NUMBERS WITHOUT MEANING – BENCHMARKING OF CIVIL ENGINEERING CONSTRUCTION PROJECTS

Scott Redwood
Student Engineer: Wollongong City Council; University of Wollongong

Abstract
In today's society the demands for efficiency and accuracy are ever more increasing. Federal Governments around the world are applying pressure to ensure Local Government organisations are offering 'best value' in terms of the services they currently provide. Demonstrating 'best value' will require cooperation from individuals at all level of Local Government to come together to develop an adequate system via the adaption of former concepts along with new ideas.
This paper considers how to provide 'best value' with respect to Civil Engineering construction projects in a Local Government environment. The concept of cost management will be explored to define an approach to solve this new age issue.
Research results in how to accurate implement the three stages of cost management: accurately derive initial estimate of Civil projects; effective collection of data for analysis and cost control of collected information.
The successful application of the researched information on 'cost management' will allow Local Government organisations to ensure they will continue to deliver their services to the community into the future.

Key Words: 'Best value'; 'Cost management'; 'Benchmark'; 'Estimate'; 'Cost control'; 'Compatibility'; 'Local Government'; 'Construction'; 'Civil Engineering'

1. INTRODUCTION

This paper focuses on the current challenges facing Local Government organisations as they strive to demonstrate 'best value' in terms of the 'best in business'. In particular it details a method for the control and monitoring of Civil Engineering construction projects developed from Hamilton's (2004) 'cost management' system. Federal Governments around the world are applying pressure on Local Governments to ensure they deliver a high standard of services when benchmarked against comparable organisations. As such, there is a political imperative to develop and adopt not only accurate controls and monitoring systems for the finite services currently delivered by Local Governments to their corresponding communities, but also construction projects as well. The following paper unpacks one effective 'cost management' system that has been developed to ensure total control of cost over the life-cycle of the construction process. The three stages of the system include: estimating project cost; cost control and data collection and analysis. This local solution will endeavour to ensure Local Governments' remain competitive in this evermore competitive world of construction management.

2. METHODOLOGY

The paper initiates with background information on the development of the current issues that face Local Governments regarding the demonstration of 'best value' on the services they provide.
It will also endeavour to provide a solution to just one of the services offered by Local Government, that is, Civil Engineering construction projects.
From here, research into the system 'cost management' is conducted to determine a solution to providing 'best value' for Civil Engineering projects.
A conclusion is drawn on the discoveries established from research into 'cost management' to deliver 'best value' for Local Governments' in terms of Civil Engineering projects.

3. BACKGROUND

Local Government organisations in the United Kingdom, United States, and recently Australia are required and encouraged to demonstrate 'best value' (Kline, 2003) with regards to the present services they provide.

'Best value' as defined by Kline (2003); the Blair administration and the U.S. require their corresponding Local Governments to be competitive with the 'best in business' and demonstrate continual improvements of the delivery of services.

To remain competitive within specific areas of service and maintenance, Local Governments have utilised two pre-existing techniques to demonstrate 'best value'. They are: benchmarking and competitive tendering. Currently, a number of Australian Local Governments are experiencing organisational restructures, requiring specific Local Government departments to demonstrate 'best value'.

In regards to Civil Engineering works, Hamilton (2004) believes the application of the system 'cost management' is becoming increasingly important and adopted by organisations' to help demonstrate business efficiency. The cost management system consists of three stages: estimating project cost; cost control and data collection and analysis. All three stages are required to collaborate to create '...a continuous cycle of information for the efficient implementation of projects' (Hamilton, 2004), as shown in Figure 1.

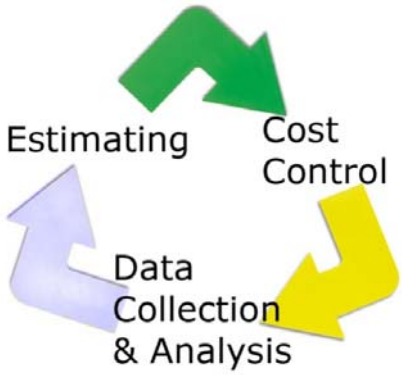


Figure 1: The three stage concept of cost management (Adopted from; Redwood 2009: Figure 1)

Shakespeare noted the importance of information required to prove efficiency and make choices:

> *"When we mean to build, We first survey the plot, then*
> *Draw the model; And when we see the figure of the*
> *house, Then we must rate the cost of the erection;*
> *Which if we find outweighs our ability,*
> *What do we then*
> *but draw anew the model in fewer offices, or at least*
> *desist to build at all."*
>
> Shakespeare W., Henry IV, Part 2

Providing 'best value' challenges the next generation. In Australia, the Federal Government passed a policy that aims to evaporate 'barriers' that give Local Government advantages over the private sector (Kline, 2003). Cost management techniques can equip the next generation with the a system to evaluate and demonstrate 'best value' with respect of Civil Engineering works in Local Government organisations.

