Waarde optimalisatie in de bouw

ONDERZOEK NAAR DE HER-ALLOCATIE VAN VALUE ENGINEERING
TUSSEN OPDRACHTGEVER EN OPDRACHTNEMER

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"Value is one of those familiar words which is difficult to define for the very reason that it is so well understood without a definition" [Miles, 1966]

Woord vooraf

Na een periode van 2,5 jaar is met dit afstudeerrapport een einde gekomen aan een dynamische, intensieve, en met name interessante Master opleiding Civil Engineering & Management aan de Universiteit Twente. Het afronden van de studie Bouwprocesmanagement ervaar ik als een waardevolle aanvulling op mijn HTS diploma Civiele Techniek, waardoor ik ben voorbereid ben om de opgedane kennis in praktijk te brengen.

Voor u ligt het resultaat van bijna negen maanden werk, wat werd gekenmerkt als een uitdagende en leerzame periode. Met name het verblijf van vier maanden aan de University of Wisconsin in de Verenigde Staten heeft vele interessante indrukken opgeleverd. Een actieve instelling in een onbekende maar kansrijke omgeving heeft ervoor gezorgd dat deuren zijn open gegaan die anders gesloten waren gebleven. Dit was echter niet mogelijk geweest zonder de steun en het vertrouwen van een aantal personen. Allereerst wil ik dhr. Veenvliet hartelijk danken voor zijn enthousiasme, de waardevolle input en de vele uurtjes die zijn opgegaan aan het uitwisselen van gedachten. Ik dank dhr. Halman voor zijn ondersteuning en zijn heldere, opbouwende kritiek, waardoor het onderzoek het huidige niveau heeft kunnen bereiken. Verder dank ik dhr. Hanna voor zijn feedback en het mogelijk maken van een leerzaam verblijf aan de University of Wisconsin. Mijn dank gaat verder uit naar de Vakgroep Civiele Betonbouw, die het praktijkonderzoek in de Verenigde Staten mogelijk hebben gemaakt, naar de Wisconsin Chapter van SAVE International voor de uitnodiging om deel te nemen aan de SAVE conferentie van 2006, en naar alle respondenten voor hun waardevolle bijdrage aan het onderzoek.

Ik wil gelijk van de gelegenheid gebruik maken om mijn vrienden te bedanken voor de samenwerking en de gezelligheid gedurende de studietijd: ik had me geen beter gezelschap kunnen bedenken. Speciale dank en waardering gaat uit naar mijn ouders, die mij al die jaren hebben gestimuleerd en gesteund om komen waar ik nu ben. Ook mijn broer ben ik veel dank verschuldigd; zijn kritische vragen en opmerkingen hebben me scherp gehouden. Tot slot wil ik Katie bedanken voor haar steun, liefde en geduld, wat veel voor mij betekent.

Menno Huiser

Enschede, januari 2007

Preface

The completion of this Masters thesis also signifies the end of two-and-a-half dynamic, intensive, and particularly interesting years in the Masters program for Civil Engineering & Management at the University of Twente, The Netherlands. The Construction Process Management degree is an invaluable addition to my Bachelors degree in Civil Engineering, and has prepared me to start my career in Civil Engineering.

This report is the result of nine months of work, a time period which can be characterized as challenging and educational. My four month research and interview period at the University of Wisconsin-Madison in the United States provided especially interesting experiences and impressions. An active attitude in an unknown but potential surrounding led to unique opportunities. All of this would not have been possible without the support and trust of some respected persons. First of all I would like to thank Mr. Veenvliet for his endless enthusiasm and the many hours we spent exchanging thoughts. My gratitude also extends to Prof. Halman for his support and constructive criticism, which has contributed to this article achieving the current level of relevance. I would like to thank Dr. Hanna for his feedback and for giving me the opportunity to have a valuable and optimal stay at the University of Wisconsin-Madison. I further would like to thank the 'Vakgroep Civiele Betonbouw' for financially supporting my empirical research in the United States, the Wisconsin chapter of SAVE International for inviting me to their annual conference, as well as all of the interview respondents for their valuable input into this research.

Furthermore, I use this opportunity to thank all of my classmates and friends for the memorable times we have had during our studies. Special gratitude goes to my parents for stimulating and supporting me all these years to realize my goals. I also owe much gratitude to my brother; his critical questions, remarks and input helped to keep me sharp. Last but surely not least I wish to thank Katie for her support, love, and patience, which means so much to me.

Menno Huiser

Enschede, January 2007

Toelichting rapport

Voor u ligt de rapportage van het afstudeeronderzoek naar Value Engineering toepassingen in de bouw. Vergeleken met andere afstudeerverslagen heeft deze rapportage een afwijkende opzet. Het rapport bestaat uit vier delen. In het eerste deel vindt u de Engelstalige en Nederlandstalige Management summaries. Het tweede deel is het hoofdonderdeel en betreft het artikel:
Re-Allocating Value Engineering between project owners and contractors in construction. Dit is een Engelstalig artikel waarin het onderzoek beschreven wordt. Deel drie bevat een Nederlandstalig procesverslag, waarin op chronologische wijze de tussentijdse bevindingen en de genomen beslissingen zijn beschreven, ter aanvulling van het artikel. Het laatste deel omvat twee bijlagen die een bijdrage leveren aan de rapportage, waaronder de beschrijving van de bijgewoonde Value Engineering workshop, en een factsheet over Value Engineering.

Rapport index:

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Management Summary

Engels
Nederlands

Management Summary

Construction projects are characterized by temporary, yet complex collaborations between different parties who all have a shared goal of realizing a project. The collaboration is structured by contracts, with specific responsibilities allocated to each party. To achieve optimal project value, it is important that the object functionality meets both the owners' and stakeholders expectations, and that unnecessary costs are avoided. In addition, contractors should be able to execute projects while maintaining acceptable risk and profit margins. Utilizing the Value Engineering methodology can be of assistance to reaching all of these goals. This process management application can be used early in the project development process to identify the functional balance between cost, reliability, and performance of a project, while assuring the owners expectations. The American construction industry effectively utilizes Value Engineering in the traditional design-bid-build delivery strategy, but lacks the efficient use of practical knowledge and performance incentives that are available within a design-build contract.

The objective of this study is to analyze the current allocation of Value Engineering techniques in the construction industry. Therefore, the available literature on Value Engineering has been studied and compared to empirical findings in the American construction industry. The literature reveals that the *project owner* predominantly initiates a Value Engineering (VE) study to ensure optimal project value. The owner's motivation can be explained by his responsibility to design, operate and maintain the finished structure. They often hire an external team of experts to execute a fully objective technical VE study. The increasing popularity of design-build delivery strategies has caused a move in design responsibility towards *design-build contractors*. While the owners step away from the design phase under this contract, they continued utilizing VE studies, without involving the contractor for their knowledge, which has become available in the design phase.

The topic of this research project has been the current application of VE in the United States, which is primarily a technically orientated value approach with a particular emphasis on generating cost reducing alternatives. The American approach is effective when the project objectives are unambiguous and the technical problems are well defined. Complex projects that involve several project stakeholders and large investments ask for a 'soft' strategic Value Planning (VP) study in order to reach consensus regarding the project objective that should be executed prior to the 'hard' technical Value Engineering approach/workshop. This approach can be achieved by addressing two separate, sequential moments within the construction process where each value study can be utilized separately. The strategic VP study has to be performed prior to the design phase, by the owner and stakeholders, and done to identify the project expectations and ultimate objectives. In the situation of a design-build contract, this exercise also helps the owner to identify the requirement specifications necessary to inform the contractors about the project objective. The technical VE study has to be utilized at the preliminary design phase, in order to create optimal project value by finding value-adding technical solutions. This VE study has to be allocated to whichever party is responsible for the design phase. In the situation of a design-build delivery strategy, which is gaining ground in the construction industry, the bidding contractors utilize a technical Value Engineering study to assure optimal value for the owner at a competitive bid, and meanwhile seek design optimization to avoid faulty design that could cause difficulties during the construction phase.

It is expected that combining the technical VE and the strategic VP study into a single project causes a complementary effect, and allows for monitoring and securing the project value at decisive moments during the development of a project.

Management Samenvatting

Bouwprojecten worden gekenmerkt door complexe, tijdelijke samenwerkingsverbanden tussen verschillende partijen, die het gemeenschappelijke doel hebben om een project te realiseren. Verschillende partijen met specifiek toebedeelde verantwoordelijkheden werken op basis van contracten samen. Om een optimaal projectresultaat te bereiken is het van belang dat er een waardevol object gerealiseerd wordt dat functioneert volgens de wensen van de opdrachtgever en de stakeholders, en dat onnodige kosten worden vermeden. Daarnaast dienen aannemers het project met een acceptabele winst en risico marge uit te kunnen voeren. De Value Engineering methodiek kan een bijdrage leveren om deze doelstellingen te behalen. Dit is een procesmanagement toepassing om vroegtijdig in het project ontwikkelproces de functionele balans tussen kosten, betrouwbaarheid en prestatie te identificeren, met inachtneming van de wensen van de klant. In de Amerikaanse bouwsector wordt Value Engineering reeds effectief toegepast bij de traditionele bestek+tekeningen organisatievorm, maar mist het de efficiënte inzet van de reeds aanwezige kennis en prestatie incentives bij een design-build contract.

De doelstelling van dit onderzoek is het bestuderen van de huidige toepassing van Value Engineering technieken in de bouwsector. De bestaande Value Engineering literatuur is geconfronteerd met de resultaten voortkomend uit een binnen het onderzoekskader uitgevoerd praktijkonderzoek onder Amerikaanse ondernemingen, publieke opdrachtgevers en consultants in de bouwsector. De literatuur heeft aangetoond dat voornamelijk *opdrachtgevers* Value Engineering (VE) studies initiëren om daarmee optimale projectwaarde te creëren. Dit is verklaarbaar, aangezien de opdrachtgever verantwoordelijk is voor het gebruik en onderhoud van het te bouwen project, en onder de traditionele contractvorm tevens de eindverantwoordelijkheid draagt voor het ontwerp. Vaak dienen zij voor het uitvoeren van een objectieve VE studie een team van externe deskundigen in te huren, aangezien deze in veel gevallen niet binnen de organisatie aanwezig zijn. De toenemende populariteit van design-build contracten heeft een verschuiving van ontwerp verantwoordelijkheden veroorzaakt richting de *design-build aannemer*. Hoewel de opdrachtgevers zich bij deze contractvorm terugtrekken uit de ontwerpfase, zijn ze doorgegaan met het uitvoeren van VE studies, zonder de beschikbare kennis van de aannemers in te zetten.

De onderzoeksresultaten hebben aangetoond dat de huidige toepassing van Value Engineering in de V.S. voornamelijk technisch georiënteerd is, met de nadruk op het creëren kosten reducerende alternatieven. Deze benadering is voornamelijk effectief wanneer de projectdoelstellingen eenduidig zijn en de technische problemen zijn gedefinieerd. Complexe projecten met meerdere belanghebbenden en grote investeringen vragen om een strategische Value Planning (VP) studie, waarbij overeenstemming ten aanzien van de projectdoelstellingen moet worden bereikt. Dit moet voorafgaand aan de technische VE studie plaatsvinden. Deze benadering is realiseerbaar door in het bouwproces twee aparte value studies te laten plaatsvinden, waarbij in de planning fase door de opdrachtgever en belanghebbenden een Value Planning studie wordt uitgevoerd. In het geval design-build contracten is deze studie tevens effectief voor het specificeren van het Programma van Eisen naar de aannemers. De technische VE studie wordt vervolgens tijdens het voorontwerp toegepast om op basis van technische verbeteringen de projectwaarde te optimaliseren. Deze studie dient te worden toegekend aan de partij verantwoordelijk voor het ontwerp. In het geval van een design-build organisatievorm zijn dit de tenderende aannemers, die door middel van VE optimale projectwaarde voor de opdrachtgever kunnen creëren, tegen een scherpe aanbieding. Daarnaast geeft het hen de mogelijkheid om het ontwerp te analyseren op maakbaarheid om zodoende problemen in de uitvoering te voorkomen.

Verwacht wordt dat het samenvoegen van een strategische Value Planning en een technische Value Engineering studie binnen een project leidt tot een complementair effect, wat de mogelijkheid biedt om gedurende de ontwikkeling van een project op cruciale momenten verhoogde projectwaarde zeker te stellen.-

Waardeoptimalisatie in de bouw:

Onderzoek naar de her-allocatie van Value Engineering
Tussen opdrachtgever en opdrachtnemer

Artikel

'Re-allocating Value Engineering between
project owners and contractors in construction'

RE-ALLOCATING VALUE ENGINEERING
BETWEEN PROJECT OWNERS AND CONTRACTORS IN CONSTRUCTION

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Abstract

Value Engineering is a creative systematic approach that identifies opportunities to remove unnecessary costs and to maximize the functional value of a project, while assuring quality, reliability and performance that meet or exceed the owner's expectations. The current application of Value Engineering in the American construction industry is under the authority of the public owner, which is predominantly technically orientated and focused on cost reductions. A Value Engineering workshop calls for specific expertise that owners oftentimes do not have. Contractors do have the necessary knowledge, but are usually only involved in the execution phase. With the growing interest in Design-Build delivery strategies, contractors, however, are getting more involved in the design phase. This study aims for re-allocation of Value Engineering studies between owners and contractors.. Two Value Engineering allocation models have been developed; one for the traditional Design-Bid-Build situation and one for the Design-Build delivery strategy. The traditional Design-Bid-Build contract allows the owner to perform Value Planning and Value Engineering studies. The Design-Build model, however, asks for an early Value Planning study allocated to the owner, followed by a technically orientated Value Engineering workshop, to be executed by the bidding contractors in the preliminary design phase. This approach creates a favorable situation for both the owner, who receives optimal project value through efforts during the tender activities, as well as the Design-Build contractors, who have the opportunity to submit a competitive bid, and analyze the design for avoidable constructability issues.

Keywords: value engineering, value management, value planning, traditional contract, design-build, construction industry, task allocation, PDS, unnecessary costs

1. Introduction

Value Engineering has become a highly utilized process in the construction industry over the past decades. It is a proven technique that makes use of a systematic approach to identify the functional balance between costs, reliability, and performance of a product or project, while still assuring that customer's expectations are met [Zimmerman, 1982; Dell'Isola, 1997]. The application of Value Engineering (VE) in the construction industry has been observed in a number of countries around the world, and is recognized as one of the most effective methodologies for achieving 'best-value-for-money' [Shen, 2003]. Since its introduction, the development of Value Engineering in construction has put the VE study objective far beyond its original intention, which was seeking substitutes for materials in shortage. It is now also being used to facilitate strategic decisions, to enhance communication and consensus among stakeholders, and to define the project scope [Barton, 2000]. Numerous studies have been performed to improve the VE process, by defining the critical success factors, optimizing the VE study components, and determining what expertise is required to execute a VE study. Little emphasis, however, has been given to the allocation of VE efforts. There may be consensus about what makes a VE team effective, though the literature is unclear about whether the owner or the contractor should facilitate a VE study. The current literature indicates that several public

owners in the United States are performing their own value studies [Kelly and Male, 1993; Palmer et al, 1996]. However, It is questionable whether the owners should in any situation engage value studies, or rather should leave the responsibility with the producer (contractor) in certain instances. This is common in the manufacturing and process industry, where VE was practiced first.

Large public owners in the U.S. moved to Design-Build project delivery systems, but still utilize VE studies in-house, prior to procurement. While traditional Design-Bid-Build contracts caused the vast majority of formal VE studies to be executed by the public owners, the recent emergence of the Design-Build delivery strategy has created the opportunity for Value Engineering professionals to conduct formal value studies for competing Design-Build teams during the project pursuit stage as well as during the final design portion of project development [Fanning, 2006]. This article facilitates the idea of Fanning by proposing the reallocation of Value Engineering efforts between the owner and the contractor in certain instances, as opposed to the current situation where no distinction is made in the allocation of Value Engineering for different project delivery systems.

This article will commence with a historical background of Value Engineering and the evolution of this technique, in order to demonstrate the motive for this research. The current utilization of VE techniques and the construction phases in which they can be applied will then be addressed. The factors that current literature considers essential in the performance of an effective Value Engineering study will also be discussed, after which the literature will be confronted with the results of our empirical study on the current VE practice by American public owners and contractors in the construction industry. Based upon the observations made, we will conclude with a proposition for a renewed approach of Value Engineering allocation that is based on the allocation of responsibilities within certain forms of delivery systems.

2. Literature review

Review methodology

The relevant literature to conduct this research has been collected from several literature collections and databases. An important resource has been the Lawrence D. Miles Collection, which is situated in the Kurt F. Wendt library at the University of Wisconsin. Furthermore, several textbooks located at the University of Twente in the Netherlands have been studied. Consulted online databases include the SAVE International conference proceedings, Science Direct, L.D. Miles Foundation, and Google Scholar.

