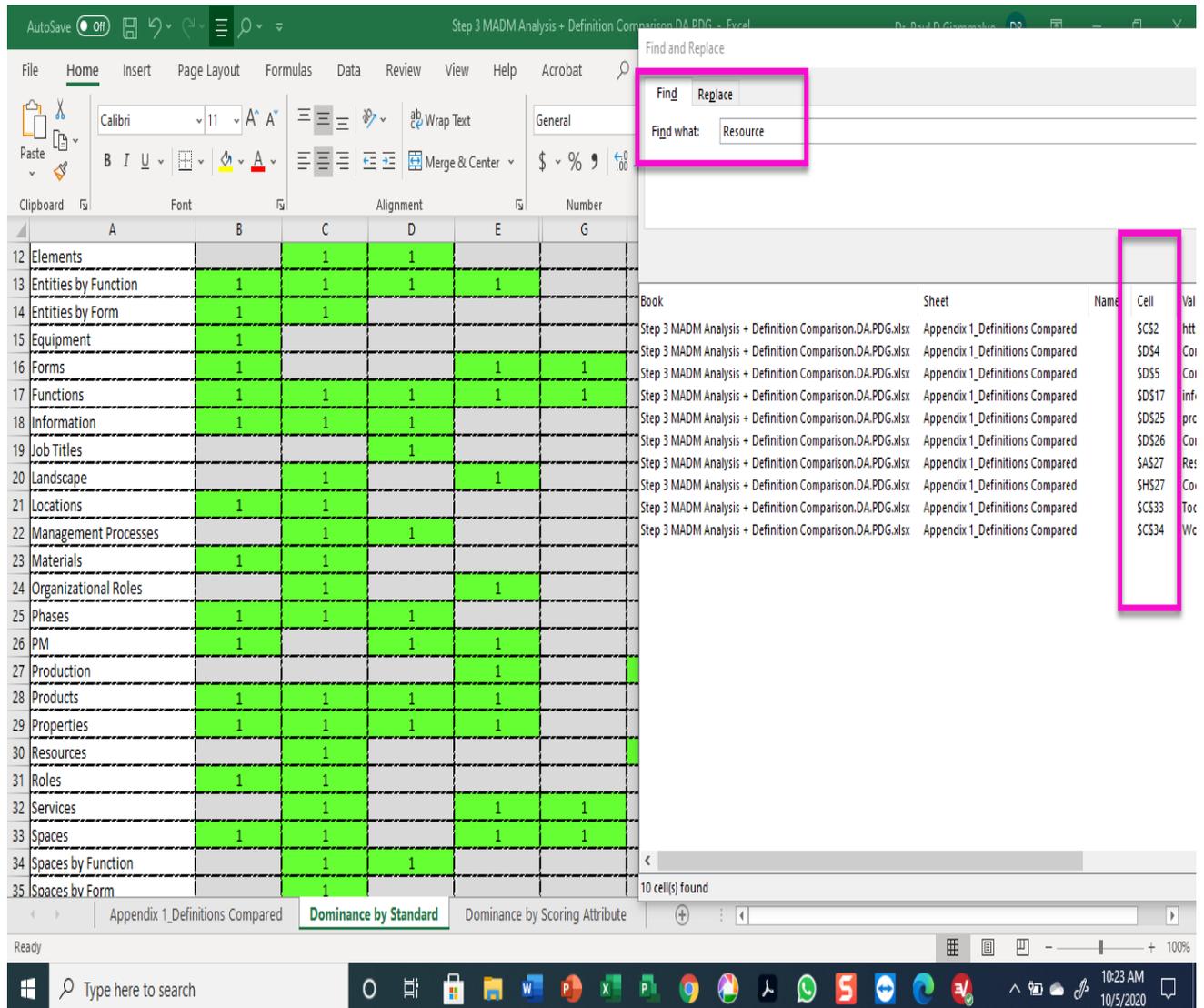


Figure 6: Illustrating How the Scoring Model was Created Based on Key Word Analysis

Now that we have defined the way we have established our MADM analysis, we can have a two-step process; first, we will rank order by our feasible alternatives and then by scoring attributes.