4. CIVIL ENGINEERING WORKS

Many important comforts taken for granted in our day to day lives owe themselves to the practice of Civil Engineering and also Local, State and Federal Governments who fund the recommended Civil Engineering projects.

Generally, in the perspective of Local Government, and intern the relevant scope of the service requiring an expression of 'best value', Civil Engineering works comprises of the construction of new infrastructure and renewal of existing public assets. The construction of assets in question varies between different Local Government organisations. Construction of Local Government assets could encompass the following:

- Stormwater (pipe, pits, detention basins, wing-walls, and kerb and gutter)
- Local roads (sub grade, sub base, riding surface)
- Footpaths (inc. Pram ramps)
- Cycleways
- Bridges
- Traffic facilities (e.g. round-abouts, chicane, islands)
- Retaining walls
- Car parks
- Driveways

5. COST MANAGEMENT

Cost management is a system that delivers a continual cycle of information allowing monitoring, accurate decision making and benchmarking in regards to the construction of the previously stated Civil Engineering project scope. For efficient implementation of

the cost management system for Civil Engineering projects. Constant collaboration between all three stages of cost management is required (Hamilton, 2004).

This paper will focus on the three stages of cost management and its accuracy for demonstrating 'best value' with regards to Civil Engineering works. As stated above, the three stages of cost management are: estimating; data collection and analysis and cost control.

5.1. Estimating

The importance of an accurate estimate is becoming increasingly important for Local Government organisations to help signify 'best value' regarding Civil Engineering works (Kline, 2003). First, we must accept that our estimates will not be spot-on due to actuality that '...an estimate which is by definition subject to some error.' (Ashworth & Skitmore, 1986); but in today's climate, accepted variation from initial project estimate and final construction cost is ± 5 to 10% (Di Natale, 1982). The questions could be asked, "how can this be achieved?" and "What factors need to be controlled?" Hamilton (2004) believes there are three main contributing factors that hinder or increase the accuracy of the project estimate. They are: design basis; planning basis (what is realistic?) and an appropriate cost estimating method.

5.1.1. Design Basis

Design basis encompasses the technical information given from the design/ consultancy department and/or organisation to the construction team (estimators). The design basis which the final estimate is based is considered to be the 'definitive' estimate (Ashworth & Skitmore, 1986). A high level of design detail specifies the quantities of materials; type of materials; construction methods used; desired workmanship for installation and location for a specific Civil Engineering project (Van Kempton, 1983). According to Hamilton (2004) and Ashworth & Skitmore (1986), an important aspect to the design basis is the 'quality' of the designers' information supplied and the degree of detail required for each specific Civil Engineering project. The skill and experience of the estimators and managers can also lead them to make conclusions on the 'likelihood' of future variation to the design basis proposal (Hamilton, 2004).

5.1.2. Planning Basis

Planning basis is physically 'how' the asset will be constructed (Hamilton, 2004). Civil Engineering projects are 'generally' broken down into smaller activities; the scheduling of activities to be constructed can greatly affect the overall project estimate. An in-depth understanding of construction practice and experience from the construction manager can facilitate the civil estimator to determine a definitive estimate from the 'design basis' within the accepted tolerances stated by Di Natale (1982).

It is important to excogitate a clear construction schedule of activities to determine accurate plant and labour allocation. Pre-empting required plant and labour hours for specific activities is difficult. Chrystal-Smith (1976) states an accurate definitive cost can only be obtained if '...great care and accuracy must be exercised in allocating these hours...'.

Work breakdown structure (WBS) is a common method adopted to facilitate the development of the planning basis. WBS is a level-by-level breakdown of project scope into deliverable-orientated activities (Lemass & Carmichael, 2008). Application of WBS segregates 'work packages' (scope of works) into simpler project activities allowing for logical progression for the asset construction. From literature, shortcomings from improper planning:

> *"When there is poor scope definition, final project costs can be expected to be higher because of the inevitable changes which disruption project rhythm, cause rework, increase project time, and lower the productivity and morale of the workforce."*
>
> C.I.I. 1986

Bar charts (Gantt Charts) are common place amongst the Engineering profession. Named after the celebrated American Engineer, Henry L. Gantt (1861 – 1919), bar charts exemplify the flow of logical progression of segregated WBS activities; allowing the quick and accurate maturity of a planning basis and adding to the successful development of a definitive estimate.