Historical background

Value Engineering originated from the Value Analysis technique, which was developed by Lawrence D. Miles in 1947. Miles, then working for General Electric, experienced difficulties purchasing the needed components for GE's manufacturing plants, due to the scarcity of materials during WWII. To find a proper solution, Miles solved the scarcity problem by questioning the functions that each scarce component fulfilled. He then investigated what available products could perform the same function, without sacrificing quality and functionality. This approach appeared to be successful, and was even cost-saving in most instances. It was the beginning of the Value Analysis technique [SAVE Standard, 2005].

The purpose of Miles' Value Analysis is to find ways to improve existing products in three basic steps [Miles, 1989]:

- Identifying its functions
- Evaluating its functions
- Creating value-adding alternatives

The primary steps that need to occur in the Value Analysis approach are structured in a Job Plan. Miles developed this framework to organize the structured team approach, which provides a vehicle to carry the study from inception to conclusion and logically separates the study into sequential tasks [Lane Davis, 2004]. A schematic overview of the various steps taken during the Job Plan process is given in figure 1.

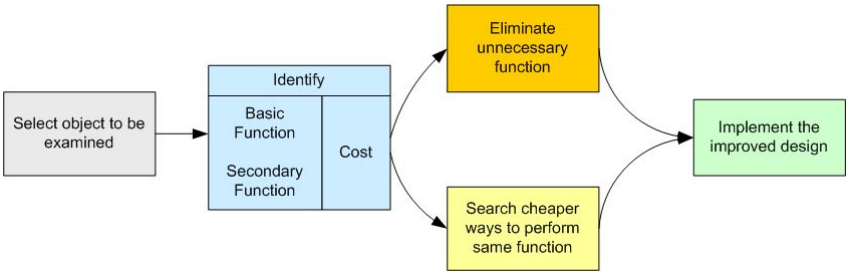

figure 1 - Job plan process [Ho et al, 2000]

The outcome of this process are design solutions to improve the product's value, which can be achieved either by reducing the production cost through replacing components for cheaper alternatives, or improving the functionality by adding functions or removing unnecessary functions. This can be explained by the value equation [Gerhardt, 2006]:

$$\text{Value} = \frac{\text{Function}}{\text{Lifecycle costing}}$$

This equation shows that value can be improved by either increasing the function of the object, or lowering its production costs. The production cost can also be lowered by removing waste from unnecessary cost. Dell'Isola [1994] defines unnecessary cost as any item that does not provide quality, use, life appearance or customer features. Apart from Cost Value, Miles [1966] also defined three other types of value: Use Value (ability to meet the user's needs), Esteem Value (contributes to desirability or saleability), and Exchange Value (ability for free trade in the marketplace). Since these forms of value are often difficult to express, it is difficult to make decisions based solely on those values.

After the initial success of the functional analysis approach at GE, companies from the manufacturing and process industry, both in the United States and in other countries worldwide, started to implement the Value Analysis program. Although a wide variety of terms were introduced for these Value programs to specify their application, the basic objectives and philosophy remained the same. The first Government organization to implement a formal program was the Department of Defense's Navy Bureau of Ships in 1954. They named the technique Value Engineering (VE) to reflect the emphasis on engineering [GSA Handbook, 1976].

By 1961, their VE program was formally implemented throughout the American Department of Defense (DOD).

Initially, the use of Value Analysis primarily dealt with studying improvements of manufactured hardware. The formal value program at DOD, however, also involved their design and construction agencies, including the Corps of Engineers. Between 1963 and 1965, programs were started by staffing full time Value Engineers. After the application of VE in the construction design process, manufacturing companies in Japan, who had already adopted VA programs to improve their products, started to use VE for New Product Development (NPD) in the 1970's. The VE approach for NPD in the American manufacturing industry, however, only recently evolved [Gerhardt, 2006]. The evolution from VA to VE is similar to the development of Deming's Quality Management techniques. His method was invented and successfully used in the United States during WWII, but companies lost interest in it once the war was over. Instead, Deming's method gained considerable success in the Japanese manufacturing industry, years after the war. The US industry readopted the technique in the 1980's, after its success in Japan became evident.

The current application of VE puts great emphasis on total Life Cycle Costing, rather than the initial production cost which GE was aiming for in the early days. Life Cycle Costing concentrates on optimizing energy consumption, maintenance and operations costs, replacements, staffing cost, etcetera [Dell'Isola, 1997]. This development makes Value Engineering particularly interesting for owners who are responsible for operating and maintaining the object.

Established in 1966, The Society of American Value Engineers (SAVE international) has become a leading organization in making efforts to standardize the Value approach. SAVE prefers to use the term Value Methodology; a methodology that includes all Value related approaches, including Value Analysis (VA), Value Engineering (VE) and Value Management (VM). The Value Methodology is a systematic application used to identify functions, understand their impact in cost and performance, and meet the user's wants and needs. The core part of the Value Methodology is a 40 hour workshop, which consists of a concise and intensive study performed by a multidisciplinary team of experts, usually with backgrounds in cost, estimating, procurement/materials, and those technical disciplines unique to the project such as design, manufacturing, construction, environmental, and marketing [VM Standard, SAVE international, 2005]. The VE team is led by one or two certified facilitators who guide the team members through the workshop's phases and motivate the members to be creative. Common techniques that are used during these workshops include: function analysis, often visualized in a FAST-model[1]; brainstorm session; as well as life cycle costing. The workshop is typically held for forty hours over the course of one work week, but exceptions are made, depending on the complexity and project size.
Because the term Value Engineering is a commonly used term in literature to keep discussions orderly, the term Value Engineering (VE) will be used in this paper for the same reason and will represent all value related studies.

[1]FAST-Model : Function Analysis System Technique. Two common types are known: the Customer orientated and Task orientated FAST model

Value Engineering in Construction

The introduction of the Value Engineering technique in the construction industry was encouraged by legislation that was passed in 1963 by the Armed Services Procurement Regulation (ASPR) committee, which required large federally funded projects to be reviewed in a formal Value Engineering study, with the intention to develop a more efficient construction process.

Value studies in the manufacturing industry were normally performed by the producers. As the initiator and financer of the production, it is in producer's interest to improve the product value and return. In contrast, the initiative in the construction industry to commence a project is normally made by the customer (owner). For that reason, bid-build contracts in the 1960's included incentives to the experienced contractor (producer) for submitting VE change proposals (VECP) based on a complete design, in order to improve the project value. Reasons for these incentives included: 1) to make use of the contractor's knowledge; 2) to improve bidding criteria; 3) to reduce operational and maintenance costs; 4) to imbed regulations for sharing VE savings in a contract [Dell'Isola, 1975]. Besides that, owners realized that they had conflicting goals with the engineering firms that designed their projects. While the engineering firms primary aimed for designing representative and unique objects, the owners' most important goal is often to reach maximum value at minimal cost, which moved owners to facilitate an objective design review by the means of a VE study. VE studies are predominantly for the benefit of the owner, and since oftentimes a reduction in construction costs improves the relative project's value, it would result in a negative impact on the contractor's profit, as the profit is normally a percentage of the construction bid. Therefore, proper compensation arrangements for the contractor's VE efforts needed to be included in the contract [Zimmerman, 1982].

Value Engineering is mainly beneficial early in the design process [Dell'Isola, 1997]. The approach is often executed by (public) owners, and has demonstrated its added value in the USA. The study is typically held in a VE workshop with a team of experienced professionals. These experts are either from external sources, members of the project's design team, or a combination of both project insiders and outsiders [Lane Davis, 2004]. The VE workshop is lead by one or two certified team facilitators (in-house or hired as well). The input for this workshop is provided by the client and/or the design team. The VE study results are value improving proposals that are to be implemented into the design [SAVE standard, 2005].

Value Planning and Value Engineering

When the US Navy and Army started using the Value Analysis approach, they changed the name Value Analysis to Value Engineering (VE), which has become a commonly accepted term in the United States. Value Engineering literature from authors in European countries and other continents, oftentimes refers to VE as Value Management (VM). According to Male and Kelly [2004], however, this is not legitimate. They write: *'The European Standard for Value Management defines VM as a style of management, which evolved from Value Analysis in the 1940s into services, projects, and administrative procedures'. Although often the exact same technique is meant, a clear distinction can be made between Value Engineering and Value Management*.

The Value Engineering approach, which has been developed and broadly implemented in the USA, is primarily technically orientated and puts great emphasis on cost reduction. Furthermore, this *hard* approach uses the philosophy from the scientific method, assuming that problems are

essentially technical and exist independently from the human perception. This differs from the function approach that has been developed in the United Kingdom. By the name Value Management, this *soft* strategic approach is concerned with defining what value means to the owner within a particular context (*focus*). This is drawn from the philosophy of social science and emphasizes that differing perceptions are an essential ingredient of real world problems [Green, 1997]. Value Management addresses the value process during the concept, definition, and implementation and operation phases of a project, and takes more of a management role, as opposed to the technical focus of Value Engineering [Walker, 1999]. Green also uses the term Value Planning for Value Management, to put emphasis on the early value efforts in the planning phase; Walker addresses Value Planning as the initial phase within the Value Management approach. This article will use the term Value Planning (VP) to refer to the soft strategic approach that determines the expected project value and expectations by the owner and stakeholders when developing the project objectives.

When performing a VE study, it is assumed that all feasible design alternatives provide the same level of functional performance and can therefore be assessed on the basis of cost alone. The VP approach has a broader application and is especially effective when the desired functions and objectives are ambiguous and still debatable (*uncertainty*). The ambiguous project objectives among the owner and other stakeholders are addressed and identified during the VP phase, and forms the *hard* input for the technical VE study. According to Green [1997], function analysis studies that solely focus on VE are largely meaningless in isolation of the guiding principles extracted from Value Planning efforts. In figure 2, the main differences between VP and VE are placed side by side.

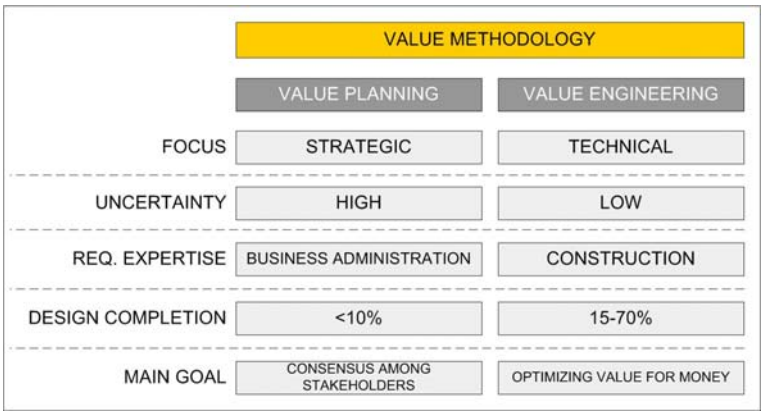

figure 2 - Value Planning vs Value Engineering

The allocation of VP and VE efforts is distinct, since they both deal with a very specific part of the construction process. Strategic VP is focused on determining the project expectation by the owner and other stakeholders. Its output is a presentation of the project mission in clear and objective terms, as well as the strategic fit with the corporate aims of the stakeholders [Male and Kelly, 1998]. Other factors, such as legislation, budget, environment and timeframe are thoroughly discussed during the study to make sure that the requirement specifications are flawless and unambiguous towards the designers. This part can only be properly executed when the owner is closely involved and should commence prior to the design phase.

The technical VE study, conversely, improves the project's value in such a way that the required functions are fulfilled or exceeded, while the costs to achieve those functions decline. VE is

predominantly implemented in response to projected cost overruns. It is important that VE studies are performed by a multi disciplined team of highly skilled professionals with relevant expertise. Technical insight is required to address equivalent substitutes that increase the present value. The proper level of abstraction to discuss technical issues is usually reached in the design phase, in which the owners' needs are being transferred into a constructible design that fulfils those needs. It can therefore be said that a VE study has to be initiated by the particular actor that is responsible for, and closely involved with, the design phase.

Prerequisites for successful value studies

The performance and level of success of a Value Planning or Value Engineering study can be influenced by certain important variables that have been described by a wide range of authors [Dell'Isola, 1997; Male and Kelly, 1993; Fanning, 2006; Palmer et al, 1996; Fowler, 1990]. These variables have an impact on the rate of success and therefore the level of added value. These variables are: 1) Timing of Value Engineering studies; 2) Team composition; and 3) Management support.

Timing of Value Engineering studies

The moment of executing a technical VE study in the construction process strongly influences the proposed results. Even though Value Engineering can be applied at any point in the construction process, there is overall consensus in the literature that typically the earlier it is applied in the construction process, the higher the return on time and effort invested and therefore the higher the value [Dell'Isola, 1997; Male and Kelly, 1993; Fanning, 2006]. There are four main stages within the construction process where VE studies are being utilized: the planning phase, the design phase, the construction phase and the maintenance and operations phase [Dell'Isola, 1997]. The graph in figure 3 shows that any major change in the maintenance and operations phase is nearly unacceptable, cost adding and subject to large resistance. The last stage will therefore be ignored in this study.

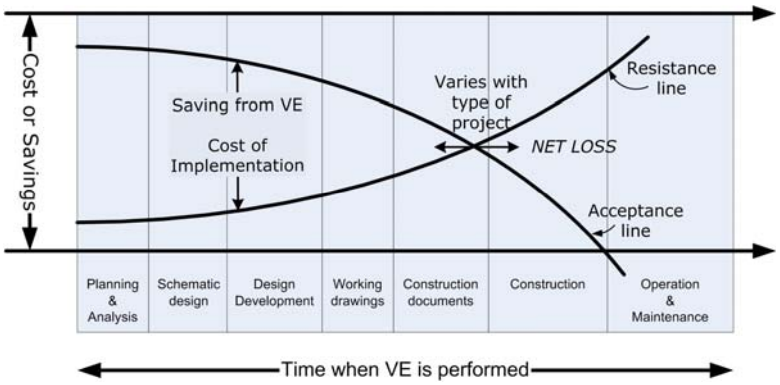

figure 3 - Consequences on VE allocation [Dell'Isola, 1997]

The activities and outcomes of the three remaining stages are the following:

Planning phase

The major benefit to proposing any changes on the initial project plans in this stage is that the changes will have a relatively small impact on schedule and redesign cost and will therefore face little resistance on the implementation. The early execution of Value Engineering will also create a common understanding and consensus among the stakeholders about the ultimate project

objectives. The Value Planning approach is most suitable in this phase and should be utilized prior to the design activities.

Design phase
In this stage, there is already and increasing risk of resistance by the design team, due to the additional work that would be required and the design team's initial support of the original developed design. An incentive is necessary to accelerate any changes. This is part of the Value Engineering efforts and requires proficient technical and practical knowledge.

Construction phase
Value improvements in this stage are normally addressed by contractors that submit a VE Change Proposal (VECP), which is either adopted in the construction contract or is an initiative by the contractor. Any changes at this stage are normally time-consuming and costly, which makes it essential for the contractors to suggest adjustments that achieve major unnecessary cost reductions.

Palmer et al [1996] recognize two different thoughts about how VE should be implemented. As they make the distinction between the Alpha and Beta school, they point out that the Alpha school prefers a VE study at a 35% design completion, which allows preliminary cost estimates, while the Beta school indicates that an early (10%) concept design stage is more effective. The latter school coincide with the Value Planning methodology.

Team composition
The success of especially Value Engineering also depends on the study team selection. A multidisciplinary team with credibility is important to achieve maximum implementation. Male and Kelly [1998] note that having the right team facilitator(s) is the key to success. There is an ongoing debate whether to use a completely independent expert team or the existing project team. Male and Kelly claim the latter to be desirable, with the option of bringing in experts to the workshop if required. SAVE International advises the use of experts not directly involved with the specific project, since team members will then be encouraged to assist in the free development of ideas [SAVE standard, 2005]. Palmer et al [1996] also points out the dissention between practitioners who prefer using an external team, and practitioners that believe in the allocation of the project designers.

VE studies have the tendency to fail under 'second-guessing syndrome', which happens when the study is performed by an external team without involving the key persons on that particular project (stakeholders, owner). This often leads to increased resistance towards the VE-teams' change proposals. Besides a disappointing implementation ratio, it also creates an antipathy against the value programs on a broader scale [Fowler, 1990]. Team members should be willing to accept changes and be open-minded in order to identify and develop ideas that are different from the original concept of the object. The team members, however, are inherently limited to in their rationality, also known as *Bounded Rationality*, which is caused by a lack of available time and information to make optimal decisions [Daft, 2003]. The development of new, cost reducing alternatives is therefore also bound and not solely dependent on the team composition.

Management support

Top management support is essential to address an effective value engineering program. This support, in any type of organization, is needed to demand the Value Engineering application, endorse implementation of the recommendations, facilitate the availability of human resources and financial budget, and to develop a value engineering culture in the organization. The success and growth of the Value Engineering program depends upon the belief in the program in various areas such as engineering, procurement, construction, planning, and estimating [Mansour, 1994]. The US Army's VE program, for example, receives broad management support, considering that participating organizations are required to submit their annual VE master plan, and specific training is required of both the government and contractors [DOD VECP report, 1997].

