VALUE ENGINEERING FOR DRAINAGE AND STREAM WAY IN ROADS AND HIGHWAYS CONSTRUCTION

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Specially Dedicated To…

My Wife and My Children

Thanks for all the love, support, motivation and always being there

whenever I need them

My Supervisor

Assoc. Prof. Dr. Abdul Kadir Bin Marsono

For his guidance and assistance throughout the whole thesis

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By praising the Almighty Allah SWT and the Seal of the Prophets Allah SAW and his progeny RA.

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ABSTRACT

Value Engineering (VE) is a total management approach to improve the quality of construction projects. It increases the efficiency and performance of the projects to gain the best integrated benefits. The VE focuses on function analysis of the researched subjects and strives to achieve the required function reliably at the lowest Life Cycle Cost (LCC). It seeks optimizing and improving decision making to realize the optimal expenditure of owner funds while meeting required function. The VE teamwork involving construction, design and maintenance staff reviewed the construction project features and acquire for ways to improve quality, control costs and time. This study focused on investigating the role of VE for existing main road construction projects. It uses the Drainage Engineering Systems (DES) and Surface Stream Way Drain (SSWD) after rainfall in the environmental health view point related to VE. It predicates to decrease the air pollution and increasing the health of environment. The main goal of this study is to design an enhanced VE framework with main factors of drainage management in the main road. In this study, VE questionnaire was sought to determine the overall thoughts, vistas, notion, comprehending and understanding in addition to the connection to LCC price for drainage and runoff of main roads, highways and streets. The quantitative data were analyzed using one-way ANOVA technique and Factor Analysis of smart PLS. The expert respondent provides scientific data, on the initial questionnaire with thirty perfect answers. The qualitative data was used to support the quantitative results to provide a mathematical framework between the twelve important main factors of VE, DES and SSWD related to the factors of Construction Management (CM), Materials (M), Environment (E), Human Resource (HR), Quality (Q), Aesthetic (A), Cost (C), Time (T), Waste Materials (WM), Safety and Safety Driving (S and SD) and Recycling (R). The findings revealed that the VE by working team can increase performance and increase runoff collection of main roads, highways and streets. The framework also decrease within the lowest possible cost, time, waste materials and increase possible quality, aesthetic, safety driving and most possibly can effect construction management, materials, recycling, human resource and environment. The new framework of VE accepts all twelve main factors with only aesthetics factor being rejected. The new VE framework is capable to save cost, time and increase quality of road drainage system.

ABSTRAK

Kejuruteraan Nilai (VE) adalah pendekatan pengurusan untuk meningkatkan kualiti projek pembinaan. Ia meningkatkan kecekapan dan prestasi projek untuk mendapatkan manfaat terbaik secara bersepadu. VE memberi tumpuan kepada analisis fungsi subjek yang dikaji dan berusaha untuk mencapai fungsi yang diperlukan pada tahap kos kitar hayat (LCC) yang paling rendah. Ia bertujuan mengoptimum dan meningkatkan proses membuat keputusan untuk merealisasikan perbelanjaan optimum pemilik di samping memenuhi fungsi diperlukan. Pasukan kerja VE yang melibatkan staf pembinaan, reka bentuk dan penyelenggaraan pembinaan memperoleh jalan untuk meningkatkan kualiti, kawalan kos dan masa. Kajian ini memberi tumpuan kepada penyelidikan tentang peranan VE untuk projek pembinaan jalan utama sedia ada. Ia menggunakan Sistem Kejuruteraan Saliran (DES) dan Laluan Peparitan Permukaan (SSWD) selepas hujan dari sudut pandangan kesihatan alam sekitar yang berkaitan dengan VE. Ia juga mengurangkan pencemaran udara dan meningkatkan kesihatan alam sekitar. Matlamat utama kajian ini adalah untuk merekabentuk rangka kerja VE baru dengan faktor-faktor utama pengurusan perparitan di projek jalan utama. Dalam kajian ini, soal selidik VE telah di peroleh dari pendapat, pandangan, tanggapan dan pemahaman responden yang berkaitan dengan harga pada LCC untuk saliran dan air larian jalan raya utama, lebuh raya dan jalan biasa. Data kuantitatif dianalisis menggunakan teknik ANOVA sehala dan Faktor Analisis PLS pintar. Responden pakar menyediakan data saintifik pada soal selidik awal dengan tiga puluh jawapan yang munasabah. Data kualitatif telah digunakan untuk menyokong keputusan kuantitatif dalam menyediakan rangka kerja matematik di antara kedua belas faktor utama. Faktor utama VE pada DES dan SSWD adalah berkaitan dengan faktor-faktor Pengurusan Pembinaan (CM), Bahan-bahan (M), Alam Sekitar (E), Sumber Manusia (HR), Kualiti (Q), Estetika (E), Kos (C), Masa (T), Bahan sisa (WM), Keselamatan dan Keselamatan Memandu (S and SD) dan Kitar Semula (R). Dapatan kajian menunjukkan bahawa VE oleh pasukan kerja boleh meningkatkan prestasi dan meningkatkan pengumpulan air larian jalan raya utama, lebuh raya dan jalan biasa. Rangka kerja ini juga berkemungkinan dapat mengurangkan kos, masa, merendahkan bahan sisa dan meningkatkan kualiti, estetika, keselamatan memandu. Ia juga memberi kesan terhadap pengurusan pembinaan, bahan-bahan, kitar semula, sumber manusia dan alam sekitar. Rangka kerja baru VE ini menerima kesemua dua belas faktor utama dengan hanya menolak faktor Estetika di dalam rangka kerjanya. Rangka VE baru ini mampu untuk menjimatkan kos, masa dan meningkatkan kualiti sistem saliran jalan raya.

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A	-	Aesthetic
AHCO	-	American Heritage College Dictionary
ASHTTO	-	American Association of State Highway and Transportation Officials
BV	-	Best Value
C	-	Cost
CBR	-	Case-Based Reasoning
CC	-	Conduct Current
CM	-	Construction Management
CP	-	Creative Phase
CPII	-	Construction Project In IRAN
CPM	-	Critical Pass Method
CR	-	Cost Reduction
DB	-	Design Build
DBD	-	Decision Build Design
DC	-	Design Criteria
DES	-	Drainage Engineering System
DES & SSWD	-	Drainage Engineering System and Surface Stream Way Drain
DOD	-	Department Of Defence
DOT	-	Department Of Transportation
DP	-	Development Phase
DSS	-	Decision Support System

E	-	Environment
EC	-	Energy Cost
EE	-	Engineering Economic
EFA	-	Exploratory Factor Analysis
EOOI	-	Engineering Organization Of IRAN
EP	-	Evaluation Phase
EP	-	Expensive projects
EVM	-	Earned Value Management
FAH	-	Federal -Aid Highway
FAP	-	Function Analysis Phase
FAS	-	Federal -Aid System
FH	-	Federal Highway
FHWA	-	Federal High Way Administration
FLHP	-	Federal Lands Highway Programs
FM	-	Framework Methodology
FP	-	Functional Performance
FP	-	Function Phase
GEC	-	General Electric Corporation
HR	-	Human Resource
IC	-	Initial Cost
IDA	-	Institute Defence Analysis
IVES	-	Indian Value Engineering Society
IP	-	Implementation Phase
IPABO	-	Iranian Programming And Budget Organization
JP	-	Judgment Phase
LCA	-	Life Cycle Assessment
LCC	-	Life Cycle Cost