5.1.3. Cost Estimating Method

Cost basis is the selection and description of the most appropriate estimating methods, unit rates and quantities (Hamilton, 2004). Currently established estimating methods are (Ashworth & Skitmore, 1986, and Hamilton, 2004):

- Conference estimating
- Comparison estimating
- Graphical estimating
- Unit technique
- Resource estimate
- Factor estimating
- Exponent estimating
- Building estimating

Three methods in particular have been identified by Redwood (2009) to be 'most-common' when developing a definitive cost estimate in the field of Civil Engineering; they are:

- Unit technique
- Comparison estimate
- Resource estimate

Unit technique method relies on collated data derived from industry to develop databases of applicable unit rates, i.e. Rawlinsons (2006). Comparison estimate method is widely used for building projects when considerable time is expended into the development and analysis of data bases which relies on extensive capturing of previous project information (Ashworth & Skitmore, 1986). Cost Engineers must adjust historic Civil Engineering projects either subjectively or quantitatively using their training, experience and innate skills to develop accurate definitive project costs. Resource estimate method is the breakdown of plant, material and labour into specified tasks over a pre-determined duration (Ashworth & Skitmore, 1986). Wood's (1982) identified this method to be extensively used by contractors for even the 'run-of-the-mill' type construction projects.

Estimating methods have been identified in Local Government environments to be applied both independently and simultaneously when developing a definitive Civil Engineering project cost.

5.2. Data Collection & Analysis

Data collection and analysis (DCA) is the stage required in the 'cost management' process which sustains the comparison of actual civil project cost to that initially estimated. All organisations can benefit from the successful implementation of the DCA process. However, DCA is the most abandoned stage in the cost management system (Hamilton, 2004); which hinders the 'core' function of cost management, in delivering a continuous cycle of accurate information. This neglected 'link-in-the-chain' delivers an essential tool for Cost Engineers to benchmark construction progress and completion of Civil Engineering projects. Hamilton (2004) instigates the importance of DCA as a particular stage in the cost management system; by demonstrating the advantages and implications to an organisation when DCA is implemented at certain degrees of exertion.

> *"At its best it is logical and methodical in gathering and using this information. All companies and organisations can benefit from this process. Lack of this effort will burden organisations with repeated mistakes."*
>
> Hamilton A. C. 2004

From this, an appropriate level of collection, analysis and an acceptable standard of accuracy of the information are entirely set by the given organisation. With careful deliberation from the organisation regarding the appropriate levels needed for successful implementation of DCA, a maximisation in benefits can be administered. The potential benefits for the organisation range from: accurate recording of project progression; benchmarking of specific project activities; increasingly more accurate rate estimating; precise record of variation in project scope and an accurate historical database.

Newcastle City Council (NCC) has already taken the lead by successfully developing and implemented a DCA system. The DCA system has proven effective and accurate for NCC when collecting data for analysis in regards to their Civil Engineering projects; further explanation can be found in section 5.2.1 Case Study.

5.2.1. Case Study

NCC has a four stage approach when collecting data for analysis. This approach required the coordination of several key personal to achieve accurate results. It relies on upper management to ensure diligence by the key personal to maintain this accuracy.

The key personal and functions of the DCA implemented by NCC can be best illustrated by Figure 2.

Figure 2: The stages in Newcastle City Council's DCA system.

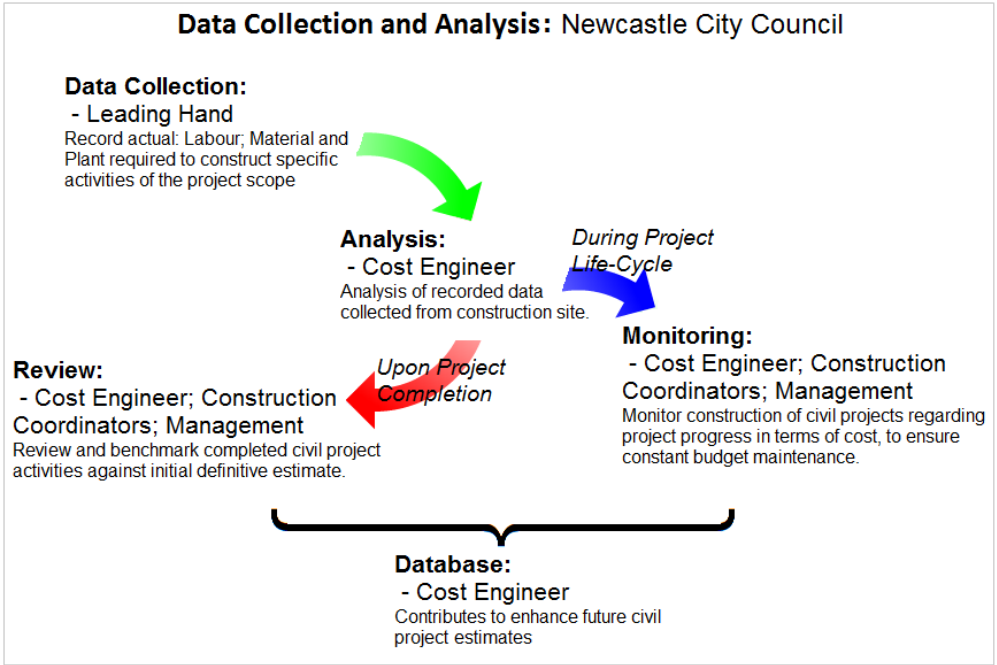
It can be noted that this continuous flow of information within the NCC DCA stage not only controls the collection and analysis of information, but also, monitors progress with respect to project budget, benchmark against initiative definitive project estimate and the maintenance of the unit rate database to enhance future civil project estimates, and intern the level of the benchmark.