3. Practical application

Empirical evidence

As mentioned in the literature review, the Value Engineering approach was developed in the U.S., and has been widely implemented in both the U.S. industrial and construction sector. In addition, much emphasis on Value Engineering is given at the University of Wisconsin-Madison, which also houses the Lawrence D. Miles library. The author of this paper decided therefore to further develop the theoretical research at this university, and use this location as the starting point to gather empirical evidence from American organizations in the construction industry to compare the literary facts with empirical evidence.

Following the theoretical findings from the available literature, a structured questionnaire was drafted to investigate the motivation, development and execution of value adding efforts at organizations in the construction industry by personal interviews. Sequentially, organizations were selected and approached to participate in an interview. The organizations were selected based on the presence of a VE program, their VE 'reputation', and geographical location. To create a multi-perspective view on the current application, two large public owners, four general contractors (of which three are based in Wisconsin), and two consultant firms in engineering and VE services were questioned. Additionally, a formal Value Engineering workshop at the City of New York Office of Management and Budget was attended and the author observed and participated in the VE process first-hand to gain direct involvement and knowledge with the method.
Ultimately, the reflection between theory and practice offers an accurate perspective on how Value Engineering is being used in this experienced market.

Interview Method

The research data was collected in semi-structured, in-depth interviews. This method is flexible, and encourages adaptation to each situation and individual interviewed. To ensure the richness of the response, the interviewees were first informed about the aim of the study, what their participation would involve, and how the results would be disseminated. The questions were focused on their overall experience with the VE approach, rather then focusing on specific projects. Open interview questions based on the purpose of the study allowed experts to talk freely about their experience. The interview concluded with 19 short rating questions that had to be answered by a five point Likert Scale, to determine the opinion on VE related items that have been marked in the literature as influential factors on the successful application of VE studies.
Interviews started with some general questions about the respondent's organization, such as the type of work, annual turnover and the annual number of projects performed. Subsequently, respondents were asked to discuss their VE program and how it was executed. Later in the interview, the questions were directed to the opportunities and barriers of these methodologies. The average interview length was approximately 1.5-2 hours.
During the interviews, notes were made and conversations were digitally recorded and transcribed directly after each interview. Three interviews were held by phone; the remaining interviews took place in person, either at the company of the respondent, or at a location that was both convenient for the respondent and the interviewer.

Interview results

The flexible, qualitative interview approach provided a wide range of opinions and perspectives on the application of Value Engineering in the American construction industry.
Two experienced VE consultants have provided valuable perspectives on the effective utilization of Value Engineering studies. Their facilitating role as 'third' parties in the construction industry, however, is not preferable for allocating Value Engineering responsibilities, as they are not in the position to take any early initiatives. Therefore, their responses have not been adopted in the reflection of the interview results, but their ideas about the methodology have been taken in consideration for rating the factors that could influence the application and success of Value Engineering.
The following topics have been addressed in the literature as key factors for executing an effective VE study, which were incorporated into the semi-structured interviews. The corresponding and conflicting perspectives of the owner and contractor respondents have been analyzed and allocated under these topics;

- What is the driving force for an organization to apply VE?
- What party in the construction process performs the VE study?
- At what project stage is VE executed?
- What VE methods are used?

What is the driving force for an organization to apply VE?

During the interviews it became apparent that the motives to apply VE in the construction process differ between the public and private organizations. For instance, one of the main objectives for using VE for public owners was to reduce unnecessary construction costs, as public owners faced major cost and time overruns in their projects. A second motive for using VE among public owners was the implementation of legislation that mandates public executive agencies to establish and maintain cost-effective value engineering procedures and processes. This Act, the Defense Authorization Act (also known as public law 104-106), was enforced by the US government on February 10, 1996. In addition to the above, one of the interviewed public owners interviewed, who is responsible for the budget allocation for public facilities in the city they represent, also put considerable emphasis on the so called *esteem* value for the city's residents. Though this type of value cannot be expressed into cost, it is to some extent possible for public owners to validate a decision based upon the esteem perception. Both public owners addressed they only allocate a VE study when the project estimate exceeds a certain level. At one organization this level is set at $1 million, while the other uses a $30 million minimum.
The contractor respondents expressed different motives for implementing VE They were not motivated by a need to reduce construction costs or a requirement by a owner or higher authority, but instead mainly desired to facilitate their clients with transparent design tradeoffs that could increase the project value. Especially in the private sector, where open bidding based on lowest price is not common, it is essential for contractors to build up a sustainable relationship with their clients based on trust and service to ensure their continuality. Offering services for the owner's benefit seems to contribute to that relationship. Using VE in the design process gives contractors the ability to apply their construction experience for the development of cost saving alternatives. Private owners with limited expertise in construction can be assisted with cost reducing value tradeoffs to keep the project within budget.
In sum, the public owners indicate that their motivation to perform their own VE study, with the help of external expertise, is that they feel responsible to optimize the value of the project before

bringing it out for bid. The contractors, however, feel the necessity to make additional customer service offerings by improving the value for the owner and leave behind their competition.

What party in the construction process performs the VE study?

Although much is published on the general allocation of VE, no clear statement is made about what party should perform the VE study, i.e. the owner or contractor. The two public owners interviewed indicated that they facilitate an extensive VE program on the vast majority of their projects. The VE studies within their organizations are initiated by a special VE task force, which makes arrangements for the actual study. For each study, the task force hires a specialized VE consultant with the responsibility to 1) lead the study, 2) select the external, multidisciplinary VE team in cooperation with the VE program director and their project manager, and 3) help the client with the preparation and completion before and after the 40 hour VE workshop. To cater short time frames, the owners have long term, on-call requirements contracts with a number of VE consultants, to bring in the needed consultants without having to conflict with schedule concerns. One owner, using primarily a traditional design-bid-build procurement strategy, performs formal VE workshops based on preliminary designs, prepared by allocated design teams. The design teams are only involved at the very beginning of the VE study to clarify the design to the VE team, and at the end of the study to become informed about the value improving recommendations. The other public owner mainly initiates Design-build contracts. At first, the concept design of the awarded DB entity was Value Engineered by the owner, after which the approved change recommendations were given back to the DB contractor. Due to increasing resistance by the design teams to implement those changes, the owner decided to perform a VE study in the planning phase, before procurement starts. This seemed to be more effective (see adjacent text box).

> The United States Department of State Overseas Building Operations performs VE studies both before and after rewarding a Design-Build contract. When allocating the study before the contract is being award, they documented an average $90 return on investment (ROI) on ever $1 spent on the VE study. Studies executed after the project awarding reach an average of $39 ROI for every $1 spent [Bethany and Kaplan, 2004]

A different approach was visible when interviewing the contractors, who are often involved early in the design process due to the Negotiated-Bid delivery strategy by private owners. The contractors either take the initiative to perform a VE study, or are requested by the owner to perform one. The design is analyzed by the contractor's pre-construction team, after which the possible options are discussed with the final decision maker; which is normally the owner. It should be noted that the allocation of VE efforts by the contractors is dependent on the delivery strategy. There is usually no time or incentive for the contractor to perform a VE study in a traditional design-bid-build PDS.

At what project stage is VE executed?

The project stage in construction at which VE techniques are utilized is strongly dependent on the type of delivery system the owners chose to use, as well as the identity of the party responsible in executing the study. It is commonly recognized that change proposals that originate from a VE study should be adopted into the design as early as possible, to ensure that the added value exceeds the additional costs to change the design.

The public owners point out that when the project is to be built under a traditional design-bid-build contract, the VE studies can be performed as early as at 15% design completion, and as late as at 70% completion. Late studies will inevitably be less effective then VE studies performed in the early stages. Moreover, when the project estimate or complexity is far above average, the

owners may decide to have two separate VE studies at different stages in the design phase. As for contracts, the VE workshop is performed before the project is awarded (in the preliminary design phase).
The timing for VE by the contractors is heavily dependent on the owners' choice as to when to involve the contractors in the design phase. The common negotiated-bid PDS leaves opportunities for the contractor to be involved early in the design process, which gives them the chance to implement VE in the early design stage. One contractor working for a large public owner explains the contractor doesn't perform extensive VE studies, as the owner has already done this before the contract is awarded. As mentioned before, a bid-build PDS leaves little chance to perform VE by the contractor. Besides a lack of time, it is oftentimes not feasible to implement any change proposals when the design is nearly complete.

What VE method is being used?

The literature study contained several ways to perform a VE study. The interviews taught that American organizations primarily use the 'American' technical Value Engineering study, without using the strategic Value Planning study developed in the UK. Each respondent indicated that VE studies are more or less based on unambiguous project objectives, with a primary goal to reduce cost without sacrificing any functions. Though technical VE is commonly used, there is a variance in the methodology used to perform the study.
Both public owners indicated that they have a Value Engineering task force within their department that is responsible for the execution of each Value Engineering study. They require a certain work method from the VE consultant firms that lead the actual study. The firms do have to submit proposals with detailed information about their work method on each particular project, and are selected to execute a study accordingly. Public owners (agencies) are mandated by law to perform a formal study when project cost estimates exceeds $1 million [Circular No. A-131, par. 8.2 Federal OMB]. Their VE workshop is considered to be the formal approach the literature requires, with sequential steps that are structured in a Job Plan, and executed by a multidisciplinary team under the lead of a certified VE facilitator.
The interviewed contractors show a more divergent VE application. One contractor (with in-house CVS[2] expertise) utilizes a formal VE approach, including a workshop structured by a Job Plan. During the process, they use their own resources, often accompanied by the owner as the key decision maker, and additional external expertise if necessary. The studies are led by in-house VE facilitators. The remaining three respondents utilize an unstructured, informal VE program, integrated with other pre-construction activities. The informal approach is often an in-house developed log, in which each change proposal is written down, accompanied with rough cost estimation. These items are periodically discussed with the design team and the owner during progress meetings. These contractors find the formal VE approach to be ineffective within their organization, as it is too time consuming and only rewarding on large, complex projects. Additionally, in the private sector it is argued that owners often already know what they want, which makes a formal VE study irrelevant. For one of the respondents, his company's choice to deploy an informal VE study was intentionally, since he was familiar with the SAVE method and is even certified by SAVE (AVS)[3].

[2]Certified Value Specialist, certified by SAVE international
[3]Associate Value Specialist

The interview results are summarized in table **1** to indicate the corresponding as well as diverging perspectives by the two main parties on each of the four topics.

table 1 – Summary of interview responses

TOPIC	PUBLIC OWNERS	PRIVATE CONTRACTORS
▪ What is the driving force for an organization to apply VE?	▪ Creating more efficiency during the design and execution phase ▪ Ensuring consistency ▪ Reducing initial costs and LCC	▪ Facilitating owner by providing cost components for decision making ▪ Differentiating from competition
▪ What party in the construction process performs the VE study?	▪ Predominantly owners at public works ▪ Hired VE facilitators and external expertise to execute VE study	▪ (General) contractors at private projects ▪ In-house expertise and facilitator
▪ At what project stage is VE executed?	▪ 15%-70% design completion ▪ Depending on type of PDS (Design-build contract requires an early VE study, prior to procurement)	▪ Preferably at the beginning of the design phase. ▪ Negotiated-bid allows early involvement ▪ Planning phase if possible
▪ What VE method is being used?	▪ Technical VE study ▪ Formal approach ▪ Structured by Job plan	▪ Technical VE study ▪ Both formal and informal ▪ Semi-structured approach

Respondent comparison

At the end of each interview, respondents were asked to give their opinion on a number of statements that have been marked in the literature review as being influential factors on the application of VE studies and its success. By rating each item with the Likert Scale, the respondents were able to indicate the relative level of importance of items within four areas. The results are reflected in the rating matrix (figure 4).
When analyzing the ratings, it shows the different perspectives on VE between contractors, owners and consultants. First, the average rating per group has been determined, after which the total average is calculated, while keeping in account the number of respondents per group. At last, the deviation between the two group average extremes has been determined to indicate the level of unanimity between the respondents. Whenever the deviation is equal or less then 1.0, the unanimity level is considered high; between 1.0 and 2.0 it is variable; and with a difference of 2.0 or more, it means there is poor unanimity. The main purpose of this matrix is to illustrate the level of shared perspectives on VE. The respondents perspectives on VE appear to differentiate a lot. This can be explained by the fact that each party is on a different 'side of the table', i.e. they each have different stakes or goals in the project.

There are three items with an average score above 4.0 that is worthy of attention. The moment of contractor involvement is considered essential by the contractors, but not by the other respondents, indicating that contractors feel their organization has an important role to play in making VE successful. Another noteworthy point is the time frame of VE allocation in the design phase. The proper timing of VE activities seems to have considerable impact on the study results. Lastly, the resistance to change is commonly identified as a main barrier for effective VE use among all groups interviewed. This indicates that organizations are reluctant to adopt new methodologies such as VE. To overcome this barrier, it is essential to demonstrate the possible

potential of VE studies and opportunities for the organization when utilizing the function approach. It should be noted that the respondents' points of view are based on their VE experience, gained over multiple, incomparable projects. The results may have been more accurate when it was focused on one certain type of project. However, because each respondent fulfills a respective position at authoritative organizations, this survey can be considered to represent the market to some extent.

				Contractor					Owner			Consultant		
Much unanimity - when difference is ≤1 Variable unanimity - when difference is 1<x<2.0 Poor unanimity - when difference is ≥ 2.0	Total average	Maximum deviation	Contractor 1	Contractor 2	Contractor 3	Contractor 4	Average contractors	Owner 1	Owner 2	Average owners	Consultant 1	Consultant 2	Average consultants
1. What is organization's motivation to implement VE?			**level of importance 5 = high, 1 =low**										
1.1 LCC reduction	3.5	2.3	3	2	4	2	**2.8**	5	5	**5.0**	5	5	**5.0**
1.2 Satisfying client ->follow orders	3.9	0.8	5	3	5	2	**3.8**	5	3	**4.0**	4	5	**4.5**
1.3 Setting apart from competition	3.1	3.3	5	4	4	-	**4.3**	-	1	**1.0**	5	3	**4.0**
1.4 Professionalizing	3.0	2.3	4	4	4	1	**3.3**	-	1	**1.0**	3	3	**3.0**
1.5 Mandated by higher authority	3.7	0.5	2	5	2	5	**3.5**	3	5	**4.0**	4	4	**4.0**
2. What influence do these factors have on the success of VE efforts?			**level of influence 5 = high, 1 =low**										
2.1 Moment of contractor involvement	4.3	2.0	5	5	5	5	**5.0**	-	3	**3.0**	-	3	**3.0**
2.2 Percentage of design completion	4.5	1.0	5	5	5	5	**5.0**	-	5	**5.0**	-	4	**4.0**
2.3 Evidence of past performance (trust)	2.8	1.3	2	4	4	1	**2.8**	-	4	**4.0**	4	3	**3.5**
2.4 Knowledgable owner	2.9	1.0	2	4	3	3	**3.0**	-	4	**4.0**	2	4	**3.0**
2.5 Rewarding system	2.7	1.5	4	3	2	-	**3.0**	-	4	**4.0**	5	4	**4.5**
3. What is the most common type of value improvement in your organization?			**level of occurance 5 = often, 1 =rare**										
3.1 Change in material use	3.8	0.5	5	3	4	3	**3.8**	3	5	**4.0**	2	5	**3.5**
3.2 Change in floorplan lay out	3.3	2.3	1	5	3	2	**2.8**	5	5	**5.0**	5	3	**4.0**
3.3 Improved maintainability	3.2	1.0	3	2	3	4	**3.0**	4	4	**4.0**	3	3	**3.0**
3.4 Efficient construction sequence	3.7	2.0	4	2	4	5	**3.8**	3	2	**2.5**	5	4	**4.5**
3.5 Different material source	3.4	1.3	5	4	2	4	**3.8**	3	3	**3.0**	3	2	**2.5**
4. What are the main barriers for effective VE use?			**level of obstruction 5 = high, 1 =low**										
4.1 Unawareness of added value	3.9	0.8	5	5	2	3	**3.7**	5	4	**4.5**	4	4	**4.0**
4.2 Reluctance to invest additional money in early project stage	2.5	1.5	5	5	1	-	**3.0**	1	4	**2.5**	1	2	**1.5**
4.3 Lack of construction experience in design organisation	2.8	2.5	2	2	3	5	**4.5**	1	3	**2.0**	3	3	**3.0**
4.4 Resistance to change	4.3	1.0	4	5	4	5	**4.5**	4	5	**4.5**	5	2	**3.5**

Organization	Turnover	Respondent function
Contractor 1	$190 mln	Vice President of Project Management
Contractor 2	$600 mln	Director, Value Optimization
Contractor 3	$200 mln	Preconstruction Project Manager
Contractor 4	$1,500 mln	Project Manager International operations
Owner 1	$52,900 mln	Project manager
Owner 2	$1,500 mln	Value Engineering Manager
Consultant 1	-	Vice President - Operations
Consultant 2	-	President

figure 4 - Respondent comparison overview

Case study

A VE case study was executed at the City of New York Office of Management and Budget (OMB) by attending a 40-hour Value Engineering workshop on one of the city's projects. OMB is the budget distributor to the City's Agencies and responsible for proper expenditure. The VE study was held for a project to convert an existing elevated rail track into a public park. It was the second workshop held for this project and was conducted at 30% design completion. The OMB has requirement contracts with VE consultants, which states that they have to provide a certain amount of service over a period of time. They have a pool of about six SAVE certified VE firms and sent out a request for a VE proposal to each firm. The selection of the proposal is based on: past performance, the selected team members for the VE study (submittal of capabilities, resumes etc), how they carry out the process (OMB requires SAVE methodology) and the number of VE facilitators that will be provided for the study.

