VALUE MANAGEMENT IN INFRASTRUCTURE PROJECTS IN WESTERN AUSTRALIA: TECHNIQUES AND STAGING

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Infrastructure projects to service the mining industry in Western Australia (WA) are on the increase, somewhat in contrast to a stalling of projects nationally and globally. It remains important therefore for WA companies to be competitive in the realisation of a client's brief. Value management (VM) has long been regarded as an effective means to eliminate unnecessary capital and life-cycle costs, however, whilst many are familiar with the underlying theory, its use locally is perceived to be less widespread. The research presented here investigates the extent to which value management is implemented by Western Australian engineering and construction companies in both the design and construction fields; exploring, the various value management techniques used in practice and, VM staging. This study documents benefits achieved by means of value management and, the attitudes of industry professionals towards the feasibility or need in establishing a compulsory value management procedure for all (civil engineering) developments. To investigate current value management implementation in WA a pilot-study research methodology embraced a qualitative semi-structured interview approach of ten respondents from organisations involved in design and construction of civil engineering work. Straw poll project results suggest WA industry to be well aware of both, the concept of value management and, the benefits that may arise from its use to address the life-cycle of a project; case-study specification analysis is then presented to explore VM benefits/disbenefits explicitly. The research presented here concludes that industry does have formal value management procedures within a preliminary design phase. Findings show however that industry is resistant to a statutory requirement for value management and, argue that in WA competition is enough to drive the uptake and utilisation of VM.

Keywords: value management/engineering, design-specification, Western-Australia.

INTRODUCTION

As engineering and building challenges increase in complexity due to environmental and political factors inherent in the modern age, as well as ever accelerating changes in technology, construction companies are seeking ways to remain competitive in today's market (Qiping 2004). As the engineering industry expands and the projects undertaken may be increasingly multifaceted, it is important for companies to provide

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value for clients. Value management is an effective design management method able to reduce unnecessary capital and life cycle costs (Kelly 2004).

This project paper investigates the extent to which value management is implemented in Western Australian engineering companies in both design and construction fields. It also determines the various value management techniques that are used within value management as well as the time at which value management is usually implemented. Case-study discussion documents the benefits achieved by means of value management and the attitudes of industry professionals towards the feasibility or need of establishing a compulsory value management procedure for all civil engineering projects.

LITERATURE REVIEW

The roots of value management might be traced back to the US General Electric Company which, at the time of the Second World War, sought solutions to address the significant shortages of available resources, skilled labour and raw materials. Electrical engineer, Lawrence Miles, saw the need to drastically update the procedure of manufacturing products to counteract the effect of short supplies of highly demanded commodities and is credited with developing a formal procedure of resource optimisation, which he termed value analysis (Smith 1998); this analysis documented the benefits of substituting materials, which actually improved the quality of the final product while at the same time reducing costs. Although value management was born out of the manufacturing industry, it has developed rapidly and spread across several industries on a global scale (Ashworth 1997).

This concept was extensively used in the design stages of US construction projects by the late 1960s. During this time, the UK construction industry showed interest in the concept (Palmer 2002). The UK construction industry adapted Mile's value analysis and developed it under the name 'value management'.

The term 'value management' is considered somewhat synonymous with 'value analysis' and 'value engineering'. Despite an (ongoing) Australian Engineering bias towards an American branding of Value Engineering (VE), Value Management (VM) was formally recognised in the Commonwealth of Australia, and the state of Western Australia, in 1977 with the establishment of the Institute of Value Management Australia (Spaulding 2005).

Value Management (VM) and the analysis techniques involved is applicable as an design management methodology, and is argued as being as relevant to civil engineering infrastructure projects, as it is to architecturally orientated building projects. VM is a systematic means to improve the value of products and services and might be argued as essential in any objective comparison of the available alternative fit-for-use materials and specification options in (civil) engineering design. VM can be defined as 'a service that maximises the functional value of a project by managing its development from concept to use through the audit of all decisions against a value system determined by the client' (Kelly 2004).