LCIA	-	Life Cycle Impact Assessment
LCP	-	Life Cycle Project
MA	-	Maintenance Ability
M	-	Materials
MCR	-	Main Construction Roads
MRCP	-	Main Road Construction Projects
MRS	-	Main Road Safety
MS	-	Mathematical Standard
NCHRP	-	National Cooperative Highway Research Program
NHS	-	National Highway Systems
O	-	Operability
OP	-	Orientation Phase
OR	-	Owner Requirement
PMBOK	-	Project Management Body Of Knowledge
PMO	-	Project Management Office
PP	-	Presentation Phase
PV	-	Present Value
Q	-	Quality
QM	-	Quality Management
R	-	Recycling
RFP	-	Request For Proposals
RM	-	Runoff Management
ROA & V	-	Regard Of Aesthetics and Environment
ROI	-	Return On Investment
ROP	-	Return Of Profit
RP	-	Recommendation Phase
S	-	Safety

S & SD	-	Safety and Safe Driving
SAVE	-	Society American Value Engineering
S	-	Scalability
SIVE	-	Society Iranian Value Engineering
SP	-	Standard Plans
SSWD	-	Surface Stream Way Drain
SW	-	Support Weight
SWS	-	Surface Water Stream
T	-	Time
TS	-	Time Scheduling
TT	-	Transmit Torque
VA	-	Value Analysis
VC	-	Value Creation
VD	-	Value Design
VE	-	Value Engineering
VECP	-	Value Engineering Change Proposal
VEITPM	-	Value Engineering Information Technology Project Management
VEP	-	Value Engineering Plan
VI	-	Value ĺimprovements
VI	-	Value Index
VM	-	Value Methodology
WM	-	Waste Materials

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Value Engineering (VE) is a way of evaluating a process by studying the functions of. It includes a critical evaluation of processes carried out in terms of components, equipment and all cost occurring items in producing a product or projects. The implementation of the VE procedure on a project typically involves some combination of performance evaluation such as; quality, reliability, durability, safety, effectiveness, or other desirable characteristics. The main aim of VE is to focus on cost saving, and on the other areas of a client needs during the constructional projects such as building, dams, and transportation. VE introduces sub- systems and makes a relationship among them in order to highlight the most prominent aspect of construction project. Consequently, the efficiency and quality of the project can be enhanced (Chung *et al*., 2009). VE can be presented as a pre-designed model to conquer the challenges of the construction projects (Abidin and Pasquire, 2007). VE also helps to reduce costs and manage time ((Robichaud and Anantatmula, 2011) and at the similar time enhances quality and effectiveness with the addition of benefit to the projects. It is truly carried out to stabilize price and offers a very well-considered method by using of functional plan and team of specialists (Issa *et al*., 2013)

VE helps corporations to be more efficient in handling initiatives both locally and globally by:

- Detailing on cost breakdown;
- Usefulness and profitability;

- Enhancing Quality and Values;
- Managing time (scheduling) efficiently;
- Enhancing team working;
- Optimizing Design and Operation (production);
- Using all resources efficiently and
- Solving methodically for problematic projects and special projects

VE is an inventive and also problem-solving soft application, also it is a systematic framework to optimize values within a particular scope of work through process engineering (Ross and Rhodes, 2008). The profit of VE application tend to be superiorly realized from the project's goals by getting much more worthy with investment along with the particular client' desires for improve spacing the characteristics and challenges, (Chi *et al*., 2014).

A VE program typically involves a several specific venture and course of action to create merchandise through a simple and effective ideas and productive venture decision (Davis, 2013).

During the World War II (1939-1945), due to the shortage of resources for reconstruction of the buildings, the development was connected to an innovation based on the idea of VE. The solution was often sorted in situation along with fewer change. After that, analytical discipline had been formulated in exclusive market sectors which are targeted to be able to question the standard ways of design to find the less price alternatives (Zarandi *et al*., 2011a). In the 1940s, the VE was initially used by Lawrence D. Miles who discussed one method, which has been applied in the General Electric Corporation (GEC) by considering a different problem -solving solution to fulfill the actual asks. This particular action spied out the door (throughout World War II) with regard to other new methods to watch out to any work needed within multiple methods.

In 1947, Mr. Miles and his team developed a step-by-step system, called Value Analysis (VA) it analyze a product's cost that relate to a function to ferret out unnecessary costs. As a result of substantial investment in knowledge, the new methodology called Value Analyze (VA) was developed, tested, and proven to be highly effective. However, until 1952 that VA began its growth throughout various industries. The Federal-Aid Highway (FAH) act of 1970 in USA to made as the first Federal Highway (FH) reference to VE. It is requiring that in such cases the Secretary of determines an advisable plans, specifications and estimation for proposing projects on any Federal-Aid System (FAS) which is accompanied by a VE or other cost reduction analysis. The USA congress extended the federal VE role with the passage of the National Highway Systems (NHS) (Aminzadeha and Ismailb, 2011).

It was absolutely determined that all federally financed Country National Highway System (NHS) projects worth more than US$25 million (RM 75 million) should be worked with VE in order to calculate price tag as well as budget. It was then considered to apply VE in every government assignments or, particularly assignments wherever price tag is cut and received possibility for cost savings. It absolutely was the decision through Federal Highway Administration (FHWA) that every condition will utilizes VE, within their interstate along with highway undertaking design advancement and constructing (Chi *et al*., 2014).

1.2 Problem Background of The Study

Annually, an enormous sum of money is needed on investing of infrastructure and building advancement that needs to be completed with lowest price tag and in the smallest moment doable. There is a requirement to Return On Investment (ROI) as the particular challenge that need to support financial savings a high. VE has been defined as a cost lowering process which is able to discover and determine price lowering methods across the challenge of prerequisite decreasing the Life Cycle Cost (LCC) projects, Life Cycle Assessment (LCA) and Life Cycle Impact Assessment (LCIA). All of mentioned issues feasible by means of method of

assessing which impacts on product or service during its life in VE (Hischier *et al*., 2009; Finnveden *et al*., 2009). Also, one of the key requirements of each project is to define ROI that VE recognised as most appropriate value to avoid on increasing cost (Giel and Issa, 2011). Clearly such actions are usually obtained to optimize cash to build the main roads, freeways, highways and streets construction projects. VE is usually one in a position to resolve conditions that may appear throughout the project implementation; spending additional tasks. VE affords the alternative to choose the easiest method to enhance efficiency for the lowest probable cost by supporting a good quality (Miles, 2015).

VE is associated with project management body of knowledge "Project Management Body Of Knowledge (PMBOK)" and Earned Value Management (EVM) as a powerful project management method that is implemented in engineering and construction projects. There are various recommended methods and frameworks for EVM practices, such as ANSI/EIA-748, PMI'S and the practice standard for EVM (Kwak and Anbari, 2012).