The 40-hour workshop is performed in a meeting room at OMB (figure 5). The VE team chosen was a multi-disciplinary team led by the VE team coordinator and his assistant. The awarded VE consultancy firm also provided an office assistant to keep a record. The VE team consisted of two landscape architects, an architect/planner, a structural engineer, an electrical engineer, the owner's representative, a construction manager, and a cost estimator. Moreover, OMB was represented by the VE director and the project manager.
The workshop was structured by seven Job Plan stages, spread out over five days. During the functional analysis phase, nine main functions were addressed, such as *convey water, facilitate access*, *secure park*, *support visitors*, etc. These functions formed the guidelines within which to generate ideas. Unlike the SAVE standard, the facilitator did not use a FAST-diagram to classify or rank the functions. After the creativity phase, which generated around 300 ideas that could improve the project value, a selection was made by the team members to reduce the number of ideas. This was achieved by having each team member select five high potential ideas. The ideas were then ranked on the scale of 1-5, where 1 is impossible to implement and 5 is a great idea. Other possible ratings were 'design suggestion', 'out of scope', and 'already been done'. Before developing the recommendations, the ideas were verified with the design team to make them worthy proposals. Once all the proposals were developed and estimated, they were presented to the design team, owners and other stakeholders. After the 40-hr workshop, there would be a Post study to ensure follow up, where the owner and stakeholders indicate in writing which recommendations will be accepted and which are rejected. An implementation meeting is scheduled later, where the design team is able to present the modified design to the owner and the VE workshop facilitator.


figure 5 - Image of OMB Value Engineering workshop

4. Cross analysis between theory and practice

After having studied both the theoretical literature and the empirical findings on the allocation of VE, it was noticed that there were several corresponding steps found in both the literature and in practice. However, there were also findings in practice that have not been found in the literature. This section will discuss these differences and parallels briefly.

Job plan

The literature [e.g. Dell'Isola, 1997; Lane Davis, 2004; Shen, 2003] is fairly unanimous about the effective use of a Job Plan. This systematic approach consist of sequential phases, ranging from 3 to 7 steps, that structure the VE study and helps the team to oversee the process. The practical input by the respondents and the case study indicate that the Job Plan is indeed the guideline used by many organizations for orderly progression through the formal VE process and is considered to be an effective approach.

VE workshop

As with the Job Plan, the workshop with a multidisciplinary team is often described as the most effective approach to conduct a VE study. This method has been adopted by the public owners, as well as by one of the contractors. SAVE International promotes the 40-hour workshop, as do the public organizations and consultant firms. The literature contains an ongoing debate about whether an external, objective team of professionals should be used, or whether design team members should be used, with external help only if necessary. Owners often bring in an external team of experts, including an external certified VE facilitator to lead the team, while VE executing contractors normally use their design team to perform the study, led by an in-house Value Specialist.

Owner practice

The literature suggests that the owner primarily uses VE as a method to improve the project value on a whole life approach. This has been confirmed during the interviews and the case study. The owners have an extensive VE program, directed by a team that is responsible for: selecting potential projects, organizing the VE workshops, and the preparation and completion of the studies. As some authors suggest [Kelly and Male, 1993; Dell'Isola, 1997; Palmer et al, 1996], the owners bring in VE consultants to organize and run VE workshops. Teams are formed with external professionals that bring in the necessary expertise to VE specific projects. The owner remains closely involved during the entire process.

Timing

There is overall consensus in the literature, as well as in practice, that VE efforts are most effective when performed and implemented early in the construction process. Early adjustments on designs have limited effect on the project cost and schedule, while late design changes can have considerable impact on these items. The exact moment of implementation varies from as early as the conceptual phase (before design is initiated) up to efforts at a 70% design completion. It should be noted that the value adding changes should exceed the additional effort, time and money to implement those changes. Especially later in the design phase, this concept becomes crucial.

Formal and informal VE

The literature is generally confident about the use of a formal application of VE, including a Job Plan, VE workshop and multidisciplinary teams let by a skilled facilitator(s). In practice, the formal application can be very time consuming when considering the efforts needed to bring in the right professionals and facilitator, prepare and finalize the study, etcetera. For organizations that do not rely on VE and only recognize it as another tool to facilitate the owner or to reduce construction costs, it may not feasible to set up a formal VE study. It is more suitable for these organizations to conduct short meetings throughout the pre-construction phase, where they address possible alternatives to reduce the construction cost while respecting or exceeding the functional requirements by the owner. Oftentimes, Pareto's Law of Distribution, exposing 80% of the cost resident in 20% of the project, is used to make a selection of components that are worth reviewing. The change suggestions are listed in a database, including a rough estimate of the potential savings. This informal approach which is done within the design team may be less effective than a formal workshop, but the results are often satisfying for both the contractor and the owner.

Value engineering study motivation

The literature primarily portrays Value Engineering as a means to establish considerable savings in construction and life cycle costs, improve the functionality of an construction, or to reduce risks later in the development process. These benefits are mainly viewed from the owner's perspective and seem to be their predominant drive to do so.

Interviews showed that contractors are performing formal and informal value studies with the same goal of additional value for the benefit of the owner. The contractor, however, expects to receive indirect gain from it too, by means of follow orders resulting from the provided additional service that distinguishes him from his direct competition. Since one of the major goals for contractors is continuality, building a good relationship with the owner to ensure future projects is crucial.

Application by contractor

While the literature mainly covers the formal VE approach that is being executed by large public owners and producers in the manufacturing industry, the empirical study demonstrates an alternative approach. It became apparent in the interviews that general contractors, who primarily work for private owners, take the initiative to use the Value Engineering approach during the pre-construction phase. VE can be beneficial for the contractor to offer the owner cost/worth tradeoffs in the occasion of major budget overruns. This type of VE approach has not been found in textbooks and articles, but does occur when owners request contractors to submit VE Change Proposals. Instead, the primarily focus is on the execution of formal VE workshops, success stories of VE in different industries, or prerequisites for an effective VE study. Palmer et al [1996] notice that in case of VE, the theory is a representation of practical developments, rather then the practice being a reflection of the theory. The historical development of VE in construction is such that VE programs were implemented first and were then followed by texts on the subject, often written by the same people who had developed the VE programs.

This may be an explanation for the 'blind spot' in the literature. The author of this article has attended the Annual SAVE International Conference 2006 in Savannah, Georgia. At this conference, representatives from organizations in a wide range of industries shared their latest experiences with the technique introduced by Miles. Also, researchers gave an update on the development of the function approach. After having analyzed the attendee list, it appeared that

35% were public owners (predominantly from the USA), and another 19% were consultants, who are usually hired by public owners to perform a formal VE study. As the diagram in figure 6 shows, contractors represented only 2%, while the engineering firms had an 11% share in the total number of attendees. Based on these facts, it can be said that the vast majority of *active* SAVE members that contribute to the refinement of the value approach are either employed by public owners or offer specific services to them. This could explain why the literature puts such great emphasis on formal, owner controlled VE programs, while contractor initiatives are underexposed. It can be assumed that contractors are mainly focused on reducing unnecessary costs, and use the VE technique as a tool to achieve this. The methodology is predominantly developed by owners and consultants, who are accustomed to using a formal VE approach, and who recognize the necessity to keep improving the methodology. Conversely, it can be discussed whether contractors currently recognize the advantage of utilizing VE studies to their fullest extent, since owners (in particular in the public sector) predominantly execute VE studies themselves. The interviews taught that mainly contractors who work for private owners do perform some sort of Value Engineering, which differs in most cases from the more effective formal approach used by the public owners.

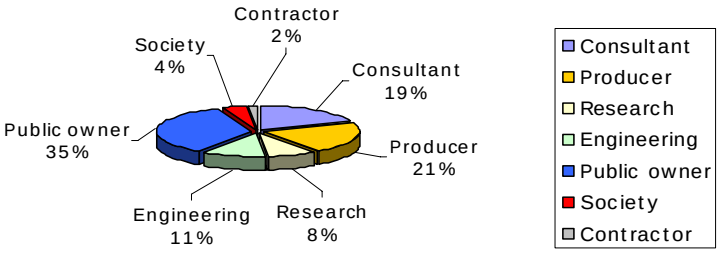

figure 6 - Organizational representation at SAVE conference

5. Discrepancy between owner and contractor VE allocation

The VE implementation does differ from the VE literature pertaining to VE studies. Although both owners and contractors utilize VE studies to improve the overall project value, they are motivated by their own specific incentives. Owners and contractors differ in areas such as the level of technical expertise, their project commitment, and the organizational stakes in successful project completion. The observations made in the American construction industry, as well as the conclusions drawn from the literature, have raised different perspectives on the current allocation of Value Engineering. Public owners indicate that their VE program is effective in minimizing the unfavorable characteristics of traditional design-bid-bid. Nevertheless, while many public owners have changed their delivery strategy into Design-Build to stimulate early contractor involvement, they kept executing technical VE studies in-house to ensure optimal project value. The potential to participate contractors in these activities has been ignored by owners, as they prefer to retain control over possible value aspects to maximize cost savings and minimize the risk for misinterpretation of the requirements by the Design-Build contractor. Despite these proposed advantages for the owner, it comes into question whether these advantages exceed potential time and cost savings from innovative solutions, if contractors are being held responsible for utilizing a VE study. With the right incentives and collaboration, a win-win situation could be created for both the owner and awarded contractor.

6. Renewed approach for Value Engineering allocation

Different perspectives arising from the literature and empirical studies create a base to initiate a different VE approach, where the organizational stakes and qualities of the involved parties are taken into account to optimize effectiveness. This chapter will propose a composition with the 'American' technical VE study and the strategic orientated VP study developed in the United Kingdom. It is believed that allocating a Value Planning study to the right party, prior to performing a technical VE study, will help clarify the project objectives, which is necessary to utilize an effective technical VE study.
Rather than just allocating the traditional cost-orientated VE approach to a single organization, we argue that a valuable addition can be made by allocating a VP study as known in the UK building industry, prior to the design phase. In the following sections, the influence of delivery strategies on the allocation of VE is first specified. Subsequently, two schools identified in practice will be briefly described, followed by the Value Engineering responsibilities that organizations in the construction process have to take, based on their level of commitment with certain project phases.

Project Delivery System

The construction industry is known for close cooperation between the customer (owner) and the producer (contractor) during the building process. This opens the opportunity for either the owner or the contractor to execute the Value Engineering process. In the literature, no clear statements are being made about the designated initiator to execute a VE study, although it is often suggested that the owner allocates VE studies.
The allocation of construction phases to actors within the construction process is directed by the owner, and is largely depended on the type of Project Delivery System (PDS). The PDS selection is usually based on either personal experience or mandated by a higher authority [Sanvido, 1999]. Although numerous variations in PDS are known, this paper will focus on the two most common types: Design-Bid-Build and Design-Build. Other delivery systems have attributes that are more or less derivatives from these two. Each PDS has a certain influence on the relationship between parties, and therewith also on the final project result. As for 'traditional' Design-Bid-Build, it gives the owner the ability to maneuver the design process in detail, while leaving possible valuable input by the contractor aside. Taking into consideration that the literature describes early VE efforts to be most beneficial, the owner is likely to execute a VE study. In the event of a Design-Build strategy, the contractor is involved and responsible for the design phase, which offers opportunities for him to initiate a VE study.

The owner has to make the far reaching decision on how he wants a project to be executed. This is dependent on a number of trade offs. Design-Bid-Build does not appear to be the best strategy, since the minimum required standards motivate the contractor to lower performance. Besides that, the process places the client and the contractor on opposite sides, with different objectives. The extensive specifications and the owners responsibility to manage the process allows inexperienced contractors to bid, while if no detailed direction were given, they could not have competed on the project. However, the DB delivery strategy should only be used when the owner has a good idea of what he or she wants; when the construction time is limited; and when the owner has performance information on alternatives.
To briefly indicate the differences between the two delivery strategies, the following overview (table **2**) is adopted to cross analyze the characteristics in the construction phases.

table 2 - Design-Bid-Build versus Design-Build Project Delivery System

Design-Bid-Build	Design-Build
CHARACTERISTICS	CHARACTERISTICS
▪ Certainty about design, costs and duration ▪ Design completion before tendering and contractor involvement ▪ Separate design and construction responsibilities	▪ Level of uncertainty for owner about design and cost – control loss ▪ Reduced delivery time: no finished design needed to commence construction ▪ Stimulating innovation ▪ Combined design and construction responsibilities
PLANNING PHASE - OWNER	PLANNING PHASE - OWNER
▪ Allocation of (in-house or external) design team to prepare conceptual design ▪ No clear transition between planning and design phase ▪ Reach consensus among stakeholders	▪ Allocation of (in-house or external) expertise to prepare conceptual design ▪ Preparing unambiguous requirement specifications in accordance with stakeholders - consensus ▪ Over- or under specification can have considerable impact on later project development by contractor ▪ Request for proposal to pre-selected Design-Build entities
DESIGN PHASE – OWNER	DESIGN PHASE - CONTRACTOR
▪ Owner responsibility for design ▪ Due to absence of competition, no specific drive for design team to create best value for owner ▪ Procurement when design phase is finished ▪ No opportunity to involve construction knowledge	▪ Contractor responsibility for design ▪ Bidding creates strong incentive for contractor's design team to create optimal value for owner ▪ Procurement in early design phase ▪ Opportunity to implement construction knowledge in design - Constructability
CONSTRUCTION PHASE – CONTRACTOR	CONSTRUCTION PHASE – CONTRACTOR
▪ Construction commences based on finished designs, provided by owner ▪ Design errors are at owners risk Contractor tries to minimize own risk and maximize return	▪ Construction errors due to design are at contractors risk ▪ Minor design changes are possible ▪ Ongoing value emphasis to remain within maximum guaranteed price (common in DB contracts)

VE allocation schools

Resulting from the theory and empirical evidence, two major schools are identified that allocate the Value approach in the American construction industry. In the public arena, owners allocate VE studies to increase the value of the project by improving its functionality or lowering the life cycle cost. In the situation of Design-Bid-Build, the VE team is performing a study based on the preliminary designs. This could also be done in a Design-Build contract, except that DB contractors will have to implement any Value adding changes that resulted from the study. This appears to be problematic in practice, as they may be reluctant to do so. To overcome this issue, one of the interviewed owners moved the VE study upfront into the planning phase to determine a requirements program that ensures optimal value for money to the owner. State Departments of Transportation, which are governed by the Design Build Final Rule 23 CFR & 627.5, are now mandated to perform a VE study analysis prior to the release of RFP documents to the contractors [Fanning, 2006].

In the private sector, contractors use a more informal VE approach, which is adopted as part of their overall pre-construction activities. One contractor respondent facilitates a formal VE

program, which is not included in the standard pre-construction activities, but an optional service. The VE studies by the contractors are performed with basically in-house expertise and are led by their own value specialists. Consultancy firms could be identified as a third school of VE users, as they effectively run Value Engineering studies to facilitate their clients. Their position allows objective studies, which are commonly respected by the involved parties. Being a 'third party' in the construction industry, the consultant firms will, however, not be further considered in this study, despite their important role in the VE approach. Their position allows for services to both owners and contractors in construction and are therefore not determinative.

Value study tasks linked to responsibilities

Of interest is what party is in the best position to allocate a value study under certain circumstances. As mentioned in the literature review, the function approach can be used for strategic and technical purposes. The focus of VE studies should be allocated to the party that has a stake in the outcome of such a study. For instance, a strategic Value Planning study is only beneficial to the owner, as he or she is responsible for operating, maintaining, or selling the object. A contractor does not have a stake in whether or not the object can be used or whether it is in conflict with its environment after completion. On the other hand, a technical Value Engineering study is performed to improve the design efficiency and constructability in order to maximize the project value. It should therefore be used by the party responsible for the designs. This responsibility is determined by the type of project delivery system. In case of a traditional Design-Bid-Build contract, it is the owner's responsibility to generate detailed designs and in some cases specifications of quantities. The owner often hires a design consultant to make the designs for him, after which the owner transfers the design to the bidding contractors. Any errors or deficiencies that occur during construction because of faulty design is the owner's responsibility.