#	Key Word	Omiclass	Uniclass	ISO 12006-2	CoClass	CCS	ISO 81346-12	Norsok Z-014	TOTAL ROW
1	Activities	1	1					1	3
2	Agents		1	1				1	3
3	Aids			1					1
4	Built Spaces			1		1			2
5	CAD			1					1
6	Classes		1	1	1	1			4
7	Complexes/Complexity		1	1	1			1	4
8	Components	1			1	1	1	1	5
9	Disciplines	1	1	1					3
10	Documents		1			1			2
11	Elements	1		1					2
12	Entities by Function	1	1	1	1	1			5
13	Entities by Form	1	1						2
14	Equipment		1			1			2
15	Forms		1		1		1		3
16	Functions	1	1	1	1	1	1		6
17	Information	1	1	1					3
18	Job Titles			1					1
19	Landscape	1			1				2
20	Locations	1	1						2
21	Management Processes	1		1					2
22	Materials	1	1						2
23	Organizational Roles	1			1				2
24	Phases	1	1	1					3
25	PM		1	1	1				3
26	Production				1			1	2
27	Products	1	1	1	1				4
28	Properties	1	1	1	1				4
29	Resources	1						1	2
30	Roles	1	1						2
31	Services	1			1		1		3
32	Spaces	1	1		1		1		4
33	Spaces by Function	1		1					2
34	Spaces by Form	1							1
35	Systems		1						1
36	Technics				1	1	1		3
37	Tools	1	1		1				3
38	User Spaces					1			1
39	Work Results	1		1					2
	TOTALS BY COLUMN	24	22	19	16	9	6	6	

Figure 7: MADM analysis, rank order by feasible alternatives, rows²⁸

²⁸ MADM analysis, rank order by feasible alternatives, rows, by Author and Dr Paul D. Giammalvo

#	Key Word	Omniclass	Uniclass	ISO 12006-2	CoClass	CCS	ISO 81346-12	Norsok Z-014	TOTAL ROW
1	Functions	1	1	1	1	1	1		6
2	Components	1			1	1	1	1	5
3	Entities by Function	1	1	1	1	1			5
4	Classes		1	1	1	1			4
5	Complexes/Complexity		1	1	1			1	4
6	Products	1	1	1	1				4
7	Properties	1	1	1	1				4
8	Spaces	1	1		1		1		4
9	Activities	1	1					1	3
10	Agents		1	1				1	3
11	Disciplines	1	1	1					3
12	Forms		1		1		1		3
13	Information	1	1	1					3
14	Phases	1	1	1					3
15	PM		1	1	1				3
16	Services	1			1		1		3
17	Technics				1	1	1		3
18	Tools	1	1		1				3
19	Built Spaces			1		1			2
20	Documents		1			1			2
21	Elements	1		1					2
22	Entities by Form	1	1						2
23	Equipment		1			1			2
24	Landscape	1			1				2
25	Locations	1	1						2
26	Management Processes	1		1					2
27	Materials	1	1						2
28	Organizational Roles	1			1				2
29	Production				1			1	2
30	Resources	1						1	2
31	Roles	1	1						2
32	Spaces by Function	1		1					2
33	Work Results	1		1					2
34	Aids			1					1
35	CAD			1					1
36	Job Titles			1					1
37	Spaces by Form	1							1
38	Systems		1						1
39	User Spaces					1			1
	TOTALS BY COLUMN	24	22	19	16	9	6	6	

Figure 8: MADM analysis, rank order by scoring attributes, column²⁹

²⁹ MADM analysis, rank order by scoring attributes, column, by Author and Dr Paul D. Giammalvo

Step 3

At this point, we can now proceed to combine the two previous tables into a single table that we have now sorted both based on our feasible alternatives and our scoring attributes. This will allow us to select which standard complies with our requirement.