However, VE is not being fully utilized in developing countries, because there is a little technical knowledge and expertise in this area that are available in these countries. In the construction project such as highways, main roads and freeways, Iran is considered as one of the developing country which suffering from the need to implement of new concept such as VE. Performing the VE in roads and highways in developed countries indicate that repeating the same procedure of Iran as developing country is a promising idea. Introducing VE can dedicate the functionality to the Engineering Organization Of Iran (EOOI). Observing VE in construction of roads and highways by introducing a true model including the key constructs cause, the estimation of project can become close to the final implementation of the project by saving time, money and other capital advantages. Moreover, a reliable model of VE can be regarded as novel paradigm for other Construction Project In Iran (CPII). Some are dilemma regarding to the construction project in Iran are as follow:

- The average life of the nation's main roads and highways is 2 to 9 years(Larson, 1993);
- The number of unfinished projects is 8000;
- 27% of highway projects was implemented partially;
- 28% of projects have difficulties in the operation; every year due to lack of proper and efficient operation of the construction system, the country loses an equivalent of US$1650 million (RM4950 million)(IHWTI, 2009), (Institute High Ways Transportation Iran, 2009). Therefore, most problems are caused by the following:
- Lowest quality in main roads and highways construction (Xia, 2013).
- Wastage in construction materials.
- Cost construction more than budgeted (Kelly and Male, 1991); and
- Lack of human expert in main roads and highways construction

VE might be utilised in deriving worth for main road, freeway and highway projects. It can be made through technology associated with design in order to optimize the purposes. VE model keep a value for money technique with regard to a Life Cycle Project(LCP) and time (Petroutsatou *et al*., 2012).

Some researchers who have study on the main road construction projects by applying VE to include: cost management and reduction, quality improvement, resource optimization implementation, the detailed costs breakdown, improve teamwork, improve the quality and quantity indicators, methodical system for specific projects and problematic projects (Vilasini, 2014).

But there is not any research from the view point of VE on the Surface Stream Way Drain (SSWD) after each rainfall. Surface waters are one of the most noticeable polluted waters and are deranging the road and highway. Therefore, this research focused on investigating the role of VE of main road construction projects that uses the Surface Stream Way Drain (SSWD). Figure 1.1 show the uncontrolled

water stream on the surface of the roads and highways that create difficulties to driver and pedestrian.

Figure 1.1 Water stream effect source in Flooding rainfall, Tehran, 2011.

Construction projects have numerous dependencies that come from concept of construction operations such as policy, environment, culture, budget, and many other that cause changes in the construction project consequently. In such varying condition any proposed method and algorithm by specialist in construction field need revision and improvement by others for a new situations. Therefore, this work would be treated differently, but the main architecture or prime framework would be preserved.

The absolutely obvious challenge with respect to the VE method in main road construction in Tehran is a Surface Water Stream (SWS) (handling the main road SWS). The influential remedy of that could be executed explicitly is including the VE principles in this case. The surface water stream drain is not alone in a prominent component of VE in the main road construction instead, a technical part, costs, environment, human resource and quality are also a parameter in order to cast a complete algorithm. This matter is the main consideration of this study.

Soil, water and weather are also the main parameters in SWS study, in contrast to the structures, but less attention to the water effects (drainage and stream way) in highways and roads (Jochimsen *et al*. 2004) are also found. Various studies

have been done on the main road construction projects by implementing VE including: cost management and reduction, quality improvement, resource optimization implementation, the detailed costs, improve teamwork, enhance the quality and quantity indicators, methodical system for particular projects and problematic projects. However, there is not any research from the VE point of view on the Surface Stream Way Drain (SSWD) and Drainage including a Runoff Management (RM) there are very important after each rainfall. Surface water is one of the most polluted waters and have very noticeable effect on the environment. Therefore, this research focused on investigating the role of VE of main road construction projects specifically, the Surface Stream Way Drain (SSWD) to decreasing the air pollution and increasing the health of environment.

Main roads and highways construction projects regulation may vary not only among countries but also between regions on state in a country. As matter of fact, streets, main roads and highways drainage has becomes a controversial issue for highways and roads in Iran (Tajrishi Masoud, 2013). The Iran government has introduce a DES&SSWD that associated items as the main part of a construction projects such as; cost, time, human resource, construction management, aesthetic, quality, safety and so on. In other word, DES & SSWD is not only pivoted on deviation of water from surface but also can be regarded as influential matter in construction of roads and highways as discussed in this chapter.

According to Iranian Programming And Budget Organization (IPABO) (PBO country, 2016), drainage is a special item from designing and execution of construction. Thus it is crucial to know the relationship between DES & SSWD and other items then may in dude. Climate and environment situation in Iran that causes DES & SSWD implementation become more flexible than other items. In DES & SSWD the traditional material and novel material can be used to provide desired design characteristics. Different engineering methodology is used as well. Clearly, DES & SSWD is regarded as one of the prime factor and can develop VE concept in Iran.

1.3 Objectives of the Study

The aim of this study is to develop a framework for value engineering in road construction projects. This framework is to include drainage eingineering system, surface stream way drain in construction management of main roads, highways and streets to increase projects value while reducing costs, maintaining quality and implementing the manpower efficiently, reduce the construction materials and materials disposal. The proposed framework can be generalised and implemented for other type of construction projects as well.

The following are the key objectives of this research work:

1. To identify the criteria of value engineering and drainage eingineering system, surface stream way drain for main roads construction in Iran.
2. To categorize and prioritize the extracted criteria of value engineering and drainage eingineering system, surface stream way drain for main roads, highways and streets at construction projects in Iran.
3. To develop a new framework of value engineering and drainage eingineering system, surface stream way drain for main roads, highways and streets in construction projects.
4. To validate the framework for value engineering and drainage eingineering system, surface stream way drain for main road construction

1.4 Scopes of Study

The provincial selected for this study for (pilot and actual survey) is Tehran, as one of the large-population province of Iran, It is located in the north. (Figure 1.2). As one of the most strategically important investment and development areas.