A common value management exercise generally involves seven phases; orientation, information, creativity, evaluation, development, presentation and feedback (Kelly 2004). A comparison of international journals investigating the issues concerned with the successful implementation of value management has several recurring factors. There are costs associated with implementing value management; some suggest that value management does not provide a decent return on investment to warrant spending

resources on it. However many types of projects (predominately complex, unique or repetitive) do benefit greatly from value management are (Smith 1998), where VM costs about 1% of the total project cost and can result in positive returns (Norton 1995). In conjunction with the cost of implementation, some suggest that 'lack of time to implement value management' remains a serious impediment particularly for segmented delivery methods such as design-bid-build contracts, where it is common to fast track the construction stage and leave minimal time for development of alternative solutions (Cheah 2005).

Often engineering companies have reservations about using value management. This fact stems from the evidence that there is a lack of knowledge about value management, as a result there are no opportunities given to employ creative thinking techniques to develop alternative solutions (Bowen 2010). Application is also directly influenced by senior management and company policy as it is argued by some that there is lack of support from individuals with authority to call for the formal application of value management within the preliminary design stages (Qiping 2004). To an extent this might be argued to stem from a traditional (somewhat blinkered) fixation, by both Western Australian mining clients and their representatives, upon the capital cost and need for quick installation of civil engineering components, to the exclusion of infrastructure cost-in-use variables, as a means to simply get them in, to allow mine-resource extraction and transportation to commence as soon as possible.

Wixson and Heydt (1991) comment on the importance of 'people', stating that it is the people involved in the team that have a direct bearing on the success of a value management study; therefore, top level managerial support is critical (Cheah 2005). Whilst acknowledging this to be the case, it might be suggested that the mining industry currently exploiting the huge resources available in the northern region of Western Australia (an area the size of Western Europe with a population of just 2.5 million) have traditionally regarded infrastructure support as a somewhat peripheral concern. This historical attitude is changing however, with senior (client) personal and design consultants recognising that the majority of the support structures and facilities put in place two or three decades ago, to facilitate mining operations, have now reached and overrun their expected life-cycle requiring essential expansion refurbishment and retrofitting.

When considering the need to design and construct support and infrastructure facilities for the future, West Australian design-teams are now being charged to compare objectively, alternative design specification solutions; value management exercises are relevant and somewhat fundamental, with life-cycle cost analysis (LCCA) a key measurement technique to assist with value management exercises to best determine the effectiveness of design proposal options (Selg 2006). By reducing risks and life cycle costs, the end result will be a deliverable that provides the most benefit for the client (Harvey 2008).

Value management techniques:

To assist (civil engineering) design teams address alternative infrastructure solutions a number of (documented) value management techniques can be argued as relevant. One such technique is that of 'Brainstorming' (Stewart 2010), which seeks open, non-critical discussion of alternative design solutions.

Review of alternative materials 'strengths, weaknesses, opportunities and threats' (SWOT) might be argued to help specify the objective of the project and identify all

factors, internal and external, that will either be favourable or unfavourable (Armstrong 1992).

Infrastructure (civil engineering) design options may also be assessed by a 'Function Analysis System Technique' (FAST) of the particular elements which comprise a project. It determines what functions are to be delivered, what something must do and not what it is. By focusing on the function, designers may focus on alternatives to achieve the function. 'Risk-Analysis', alongside FAST, allows a structured approach to identify potential risks associated with the project which are then attributed costs in regards to money, time and negative impacts (IVM 2011).

VM may also be deemed to encompass 'Cost-Benefit analysis' (B/C) as a systematic approach in comparing the quantifiable benefits and costs for a particular project or indeed the overall value of the contributory components or sub-components. The fundamental purpose is to determine whether the investment of time and money is worthwhile. Whilst, in the hugely profitable mining industry, infrastructure investment usually is worthwhile, this method is relevant when considering alternative solutions for the same projects. Usually the option with the highest ratio, namely higher benefit relative to cost, is considered as being the most appropriate option (Flyvbjerg 2008).

VM analysis might also be complemented by a 'Stakeholder Analysis' technique where all major stakeholders with influence or authority over a project are identified to assist in focusing the scope and attention of the value management exercise to consider major priorities. These priorities usually seek to satisfy the stakeholders (IVM 2011). Whilst perhaps it might be somewhat glibly stated that a Stakeholder Analysis is largely a client's briefing procedure, this more structured, defined approach might well identify, and allow consultation with, any individuals who may otherwise have slipped through the client briefing 'net'.