This differs from a Design-Build PDS, where the contractor is responsible for both the design and execution. Design-build is used to integrate construction knowledge into the design process to ensure a buildable design and proper material use. Unlike with design-bid-build, the contractor has to bring out the best design for reasonable cost to win the project, rather then just offering the lowest bid. This requires a pro-active standpoint, where more emphasis is placed upon ensuring the clients best value. If the VE study is performed properly, there is a win-win situation for both the owner and the contractor who receives the work. The VE opportunities within different project delivery systems are listed in table 3.

table 3 - VE opportunities within both project delivery systems

DESIGN-BID-BUILD VE OPPORTUNITIES	DESIGN-BUILD VE OPPORTUNITIES
▪ Strategic VP study initiated by owner to ensure unambiguous project expectation, to reduce risks ▪ Objective evaluation by external VE team on technical aspects at early design phase. Focus on project value and Constructability ▪ Owner can require Value Engineering Change Proposals from contractors (VECP), with proper incentives	▪ Strategic VP study initiated by owner to ensure unambiguous requirement specifications, to reduce risks ▪ Technical VE study initiated by contractor to ensure optimal project value to satisfy owner and keep construction cost down to win project – Constructability review advisable

Value Engineering in Design Bid Build

Whenever a project involves more then one stakeholder, there will be various expectations about the resulting object, ranging from functionality, cost, and time frame to environmental impact, return on investment, etc. Knowing that these aspects could have a major influence on the design output and time schedule, it can be rewarding for the owner to reach early consensus among the stakeholders about the project purpose, value, and expected functionalities. This process can be directed by a strategic Value Planning workshop. Depending on the complexity of the project, the workshop can be performed in a few days. The owners can either lead this workshop, or bring in external expertise for quick and thorough analysis. During the VP study, non-technical topics concerning budget, planning, project purpose and context, safety, and project environment can be discussed. These higher order issues need to be worked out before commencing detailed design activities in order to reduce the risk for costly changes later in the design.

As for the design phase, the owner has the opportunity to bring in an independent Value Engineering team to avoid major budget overruns, which could even result in the adjournment of the project. It is preferable to use an independent team, rather then the design team, to ensure an objective review. It is common practice that with Design-Bid-Build delivery strategies, owners are closely involved in the design phase and design decisions are predominantly based upon aesthetic qualities, rather then cost efficiency. Once the design team is awarded to complete the designs, there are no strong incentives to keep the construction and life cycle costs down. An independent VE team has the ability to review the design for inefficiencies and may advise the owner how to improve the cost/worth ratio. Through a technical VE workshop, experts of relevant disciplines thoroughly analyze the preliminary designs prepared by the design team. The workshop, which normally involves a brainstorm session, is effective to identify and overcome potential problems or deficiencies for the benefit of the owner. A constructability review is often part of a formal VE study and can be essential, since the building experience of contractors is only involved when the designs are complete. Moreover, problems in construction due to poor design could cause extensive additional cost for the owner. The study results in recommendations towards the owner and the design team to make value adding changes. The owner will have to negotiate with the design team about the implementation of these recommendations, as they can have a major impact on the existing design. For the approach to be effective, it is important that the study is performed early in the design process. Design change costs increase proportionally as the design develops. The allocation and timing of Value Planning and Value Engineering studies are adopted in the VE allocation model for Design-Bid-Build PDS (figure 7 on the next page). It also indicates the hard gate, which is the moment where the procurement takes place. Past this point, the owner is no longer able to propose any changes without risking major cost consequences.

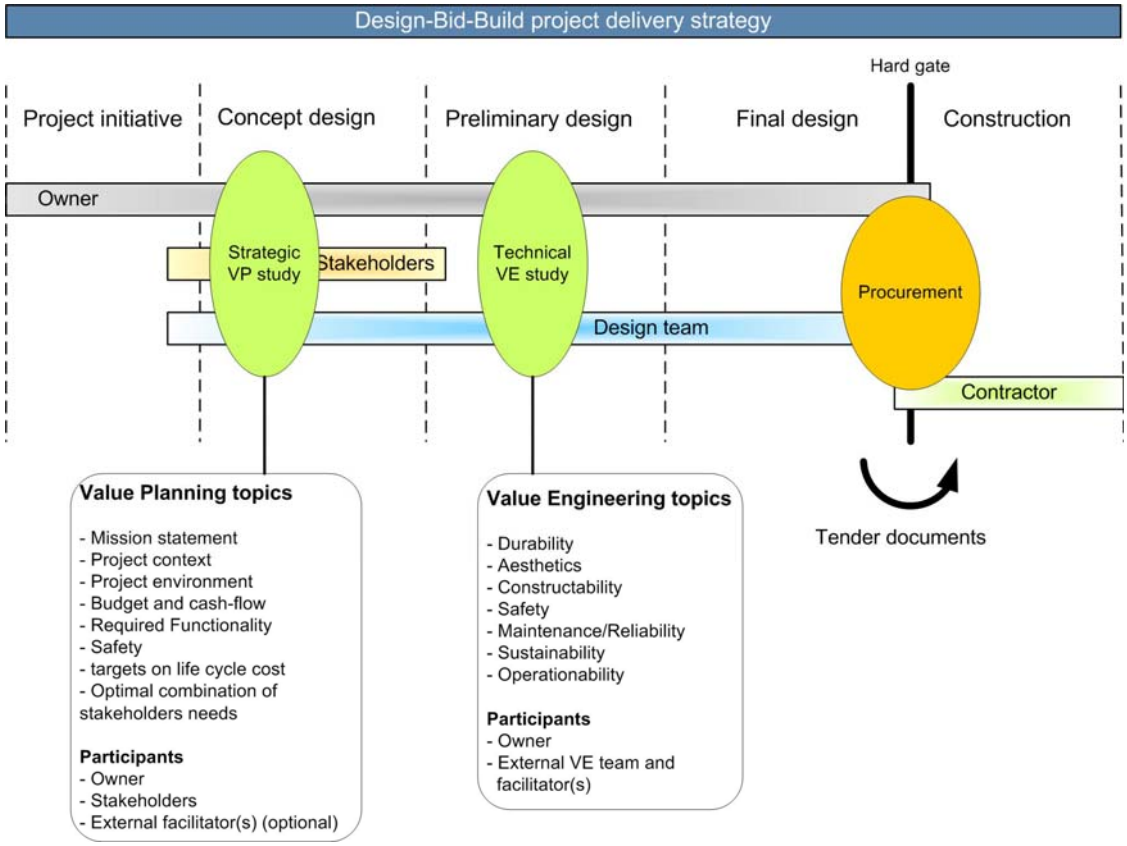

figure 7 - VE allocation Design-Bid-Build PDS

Value Engineering in Design Build

Owners have the opportunity to reduce the risk and uncertainty that Design-Build project delivery brings, by examining their own objectives and negotiating about the object functions with other stakeholders, and achieving consensus on these functions [Green, 1997]. The strategic VP approach can be very effective in this stage to make sure that the opinions and requirements of the stakeholders are in tune. Any argument that occurs when the project is awarded to a Design-Build entity could cause major change orders and therefore price increases and additional delivery time. Male and Kelly [1998] point out some of the areas the VP teams should focus on: the project context, the client's value system and success indicators, overall scope and purpose of the project, cash flow constraints, operating expenditure and other life cycle costs.

A Request for Proposal goes out to Design-Build entities once the requirements are clear and unambiguous. These entities are usually contractors, as they are in a stronger position to carry risks than design firms. The contractors have their own in-house design department, or hire a design team to prepare the designs. It is the contractor's responsibility to ensure owner satisfaction by developing a design according to the requirements.

The major incentive of contractors to fulfill the owner's needs is their direct competition with other firms to gain the award of the project. It is therefore interesting for the contractor, who tries to keep the construction cost down by making important trade offs in the design, to use a technical orientated Value Engineering workshop to make sure that the owner receives optimal value for money, by designing an object that owns the required functionalities, while ensuring minimal costs. Moreover, the contractor assumes responsibility for problems in construction due to design errors, which makes it essential for him to do a constructability review. This review enables the contractor to avoid unnecessary costs during construction. As seen during the case study, as well as mentioned during the interviews, constructability is an important topic that is often addressed during VE studies. This can be explained by the fact that a well designed construction sequence speeds up the construction time and reduces design changes, which could save considerable money during construction. Other topics that were addressed during the case study workshop included maintenance, sustainability, aesthetics, safety, durability and operationability. During the study, these topics seemed to be very effective to cover the essential parts of the project. A prerequisite to contractors for proposing value improving solutions is that owners allow sufficient space for contractors to implement the innovative improvements, by leaving space for alternatives. The owner should be cautious therefore, of making too detailed a description, and instead leave options for alternatives wherever possible. Besides, the owner should provide information about their organizational structure to the contractors, in order for them to fine-tune the maintenance and operationability to the owners' organization.
Although the contractor has the needed expertise in-house to perform a VE study, it may be necessary to hire a Certified Value Specialist (CVS) to lead the study and structure the team of experts. Besides, it is imaginable that in order to facilitate the owner's functional requirements to its fullest potential, the contractor brings in some particular knowledge about operating and maintaining the object once it is operational. This will help the designers view the project from the owner's perspective to find the right balance between pleasing the owner and maximizing profit for the design-build entity. Several VE studies will be performed simultaneously by each contractor that is tendering for the project. During that process, the owner should be available at certain points in order for the contractors to validate their VE study results. This is important since the ultimate goal is to offer an object that meets or exceeds the contractors expectations. The

contractor that succeeds best in creating optimal project value by integrating the required functions against the lowest life cycle costing should win the project. Once the project is awarded, the value approach during the remaining design work can still be beneficial for the contractor to keep the project below the maximum guaranteed or lump sum price that is agreed on between the owner and the contractor. Any VE proposals always have to be discussed with the owner before any changes are implemented, as the functionality may vary from the initial winning design. The suggested timing and allocation of strategic VP and technical VE studies are displayed in the VE allocation model for design-build PDS (figure 8). In this instance, the hard gate has been moved forward to right before the design phase, which means that the requirement specifications should be unambiguous at that point. Again, any major changes opposed after this point by the owner, could lead to major cost consequences.

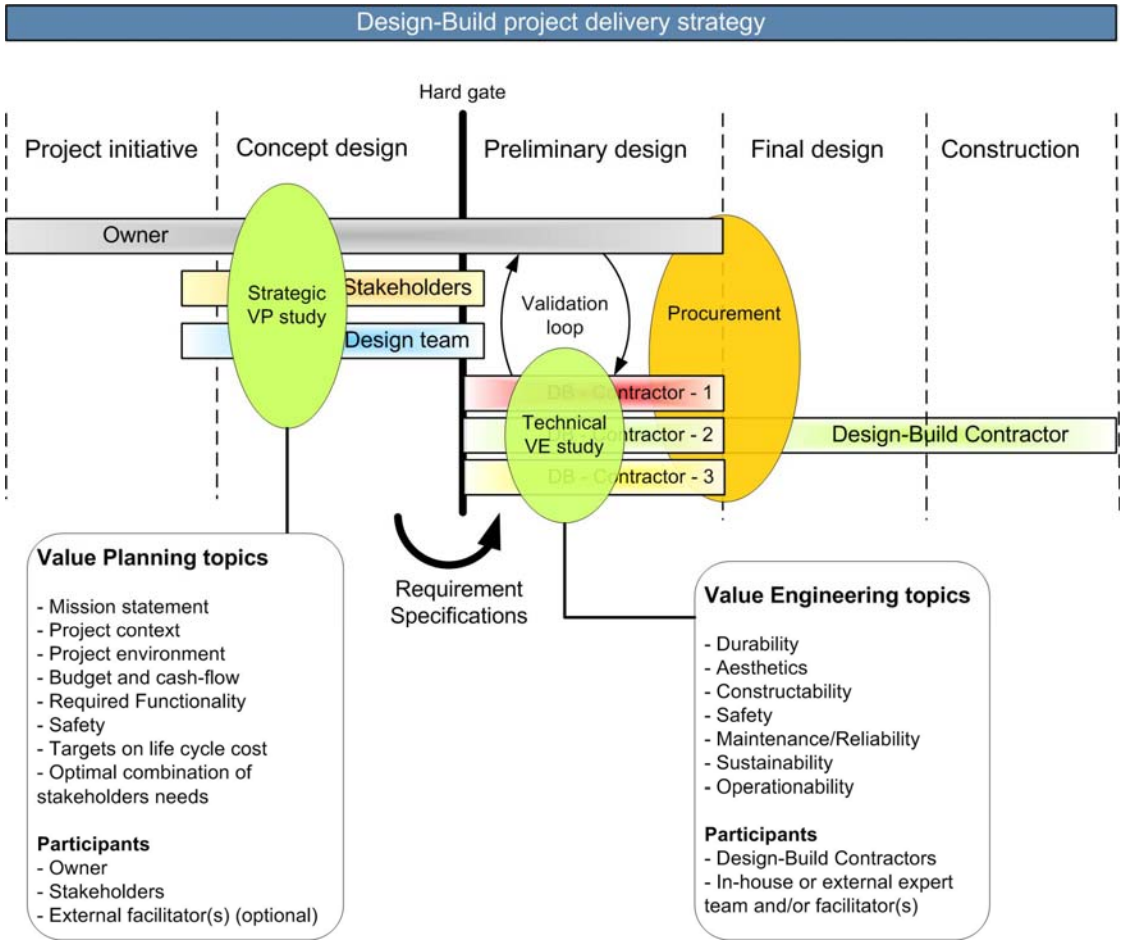

figure 8 - VE allocation Design-Build PDS

7. Discrepancies between both models

When comparing the two VE allocation models, some similarities and differences are noticeable. The major similarities are the timing and the content of both the strategic and the technical value workshops in both models. Differences can be found in the list of participants during the technical VE study. The Design-Bid-Build model addresses the owner and an external VE team with facilitators to conduct the workshop. The model indicates the contractor as the main participant, assisted by a team of their own experienced people and one or two facilitators, who are either in-house or hired for the workshop. Although the owner is not mentioned as a participant, he or she will be sporadically involved to enable the validation between the contractor's perceptions and the owner's expectations. Another discrepancy is the position of the point of no return, or the hard gate, where the owner no longer has full control over the project. In the Design-Bid-Build situation, this moment concurs with the procurement phase, prior to the construction phase. The hard gate arises prior to the preliminary design in the Design-Build strategy, while the moment of procurement occurs after this phase. This indicates that the owner is giving up influence on the design, which is typical for Design-Build delivery strategies. The decreased control in the design phase by the owner has to be compensated by providing a complete set of clear requirement specifications.

The application of a particular VE allocation model is determined by the owner's choice to use a particular project's delivery system (PDS). This decision directly cancels out one of the models, as it does not match with the allocation of responsibilities that is typical for each PDS. Subsequently, the owner has to approach other stakeholders and make arrangements to participate the early VP study. The required outcome of the VP workshop is slightly different in a design-build situation as apposed to design-bid-build.
The outcome of the strategic VP workshop in a Design-Build situation requires a more unambiguous outcome as opposed to the same study in a design-bid-build situation, since with the former situation the VE outcome is also the input for the requirement specifications for the tendering contractors that will perform the technical VE workshop. Issues that have been left out in a Design-Bid-Build situation can still be introduced by the owner during the design phase.
Effective technical VE workshops in the early design phase are in both instances for a large part affected by owner decisions. These decisions include the composition of the technical VE workshop in the Design-Bid-Build situation, and leaving adequate space for contractors to introduce value adding alternatives in their VE studies. It is therefore important that owners understand their initial role for receiving the optimal project value.

8. Discussion

The objective of this study was to analyze the current allocation of Value Engineering techniques in the construction industry for opportunities to improve its effectiveness. Therefore, the available literature on Value Engineering has been studied and compared with empirical findings in the American construction industry. The literature reveals that the project owner predominantly initiates a Value Engineering study to ensure optimal project value by reaching a high cost/worth ratio [Dell'Isola, 1997; Zimmerman, 1982]. The owner's concern can be explained by his responsibility to finance the project, as well as to operate and maintain the structure. This situation has been confirmed in practice by two authoritative public owners. Owners often hire an engineering firm to prepare the project designs as owners don't have the necessary human resources within their own organization. This is also an explanation why they hire external experts to execute a fully objective technical Value Engineering study. The increasing popularity of Design-Build delivery strategies caused a move in design responsibility towards the contractors. While the owners step away from the design phase in this strategy, they continued to utilize the technical VE study without using contractor knowledge that has become available in the design phase.

This research has reviewed the current application of VE in the United States, which is primarily a technically oriented value approach with a particular emphasis on generating cost reducing alternatives, and is predominantly utilized under the responsibility of the owner. The American approach is merely effective when the project objectives are unambiguous and technical problems are well defined. When dealing with more complex projects that involve several project stakeholders and large investments, the early project stages are often dominated by dynamic problems and uncertainty. Before commencing preliminary design activities and efforts to increase the project value through a technical VE workshop, these problems need to be defined by bringing together the project stakeholders to reach consensus about project objectives [Green, 1997]. This can be achieved by allocating a 'soft' strategic Value Planning study prior to the design phase, which prepares the input for the technical VE workshop scheduled in the early design phase. This article suggests that the Value Planning approach, which is developed and often used in the UK, has the ability to fortify the technical 'American' Value Engineering approach, if both techniques are allocated according to design responsibilities.