#	Key Word	Omniclass	Uniclass	ISO 12006-2	CoClass	CCS	ISO 81346-12	Norsok Z-014	TOTAL ROW
1	Functions	1	1	1	1	1	1		6
2	Components	1			1	1	1	1	5
3	Entities by Function	1	1	1	1	1			5
4	Classes		1	1	1	1			4
5	Complexes/Complexity		1	1	1			1	4
6	Products	1	1	1	1				4
7	Properties	1	1	1	1				4
8	Spaces	1	1		1		1		4
9	Activities	1	1					1	3
10	Agents		1	1				1	3
11	Disciplines	1	1	1					3
12	Forms		1		1		1		3
13	Information	1	1	1					3
14	Phases	1	1	1					3
15	PM		1	1	1				3
16	Services	1			1		1		3
17	Technics				1	1	1		3
18	Tools	1	1		1				3
19	Built Spaces			1		1			2
20	Documents		1			1			2
21	Elements	1		1					2
22	Entities by Form	1	1						2
23	Equipment		1			1			2
24	Landscape	1			1				2
25	Locations	1	1						2
26	Management Processes	1		1					2
27	Materials	1	1						2
28	Organizational Roles	1			1				2
29	Production				1			1	2
30	Resources	1						1	2
31	Roles	1	1						2
32	Spaces by Function	1		1					2
33	Work Results	1		1					2
34	Aids			1					1
35	CAD			1					1
36	Job Titles			1					1
37	Spaces by Form	1							1
38	Systems		1						1
39	User Spaces					1			1
TOTALS BY COLUMN		24	22	19	16	9	6	6	

Figure 9: Combination by feasible alternatives and scoring attributes of the MADM analysis,³⁰

³⁰ MADM analysis, rank order by scoring attributes, by Author and Dr Paul D. Giammalvo

Step 4

As we have now made our analysis, we can now eliminate any feasible alternative that has a score minor to 19, so we can then proceed to exclude the international standards that are not compliant with the requirements.

#	Key Word	Omniclass	Uniclass	ISO 12006-2	TOTAL ROW
1	Functions	1	1	1	3
2	Entities by Function	1	1	1	3
3	Products	1	1	1	3
4	Properties	1	1	1	3
5	Disciplines	1	1	1	3
6	Information	1	1	1	3
7	Phases	1	1	1	3
8	Classes		1	1	2
9	Complexes/Complexity		1	1	2
10	Spaces	1	1		2
11	Activities	1	1		2
12	Agents		1	1	2
13	PM		1	1	2
14	Tools	1	1		2
15	Elements	1		1	2
16	Entities by Form	1	1		2
17	Locations	1	1		2
18	Management Processes	1		1	2
19	Materials	1	1		2
20	Roles	1	1		2
21	Spaces by Function	1		1	2
22	Work Results	1		1	2
23	Components	1			1
24	Forms		1		1
25	Services	1			1
26	Built Spaces			1	1
27	Documents		1		1
28	Equipment		1		1
29	Landscape	1			1
30	Organizational Roles	1			1
31	Resources	1			1
32	Aids			1	1
33	CAD			1	1
34	Job Titles			1	1
35	Spaces by Form	1			1
36	Systems		1		1
37	Technics				0
38	Production				0
39	User Spaces				0
TOTALS BY COLUMN		24	22	19	

Figure 10: Key Words Rank Ordered by Number of Standards³¹.

Now we have all the elements to analyse which standard could be the best fit for our need and if this is complete or we will have to add further attributes to comply with the technical requirements, this will allow us to properly understand which are the answers to our technical papers questions.

³¹ Key Words Rank Ordered by Number of Standards, by Dr Paul D. Giammalvo and Author

FINDINGS

Step 5

As we can see we have no shortage of project breakdown structures, see WBS, CBS, CWBS which are “flat filed” or better known as 2-D coding structures, but do the ones examined answer our questions? Moreover, do they comply with our requirements?

Based on the results of step 4, we can clearly see which standards have the highest score, but we can also see that the standards agree only for the first seven scoring attributes.

#	Key Word	Omniclass	Uniclass	ISO 12006-2	TOTAL ROW
1	Functions	1	1	1	3
2	Entities by Function	1	1	1	3
3	Products	1	1	1	3
4	Properties	1	1	1	3
5	Disciplines	1	1	1	3
6	Information	1	1	1	3
7	Phases	1	1	1	3

Figure 11: Top attributes in an agreement between the standards³²

And we can see that for the rest of the attributes, the standards are not in complete agreement or completely lack some of the attributes. The following attributes are only answered by two of our selected standards.