RESEARCH METHOD

The objectives of this study included the investigation into the extent of value management implementation in the Western Australian engineering industry, alongside an investigation into issues deemed critical with regards to the success of value management. The study also sought to assess: the level of familiarity with value management locally; common value management study techniques; timing of VM implementation; issues that hinder VM success and the benefits that arise from implementing a value management approach.

To measure and achieve study objectives, a semi-structured interview questionnaire methodology was developed, to identify issues key to value management, from a sample catchment of companies directly involved in design and construction of civil engineering work. Respondents were actively selected from the region's largest local companies (including BHP-Billiton, SKM, GHD, AECOM, Brookfield-Multiplex and BG&E) whose extensive project portfolios contribute greatly to state turnover in the mineral and oil and gas rich region of Western Australia.

The semi-structured interview was designed to include multiple-choice questions with an opportunity to share comments. Responses were given quantifiable scores to aid in analyses, supported by opinion gleaned from participating professionals. This research pilot study targeted 10 experienced professional civil engineers working in and around Perth Western Australia.

A case-study to assess and compare alternative design material specifications seeks to allow quantitative research findings regarding potential actual cost savings, to

complement qualitative research data generation regarding VM technique applications and appropriate stage implementation.

PRIMARY RESEARCH RESULTS AND DISCUSSION

Characteristics of Interviewees

The number of respondents was limited to 10 civil engineering companies: 6 of these companies specialised in design, 2 were involved in design-build and the remaining 2 companies were involved in construction. As Western Australia continues its development in civil and mining works, most of the respondents, 90%, noted that they are involved in industrial related work such as mining. Additionally 50% stated they are also involved with building and engineering work such as large commercial buildings and infrastructure; representative of the different types of work in Western Australia.

Familiarity with Value Management

A major aim of the interview questionnaire was to determine familiarity with the concept of value management. Out of the 10 respondents interviewed, all of them indicated that they are familiar with the concept of value management as a design management tool and noted that it is very effective at reducing unnecessary costs.

The interview responses also noted that 90% of the interviewees have an in-house structured, management policy that includes appropriate value management procedures, which is largely concerned with review of principal fit-for-use component specification alternatives. The companies who stated that they do have a value management policy were also primarily design based companies. This supports secondary research investigations, that it is primarily the designers' responsibility that has the biggest impact on both the capital cost of a project as well as the life cycle cost (Selg 2006).

The respondent companies also spanned both the private and public sectors across several fields of work including engineering, building and industrial infrastructure applications; private companies encouraged the use of value management as a means to increase the value of a project for the client while also promoting themselves as a competitive player in the engineering industry.

Utilisation of Value Management Techniques

Having introduced some of the range of theoretical VM techniques in the literature-review section above, Table 1 highlights the most common techniques considered applicable to a value management study in Western Australian civil engineering projects. The most used techniques are "Cost-Benefit Analysis" and "Risk Management", scoring 80% each; followed by "Brainstorming" and "Stakeholder Analysis". These techniques can easily be applied to the early design stages, specifically in the value management studies, to enhance the overall value of an engineering project. It was also commented by a number of respondents that early contractor involvement is an important technique. Early (sub) contractor involvement is beneficial because construction knowledge can be successfully integrated into the design procedure to create an effective solution in terms of constructability. Many of the respondents noted that a combination of these techniques are advantageous in the development phases of the value management study, quoting that all stakeholder concerns are explicitly considered along with the potential risks of each alternative.

These issues are further considered by means of a cost-benefit analysis that attempts to compare qualitative and quantitative factors that affect the cost and benefit.