Combining the strategic Value Planning and the technical Value Engineering study into a single project causes a complementary effect, which allows for monitoring and securing the project value at decisive moments during the development of a project. The separation of both studies into different project phases enables the proper allocation to the organization responsible for that project phase. With the necessary incentives already in place to successfully complete each specific phase, it will stimulate the designated party with the necessary knowledge and skills to optimize the project value by using the VE techniques. It is expected that the proper allocation of VE tasks to the adequate parties will lead to more efficient VE studies, with a higher proposal implementation rate.

Towards the practical utilization of Value Engineering, the models that are presented in this article are fairly accessible and relatively simple to implement. It offers a different perspective on the allocation of VE efforts, in which owners, contractors and other participants can recognize

their specific role. The owner is the decision maker concerning the delivery strategy and the use and allocation of VE, and has to realize the effects of re-allocating those tasks. However, contractors that recognize the potential added value of utilizing their own technical VE study, are in the position to propose this to the owner as a signal of customer orientation and commitment to the project, and convince the decision maker to re-allocate value related responsibilities. The interviews held with the contractors already indicate that they recognize the added value of VE to some extent for their own organizations. Once the owner recognizes the advantages of having the contractors perform a technical VE study, the contractors will receive more responsibility and therewith leeway in their design activities. Subsequently, this allows the contractors to reduce the risk of faulty design and therefore avoid costly delays or changes in construction under their liability.

The creation of the two VE allocation models presented in this research is the result of a study on the characteristics of Value Engineering, the prerequisites for its success, as well as a study of the available literature about technical VE and strategic VP techniques. The motive for focusing on the allocation of VE tasks came forth from personal interviews with respected professionals who are employed by authoritative organizations in the American construction industry. Though the developed models are largely based on the conclusions that were drawn from the empirical evidence, the models have not yet been put into practice to prove their effectiveness. Furthermore, the number of respondents and their backgrounds are informative yet are a limited representation of the entire American construction industry, since public works contractors have not been interviewed. The main reasons for the slight amount of the empirical evidence include a restricted time frame in the U.S., lack of the financial resources, as well as the limited availability of representative respondents. Nonetheless, if these models are to be further developed, these constraints can be compensated by collecting feedback from expert meetings or pilot projects that review the operability of the models.

9. Summary

This article designates two separate moments in the construction process wherein two distinct value studies are to be performed. The first is a strategic Value Planning study, used to identify the project expectations, and to reach consensus about the true project objectives. This study should be allocated to the owner. The second study is a technical Value Engineering study used to create optimal project value by finding value adding technical solutions. This study should be allocated to the party responsible for the design phase. In the situation of a Design-Build delivery strategy, which is gaining ground in the construction industry, the bidding contractors will utilize a technical Value Engineering study to assure optimal value for the owner at a competitive bid, and meanwhile seek design optimization to avoid faulty design that could cause difficulties during construction. The reallocation of VE efforts creates an improved situation for both the owner and the awarded contractor.

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Waardeoptimalisatie in de bouw:

Onderzoek naar de her-allocatie van Value Engineering
Tussen opdrachtgever en opdrachtnemer

Procesverslag

1. Inleiding

De samenstelling van deze afstudeerrapportage is afwijkend ten opzichte van andere scripties. Het hoofdverslag is geschreven in de vorm van een artikel, met de mogelijkheid tot publicatie. Deze opzet heeft tot gevolg dat het proces dat vooraf is gegaan aan het eindresultaat maar beperkt aan de orde kan worden gesteld in het hoofddocument. Daartoe is gekozen om een begeleidend procesverslag toe te voegen, waarin wordt beschreven met welke doelstellingen dit onderzoek is gestart, welke fases het heeft doorlopen, en beschrijft het de wijzigingen die zich hebben voorgedaan gedurende het proces, om te komen tot het uiteindelijke resultaat.
Dit rapport begint met de oorspronkelijke aanleiding van het onderzoek, gevolgd door het plan van aanpak, de uitvoering van de literatuur- en praktijkstudie, en de tussentijdse resultaten. Vervolgens wordt de wijziging in de onderzoeksdoelstelling besproken met tot slot de behaalde resultaten en een reflectie.

2. Aanleiding tot onderzoek

De oorspronkelijke aanleiding tot het onderzoeken van de Value Engineering en Constructability methodieken komt voort uit aandachtspunten van verschillende Nederlandse instanties, die de gemeenschappelijke doelstelling nastreven om het Nederlandse bouwproces te verbeteren. Binnen verschillende disciplines in de bouw wordt zowel door publieke opdrachtgevers en aannemende partijen reeds enige jaren kenbaar gemaakt dat de huidige procesgangen niet wenselijk zijn. De in 2002 gestarte Parlementaire Bouwnijverheid enquête heeft de gevolgen van deze onvolkomen markt verder bloot gelegd. Haselhoff en Rijlaarsdam [1988] spreken van een negatieve spiraal, dat gevoed wordt door ontevredenheid, wantrouwen en gebrek aan wederzijds respect. Dit standpunt wordt bijgestaan door Kashiwagi et al [2006], die aangeeft dat er onvoldoende voldaan wordt aan de wensen van de klant. Dorée [2001] wijst de scheiding tussen de ontwerp- en uitvoeringsfase aan als de grootste veroorzaker van het disfunctioneren van de bedrijfstak. Dit heeft geleidt tot ontevredenheid over het projectresultaat bij de opdrachtgevers en tegenvallende projectresultaten bij de opdrachtnemers.

Ter ondersteuning en stimulering van de markt zijn er vanuit de overheid en diverse landelijke instanties initiatieven genomen om de problemen te analyseren en het verbeterproces te begeleiden. De PSIB[1] geeft in haar impulsprogramma aan dat structurele ontwikkelingen dienen plaats te vinden ten aanzien van kennisintegratie en procesefficiëntie. De Ministeries van EZ, VROM en V&W noemen in hun toekomstvisie dat het vertrouwen hersteld moet worden, en dat *'Value for Money'* een prominente rol moet gaan spelen. Daarnaast dient de klantgerichtheid en aanbesteding op basis van functionele eisen onder de aandacht te worden gebracht.

Deze landelijke doelstellingen hebben overeenkomsten met resultaten die worden behaald met beproefde bouwproces methodieken die met name buiten Nederland, en in het bijzonder in de Verenigde Staten, worden toegepast. Een van deze methodieken is Value Engineering; een proactieve en creatieve projectmanagement techniek waarmee in een vroeg stadium mogelijkheden kunnen worden geïdentificeerd om onnodige kosten weg te nemen en daarmee de functionele projectwaarde van een project te maximaliseren [Dell'Isola, 1997; Male at al, 1998]. Constructability is de tweede benadering, waarbij uitvoeringskennis en ervaring vroegtijdig in

[1] Proces- en Systeem Innovatie in de Bouw

het bouwproces wordt geïntroduceerd, om zodoende vanaf de planningsfase tot en met de uitvoering van een project een gestroomlijnde uitvoering te bewerkstelligen [CII, 1986].

Beide technieken zijn in Nederland momenteel relatief onbekend en worden slechts op zeer kleine schaal toegepast in de Nederlandse bouwsector, maar kunnen mogelijk een positieve bijdrage leveren aan het bouwproces, waaronder het vergroten van de projectwaarde door het vermijden van faalkosten. Een initiële oriëntatie in de beschikbare literatuur over Value Engineering en Constructability bracht naar voren dat de University of Wisconsin – Madison, in de Verenigde Staten met name in de jaren '80 een grote rol gespeeld heeft in de ontwikkeling van Constructability, veelal in samenwerking met de Construction Industry Institute (CII). Daarnaast biedt de universiteit sinds 1957 Value Engineering cursussen aan, waar veelvuldig aan wordt deelgenomen door Value Engineering gebruikers uit het bedrijfsleven. De Kurt F. Wendt Library op de universiteit huisvest de complete collectie van de Lawrence D. Miles Foundation. Deze collectie bevat al het werk van Miles, de bedenker van de Value Engineering benadering, evenals een brede collectie van overige Value Engineering literatuur.

Daarnaast is uit de initiële literatuur beschouwing naar voren gekomen dat beide toepassingen al decennia lang met name in de Amerikaanse bouwindustrie wordt toegepast. Dit heeft de aanleiding gegeven om zowel de literatuurstudie en het praktijkonderzoek in de V.S. uit te voeren.

3. Plan van Aanpak

De University of Wisconsin is in het najaar van 2005 benaderd voor het beschikbaar stellen van een werkplek om de literatuurstudie te kunnen verrichtten. Daarnaast biedt deze locatie een praktische uitvalshoek voor bedrijfsbezoeken om persoonlijke interviews af te nemen met deskundigen op het gebied van VE en CS. De praktijk studie heeft tot doel om de literatuur te verifiëren met de huidige toepassing van de bestudeerde technieken, en daarnaast om met de ervaringen van de gebruikers van deze technieken een eigen visie te creëren.

Gelijktijdig is begonnen met het opstellen van het onderzoeksplan. Op basis van de verschillende beleidsvoorstellen van verscheidene Nederlandse instanties om het huidige bouwproces te verbeteren, is de volgende probleemstelling gedefinieerd:

"De Nederlandse publieke bouwsector zal de integratie van de disciplines binnen het bouwproces moeten verbeteren, teneinde een hogere efficiëntie, toegevoegde waarde en rendement te behalen".

Vervolgens is de doelstelling van het onderzoek gedefinieerd:

"De toegevoegde waarde van Constructability en Value Engineering in het Amerikaanse bouwproces dient te worden geanalyseerd ten aanzien van de integratie van project disciplines, teneinde de ontwerp output te verbeteren. Daarnaast wordt de mogelijkheid tot samenvoeging van beide methodieken bestudeerd, ter bevordering van implementatie mogelijkheden in de Nederlandse bouw".

De formulering van de onderzoeksdoelstelling leidt tot de volgende centrale onderzoeksvraag:

"Op welke wijze kan, gebaseerd op de ervaringen van Amerikaanse bouwondernemingen, opdrachtgevers en consultants, de invoering van Constructability en Value Engineering een positieve bijdrage leveren aan

de integratie van proces disciplines in de Nederlandse civiele sector, en daarmee de doelstellingen van zowel de opdrachtgevers en de opdrachtnemers verwezenlijken".

Op basis van de bevindingen uit de literatuurstudie en uit de verificatie door middel van persoonlijke interviews met deskundigen uit de praktijk zal antwoord worden gegeven op de gedefinieerde onderzoeksvragen, die vooraf worden gegaan door een aantal concrete subvragen.

De bevindingen uit de literatuur en de Amerikaanse bouwsector worden vervolgens voorgelegd aan Nederlandse bouwondernemingen en opdrachtgevers om hun visie op de toepassing van Value Engineering en Constructability binnen de Nederlandse bouw in kaart te brengen. Deze resultaten moeten leiden tot concrete implementatie aanbevelingen naar Nederlandse bouwondernemingen.

4. Resultaten literatuur en empirie studie

De uitgevoerde literatuurstudie was voornamelijk gericht op de *ontwikkeling* en *toepassingsvormen* van Value Engineering en Constructability, evenals de kritische factoren die van invloed zijn op de succesvolle uitvoering van de methodieken.
Op basis van de bevindingen uit de literatuur, zijn de volgende onderzoeksvragen beantwoordt:

Wat houden de VE en CS methodieken in?

Value Engineering is een formeel proces waarbij gedurende een aantal dagen met een team van experts op systematische wijze wijzigingsvoorstellen gegenereerd worden die de waarde van het project op de lange termijn verhogen. Deze formele methode maakt gebruik van een systematische Job Plan aanpak, bestaande uit een aantal gedefinieerde stappen die leiden tot een gestructureerde workshop met het gewenste resultaat. Het onderdeel waarmee Value Engineering zich onderscheidt van andere proces management technieken, is de Functionele Analyse, waarbij een project wordt geanalyseerd op functionele eisen, die zijn afgeleidt van het programma van eisen. Overbodige functies worden indien mogelijk verwijderd, en voor de uitvoering van de gewenste functies wordt gezocht naar alternatieven, om hiermee onnodige kosten te vermijden. Onnodige kosten worden gedefinieerd als kosten die niet bijdragen aan de kwaliteit, het gebruik, de uitstraling, of specifieke wensen van de opdrachtgever.

Constructability maakt gebruik van praktijkkennis en ervaringen uit voorgaande projecten om deze op effectieve wijze te implementeren in nieuw te ontwikkelen projecten. Door onder andere gebruik te maken van 'lessons learned' databases en speciaal ontwikkelde software kunnen gedurende het ontwerp- en uitvoeringsproces risico's als kosten- en tijdsoverschrijdingen vermeden worden en zodoende het project efficiënter uitvoeren. In tegenstelling tot Value Engineering vindt Constructability niet per definitie op een bepaald moment plaats, maar is het een continu proces, parallel lopend aan de ontwerp voortgang. De huidige toepassing is niet erg gestructureerd, zoals het geval is bij Value Engineering.

Hoe dragen VE en CS bij aan ontwerpverbeteringen?

Value Engineering biedt de mogelijkheid om met een multidisciplinair team een concept ontwerp te analyseren en door middel van brainstorming tot waardige alternatieven te komen die de oorspronkelijke functionaliteit van het object behouden of overtreffen, terwijl de kosten omlaag gebracht worden door onnodige kosten te vermijden. Deze kritische analyse leidt tevens tot het

identificeren van eventuele Constructability issues De huidige Value Engineering toepassing levert met name voor de opdrachtgever directe toegevoegde waarde op.

Constructability is onder andere effectief doordat voorgevallen problemen worden gearchiveerd in een database om deze in het vervolg te vermijden. Uitvoeringsproblemen worden reeds in het ontwerp weggenomen. Daarnaast wordt gebruik gemaakt van check listen om ontwerpen te controleren op veel voorkomende knelpunten. Deze maatregelen zorgen ervoor dat een ontwerp vroegtijdig wordt geoptimaliseerd. De resultaten leveren in eerste instantie tijdsbesparingen en risicoverlaging op voor de uitvoerende partij, maar zijn daardoor indirect ook waardevol voor de opdrachtgever.

Wat zijn de kansen en beperkingen van het combineren van VE en CS?

Value Engineering en Constructability hebben een aantal overeenkomsten, wat het samenvoegen van beide technieken mogelijk maakt. Beide technieken zijn met name effectief wanneer deze vroegtijdig in het bouwproces te worden toegepast, indien mogelijk reeds in de planningsfase. Daarnaast is vastgesteld in de praktijk dat Constructability in sommige Value Engineering studies een belangrijk punt van aandacht is, waarbij alternatieve ontwerpen kunnen leiden tot een verbeterde uitvoering. In de literatuur wordt tevens gesproken van het samenvoegen van Value Engineering en Constructability onder het Total Quality Management principe. Russell et al [1994], stellen dat CS en VE als onderdeel van TQM kan worden beschouwd, aangezien beide overeenkomstige doelstellingen hebben: probleem vermijding, effectieve samenwerking en continue verbetering. De centrale gedachte van TQM is dat de prestaties gedurende het proces doorlopend wordt geobserveerd, wat tot in zekere mate ook het geval is met VE en CS.

Een beperking van de samenvoeging is dat Value Engineering in de publieke sector voornamelijk door de opdrachtgever wordt uitgevoerd, terwijl de effectiviteit van Constructability pas volledig wordt benut wanneer deze wordt uitgevoerd door de uitvoerende partij. Door contractuele beperkingen kunnen de uitvoerende partijen in veel gevallen niet aan de Value Engineering studie deelnemen, aangezien deze reeds vóór de aanbesteding wordt uitgevoerd. Hoewel het in de praktijk voorkomt dat het Value Engineering team een Constructability review uitvoert zonder de uitvoerende partij, leidt dit vanzelfsprekend niet altijd tot het gewenste resultaat. Bovendien zijn Constructability resultaten in eerste instantie voornamelijk interessant zijn voor opdrachtnemer, terwijl Value Engineering in de huidige toepassing met name voor de opdrachtgever voordelen biedt. Deze discrepantie is in de huidige situatie moeilijk weg te nemen.

5. Tussentijdse bevindingen Value engineering en Constructability

Tijdens de literatuurstudie is gebleken dat Value Engineering vanuit verschillende optieken en in vele industrieën wordt toegepast en beschreven. Daarnaast is SAVE international een actieve organisatie waar veel aandacht wordt besteedt aan de verbetering en verspreiding van het Value Engineering principe. Dit in tegenstelling tot Constructability, wat ontwikkeld is door en voor de bouwindustrie, maar nauwelijks door de gebruikers naar een hoger plan wordt gebracht. Mede hierdoor is het gebruik van Constructability minder uitgebreid vanuit verschillende perspectieven in de literatuur beschreven en lopen de vaak informele verschijningsvormen zeer uiteen.

In de praktijk blijkt dat Value Engineering op een veel expliciete wijze wordt toegepast dan Constructability. In totaal zijn er tien interviews afgenomen met representatieve respondenten, waarvan slechts één interview georiënteerd was op Constructability toepassingen. Deze onevenredige verdeling heeft een aantal oorzaken. Allereerst wordt verondersteld dat Value Engineering wordt toegepast als een additionele service waarmee ondernemingen zich willen profileren. Hierdoor is het relatief eenvoudig om te achterhalen welke ondernemingen Value Engineering kennis in huis hebben. Ondernemingen met Constructability programma's bleken daarentegen moeilijk te identificeren, wat waarschijnlijk wordt veroorzaakt doordat ondernemingen de techniek voornamelijk impliciet toepassen en deze is opgenomen in overige ontwerp werkzaamheden.