#	Key Word	Omniclass	Uniclass	ISO 12006-2	TOTAL ROW
8	Classes		1	1	2
9	Complexes/Complexity		1	1	2
10	Spaces	1	1		2
11	Activities	1	1		2
12	Agents		1	1	2
13	PM		1	1	2
14	Tools	1	1		2
15	Elements	1		1	2
16	Entities by Form	1	1		2
17	Locations	1	1		2
18	Management Processes	1		1	2
19	Materials	1	1		2
20	Roles	1	1		2
21	Spaces by Function	1		1	2
22	Work Results	1		1	2

Figure 12: Attributes agreed by only two of the standards³³

³² Top attributes in an agreement between the standards, by Dr Paul D. Giammalvo and Author

³³ Attributes agreed by only two of the standards, by Dr Paul D. Giammalvo and Author

Continuing our selection, we can now see those attributes that are only met by one of the standards.

#	Key Word	Omniclass	Uniclass	ISO 12006-2	TOTAL ROW
23	Components	1			1
24	Forms		1		1
25	Services	1			1
26	Built Spaces			1	1
27	Documents		1		1
28	Equipment		1		1
29	Landscape	1			1
30	Organizational Roles	1			1
31	Resources	1			1
32	Aids			1	1
33	CAD			1	1
34	Job Titles			1	1
35	Spaces by Form	1			1
36	Systems		1		1

Figure 13: Attributes agreed by only one of the standards³⁴

And finally, we can see that some of the attributes are not met by any of the standards.

#	Key Word	Omniclass	Uniclass	ISO 12006-2	TOTAL ROW
37	Technics				0
38	Production				0
39	User Spaces				0
TOTALS BY COLUMN		24	22	19	

Figure 14: Attributes agreed by none one of the standards³⁵

Based on these observations we should now ask ourselves how each of our eight high-level criteria compare to the 39 attributes and if we have any weaknesses, strengths, opportunities, threats and which of the critical work best answer our high level 8 questions. prior to making our recommendations.

³⁴ Attributes agreed by only one of the standards, by Dr Paul D. Giammalvo and Author

³⁵ Attributes agreed by none one of the standards, by Dr Paul D. Giammalvo and Author

We can see how to compare our keywords with our high-level attributes and see if we are able to answer all our questions.

#	Key Word	How	Who	What	How Much	For What	Where	When	Why	TOTAL ROW
1	Documents		1	1	1			1		4
2	Activities	1		1				1		3
3	Built Spaces			1	1		1			3
4	Production	1			1			1		3
5	Resources	1	1		1					3
6	Spaces			1		1	1			3
7	Disciplines		1		1					2
8	Information	1		1						2
9	Services		1		1					2
10	Technics	1	1							2
11	Elements			1			1			2
12	Equipment	1			1					2
13	Management Processes	1	1							2
14	Materials			1	1					2
15	Roles	1	1							2
16	Spaces by Function			1			1			2
17	Work Results	1			1	1				3
18	Functions			1		1				2
19	Components						1			1
20	Entities by Function					1			1	1
21	Classes		1							1
22	Complexes/Complexity	1								1
23	Products			1						1
24	Properties			1						1
25	Agents		1							1
26	Phases							1		1
27	PM		1							1
28	Tools	1								1
29	Entities by Form					1			1	1
30	Locations						1			1
31	Organizational Roles		1			1				2
32	Aids	1								1
33	CAD	1								1
34	Job Titles		1							1
35	Spaces by Form						1			1
36	Systems	1				1				2
37	User Spaces		1							1
38	Forms					1				1
39	Landscape									0
	TOTALS BY COLUMN	14	13	11	9	8	7	4	2	

Figure 15: Top 8 high-level questions compared to our key words³⁶

We have now established how the eight high-level questions respond to our attributes, but how does each of our standards comply individually? We can see that our highest attribute that answers the highest number of high-level questions documents, which is, as per figure 10, only part of the UniClass Standard.

³⁶ Top 8 high-level questions compared to our keywords, by Dr Paul D. Giammalvo and Author

So, which of our top 3 standards comply most or can better answer our eight high-level questions? If we rank order how the attributes compare to each of our standards, we can notice a few issues with the standards.

