



Position Paper 2.21: P1

The Role of Location in Existing Project Management Structures

Project 2.21:

New project management models for
productivity improvement in infrastructure



**Sustainable
Built Environment**
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Project Partners



Project Team

Project leader

Prof. Russell Kenley (Swinburne)

Research team members

Professor Geoff West (Curtin)
Dr Toby Harfield (Swinburne)
Amin Vafaeikararoudi (Swinburne)
Juliana Beddgood (Swinburne)
Raphael Dua (Balmoralhill Pty Ltd)

Industry team members

David Bobbermen (QTMR)
Chris Harrison (RMS)
David Grenfell (JHG)

Synopsis

Position Paper 1 proposes a matrix project breakdown structure for construction project management. First, it outlines a brief history of the development and purpose of project management processes. It then suggests an alternative solution to the problem of location related data repetition in project management processes.

The Work Breakdown Structure, a fundamental of project management, provides a method for assigning work packages, through a decomposition based on hierarchical 'parent and child' segmentation of the total project, to the lowest level of decomposition. Construction requires the consideration of location in the decomposition process. Location-based thinking advocates that location be explicitly managed.

Traditional project management includes location within the hierarchical breakdown of project deliverables. It is possible to remove location into its own location breakdown structure (LBS) and thus greatly simplify the remaining WBS. Combining the two differently focused breakdown structures into a WBS/LBS matrix can provide a new container for project data at the intersections, requiring a great deal less repetition and effort.

Thus, location-based thinking will provide the basis for new work breakdown decomposition models such as work/location breakdown matrices for infrastructure projects.

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THE ROLE OF LOCATION IN EXISTING PROJECT MANAGEMENT STRUCTURES

The methods of project management and related structuring of project data potentially influences the efficiency of production and the administration cost of construction. Applying location-based thinking to construction projects has identified repetition associated with location. Explicitly incorporating location into project breakdown structures has the potential to significantly (1) improve project management efficiency and (2) reduce project administration costs.

Introduction

This project was borne from the idea that, to make a radical improvement to the productivity of construction work, it is first necessary to deconstruct the way we do things. Adopting the principle that you can't change what you don't understand, this project aims to deepen our understanding of the way we organise construction work.

The concepts are neither radical nor new. In fact, the ideas come from direct observation of construction management and project administration. And yet, they seem radical and perhaps even confronting. Any change can seem a challenge to what we know.

This position paper presents the case for changing the way we look at a fundamental of project management: the Work Breakdown Structure. Project 2.21 is about identifying, through discussions with project managers and analysis of real project data, the way location is already used in the breakdown and management of projects.

The case for new project management structures is made here. This case is supported by the academic literature and our interpretation of project management standards. However, it is derived from location-based thinking and thus an alternative perspective.

Defining the Problem

The construction sector contribution to Australian GDP, investment and employment remains at about eight per cent in 2012 according to The Australian Economy and Financial Markets Report by the Reserve Bank of Australia (RBA, 2013). Thus any method designed to introduce efficiency into construction management processes will benefit the economy, industry and stakeholders.

Considering the quantity of data-handling that is required for all types of construction management processes, reducing data replication will make a significant contribution to improved sector productivity. Developing new methods to reduce construction data management costs can be seen as a significant opportunity, this is especially true for publicly funded infrastructure projects.

One of the dominant themes of database research and design in records management (Ismail and Jamaludin, 2009) and data management (Andritsos et al., 2004) is a concern with data efficiency by minimising data replication.

Currently there is a dearth of Project Management literature considering project breakdown from the perspective of data efficiency and reuse. This is surprising because data redundancy

should be integral to the design and development of an efficient WBS.

Construction project management processes are determined by project management practice. The work breakdown structure (WBS), is a tool used to detail the work required to produce the final deliverables. The WBS is the commonly accepted way to define, or scope or contain the many inter-dependent actions and resources required to manage a project to completion. Thus, 'structure' is a well-entrenched concept in relation to project definition. Therefore one way of dealing with the problem of data replication would be to develop and design the WBS from a perspective other than Work.