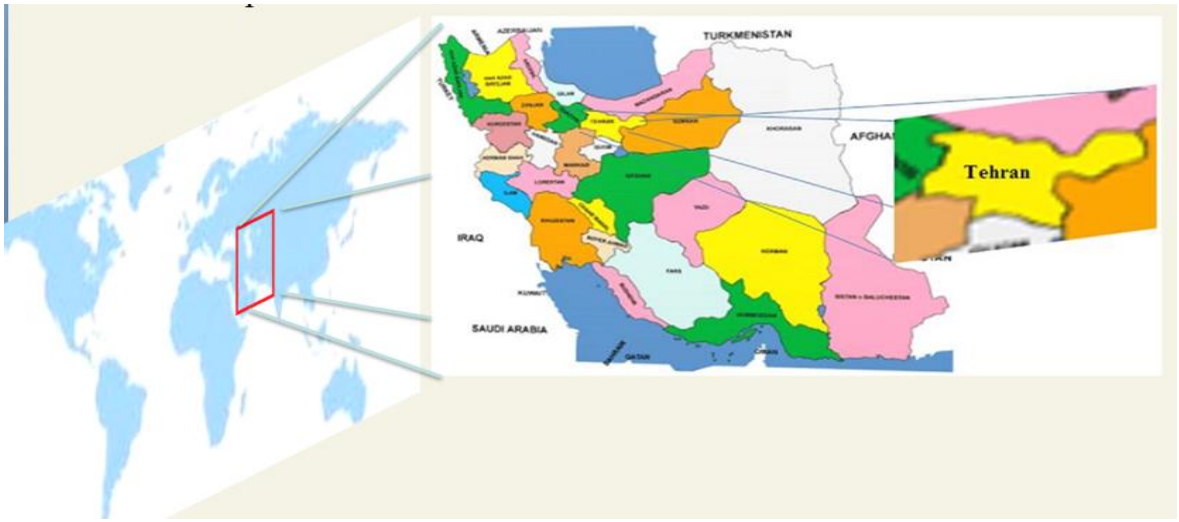

Figure 1.2 Tehran Province in the North of Iran

In this study a total of twelve criteria for VE considered are as follow for exising roads network:

1. Drainage Engineering System (DES) and Surface Stream Way Drain (SSWD)
2. Construction Management (CM)
3. Time (T)
4. Cost (C)
5. Quality (Q)
6. Safety and Safe Driving (S & SD)
7. Environment (E)
8. Human Resource (HR)
9. Materials (M)
10. Aesthetic (A)
11. Recycling (R)
12. Waste Materials (WM)

Other VE criteria such as reduce design problem, trouble-free project implementation, durability and stability, increase life cycle projects, performance improvement, investment improvement, reduced amount of rework, flexibility, increase maintenance, satisfaction of project stakeholders and development plan, etc. are not included in this study.

The criteria of VE of Aesthetic (A), Safety and Safe Driving (S&SD), environment (E) and quality (Q) one included to create an acceptable and comfortable level for customer and users. Human Resources (HR) is criteria to improve the relationship between engineering and experts. In Materials (M) criteria the scope is to find a simple method of solution to material consumption efficiently in doing the projects and implementation. In SWS, DES and SSWD criteria is to find a technical solution for sustainability to achieving its values. The Time (T), Cost (C) and Construction Materials (CM) and Waste Materials (WM) is to reach a minimum value during construction.

1.5 Research Significant

This study is important in determining the following benefit:

1. Identification of VE criteria for main road construction.
2. Prioritization of VE criteria for main road construction.
3. Finding the relationship among main road construction criteria.
4. Introducing a new VE framework for main road construction.

1.6 Operational definition of Terms

There are various businesses that apply the VE techniques such as product and process procedure system in manufacturing industry, service in business or economy activity in construction, governance, health care, and other service sector.

The focuses of value features are actually from the client point of view or to fulfil the stakeholder requirement. Obviously, VE can provide maximum benefits for stakeholders, and especially for government in infrastructure projects. Then VE is an expert procedure of finding the most effective technique for the engineering in finding the most effective technique for doing the work. By focusing on function, the maximum value from the activity is achieved with identification, processing and innovation of the work, that benefit the stakeholders and government. There are some definitions about VE as follows:

- According to Kelly, Male and Graham, (2004), VE is the process of making explicit functional benefits a client requires from the whole or parts of a project at an appropriate cost during design and construction. VE is also identifying and reducing unnecessary cost calculation method during design and construction of the project.
- VE is a systematic procedure aimed at achieving the required functions at the least, cost. In VE, all parties should realize the functions required and conditions of all design alternatives mast fulfill the same performance and selecting the best one(Dell isola,, A, 1969).
- According to the Indian VE Society (INVEST, 1977) (Gordon *et al*., 1977), VE is a function oriented, systematic team approach and a study to provide a good value in a product, system or services. This improvement is also focused on cost reduction; however, other important areas such as customer perceived quality and performance are also of paramount importance in the value equation.

According to the International Society of American Value Engineering (Save, 1972) (Michel and Woodhead, 1997), VE is a systematic application of recognized techniques, which identify the monetary value for a particular function, and provide the necessary function reliability at lowest overall cost.

Based on the definition of VE, it can be summarized that VE is systematic techniques of procedures to get the best alternative or improvement of design at the lowest cost with the same or better quality and performance during the assigned construction phase.

1.7 Brief of Research Methodology

This research will be carried according to Figure 1.3 to propose and develop a new framework of Value Engineering (VE) based on Surface Water Stream (SWS), Drainage Engineering System (DES) and Surface Stream Way Drain (SSWD) for existing main roads, highways and streets construction. It also check the validity of VE framework for drainage management system in main roads construction. The obtain VE characteristics way also useable for a new main roads constructions. VE for SWS, DES and SSWD one also mean that drainage construction.