As a stage in 'cost management' that is considered 'neglected', NCC has demonstrated the ability to successfully implement a DCA system in a Local Government organisation with respect to Civil Engineering projects. NCC has also shown the importance and valuable information that stems from an effective DCA system; linking back to the significance mentioned by Hamilton (2004) regarding DCA in the 'cost management' cycle of information to ensure 'best value' is delivered.

5.3. Cost Control

Cost control is the 'what' in 'cost management'; what should be done with the collected and analysed data to present the information with meaning? This question can only be answered by the respective organisation or department. It is at this stage in the 'cost management' system that represents the translation in the Civil Engineering project '...from theory to a reality' (Hamilton, 2004), therefore, consideration regarding cost control is indispensable for providing meaningful information.

Cost control searches out the cause of positive and negative variations (PMBOK Guide, 2004) by enabling the control of both project cost and physical project progress until completion (Staffurth, 1969), while also encompassing the capture of variations. Regardless, attempts have been made deliberately and mistakenly to link physical progress to initial definitive estimate, '...the assessment of progress has been subjective, or has been based on the proportion of allowed time or budget expenditure. Hence assessment of the budget value of work completed has been unreliable' (Staffurth, 1969); illustrating the importance for reducing bias through critical thinking when determining systems to ensure accurate and appropriate compatibility of collected information. The term 'meaningful information' is directly related to two tangible variables and functions within 'cost management', they are: cost; time; how accurate or dependable is the information determined from DCA and again, what is the information comparable with? Taking a step back, cost control is considered to receive the 'most attention' and also, deemed the 'most



important' stage in 'cost management' by contractors, owners, managers, vendors, consultants and shareholders (Hamilton, 2004). Once more, emphasis should be shifted from the ideology that 'cost control' just churns out pre-influenced numbers to suppress displeasing results, i.e. compare information that suits the situation.

Increased importance should lie in the methods applied in the retrieval of the data and how it is compiled and computed with respect to the two variables and functions. From this, it can be identified that the organisation or department is inevitably responsible to ensure the inputted information supplied via DCA is utilised to output 'numbers with meaning'.

6. CONCLUSION

In an attempt to solve the current issue of 'best value' facing Local Government organisations around the world we have identified cost management as a solution for the next generation. The main steps concerning to cost management have been expressed to illustrate their importance to solving this issue. We covered the main stages of cost management to express the importance of their accurate implementation, and how this can be achieved. While illustrating important weaknesses in each stage so they can be minimised. The important stages discussed are: develop accurate initial estimates; collect data for analysis and cost control of information. It must be noted that each stage in the process will interact differently with respect to each organisation and therefore each Local Government organisation needs to adapt the model individually. With this in mind Local Government organisations should be able to face to issue of providing 'best value' with respect to Civil Engineering projects through the creation of numbers with meaning.

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9. BIOGRAPHY

Scott Redwood:

Scott Redwood is a student enrolled in a Bachelor of Engineering (Civil) at the University of Wollongong in his 4th year of study (in 2009). Scott was awarded a

scholarship with Wollongong City Council to develop and implement a successful process for monitoring of civil construction projects via unit rates. Scott has already completed a Dip. of Civil Engineering and a Dip. of Business Management (TAFE NSW) and he is looking forward to applying what he has learnt in a theoretical sense to a practice workplace upon graduation. To fund his study Scott undertook part time work which included the following areas, kitchen hand, retail, and customer service, with some exposure to the construction industry.