Construction management processes: the importance of location

The work breakdown structure (WBS) is an integral project management tool (Norman et al., 2008) which identifies work required to complete a construction project, through analysis of deliverables. For each work breakdown structure, a number of accepted general criteria are used for project decomposition (the process of reducing through a hierarchical breakdown to the level of individual work packages).

Construction projects, whether bridges, road or rail lines, high-rise or wide-rise buildings, all have one characteristic that is different from many other projects. Each of these involves products for the built environment where location is a major feature. All construction projects provide products for a specific location; often the actual construction takes place in that location. Thus, these projects are 'location-oriented', with location being both implicit and explicit for all construction management endeavours.

In a recent study, evidence of a key criterion specific to all construction projects was verified.

Ibrahim et al. (2009) found that 'location' is a principle criterion used by Project Management practitioners for the design and decomposition of work breakdown structures for construction projects.

However, integrating 'location' into WBS decomposition necessitates substantial repetition in data and processes (for example the repetitive delivery of work packages in different locations such as floors). In turn, the finer the level of detail of location used in the WBS, the greater the consequential effort to replicate and to plan, monitor and control work packages. This acts to constrain the development of a work breakdown structure (Dashwood et al., 2002).

A Brief History of Project Management

Project Management is an integration of verified theories from a number of disciplines (Kolltveit, et al., 2007). Weaver (2007) argues that Project Management was conceived as an adaptive system by its early advocates, which suggests they expected evolution. For example, as new concepts and theories are tested and articulated, such as social network theory (Pollack, 2007), they are being incorporated into the ever more complex requirements of Project Management.

The sets of general standards and practices fundamental to Project Management, includes particular knowledge-bases from constituent academic disciplines as noted in Table 1. Project Management is an applied rather than an experimental field of endeavour. This applied focus results in continual up-dates to Project Management standards (PMI, 2003; PMI, 2006; AIPM, 2011; PMI, 2013).

The application of PMI standards is interpreted from a discipline perspective (Söderlund, 2004; Cicmil and Hodgson, 2006). Discipline perspec-



Discipline	Theory	Theory adoption in PM	PM Application
Management	Scientific Management	division of labour	hierarchy tree
Mathematics	graph theory	network modelling	visualisation of project
Operations Research	network theory	network optimisation	product completion time
Industrial Engineering	systems theory	workflow	production life-cycle
Economics	rational choice theory	best price	cost codes
Management	contingency theory	fit to use	WBS
Mathematics	probability theory	data management	work package database

Table 1: Project Management Multiple Theory Adoption History

tives can limit possibilities for changing processes to support improved productivity (Dua, 1997) such as moving the project management processes from the focus on work.

Work Breakdown Structure (WBS)

The multi-discipline nature of project management is evident in the fundamental process to breakdown a project into a manageable structure. WBS is an essential component of Project Management according to almost all scholars and practitioners (Dua, 1997; Colenson, 2000). The concept of WBS originates in network theory (Operations Research) as does much of the founding Project Management literature (Kerzner, 2007) such as Critical Path Method (CPM) and Program Evaluation and Review Technique (PERT).

The original purpose of the WBS was to ensure product completion from a task perspective. The focus of the task perspective is the project that should be delivered as specified, within budget and on time. Key issues include project scope, targets, results, planning and control (Jung and Kang, 2007). A dominant theory underlying this perspective is Taylor's Scientific Management. Also the idea of rational choice indicating that the project work should be based on rationality. Plan-

ning and control methods have a central position in this perspective (Kolltveit, et al., 2007).

The commonly accepted definition for work breakdown structure is: "...a product-oriented family tree subdivision of the hardware, services and data required to produce the end product which is structured in accordance with the way the work will be performed and reflects the way in which project costs and data will be summarised and eventually reported." (Kerzner, 2007). This product breakdown definition is also reflected in the Project Management standards (AS4817-2006; PMI-PMBok, 2013; ISO 21500, 2012).