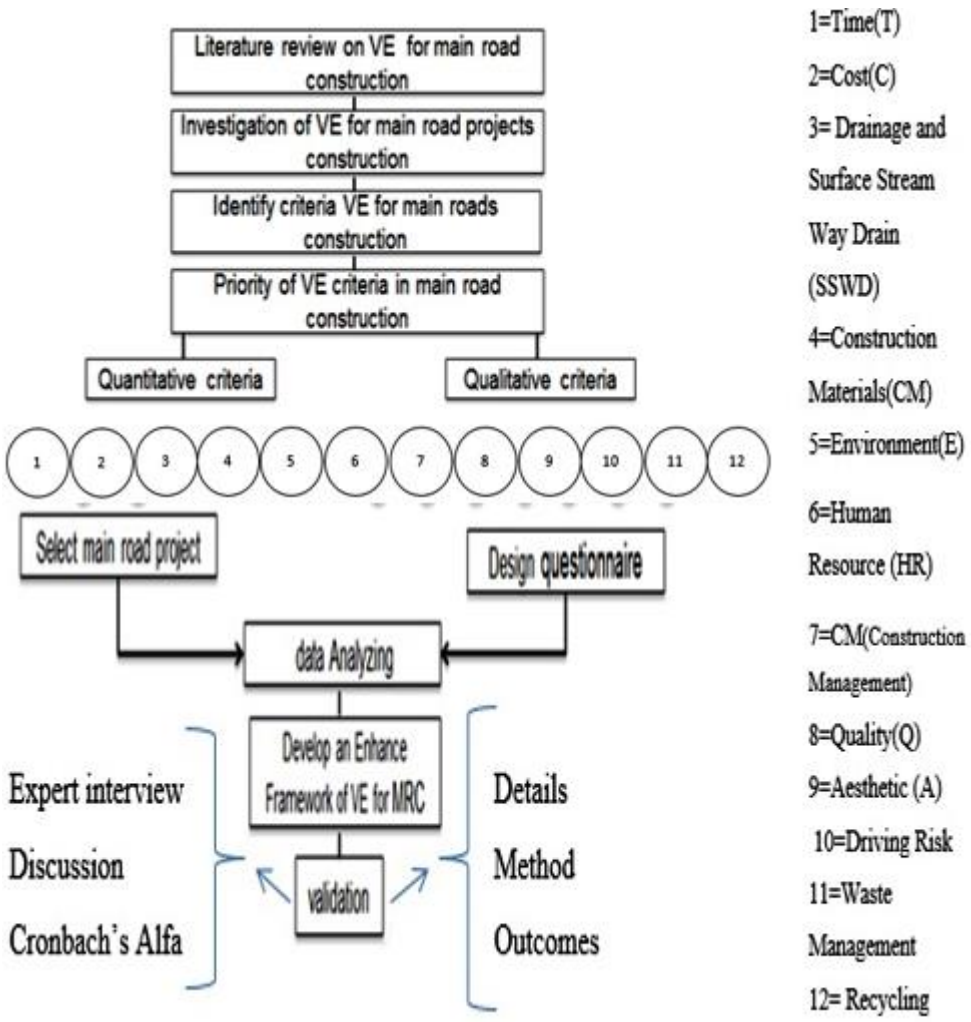

Figure 1.3 Steps of the methodology

1.8 Structure of Thesis

The thesis is structured into five chapters to include; Chapter 1 that mentions about the issue of the study. The chapter also includes the study aim and objectives. In addition, scope of the study brief of methodology and overall thesis structure are also introduced in this chapter.

Chapter 2 reviews the literature and previous works on VE for Highways and Main Roads and Streets construction. It review a development of VE in order to obtain comprehensive framework for VE in drainage constructions, Therefore this chapter has two section of one section about a VE in a few construction work

industry, and another section is about Drainage and Surface Stream Way Drain. Both sections are focusing on VE in existing Highways, Main Roads and Streets for Drainage and Surface Stream Way Drain.

Chapter 3 presents the research methodology, data collection explaining, statistical analysis technique and tools, respondent's characteristics, sampling explaination survey, and response rate and framework test.

Chapter 4 is about the data analysis. It include the primitive data analysis such as Exploratory Factor Analysis (EFA), descriptive data analysis and inferential data analysis encompassing correlation test and multiple linear regressions. The gathered data is analyzed using computer tools for interpretation.

Chapter 5 presents a conclusion of the entire thesis and derived the suggestions and recommendations for future research.

REFERENCES

Ã, J.Y., Peng, S., 2008. Development of a customer satisfaction evaluation model for construction project management 43, 458–468. doi:10.1016/j.buildenv.2006.07.044

Aapaoja, A., Haapasalo, H., Söderström, P., 2013. Early stakeholder involvement in the project definition phase: case renovation. ISRN Ind. Eng. 2013.

AASHTO, L., 1987. LRFD bridge design specifications. Washington, DC Am. Assoc. State Highw. Transp. Off.

AASHTO, T., 2003. 307 (2003) Determining the Resilient Modulus of Soils and Aggregate Materials. Am. Assoc. State Highw. Transp. Off. Washington, DC.

Abidin, N.Z., Pasquire, C.L., 2007. Revolutionize value management: A mode towards sustainability. Int. J. Proj. Manag. 25, 275–282. doi:10.1016/j.ijproman.2006.10.005

Ageron, B., Gunasekaran, A., Spalanzani, A., 2012. Sustainable supply management: An empirical study. Int. J. Prod. Econ. 140, 168–182.

Ahlin, B., Drnovšek, M., Hisrich, R.D., 2014. Exploring the moderating effects of absorptive capacity on the relationship between social networks and innovation. J. East Eur. Manag. Stud. 213–235.

Ahuja, R., 2013. Sustainable construction: is lean green?, in: ICSDEC 2012: Developing the Frontier of Sustainable Design, Engineering, and Construction. pp. 903–911.

Allen, T.M., Bathurst, R.J., 2013. Design and performance of 6.3-m-high, block-faced geogrid wall designed using k-stiffness method. J. Geotech. Geoenvironmental Eng. 140, 4013016.

Aminzadeh, Rahim and Esmaeil, A., 2013. Value Engineering in Highways Construction.

Aminzadeh, Rahim and Ismailb, Amirruddin and Arshad, I., 2011. Development Value Engineering Modeling in Construction Transportation Rahim

Aminzadeha , 2 Amirruddin Ismailb , 3 Ishak Arshad PhD student / Department of Civil and Structural Engineering , Faculty of Engineering and Department of Civil and Structural Eng. Aust. J. Basic Appl. Sci. 5, 397–402.

Ankrah, N.A., 2007. AN INVESTIGATION INTO THE IMPACT OF CULTURE ON CONSTRUCTION PROJECT. University of Wolverhampton.

Anthny, O.S., 2015. THE IMPACT OF CHANGE MANAGEMENT PRACTICES ON CONSTRUCTION PROJECT PERFORMANCE.

Bangi, U.K.M., Ehsan, S.D., 2010. Value Engineering Application in Highway Projects Amiruddin Ismail , Rahim Aminzadeh , Ali Aram and Ishak Arshad Department of Civil and Structural Engineering , Faculty of Engineering and Built Environment , 3, 699–703.

Barnes, M., 2014. THE MANAGEMENT AND ADAPTATION OF A LEGACY TRANSIT SYSTEM FOR WEATHER EXTREMES IN THE PHILADELPHIA METROPOLITAN REGION. J. Chem. Inf. Model. doi:10.1017/CBO9781107415324.004

Begg, S., Vos, T., Barrke, B., Stevenson, C., Stanley, L., Lopez, A.D., 2007. The burden of disease and injury in Australia.

Bench-Capon, T.J.M., 2015. Knowledge-based systems and legal applications. Academic Press.

Bergmiller, G.G., 2006. Lean manufacturers transcendence to green manufacturing: Correlating the diffusion of lean and green manufacturing systems. Diss. Abstr. Int. Vol. 68, no. 01, suppl. B, 294 p. 2006. 294.

Bill de Blasio, M., Dr. Feniosky Peña-Mora, C., 2015. Design Consultant Guide.

Bim, M., Jones, S. a, 2009. Building Information Modeling. Civ. Eng. Vol.1, pp 225-231. doi:10.1002/9780470432846

Booth, A.D., 2014. Digital Computers in Action: The Commonwealth and International Library: Computing Science and Cybernetics Division. Elsevier.

Brown, J.D., 2011. Likert items and scales of measurement? SHIKEN JALT Test. Eval. SIG Newsl. 15, 10–14.

Chen, W.T., Chang, P.-Y., Huang, Y.-H., 2010. Assessing the overall performance of value engineering workshops for construction projects. Int. J. Proj. Manag. 28, 514–527.

Chi, S., Murphy, M., Zhang, Z., 2014. Sustainable Road Management in Texas : Network-Level Flexible Pavement Structural Condition Analysis Using Data-

Mining Techniques 156–165. doi:10.1061/(ASCE)CP.1943-5487.0000252.

Chin, W.W., Dibbern, J., 2010. An introduction to a permutation based procedure for multi-group PLS analysis: Results of tests of differences on simulated data and a cross cultural analysis of the sourcing of information system services between Germany and the USA, in: Handbook of Partial Least Squares. Springer, pp. 171–193.

Chua, D.K.H., 2003. Value Improvement Methods.

Chudley, R., Greeno, R., 2013. Building construction handbook. Routledge.