Table 1: value management techniques utilisation

VM Technique	% application in projects
Risk Analysis	80%
B/C analysis	80%
Stakeholder analysis	70%
Brainstorming	70%
Issues Generation & Analysis	50%
Value Analysis	20%
SWOT analysis	20%
FAST analysis	30%
SCAMPER	0%

Timing of Value Management Implementation

All of the design and construction companies indicated they used value management in the conceptual design phase. 50% of the sample space also noted value management can be used during feasibility and detailed design. The preliminary design stage is the most effective time to implement value management as it has more potential to provide significant cost reductions as more appropriate solutions are developed based on a consideration of all major stakeholder issues and concerns. It was noted by the interviewees that the greatest possible savings can be achieved during the planning and definition phases, which will ensure that appropriate investment decisions are made. 40% of the respondents highlighted they incorporate value management in the post construction and maintenance phase, commenting that it is still possible for cost reductions and effective construction methods based on value engineering proposals from constructors.

Table 2: timing of value management implementation

VM Stage	% application in projects
Conceptual design	100%
Feasibility	50%
Detailed design	50%
Post-construction/maintenance	40%
Construction	10%

Factors Affecting Value Management

Time Limitations is considered by the sample as one of the biggest factors that hinders the implementation of value management (table 3 below). It was commented by several interviewees that company policy or design procedures do not allow for sufficient time, particularly in the traditional 'Design Bid Build' contracts where there is added pressure to fast track the construction phase. Indeed given the need for civil engineering consultants and contractors to realise their respective infrastructure projects early, to enable early mine-operation resource production, this is unlikely to change. Consultants therefore seem to have rationalised expectations to accommodate

the (short) period given (predominantly at the 'conceptual design' stage as described above) to allow respective fit-for-use comparisons. Although 'Time Limitations' is a significant factor in hindering value management, value management procedures are still widely used, which attests to the fact that it is a highly regarded management tool that is effective in increasing project value and reducing costs. Other factors related to the implementation of VM were found to be "Lack of Understanding" "Ambiguity" and "Lack of Commitment". These issues are related as they represent a combination of a lack of understanding that usually correlates to ambiguous concerns being presented, as well as a lacking of commitment to expend one's own efforts on the exercise.

Table 3: Mean (importance) score of issues affecting value management

VM Issues	Mean (importance) score
Time limitations	2.6
Lack of understanding	2.5
Ambiguous specification	2.3
Faulty ambiguous drawings	2.1
Lack of commitment	2.1
Lack of support	1.9
Unforeseen constraints	1.9
Budget limitations	1.7
Confrontational relationships	1.6
Nonstandard drawings	1.5

Benefits of Value Management

Implementing the value management tool into existing design and construction business procedures requires the investment of both time and money. Table 4 highlights the potential benefits that arise from implement value management. "Improved Project Value for the Client" "Improved Effectiveness" are two of the highest ranking benefits, followed by "Cost Savings", "Improved Cooperation" between parties and "Documentation of Issues and Opportunities". Improved project value and effectiveness can be expected, but it further supports that these benefits are commonly achieved when implementing value management. It was commented by some of the interviewees that the benefits will be greater, once all participants have been briefed about the value management procedure so that they are conscious of the importance of their individual participation. Feedback of information is also important as it will enable the designer to build up a knowledge base of solutions that may be applicable for future value management studies for similar projects. The benefits are evident to clients and engineering companies alike and by implementing value management they can increase their competitiveness in the industry.

Table 4: Mean (importance) score of benefits of value management

VM Benefits	Mean (importance) score
Improved project value for client	2.9
Improved effectiveness	2.7
Cost savings improved profit	2.6
Improved relationship/coordination	2.5
Documentation of issues/opportunities	2.5
Improved reputation	2.1
Reduced claims or disputes	1.8

Rating of Current Value Management Procedures

The interviewees were asked to rate the current value management procedures in the companies they represent. 25% rated their process as "Very Good". Another 25% rated it "Below Satisfactory"; whilst 13% suggested processes to be non-existent. Generally then, findings suggests that participating companies are conscious of applying value management but are still developing the effectiveness of their process. The majority of the respondents, 37%, noted that their procedure is "Satisfactory". Although it was stated their procedure is effective and has provided significant benefits, it is felt that there is room for improvement by means of additional training.