Interestingly, there is very little literature underpinning this definition (PMI-WBS, 2006). WBS emerged as a tool to ensure scope management from the earliest days of the management of projects. The WBS created a framework for network planning (CPM) and thus was seen as a method for driving task allocation in the network planning of projects in the 1950s and 60s. It seems to have subsequently been accepted as a fundamental of Project Management with very little challenge (Weaver, 2007). According to Archibald & Villoria (1967), project definition equated to work breakdown structure, with the following substructures reliant on the WBS:

- Project Organisation Structure
- Network Plan Structure
- Calendar Time Structure
- Estimating Structure
- Chart of Account Structure
- Funding and Authorisation Control Structure
- Report Structure

These sub-structures must ‘mesh’ together based on systems theory (considered difficult to achieve), with the WBS being the basic foundation in which all other project structures rest (Norman et al., 2008; Rad, 1999; Moder et al, 1983). These sub-structures should form the basis of the subsequent use of the WBS in project administration, but are rarely integrated.

The traditional, activity-based, approach places the emphasis on attempting completeness through comprehensive and inclusive breakdown of the ‘actual work to be done’ referred to as ‘activities’ based on the concept of the Critical Path (Söderlund, 2004). The Critical Path Method (CPM) was developed in 1955 to provide a method of control for coping with the complexities of managing engineering projects (Kelly & Walker, 1959). One of the primary concerns at the time was the trade-off between cost and time (Moder et al., 1983). The work package defines the useful intersection with cost accounts, therefore allowing aggregation of project costs (in the component activities) to provide total project cost, as by definition the breakdown must describe the entire project.

CPM defines individual work activities with a logical (precedence) relationship. A parallel Project Management tool, the Program Evaluation and Review Technique (PERT) developed an equivalent method for reviewing and assessing the likelihood of achieving a planned schedule concerned with probability and risk. The relationship between CPM and the WBS is that CPM as-

sumes that a set of activities can be linked with precedence relationships and once so linked will deliver each work package defined within the lowest level of the WBS.

The theme in the literature, and indeed practice as defined in the Project Management Standards (PMI, 2003; PMI, 2006; PMI, 2013), is to consider projects as being capable of decomposition through hierarchical structures. Application of the reductionist concept of decomposition is the organising principle that enables the process of sub-dividing the total project into smaller parts. This process is carried out to ensure the smallest task is defined and able to be managed within a complex system. The process of decomposition is based on hierarchical, ‘parent and child’ segmentation of the total project (PMI, 2006).

Each sub-division must fit into the defined project scope and completion deliverables. Thus, decomposition can be either a top-down or a bottom-up perspective based on rational choice theory. The lowest WBS level usually contains ‘work packages’ (Norman et al., 2008). The work packages generally form the link to subsequent processes, most particularly scheduling. Detailed time scheduling will break work packages down further into component activities, a process that may involve further hierarchical decomposition (Stal-Le Cardinal & Marle, 2006).

Location as a Unit of Analysis

An alternative methodology for construction scheduling explicitly recognises the importance of location to production efficiency. This is termed location-based scheduling. Originating in graphical methods used as early as 1929 on such innovative projects as the Empire State Building, it was further developed by the Good-year Company in the 1940s and expanded by the US Navy in the 1950s. By the late 50s, the tech-



nique known as Line of Balance (LOB) provided improved control during construction a system for deliberately tracking repetitive work cycles and was the dominant scheduling method. It was, however, overtaken by CPM upon its development in the 60s (Kenley and Seppänen (2010).

Location-based scheduling adopts 'location' as the unit of analysis and the 'task' as the unit of control. In this way, the information about a task may be described once and a hierarchy of locations, or location breakdown structure (LBS), is used to replicate information efficiently (Kenley, 2004).

Location as the unit of analysis is at the heart of a management methodology described as the location-based management system (LBMS). This concept enables all data to be allocated to a data container that has meaning during construction. Effectively, location-based data allows performance to be reported at the level of location (for example a room, zone or floor) for both many functions, including cost, quality and time throughout a project. This provides precision in planning and progress reporting or control.

The significance of location-based scheduling lies in the use of location as the unit of analysis for what is being constructed. Thus the location equates to the purpose of the WBS: to breakdown the project into its deliverables.

Location Breakdown Structure (LBS)

Ibrahim et al. (2009) found that the most frequently used decomposition criteria in the formulation of WBS for building projects are:

1. elements
2. work sections
3. physical location
4. construction aids.