Chung, B.Y., Syachrani, S., Kwak, Y.H., 2009. Applying Process Simulation Technique to Value Engineering Model : A Case Study of Hospital. Trans. Eng. 56, 549–559.

Clough, R.H., Sears, G.A., Sears, S.K., Segner, R.O., Rounds, J.L., 2015. Construction contracting: A practical guide to company management. John Wiley & Sons.

Coffin, A.W., 2007. From roadkill to road ecology: a review of the ecological effects of roads. J. Transp. Geogr. 15, 396–406.

Conference, I., 2014. RECENT ADVANCES in ECONOMICS , MANAGEMENT and DEVELOPMENT RECENT ADVANCES in ECONOMICS , MANAGEMENT and DEVELOPMENT.

Cullen, J.M., 2014. Final Value Engineering Study Report.

Cunningham, G.B., 2011. The LGBT advantage: Examining the relationship among sexual orientation diversity, diversity strategy, and performance. Sport Manag. Rev. 14, 453–461.

Cunningham, T., 2013. Choosing an Appropriate Main Contract for Building Work in the Republic of Ireland - an Overview, Dublin Institure of Technology 0–24.

Daniel P, F., 2006. Value Engineering Study Services In a Design Build World 1–10.

Davis, J.L., 2013. TMGT 458 – Project Management COURSE SYLLABUS : Spring , 2013 Instructor : Jason Lee Davis , PhD – Associate Prof . & Sr . Grad . Faculty Office Location : Charles Austin Engineering Building (Ag / IT), 213C Office Hours : See Instructor Schedule on fac.

De Smith, M.J., 2015. STATSREF: Statistical Analysis Handbook-a web-based statistics.".

Dell isola,, A, J., 1969. VALUE Engineering.

Discovery, E., Project, I.H., 2016. Request for Proposals 17011 Construction

Manager Entrepreneurship , Discovery and Innovation Hub Project Saint Mary ' s University Halifax , Nova Scotia Request for Proposals 17011 Construction Manager Entrepreneurship , Discovery and Innovation Hub Proje.

Division, D.& C., 2014. PROJECT MANAGEMENT & DESIGN ADMINISTRATION MANUAL Department of Transportation & Works Prepared By Design & Construction Division January 2014 6th Edition Project Management & Design Administration Manual - 6th Edition Table of Contents Revised January 20.

Emeasoba, U., Ogbuefi, J., 2013. Sustainable socio-economic development in Nigeria: a case for road infrastructure maintenance. J. Environ. Earth Sci. 3, 129–137.

Erdo\ugdu, M.M., Karaca, C., Kurultay, A., 2016. Economic Potentials of Energy-Efficient Residential Building Envelope Retrofitting in Turkey, in: Handbook of Research on Green Economic Development Initiatives and Strategies. IGI Global, pp. 340–367.

Ewing, R., Dumbaugh, E., 2009. The built environment and traffic safety a review of empirical evidence. J. Plan. Lit. 23, 347–367.

Federal High Way Administration (FHWA), 1996. StewardshipPlan(FHWA).pdf.

Field, C., Genton, M.G., 2006. The multivariate g-and-h distribution. Technometrics 48, 104–111.

Finnveden, G., Hauschild, M.Z., Ekvall, T., Guinée, J., Heijungs, R., Hellweg, S., Koehler, A., Pennington, D., Suh, S., 2009. Recent developments in Life Cycle Assessment. J. Environ. Manage. 91, 1–21. doi:10.1016/j.jenvman.2009.06.018

Flooding rainfall in Tehran, 2011. No TitleFlooding rainfall in Tehran, 2011 Report No. 267.

Fortune, J., White, D., Jugdev, K., Walker, D., 2011. Looking again at current practice in project management. Int. J. Manag. Proj. Bus. 4, 553–572. doi:10.1108/17538371111164010

Forture, J & White, D., 2006. No TitleFraming of project critical success factors by a systems model. Int. J. Proj. Manag. 24 (1): 53.

Fountain, Roy E, Barlow, D.P., 1959. 424.pdf.

Fuller, S., 2010. LCC and Life-Cycle Cost Analysis (LCCA).

Galloway, P.D., 2007. The 21st-century engineer: A proposal for engineering education reform. Civ. Eng. Mag. Arch. 77, 46–104.

GAO, 2009. GAO Cost Estimating and Assessment Guide. GAO Cost Estim. Assess. Guid. 440.

Garratt, A., 2009. Value Engineering PROGRAM. Manag. Decis. 1, 49–54. doi:10.1108/eb000807

Giel, B.K., Issa, R.R.A., 2011. Return on investment analysis of using building information modeling in construction. J. Comput. Civ. Eng. 27, 511–521.

Gómez, M., Macchione, F., Russo, B., 2011. Methodologies to study the surface hydraulic behaviour of urban catchments during storm events. Water Sci. Technol. 63, 2666–2673. doi:10.2166/wst.2011.174

Gorantiwar, S.D., Smout, I.K., 2005. Closure to "Allocation of Scarce Water Resources Using Deficit Irrigation in Rotational Systems" by SD Gorantiwar and IK Smout. J. Irrig. Drain. Eng. 131, 305–306.

Gordon, T., Castelli, W.P., Hjortland, M.C., Kannel, W.B., Dawber, T.R., 1977. High density lipoprotein as a protective factor against coronary heart disease: the Framingham Study. Am. J. Med. 62, 707–714.

Hair, J.F., Ringle, C.M., Sarstedt, M., 2011. PLS-SEM: Indeed a silver bullet. J. Mark. theory Pract. 19, 139–152.

Hair, J.F., Sarstedt, M., Ringle, C.M., Mena, J.A., 2012. An assessment of the use of partial least squares structural equation modeling in marketing research. J. Acad. Mark. Sci. 40, 414–433.

Hair Jr, J.F., Hult, G.T.M., Ringle, C., Sarstedt, M., 2016. A primer on partial least squares structural equation modeling (PLS-SEM). Sage Publications.

Harkey, D.L., Program, N.C.H.R., of State Highway, A.A., Officials, T., 2008. Accident modification factors for traffic engineering and ITS improvements. Transportation Research Board.

Harris, F., McCaffer, R., 2013. Modern Construction Management (Google eBook). doi:10.1515/9783990434550

Hines, P., Rich, N., 2008. mapping tools.

Hischier, R., Editors, B.W., Althaus, H., Bauer, C., Doka, G., Dones, R., Frischknecht, R., Hellweg, S., Humbert, S., Jungbluth, N., Köllner, T., Loerincik, Y., Margni, M., Nemecek, T., 2009. Implementation of Life Cycle Impact Assessment Methods.

Holweg, M., 2000. Value Analysis, Value Engineering 0–31.

Hulland, John, R.I.S., 1999. Use of partial least squares (PLS) in strategic

management research: A review of four recent studies. Strateg. Manag. J. 20, 195–204.

Ibusuki, U., Kaminski, P.C., 2007. Product development process with focus on value engineering and target-costing: A case study in an automotive company. Int. J. Prod. Econ. 105, 459–474.