Compulsory Value Management

It was noted that a significant number of client organisations, in the public and private sectors, encourage value management. However, making value management a statutory requirement was not supported by the respondents to this study. All 10 of the respondents replied that value management should not be a formal requirement for civil engineering projects in Western Australia. It was stated on several occasions that value management should not be a requirement but instead each individual company should determine for themselves whether they would invest in VM implementation. Making value management a statutory requirement for Australian projects may in fact hinder performance was a response, as they will be asked to do something that they have already considered, compounded by the fact that they will have to align their fully developed existing procedure with additional specified regulations, and as a result companies might be apt to focus on "checking the boxes" to prove they have complied, distracting teams from focusing on the main goal of improving value.

Case Study Analysis

A basic value management case-study exercise showed how the collaborative efforts of a multi-disciplinary team might be approached; with participation of both client and designers alike, to explicitly assess the best viable option from a range of alternative solutions. Respondents identified a scenario which required the construction of three retaining walls at three locations around the city. The retaining walls were constructed using the T-Block wall system. These walls are manufactured from precast concrete sections with baled rubber tyres placed in between. Before the decision was made to use the T-Block walls, the manufacturer was contacted to provide the comparative cost of construction for similar walls, to provide data towards a value management assessment. The alternative materials were considered were T-Block wall options of concrete or limestone; capital cost reduction potential is highlighted in table 5. This was presented as the initial step in an overall value management exercise that sought

to factor-in: life-cycle cost analysis; supply chain variables; tradesman expertise; client/(user) aesthetic considerations; as well as, work breakdown structure activity scheduling for the wider aspects of the project. Respondents suggested that the value management study conducted resulted in a significant cost saving accumulation due to a compounding of factors related to the repetitive nature of the project to construct multiple retaining walls.

Table 5: case-study specification comparison: percentage comparison

	Total cost	Cost of T-Block	Cost Saving	Capital cost saving
Concrete	$358,000	$229,011	$129,600	36%
Limestone	$220,400	$154,687	$65,713	30%

DISCUSSION

The general consensus of the interviewee findings validates the available literature that value management provides significant cost reductions and results in a project with increased value for the client. Previous studies argue that the cost of implementing value management is 1% of the total cost of construction, but may provide construction cost reductions of between 10-30%. In other words, VM gives a large return on minimal investment (Norton and McElligott 1995); specifically 1$ spent at concept stage can yield a saving of $100 at implementation phases (Selg 2006; Leeuw 2001). Whilst the cost to provide and maintain (civil engineering) facilities is but a drop in the (profitability) ocean for the WA resources industry, suggestions (Arditi 2002) that companies cannot afford to not use VM, rings as true for mining infrastructure as it does for more traditional building design projects.

CONCLUSION

This pilot study concludes that the Western Australian engineering industry is aware of value management procedure and familiar with its associated benefits. It indicates that value management has potential to provide increased value and effectiveness at all stages of the project life cycle. The most common techniques incorporated into a value management study are brainstorming, cost-benefit analysis, risk analysis and stakeholder analysis. This mirrors a fundamental tenet of value management, towards consideration of the most cost effective alternative solution with minimised risks while at the same time taking into consideration the opinions and concerns of all stakeholders from the beginning stages of a value management exercise. Time limitations and a lack of understanding and participation of individuals in the team will influence negatively the level of success of a VM exercise. The quality of the final decision is influenced by the level of information provided initially, compounded by the pressures to fast-track design projects to on-site construction. It might be suggested that the types of projects where value management has most potential for a high return on investment include projects that are complex and unique, or alternatively repetitive in nature. The benefit of value management across all types of civil projects depends in large part upon the commitment and initiative of each individual member making up a design (and value management) team. Value management as a statutory requirement is not supported by this WA straw poll.

RECOMMENDATIONS

Based upon the findings and conclusions of this study it might be recommended that future work seek a wider review of standardisation for value management approaches

in WA, particularly given the majority of the original infrastructure facilities have now reached and overrun their expected life-cycles, and that industry practitioners must now begin designing and installing, both fit-for-use and whole-cost appropriate, expansions, refurbishments and retrofitted facilities. Indeed, it is recommended that further case-study analyses of value management applications seek to document and address explicitly opportunities for adding value to resource-industry infrastructure.

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