Gedurende het verblijf in de V.S. is een netwerk opgebouwd met vooraanstaande Value Engineering deskundigen binnen zowel de publieke en private bouwsector, wat het vinden van de juiste bronnen op het gebied van Value Engineering heeft bespoedigd.
Naast de interviews hebben de contacten met Value Engineering deskundigen geleidt tot de mogelijkheid om de jaarlijkse vierdaagse Value Engineering conferentie, georganiseerd door de Society of American Value Engineers (SAVE) bij te wonen, en is tevens in een formele Value Engineering studie bij de New York City Office of Management and Budget geparticipeerd. Deze publieke instelling is toonaangevend op het gebied van Value Engineering workshops in de V.S. De bevindingen tijdens deze workshop zijn als casestudie in het onderzoek opgenomen (zie bijlage 1).

Bij terugkomst uit de V.S. zijn er twee interviews afgenomen bij een Nederlandse publieke opdrachtgever. In twee aparte gesprekken is eerst de Value Engineering adviseur gesproken over de ontwikkeling en huidige toepassing van Value Engineering binnen hun organisatie. Het tweede gesprek vond plaats met het afdelingshoofd van de afdeling aanbestedingen, en was sterk georiënteerd op de strategische beweegredenen om als een van de eerste organisaties binnen de bouwsector een Value Engineering programma te introduceren. Deze interviews hebben duidelijk inzicht gegeven op de wijze waarop een Nederlandse opdrachtgever Value Engineering zou kunnen implementeren, maar de toepassing door een opdrachtgever geeft onvoldoende weer hoe andere bedrijven in de Nederlandse bouwsector met de methode om zullen gaan.

De inzichten op de toepassingen in de Amerikaanse bouwindustrie hebben geleidt tot nieuwe perspectieven ten aanzien van de uitvoering van Value Engineering. In de VS blijkt de studie zeer sterk gericht op het behalen van kostenbesparing en is de Value Engineering studie technisch georiënteerd. Tijdens de literatuurstudie is naar voren gekomen dat de Engelse functionele benadering, genaamd Value Management, meer aandacht heeft voor strategische waardeverhoging, waarbij wordt gesteld dat de projectdoelstelling eenzijdig en geaccepteerd moet zijn door alle stakeholders, voordat naar mogelijke technisch functionele waardecreatie gekeken kan worden. Gedurende de praktijk studie is duidelijk geworden dat naast *publieke opdrachtgevers* ook *opdrachtnemers (met name werkzaam voor private opdrachtgevers)* Value Engineering studies uitvoeren als een afzonderlijke service naar hun opdrachtgever. Aangezien publieke opdrachtgevers vaak externe expertise moeten inhuren om Value Engineering studies te verrichten, terwijl deze expertise reeds aanwezig is bij de betrokken bouwondernemingen, is de vraag gesteld of de huidige uitvoering van Value Engineering studies in iedere situatie even doeltreffend is.

6. Herziening onderzoeksplan

De initiële intentie van het onderzoek betrof het bestuderen van Value Engineering en Constructability toepassingen in de Verenigde Staten, om vervolgens op basis van deze inzichten een uitspraak te kunnen doen over de mogelijkheden om deze technieken toe te passen op de huidige bouwproces problematiek in de Nederlandse bouwsector. Door de tegenvallende interview resultaten op het gebied van Constructability is dit bemoeilijkt. Daarnaast is de Nederlandse bouwsector onvoldoende bestudeerd om de kansen en beperkingen van het gebruik van Value Engineering en Constructability te identificeren.

Deze tekortkomingen zijn gecompenseerd door de resultaten die zijn voortgekomen uit de verrichtte literatuur- en praktijkstudie op het gebied van Value Engineering. Dit heeft geleidt tot de herziening van de onderzoeksdoelstelling. Hierbij is het Constructability perspectief komen te vervallen, en zijn de toepassingsvormen van Value Engineering centraal komen te staan. Doordat er tijdens de praktijkstudie discrepanties tussen de literatuur en de praktijk naar boven zijn gekomen, heeft dit de aanleiding gegeven om verschijningsvormen van Value Engineering nader te bestuderen.
Het huidige onderzoek is ingegaan op de situatie die momenteel zichtbaar is in de Amerikaanse bouwsector, maar tevens actueel is in de Nederlandse bouw. De ontwikkeling van Design-Build contracten leidt tot een toenemende centrale rol van de opdrachtnemers. De essentie hiervan is dat het gewenst is dat de ontwerpfase en de uitvoeringsfase bijeen worden gebracht om het bouwproces te optimaliseren en innovatie te stimuleren.

In de Verenigde Staten worden formele Value Engineering studies binnen de publieke bouwsector voornamelijk door de opdrachtgevers uitgevoerd. De aanleiding hiervoor waren de ondoordachte ontwerpen en de ongewoon hoge bouwkosten, waardoor beoogde projectdoelstellingen niet werden behaald. In de periode waarin Value Engineering werd geïntroduceerd binnen de Amerikaanse overheid in de jaren zestig, werd het merendeel van de projecten uitgevoerd volgens het bestek en tekeningen contract, waarbij de ontwerp verantwoordelijkheid bij de opdrachtgever ligt. Daardoor werden publieke opdrachtgevers in de V.S. verplicht gesteld om Value Engineering studies uit te voeren op projecten van enige omvang en/of complexiteit. De verschuiving van verantwoordelijkheden door de komst van Design-Build heeft echter niet geleidt tot een gelijkmatige verschuiving van Value Engineering verantwoordelijkheden. Dit is opmerkelijk, aangezien de aannemer de nodige kennis in huis heeft voor een dergelijke studie en daarnaast ook de verantwoordelijkheid draagt voor het ontwerp. Ontwerpfouten of verwachtte problemen in de gebruiksfase kunnen immers leiden tot het vroegtijdig uitsluiten van aannemers in de aanbestedingsfase.

Deze discrepantie is de aanleiding geweest om de onderzoeksdoelstelling te wijzigen in het herzien van de toekenning van Value Engineering verantwoordelijkheden. Op basis van de bestaande processen die kenmerkend zijn voor de traditionele bestek+tekeningen en de Design-Build contractvorm, is onderzocht hoe de belangen onder de opdrachtgever en aannemer zijn verdeeld, wat de kritieke momenten in het ontwerpproces zijn en welke resultaten door beide partijen worden beoogd. De introductie van een strategische Value Planning studie voorafgaand aan de technische Value Engineering workshop biedt de mogelijkheid om verantwoordelijkheden beter te definiëren en het type value studie hierop af te stemmen. Voor zowel het bestek+tekeningen en het Design-Build contract zijn momenten aangegeven waarop

de VE studies effectief kunnen worden toegepast. Vervolgens is door het type contractvorm aan te geven wie op dat moment de verantwoordelijkheid draagt voor die bepaalde fase in het bouwprocessen. Hiermee wordt tevens de verantwoordelijkheid voor de betreffende VE studie aangewezen. Bij bestek+tekeningen is dit de opdrachtgever, terwijl het bij Design-Build de biedende opdrachtnemers zijn.

7. Reflectie

Het onderzoek heeft halverwege een wending gekregen, waardoor de initiële doelstelling gewijzigd diende te worden. Dit werd voornamelijk veroorzaakt doordat de bevindingen uit het praktijkonderzoek niet overeenkwamen met de verwachtte resultaten, maar daarentegen wel andere interessante inzichten naar boven heeft gebracht.

De literatuur- en praktijkresultaten leverde ten aanzien van Value Engineering toepassingen aanknopingspunten om de mogelijkheid tot implementatie in de Nederlandse bouwsector nader te onderzoeken. Omwille de tijd en de onderzoek scope bleek het niet haalbaar om de Nederlandse bouwsector voldoende te bestuderen om gefundeerde uitspraken te kunnen doen over de kansen en beperkingen van het gebruik van Value Engineering in de Nederlandse bouw. Dit is de grondslag geweest om te besluiten het onderzoek te beperken tot de toepassing in de Verenigde Staten, aangezien het praktijkonderzoek voldoende aanknopingspunten leverde om een verbetervoorstel op de huidige toepassing te genereren.

Door de wijziging in het onderzoek zijn er geen aanbevelingen gedaan ten aanzien van de toepassing van Value Engineering in de Nederlandse bouwsector. Dit onderzoek levert een zienswijze op van de huidige toepassing van Value Engineering, waarbij de gestelde verbeterpunten dienen als handreiking voor ondernemingen die overwegen de techniek te implementeren.

Naar aanleiding van dit onderzoek zijn de volgende voorstellen voor vervolgonderzoek opgesteld:

- Dit onderzoek is gebaseerd op gesprekken met publieke opdrachtgevers en opdrachtnemers die voornamelijk actief zijn in de B&U sector. Om het effectiviteit van de uitvoering van Value Engineering onder Design-Build contracten nader te bepalen, dient deze toepassing te worden voorgelegd bij opdrachtnemers in de civiele bouw.
- De kans op succes van de voorgestelde Value Engineering allocatie is sterk afhankelijk van de opdrachtgever, die de ruimte en stimulans moet bieden aan de opdrachtnemers om op deze wijze het ontwerpproces in te richten. Het abstractie niveau van de modellen dient daarvoor te worden verlaagd en worden voorgelegd aan verschillende publieke opdrachtgevers in de vorm van een seminar, om de modellen af te stemmen op de organisatie van de opdrachtgevers.
- De verantwoordelijkheden die in dit onderzoek worden genoemd zijn voornamelijk gericht op de resultaat verantwoordelijkheden die de betrokken partijen hebben. De gevolgen die de voorstelde wijzigingen hebben op de juridische verantwoordelijkheden dienen echter in kaart te worden gebracht.
- De her-allocatie van technische Value Engineering verantwoordelijkheden bij Design-Build contracten, zoals in dit onderzoek is voorgesteld, biedt mogelijkheden om de initiële doelstelling tot het combineren van de Constructability en Value Engineering technieken

verder te onderzoeken. De opdrachtnemende partijen zijn in de gewijzigde benadering in de positie om beide technieken uit te voeren, waardoor de barrière tussen verschillende partijen is weggenomen en een Constructability studie mogelijk effectief tijdens de Value Engineering studie kan worden geïntroduceerd.

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Waardeoptimalisatie in de bouw:

Onderzoek naar de her-allocatie van Value Engineering
Tussen opdrachtgever en opdrachtnemer

Bijlagen

Bijlage 1: Case study Value Engineering workshop The High Line, NYC

June 18-23 2006

1. Introduction

In the third week of June of 2006, a formal 40-hour Value Engineering workshop was attended at the City of New York Office of Management and Budget (OMB). The Value Engineering workshop addressed a project that involved the conversion of an existing elevated rail track into a public park. The Value Engineering workshop, which was the second workshop held for this project, was conducted at 30% design completion, and was held at the OMB office in Lower Manhattan. This report describes the various steps taken during a formal Value Engineering study, and illustrates how the different parties are cooperate, and how the workshop process leads to the final results.

2. Project description

The High Line project is a public park that will be created on top of an existing elevated rail road. The project is estimated on $40 million. Construction activities are scheduled to start on January 1st of 2007, and the construction time is approximately nine months. The project is called 'The High Line', after the current name of the rail track. When finished, many details will reflect the former use of the elevated construction.

Project Facts

- Constructed 1929-1934
- Spans 22 blocks, from 34th Street to Gansevoort Street
- 1.45 miles long
- 6.7 acres of space atop elevated rail deck
- 30-60 feet wide and 18-30 feet high
- Built to support two fully loaded freight trains
- Primary construction materials: steel and reinforced concrete
- Owned by the City of New York

figure 9 - The High Line Project

The High Line runs through three of Manhattan's most dynamic neighborhoods: Hell's Kitchen/Hudson Yards, West Chelsea, and the Gansevoort Market Historic District (figure 9). When the High Line was built in the 1930s, these neighborhoods were dominated by industrial

and transportation uses. Now many of the warehouses and factories have been converted to art galleries, design studios, retailers, restaurants, museums, and residences.

In 2002, a group of business-owners in the High Line District joined together to advocate for the High Line's preservation and reuse. Called the Chelsea-Village Business Owners (CVBO), the group now includes over 250 High Line District businesses.

CVBO members assert that the High Line is an integral part of the historic identity of the neighborhood and that its conversion to public space will be an asset to their businesses. The High Line's linkage of three neighborhoods and the distinctive image it provides will offer new opportunities for individual businesses and the group as a whole to market their products.

The future of the High Line is supported by many organizations and individuals, who call themselves the Friend of the High Line (FHL). Friends of the High Line (FHL) is a non-profit organization dedicated to the preservation and reuse of the High Line. Founded in 1999, FHL is supported by nearly all the elected officials representing the High Line neighborhoods, numerous civic organizations, and thousands of preservationists, open-space advocates, design professionals, and civic-minded individuals and businesses from New York and across the United States.

The conceptual design for the High Line was created for an international design competition. The winning design theme was to turn the High Line into a “passive” pedestrian park. The first phase of the project was a Site Preparation contract that dealt with issues such as structure stability and renovation, lead paint removal and demolition of existing rails, and restoring and improving irrigation.

3. Value Engineering study

The project preparation activities were analyzed in an earlier Value Engineering (VE) workshop held in November of 2005. As a result of the VE study, the managing agencies decided to clear out the entire length of the High Line under the Site Preparation contract, which made it possible to conduct visual surveys and additional tests on the structure before any design element was committed. Additionally, the waterproofing task is shifted into the second (landscape design) phase so the exact locations of cut-out of some of the existing structure could be determined to avoid potential conflict with the product guarantee.

The VE workshop in June focused on the landscape design of section one of the High Line project, which is a 1.5 mile stretch. Full funding for the two remaining will depend on how successful section one turns out. The study is based on the Preliminary Design, which still contains some under developed items.

For the execution of Value Engineering workshops, OMB works with long term requirement contracts. They have a pool of approximately six SAVE certified VE firms and sent out a VE request for proposal to each firm. The selection of the proposal is based on four criteria: past performance, the selected team members for the VE study (submittal of capabilities, resumes etc), how they carry out the process (OMB requires SAVE methodology) and the number of VE facilitators that will be provided for the study.

This project was rewarded to a Canadian based VE consultant company. This consultant has a three year, $1.5 million contract with OMB. After OMB generated the Project Description and a list of disciplines deemed necessary to cover all aspects of the project, the VE consultant performed the search for adequate team members. They then submitted their resumes for OMB for approval. In this instance, most of the selected professionals where already involved in the first VE study. The VE team members are directly hired by the consultant.

4. The 40-hr workshop

The 40-hr workshop was performed in a meeting room at OMB's office (figure 10). The VE team was a multi disciplined team that was lead by two facilitators supplied by the consultant. Besides that, they also provides an office assistant to record the whole process. The VE team consisted two landscape architects, an architect/planner, a structural engineer, an electrical engineer, the agency's representative, a construction manager, and a cost estimator. Besides that, OMB was represented by the VE director and the project manager for this project.

figure 10 - Value Engineering workshop setup

Information phase
18-6-06 morning

The workshop started off on Monday by performing the Information Phase. This phase is meant to have the designers and Project Manager inform the VE team about the details of the project, as well as the current status of the design and in this case also the status of execution. The VE team is not supposed to comment on any of the presented details yet.

The Project manager presents a presentation and clarifies that the project is split up into two packages; the site preparation package and the design package. The head of the design team focuses some more on certain details of the project. The design team was assigned to make the design of the park, after it was awarded to them in a design contest. In this stage, the Friends of the High Line were represented by three persons, and so was City Hall.
Some questions were raised by the VE team members concerning lightning and electricity, but it was encouraged to save comments for the creativity phase, where the opportunity is given to raise any solutions or changes.

Function Analysis
19-6-06 afternoon

On the same day, the Function Analysis phase was initiated, lead by the two VE facilitators. The first step was to initiate the Goals, Constraints and Commitments of the project. Each response from the team members was written down on overhead sheets and pinned against the walls, which enabled the participants to check for repeating suggestions. As these sheets are needed for the entire workshop, it is important to make sure that the room is available for the length of the workshop, to prevent time loss from moving to different rooms.

Subsequently, the Function generation (as part of the function analysis) exercise was initiated. The goal of this effort is to name the functions of the project, expressed in an active verb and a measurable noun. The facilitators pointed out the restriction on using the word 'provide', as well as any word that ends with '-ize', since those words are not measurable.

The team then proceeded with the next step, which was to identify Quality Indicators. The following seven indicators were identified:

5. Durability
6. Aesthetics
7. Constructability
8. Sustainability
9. Maintenance/Reliability
10. Safety/Security
11. Visitor Support

Every participant was then given the assignment to rate the importance of each indicator, by dividing 100 points over the seven items. By adding up each ranking, the facilitators created an overview which indicated the common priorities of the team members. This 'quality model' was later used to indicate the level of importance of each suggestion, to ensure that the 'right' decisions would me made.