Ihs, A., Gustafsson, M., Eriksson, O., Wiklund, M., Sjögren, L., 2011. Road user effect models: the influence of rut depth on traffic safety.

IHWTI, 2009, 2009. One of comments Viva; IHWTI (Institute High Ways Transportation Iran, 2009.

Ismail, Amiruddin and Aminzadeh, Rahim and Aram, Ali and Arshad, I., 2010. Value Engineering Application in Highway Projects Amiruddin Ismail , Rahim Aminzadeh , Ali Aram and Ishak Arshad Department of Civil and Structural Engineering , Faculty of Engineering and Built Environment , 3, 699–703.

Issa, M.H., Attalla, M., Rankin, J.H., Christian, A.J., 2013. Detailed Analysis of the Construction , Operating , Maintenance , and Rehabilitation Costs of Green Toronto Schools 1–11. doi:10.1061/(ASCE)AE.1943-5568.0000093.

Jungerius, P.D., Matundura, J., Van De Ancker, J.A.M., 2002. Road construction and gully erosion in West Pokot, Kenya. Earth Surf. Process. Landforms 27, 1237–1247.

Kajitvichyanukul, P., Ananpattarachai, J., Amuda, O.S., Alade, A.O., Hung, Y., Wang, L.K., 2006. Value Engineering and Value Management. Management.

Kampmann, M.W., 2009. Predicting IPTV usage: an SEM approach.

Kavosi, Z., Rashidian, A., Pourreza, A., Majdzadeh, R., Pourmalek, F., Hosseinpour, A.R., Mohammad, K., Arab, M., 2012. Inequality in household catastrophic health care expenditure in a low-income society of Iran. Health Policy Plan. 27, 613–623.

Kelly, J., Male, S., Graham, D., 2014. Value management of construction projects. John Wiley & Sons.

Kelly, J.R., Male, S., 1991. The Practice of Value Management: Enhancing Value or Cutting Cost? Royal Institution of Chartered Surveyors.

Kenley, R., 2010. Construction Cost Management: Learning from Case Studies, Construction Management and Economics. doi:10.1080/01446190903552502

Kerzner, H.R., 2013. Project management: a systems approach to planning, scheduling, and controlling. John Wiley & Sons.

Kibert, C.J., 2016. Sustainable construction: green building design and delivery. John Wiley & Sons.

Klein, K.J., Knight, A.P., 2005. Innovation implementation: Overcoming the challenge. Curr. Dir. Psychol. Sci. 14, 243–246.

Ko, C.-H., Chung, N.-F., 2014. Lean design process. J. Constr. Eng. Manag. 140, 4014011.

Kobus, P.H., Plate, P.E., Hsieh, P., Shen, W., Szöllösi-nagy, A., 2013. Education of Hydraulic Engineers Education of Hydraulic Engineers Formation des ingenieurs hydraulic . iens 1686.

Kousky, C., Walsh, S., Zeckhauser, R., Kousky, C., Walsh, S., Zeckhauser, R., 2007. Issues in Legal Scholarship Options Contracts for Contingent Takings Options Contracts for Contingent Takings ∗ .

Kulak, G.L., Fisher, J.W., Struik, J.H.A., 1988. Guide to design criteria for bolted and riveted joints, American Institute of Steel Construction, Inc. doi:10.1139/l88-018

Kwak, Y.H., Anbari, F.T., 2012. History, practices, and future of earned value management in government: Perspectives from NASA. Proj. Manag. J. 43, 77–90.

Labit, B., Furno, I., Fasoli, A., Diallo, A., Müller, S.H., Plyushchev, G., Podestà, M., Poli, F.M., 2007. Universal statistical properties of drift-interchange turbulence in TORPEX plasmas. Phys. Rev. Lett. 98, 255002.

Larson, L.L.C.N.-F.-54, 1993. Lower Kenai Peninsula Dolly Varden and steelhead trout studies during 1992.

Laufer, A., 2009. Breaking the code of project management. Springer.

Lee, J.S., Miller, L.E., 2007. INCOSE - Systems Engineering Handbook. Syst. Eng. 304.

Lee, M.R., Ismail, S., Hussaini, M., 2013. Key Performance Indicator (KPI) of Contractor on Project Performance for Housing Construction in Malaysia.

Li, X., 2008. Application of Value Methodology to Improve Preservation of Infrastructural Assets in Rijkswaterstaat.

Limón, D.H., 2014. Comparative Analysis of Practices in Airspace and Construction Industries.

Mahbub, V.J., 1994. International Road Maintenance Handbook Volume I, Highways Maintenance.

Mak, C.M., Leung, W.K., Jiang, G.S., 2010. Measurement and prediction of road traffic noise at different building floor levels in Hong Kong. Build. Serv. Eng. Res. Technol. 31, 131–139.

Mandelbaum, J., 2006. Value Engineering handbook 1–41.

Mandelbaum, J., Reed, D.L., Leader, P., 2006. Value Engineering Handbook.

Marsden, J.E., Ratiu, T., 2013. Introduction to mechanics and symmetry: a basic exposition of classical mechanical systems. Springer Science & Business Media.

Marszal, A.J., Heiselberg, P., 2011. Life cycle cost analysis of a multi-storey residential net zero energy building in Denmark. Energy 36, 5600–5609.

Melorose, J., Perroy, R., Careas, S., 2015. Sustainable Development in Low-Income Housing: A New Technology. Statew. Agric. L. Use Baseline 2015 1. doi:10.1017/CBO9781107415324.004

Michel, J., Woodhead, R., 1997. Jean MICHEL Conseil.

Miles, L.D., 2015. Techniques of value analysis and engineering. Miles Value Foundation.

Mirmoradi, S.H., Ehrlich, M., 2014. Numerical Evaluation of the Behavior of GRS Walls with Segmental Block Facing under Working Stress Conditions. J. Geotech. Geoenvironmental Eng. 8, 1–8. doi:10.1061/(ASCE)GT.1943-5606.0001235.

Nadasdi, F., 2012. CAN VALUE METHODOLOGY ENHANCE THE COMPETITIVENESS OF THE SUPPLY CHAIN ?

Nevada DOT, 2012. Risk management and risk-based cost estimation guidelines.

O'Farrell, P., 2010. Value Engineering-An Opportunity for Consulting Engineers to Redefine Their Role 148.

Office of Deputy Assistant Secretary of Defense Systems Engineering, 2011. Value Engineering : A Guidebook of Best Practices and Tools.

Opencourseware, M.I.T., 2009. MIT Project Management.

Order, C.T.O., Approval, M., 2014. MCHENRY COUNTY FINANCE & AUDIT.

Othman, A.A.E., 2008. Incorporating value and risk management concepts in developing low cost housing projects. Emirates J. Eng. Res. 13, 45–52.

Owens, J.A., 2010. Project management for complex transportation projects.

PBO country, 2016. PBO Country Iran (Organization Program Budget in Iran) that before was vice president.

Pecht, M., 2009. Product reliability, maintainability, and supportability handbook. CRC Press.

Perlovsky, L., 2002. Physical theory of information processing in the mind: Concepts and emotions. Seed 2, 36–54.