This list indicates that location is embedded into the WBS hierarchy on construction projects. Indeed, Ibrahim et al. (2009) proposed a hierarchical decomposition of a building project based on these criteria. The authors indicate they were not aware of a standardised classification for the "location" criterion. They therefore simply adopted a classification based on floor level since this was identified as the definition commonly adopted by planners. However, at the time they were doing their research, little was published on location breakdown structures (LBS).

In location-based construction management theory, location is explicitly managed by introducing the concept of a Location Breakdown Structure (LBS) (Kenley and Seppänen, 2010). This raises the question: can work breakdown structure decomposition benefit from the use of an LBS in some direct way?

Work/Location Breakdown Matrix

What emerges from this discussion is that traditional project management embeds location in the major structural container WBS of construction projects whereas location-based management of construction establishes a breakdown structure as a specific container for location; an LBS.

Turner (2000) is one of the few scholars to explore the potential of considering the project 'breaking down' from a different perspective. He suggests consideration of a Product Breakdown Structure (PBS) which is indicative of project objectives and a major structural container focused on responsibility and personnel in an Organisational Breakdown Structure (OBS). Most significantly, Turner suggests the WBS is actually a two-dimensional matrix (PBS X OBS) formed by the intersection of the two hierarchical breakdowns at corresponding levels of breakdown.

Thus, the WBS is actually a 2D container for managing a project.

This important concept, considering the intersection of **two differently focused breakdown structures**, has received little further attention by project management researchers. Yet potentially this concept of the WBS as a container reveals a significantly different view of the WBS from the conventional definition of a hierarchical tree (Kerzner, 2007).

This matrix-like view provides a hint for alternative ways to break down project data. If both the WBS and the LBS are considered 'containers', then how would WBS and LBS work together to reduce repetitive data-handling in construction projects?

The Way Forward

Although Turner did not mention a Location Breakdown Structure, location-based thinking represents an opportunity to improve Project Management performance, by focusing on the problem of location related data replication. An alternative construction project management tool would be to strip out location from the WBS (to avoid repetition) and the subsequent development of an LBS and the intersection of the two structures as a matrix—the work/location breakdown matrix.

Identification of location-based data repetition in the WBS and its subsequent uses, combined with analysis of a comparative LBS, will provide the basis for new work breakdown decomposition models such as work/location breakdown matrices. This has the potential for significant savings in data storage, management and processing.

In order to explore the application of a work/location breakdown matrices as a significant tool for data management efficiency and effectiveness,

past projects need to be subjected to 'location' content analysis. This analysis will establish a topography of current construction project management locational terms such as 'geographic', 'building', 'level' or 'zone' and their use within the WBS. The objective is to understand the way that work breakdown structures use location to create project deliverables.

Analysis of the WBS terms for 'location' will also provide an indication the amount of location data-management repetition for each project. It is expected examples along a continuum from very low levels to very high levels of location data repetition will be identified.

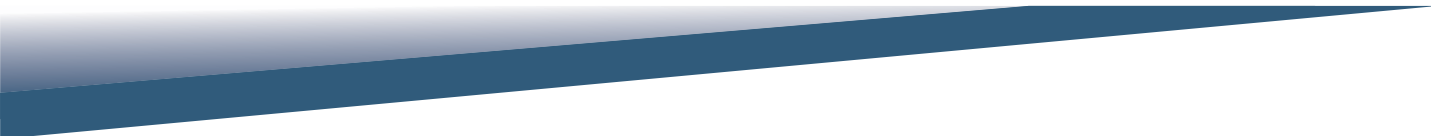
A second level of aggregation will be necessary to develop a topography linking levels of data repetition with specific types of projects. Projects of a repetitive nature, such as high-rise buildings or accommodation complexes, can be expected to have higher levels of data repetition than complex infrastructure projects such as chemical plant.

Identification of location-replication and/or repetition topography can underpin revisiting WBS decomposition to apply the LBS/WBS matrix. Substantial data repetition, during subsequent project management processes that draw upon the WBS, may also provide opportunities for data-handling reduction for construction projects.



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