Simultaneously, the design team estimator and the VE team estimator had come together in a separate room to compare their project estimates and look for any differences. The purpose for this exercise was to make sure that no mistakes were made in the initial cost estimate, which would influence the cost savings proposed at the VE workshop.

On the second day of Function Analysis, the team started to classify each function. The functions were divided in:

- Basic functions
- Secondary Functions
- Supporting Functions
- Goal
- High Order
- Low Order

The basic function of this project was defined as:

- Park (physical function)

The essential functions that come with a park are:

- Access
- Soil/Plants
- Walkways
- Utilities
- Structural
- Amenities
- Security/Safety

Wanted and unwanted items that come with the park are:

- Maintenance
- Staffing
- Revenue
- Equipment
- Programming
- Identity
- Branding

During the process, the question was raised why it was necessary to divide the list of functions into Physical and Operations. It would slow down the process. The OMB VE Director suggested to find the most essential functions that can be put under physical functions.

This caused the next step, which was to subdivide all the functions under the essential functions of the park.

After the analysis, nine main functions were addressed, that form the structure to generate ideas. The main functions are:

Convey Water	- CW
Delineate path	- DP
Distribute Electricity	- DE
Ensure CS	- EC
Facilitate Access	- FA
Install plants	- IP
Maintain park	- MP
Modify structure	- MS
Secure park	- SP
Support visitors	- SV

Creativity Phase

20-6-06 afternoon

The next phase is the Creativity Phase, which contains a brainstorm session that allows everyone to call out any idea that comes up, which is are written down on overhead sheets and displayed against the walls of the meeting room. It is prohibited to make a comment on any of the ideas, as people feel they are restricted to mention a crazy, but maybe valuable idea. However, if you do so, you have to donate 25 cents in the 'penalty box'.

On the third day, the VE team continues to finish off the creativity phase.

The OMB VE Director recalls that the City of New York really chose the designer and not so much the design itself at the design contest. Therefore, the designers might have issues by initiating changes, but it would be acceptable for the City of New York to radically change parts of the design.

After the creativity phase is over, approximately 300 ideas were written down. The next step is to narrow down that amount to about 35-50 ideas. This was done by voting, where each team member received 5 sticker dots. All the ideas were displayed against the wall on overhead sheets. By placing a sticker in front of an idea, it would go to the 'second' round. Each idea could

only be voted once. After the votes were in, some ideas that were supported by the entire VE team received a wild card.

Evaluation phase
21-6-06 late morning

After the Creativity Phase, the facilitators initiated the Evaluation Phase. The facilitator emphasized again that the value equals function over cost.
The facilitators addressed each idea and asked the team members to give their oral votes on a scale of 5 whether the cost value of the idea could be estimated. Whenever this was not possible, potential ideas could be named a 'design suggestion' if the design team should look into the value of it.

The ranking is the following:
5 - great idea
4 - good
3 - some/marginal
2 - poor
1 - fatal

D/S - Design Suggestion
O/S - Out of scope

ABD – Already be done
EC – Estimated correction

This exercise enabled each selected idea to be rated by the entire team, to ensure consensus about the most potential ideas that would further developed.

Confirmation with stakeholders
21-6-06 afternoon

After selecting and rating the 50 ideas, the design team, the Project Manager and the Friends of the High Line representative were invited at the OMB office to get briefed by the VE facilitator about the team's outcomes so far. Every attendee received a handout with all the ideas listed. The designers were somewhat resistant to certain propositions. Some of the listed ideas were already addressed earlier in the design phase. After going through all the items, some ideas were removed from the list. After this meeting, the comments and concerns from the Project Manager and the perspective of the design team were briefed to the VE-team. Decisions were made about what had to be changed in the ideas in order to make it a worthy proposal, after everyone was notified about ideas that have been dropped.

Development Phase
22-6-06 whole day

The VE team started developing and writing out their change proposals. This process started while the design team was informed on Wednesday afternoon. The development of the ideas took a day and a half. The facilitator requested the team to start with the ideas that were ranked with number 5, and to work down the list from there. Each member had the responsibility to

work on certain items, and the progress of the write-outs were constantly recorded on a overhead sheet against the wall.

Development phase continued the next morning with a group discussion about the paving of the park, which was a very large cost item that could be improved in many ways.
Some of the ideas have slightly changed from the original ideas to improve the proposal. Some additional concepts have been made to support existing ideas to make them more feasible.

Presentation phase
24-6-06 afternoon

At this stage, the last day of the 40-hour workshop, the designers, owners, field operations, the VE team members and the facilitators, who were all attending the information phase on Monday morning, come together to present the findings of the VE team that week. The participants were: (will receive from Kung)
The chief facilitator started with a brief overview of what stages the VE team has been through. There were 300 ideas generated, and out of those ideas, 72 ideas were short listed and briefly presented to the design team. Out of that shortlist, 48 proposals are actually worked out and cost estimated. The ideas are presented in a PowerPoint presentation, while the VE expert panel provides extra information on the items they have worked on. All ideas are then presented to the different parties in a booklet for later review.

5. Post study

After the 40-hour workshop has been performed, both the design team and the responsible agencies for this project are requested to formulate responses on each VE recommendation. The responses have to form one of four categories and should include an explanation of the Agencies position on the issue. The four categories are:

- *Accepted* – This recommendation should be fully implemented and incorporated into the design.
- *Partially accepted* – Part of the recommendation should be implemented and incorporated into the design, or an alternative or modified version of the idea is accepted. The accepted portion needs to be specified. If cost reductions were provided with the recommendation, the capital and O&M costs attributed to the accepted portion of the recommendation need to be included.
- *Rejected* – This recommendation should not be implemented at this time. Reasons for rejection need to be specified. In some cases one recommendation is rejected in lieu of accepting another.
- *Further study* – Although the recommendation has merit, the design is not sufficiently developed at this time to make a final determination. It will be investigated and implemented if found to be feasible.

OMB receives and reviews the responses of the design team and the agencies, after which they review with the VE consultant which proposals warrant further discussion. Then, the VE consultant sends a copy of these short listed proposals with the corresponding agency responses to the VE team members who originally authored the proposals to receive their feedback.
Based on the feedback of the VE team members, OMB and the consultant further revise the discussion list and determine which two team members should attend the Implementation Meeting. After OMB contacts all the parties to schedule this meeting, the design team presents

the modified design and will respond to the proposals on the discussion list. When all questions are met to OMB's satisfaction, the VE process is considered complete. OMB will then resign from the project, but will entertain any request for information or assistance.

6. Reflection

The Value Engineering workshop in this case study is initiated by the organization that allocates the city budget to the various agencies. While the city agency is the project owner, OMB has its financial responsibilities, and recognizes the benefits from the unnecessary cost reductions that Value Engineering generates. OMB utilizes a formal Value Engineering workshop, which is predominantly technically orientated. The necessary expertise to lead the study and to generate alternatives, is hired for the occasion. The project in this case study will be awarded by a traditional bid-build contract. This type of delivery system doesn't allow the executing parties to participate in the VE study. The workshop contained many technical solutions and improvements, including Constructability, of which many were brought up by an experienced construction engineer. The major drawback of this approach is that recommendations by the VE team are to be approved or rejected by the project owner and the design team, without taking in consideration the point of view from contractors that actually have to face these potential conflicts during construction. The current Value Engineering application has been successful for NYC OMB, and it seems to be an effective approach under the tradition design-bid-build delivery system, which is the standard for the City of New York.

Value Engineering

Value Engineering is een proactieve en creatieve projectmanagement techniek waarmee in een vroeg stadium mogelijkheden kunnen worden geïdentificeerd om onnodige kosten weg te nemen en daarmee de functionele projectwaarde van een project te maximaliseren. Door middel van een multidisciplinair team van deskundigen wordt binnen een aantal dagen op expliciete wijze een set van oplossingen aangedragen voor kosten reducerende alternatieven voor een project, waarbij de oorspronkelijke functionaliteit en kwaliteit niet wordt opgeofferd, maar anderzijds wel kan worden vergroot.

ACHTERGROND VALUE ENGINEERING

Value Engineering is gebaseerd op de Value Analysis techniek, dat voor het eerst werd geïntroduceerd in de Amerikaanse productie industrie gedurende de Tweede Wereldoorlog. Door de grote schaarste van grondstoffen en materialen werd bij een producent gezocht naar alternatieven die deze schaarse producten konden vervangen. Hierbij werden analyses uitgevoerd op de functies van de componenten waaruit eindproducten bestonden. Per component werd de vraag gesteld: 'wat moet het doen?' Door deze functies op een abstract niveau te benaderen, wordt er ruimte gecreëerd voor creatieve fysieke alternatieven. Deze benadering maakte inzichtelijk dat bepaalde functies op relatief eenvoudige wijze door niet schaarse componenten konden worden vervuld, zonder dat dit de oorspronkelijk prestatie aantast. Tevens bleek dat deze alternatieven regelmatig kwalitatief beter en/of goedkoper waren dan het origineel. Dit gaf de aanleiding voor de producent om deze techniek ook na de oorlog te gebruiken om de productiekosten omlaag te brengen en daarmee de prijsconcurrentie aan te gaan.

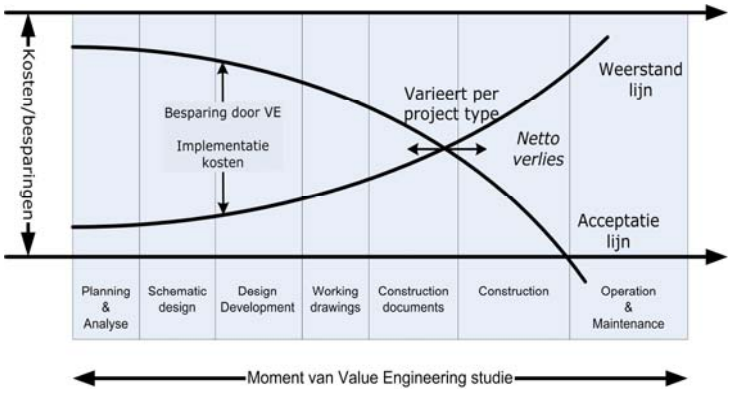
Vanaf het moment dat Value Analyse methode werd geïntroduceerd in de bouw, kreeg het de naam Value Engineering. Hoewel de functie benadering in de productie industrie voornamelijk werd toegepast op bestaande producten, is de toepassing in de bouw in het bijzonder gericht op de ontwikkeling van nieuwe projecten. Tevens is de 'waarde horizon' verlegt van enkel de initiële productiekosten naar een lange termijn focus waarbij de totale levenscycluskosten en de functionaliteit van het object centraal staan. De belangen verplaatsten zich hierbij van de producent naar de opdrachtgever.
De verhouding tussen waarde en levenscycluskosten kan als volgt worden weergegeven:

$$\text{Waarde} = \frac{\text{Functionaliteit}}{\text{Levenscycluskosten}}$$

Deze vergelijking geeft aan dat het doel om de projectwaarde te verhogen op meerdere manieren kan worden bereikt, namelijk door de functionaliteit van het project te verhogen, door de levenscycluskosten te verlagen, dan wel een combinatie van beide inspanningen.

MOMENT VAN TOEPASSING

Value Engineering is met name succesvol wanneer het vroegtijdig in het project wordt toegepast. De essentie van deze techniek is om fundamentele wijzigingen door te voeren die verstrekkende gevolgen hebben voor de bouw- en gebruikskosten. Wijzigingsvoorstellen die laat in de ontwerpfase zijn ontwikkeld, zullen aanzienlijk meer weerstand ondervinden, doordat dit spanningen veroorzaakt tussen de wijzigingskosten en de potentiële besparingen die een wijziging oplevert. Het is daarom wenselijk dat de Value Engineering studie voorafgaand, of vroeg in het voorontwerp wordt uitgevoerd.



TOEPASSING VALUE ENGINEERING

De wijze waarop Value Engineering wordt toegepast is niet per definitie eenduidig, maar er is desondanks een algemeen geaccepteerde, formele toepassing, waarbij gebruik wordt gemaakt van een workshop. Deze workshop wordt bijgewoond door een team van deskundigen op verschillende relevante vakgebieden en wordt geleidt door een of twee gecertificeerde Value Engineering *facilitators*. Deze teamleiders zijn opgeleid om door middel van groepsinteractie waardeverhogende alternatieven te genereren. De workshop wordt uitgevoerd op basis van een Job Plan; een stappenplan waarin opeenvolgende fases zorgen voor een gestructureerde workshop agenda, waarbij eerst divergerend en vervolgens convergerend gewerkt wordt. De hoeveelheid stappen die in een Job Plan zijn opgenomen zijn variabel, maar bevatten over het algemeen de fases die op de volgende pagina zijn weergegeven.

1. **Voorbereiding fase**
   - Samenstellen multidisciplinair team
   - Verzamelen beschikbare projectinformatie en eventueel voorontwerp
   - Distributie van informatie naar deelnemers aan de Value Engineering workshop
2. **Informatie fase**
   - Vaststellen van projectdoel
   - Presenteren van het huidige ontwerp, product, of proces concept door ontwerpteam
   - Vaststellen van randvoorwaarden en andere aandachtspunten
3. **Functie analyse fase**
   - Identificeren en classificeren van de functies binnen het project
4. **Creatieve fase**
   - Brainstormsessie voor het genereren van functievervullende alternatieven
5. **Evaluatie fase**
   - Beoordeling van ideeën op basis van invloed op functionaliteit en kosten
   - Selecteren van ideeën met potentie tot verdere ontwikkeling
6. **Ontwikkeling fase**
   - Geselecteerde ideeën in detail beschrijven voor verdere ontwikkeling
   - Inschatten van mogelijk risico dat ideeën met zich meebrengen
7. **Presentatie fase**
   - Presenteren van wijzigingsvoorstellen aan beslissingsnemers en overige stakeholders
   - Overhandigen van volledige en objectieve informatie ten behoeve van besluitvorming
8. **Implementatie fase**
   - Inventariseren draagvlak van wijzigingsvoorstellen bij beslissingsnemers en stakeholders
   - Opstellen actieplan hoe en wanneer de geaccepteerde wijzigingen worden uitgevoerd
   - Creëren van betrokkenheid van alle partijen om implementatie te bespoedigen
   - Rapporteren van gevolgen op de implementatie van wijzigingsvoorstellen

VALUE ENGINEERING IN DE NEDERLANDSE BOUW?

In de Nederlandse bouwsector wordt sinds enkele jaren door verscheidende organisaties gebruik gemaakt en geëxperimenteerd met Value Engineering, waaronder Rijkswaterstaat, ProRail en de stichting NAP DACE. Daarbij zijn positieve resultaten bereikt die hebben geleidt tot verdere ontwikkeling van Value Engineering.
In de Verenigde Staten wordt Value Engineering als een losstaande projectmanagement techniek wordt beschouwd, dat voornamelijk door de opdrachtgever wordt toegepast. In Nederland is dit momenteel ook het geval, maar wordt Value Engineering vooral gezien als een voorbereidende sessie op de Systems Engineering benadering.

De toenemende populariteit van design-build contracten hebben geleidt tot wijzigingen in de verantwoordelijkheden van partijen. Nu de ontwerpverantwoordelijkheid bij de *opdrachtnemers* ligt, hebben zij de mogelijkheid om zich te onderscheiden van de concurrent op basis van innovatieve ontwerpprocessen. Tegelijkertijd dienen de opdrachtgevers vroegtijdig complete en eenduidige specificaties te verstrekken aan de design-build opdrachtnemers, ten einde de projectdoelstellingen zeker te stellen. Binnen de Value Engineering literatuur zijn twee hoofdstromen bekend: de strategisch georiënteerde Value Planning en de technisch georiënteerde Value Engineering studie. De strategische Value Planning studie is met name geschikt voor een opdrachtgever om samen met de overige stakeholders de gewenste objectfuncties te analyseren en consensus te bereiken ten aanzien van de projectdoelstelling. Deze vroegtijdige eenduidigheid is essentieel om een solide programma van (functionele) eisen op te stellen. De technische Value Engineering workshop is een effectieve toepassing voor design-build opdrachtnemers om het voorontwerp, dat tijdens de tender fase wordt ontwikkeld, te optimaliseren ten aanzien van de functionele wensen van de opdrachtgever. De toepassing van de techniek kan aanzienlijke kostenbesparingen opleveren, wat de opdrachtnemer in de gelegenheid stelt om een concurrerend bod uit te brengen, zonder dat dit ten koste hoeft te gaan van de winst en risico marge.
Deze toepassing van Value Engineering heeft de potentie om een synergetische situatie op te leveren voor zowel de opdrachtgever als de opdrachtnemer die het werk gegund krijgt.

Om deze toepassingsvorm van Value Engineering in Nederland te kunnen introduceren, dient de methodiek te worden beschouwd als een onafhankelijke procesmanagement tool, dat zowel met als zonder de toepassing van de Systems Engineering methodiek implementeerbaar is.

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