#	Key Word	Omniclass	Uniclass	ISO 12006-2	TOTAL ROW
1	Documents		1		1
2	Activities	1	1		2
3	Built Spaces			1	1
4	Production				0
5	Resources	1			1
6	Spaces	1	1		2
7	Disciplines	1	1	1	3
8	Information	1	1	1	3
9	Services	1			1
10	Technics				0
11	Elements	1		1	2
12	Equipment		1		1
13	Management Processes	1		1	2
14	Materials	1	1		2
15	Roles	1	1		2
16	Spaces by Function	1		1	2
17	Work Results	1		1	2
18	Functions	1	1	1	3
19	Components	1			1
20	Entities by Function	1	1	1	3
21	Classes		1	1	2
22	Complexes/Complexity		1	1	2
23	Products	1	1	1	3
24	Properties	1	1	1	3
25	Agents		1	1	2
26	Phases	1	1	1	3
27	PM		1	1	2
28	Tools	1	1		2
29	Entities by Form	1	1		2
30	Locations	1	1		2
31	Organizational Roles	1			1
32	Aids			1	1
33	CAD			1	1
34	Job Titles			1	1
35	Spaces by Form	1			1
36	Systems		1		1
37	User Spaces				0
38	Forms		1		1
39	Landscape	1			1
	TOTALS BY COLUMN	24	22	19	

Figure 16: Attributes ranked by highest based on the eight high-level questions³⁷

³⁷ Attributes ranked by highest based on the eight high-level questions, by Dr Paul D. Giammalvo and Author

It's quite clear that none of the standards is capable of completely answering the eight high-level questions, with the OmniClass able to answer the highest number of questions, based on the top ten keywords. We should also notice how none of the standards is able to respond to two of the top 10 keywords. As we have now established what the strengths, weaknesses, opportunities, and threats of our international standards are, we can now make our recommendations.

Step 6

Considering the current trend of moving from 2D Standard WBS/CBS approach up to an 8D-WBS that better integrates with the trends in controlling and managing projects, see the real use of BIM up to 8D, Virtual reality and augmented reality, among others the author recommendations is to continue integrating the three standards so that we can reduce to a minimum the weaknesses present in the three standards as per our figure 16 analysis and maximise the opportunities that they give us plus a complete integration to a Multi-Dimensional Breakdown Structure that will enable us to anticipate the adoption of the best practices and better respond to the top 8 high-level questions.

Step 7

So, what about our initial questions? And how are we going to truck it?

1. Do the current integrated, standardised WBS/CBS solutions align to the needs of our projects? As we have seen the number of WBS/CBS is quite significant around the world with many different international solutions or even numerous national and company-specific solutions which are usually customised based on specific needs. So, while we can say that we can adopt different solutions to our needs, we cannot take a ready to use solution for our specific situation, in particular, if we want to answer the eight high-level questions asked by our stakeholders.
2. What is the recommended solution from the PMO for an integrated WBS/CBS solution? As we will have to maximise the possible sharing of information among a significant amount of public stakeholders while still assuring maximum ethical and transparency, the Author suggests pushing the boundaries of the current way of thinking to 2D structures and shift towards an integration of this two-dimensional structure to a multi-dimensional by combining the three standards into an integrated structure with a Multi-Dimensional Breakdown Structure to answer appropriately to our stakeholders.

FOLLOW ON RESEARCH

Further research is ongoing to establish the actual multi-dimensional breakdown structure that will allow real and consistent integration and capability to answer the eight high-level questions.

[To access a useful Glossary of relevant terms, click here.](#)

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Danilo Arba is a project controls & management enthusiast, with 20 years of experience. He is a Certified Cost Engineer with an Executive MBA from Politecnico di Milano. With a thorough understanding of EPC (Engineering, Procurement, and Construction) industry, he has a verifiable track record of planning multimillion/billion-dollar construction projects worldwide. He lived & worked all his life around the world from South America, Africa, South East Asia to Europe. He is adept at building and leading cross-functional teams from project conception to completion, optimising performance, contractual, and financial deliverables. Currently he is furthering his education by way of a distance learning mentoring course, under the tutorage of Dr Paul D. Giammalvo, CDT, CCE, MScPM, MRICS, GPM-m Senior Technical Advisor, PT Mitrata Citragraha, to attain Guild of Project Controls certification.

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