Petroutsatou, K., Ph, D., Georgopoulos, E., 2012. Early Cost Estimating of Road Tunnel Construction Using Neural Networks 679–687. doi:10.1061/(ASCE)CO.1943-7862.0000479.

Pica, M.M., 2015. Project Life Cycle Economics: Cost Estimation, Management and Effectiveness in Construction Projects. Ashgate Publishing, Ltd.

Podsakoff, P.M., Organ, D.W., 1986. Self-reports in organizational research: Problems and prospects. J. Manage. 12, 531–544.

Ranjbaran, Y., Moselhi, O., 2014. 4D-Based Value Engineering, in: Construction Research Congress 2014: Construction in a Global Network. pp. 1606–1615.

Rhem, K.T., Boyer, J., 2012. Loglines. September-October 2012 (techreport).

Robichaud, L.B., Anantatmula, V.S., 2011. Greening Project Management Practices for Sustainable Construction. J. Manag. Eng. 48–57, 48–57.

Ross, A.M., Rhodes, D.H., 2008. Using Attribute Classes to Uncover Latent Value during Conceptual Systems Design 1–8.

Rumane, A.R., 2010. Quality management in construction projects. CRC Press.

Salem, O., Solomon, J., Genaidy, A., Luegring, M., 2005. Site Implementation and Assessment of Lean Construction Techniques. Lean Constr. J. 2, 1–21.

Sarstedt, M., Ringle, C.M., Smith, D., Reams, R., Hair, J.F., 2014. Partial least squares structural equation modeling (PLS-SEM): A useful tool for family business researchers. J. Fam. Bus. Strateg. 5, 105–115.

SAVE International, 2007. Value standard and the Body of Knowledge. SAVE Int. Value Stand.

Scott, S., 2011. Guidelines for the use of pavement warranties on highway construction projects. Transportation Research Board.

Scott, S., 2006. Best-value procurement methods for highway construction projects. Transportation Research Board.

Soetanto, R., Proverbs, D.G., Soetanto, R., Proverbs, D.G., 2002. Engineering , Construction and Architectural Management Article information : To cite this document : About Emerald www.emeraldinsight.com Modelling the satisfaction of contractors : the impact of client performance.

Stakgold, I., Holst, M.J., 2011. Green's functions and boundary value problems. John Wiley & Sons.

States, U., Forces, J., 2010. Handbook for Military Support to Governance , Elections , and Media Handbook Series Book Three.

Strictest, I., Confidence, C., One, P., Strictest, I., Confidence, C., 2016. Design Build (DB). doi:10.1002/ejoc.201200111

Strozzi, F., Coppini, M., Rossignoli, C., Rossi, T., 2011. r P Fo r R w On ly.

Tajrishi Masoud, kamali M. and G.S., 2013. New ways of managing urban runoff surface.

Teece, D.J., 2010. Business models, business strategy and innovation. Long Range Plann. 43, 172–194.

Thom as Huw &Piccolo, L.F., 2000. i y Best Value , Planning and Race Equality Vol. 15, N.

Thomson, D.S., 2013. Practitioner understanding of value in the UK building sector. Eng. Constr. Archit. Manag. 20, 214–231. doi:10.1108/09699981311323970

Tobergte, D.R., Curtis, S., 2013. No title no title. J. Chem. Inf. Model. 53, 1689–1699.

Tohidi, H., KhedriLiraviasl, K., 2012. Six sigma methodology and its relationship with lean manufacturing system. Adv. Environ. Biol. 6, 895–906.

Tom, S., 2012. Persuasive business proposals: writing to win more customers, clients, and contracts. AMACOM Div American Mgmt Assn.

Utley, R.E., 2016. Perspectives and problems. Routledge.

Utne, I.B., 2009. Life cycle cost (LCC) as a tool for improving sustainability in the Norwegian fishing fleet. J. Clean. Prod. 17, 335–344.

Van Son, B.I.M., 2013. The Success of Systems Engineering in Public Private Partnerships (phdthesis). TU Delft, Delft University of Technology.

Venkataraman, R.R., Pinto, J.K., 2008. Cost and Value Management in Projects, Cost and Value Management in Projects. doi:10.1002/9780470261033

Vilasini, N., 2014. Generating value in alliance contracts through the lean concept.

Vujovic, A., Krivokapic, Z., Jovanovic, J., Lifvergren, S., Bergman, B., Dumitrascu, A.-E., Nedelcu, A., Alves dos Santos, E., Zeydan, M., Toğa, G., Adeoti, J.O., Kostogryzov, A., Nistratov, G., Nistratov, A., Moracanin, V., Yang, C.-C., Chakraborty, A., Tan, K.C., Cartwright, G., Oakland, J., 2012. Total quality management and six sigma. doi:http://dx.doi.org/10.5772/2559

Walker, Derek HT and Walker, Derek HT and Rahamani, Farshid and Rahamani, F., 2016. +VE Workshop Northern Water Plant-post-review-R2-final.

White, D., Fortune, J., 2002. Current practice in project management Ð an empirical study 20.

Williams, M.L., 2012. Attachment 1 Notice to LEAs of Intent to Apply for Waivers under Section 9401.

Xia, J.J., 2013. Research on the Key Technology of Road Machinery Intelligent Compaction. Appl. Mech. Mater. 373–375, 142–145. doi:10.4028/www.scientific.net/AMM.373-375.142

Xu, Y.G., Qian, C., 2014. Lean Cost Analysis Based on BIM Modeling for Construction Project, in: Applied Mechanics and Materials. Trans Tech Publ, pp. 1444–1447.

Yang, B., Fang, L., Li, J., 2013. Semi-automated extraction and delineation of 3D roads of street scene from mobile laser scanning point clouds. ISPRS J. Photogramm. Remote Sens. 79, 80–93.

Yap, C.L., 2016. Application of value management by IBS contractors in Malaysia (phdthesis). UTAR.

Younker, D., 2003. Value engineering: analysis and methodology. CRC Press.

Yunker, D., 2003. Value Engineering Analysis and Methodology.

Zarandi, M.H.F., Razaee, Z.S., Karbasian, M., 2011a. Expert Systems with Applications A fuzzy case based reasoning approach to value engineering. Expert Syst. Appl. 38, 9334–9339. doi:10.1016/j.eswa.2011.01.124

Zarandi, M.H.F., Razaee, Z.S., Karbasian, M., 2011b. A fuzzy case based reasoning approach to value engineering. Expert Syst. Appl. 38, 9334–9339.

Zhang, X., Chen, S., 2013. A systematic framework for infrastructure development through public private partnerships. IATSS Res. 36, 88–97.

Zhang, X., Mao, X., AbouRizk, S.M., 2009. Developing a knowledge management system for improved value engineering practices in the construction industry. Autom. Constr. 18, 777–789.

Zhuang, J., Liang, Z., Lin, T., Guzman, F. De, 2007. Theory and Practice in the Choice of Social Discount Rate for Cost-Benefit Analysis: A Survey 51.

Zimina, D., Ballard, G., Pasquire, C., 2012. Target value design: using collaboration and a lean approach to reduce construction cost. Constr. Manag. Econ. 30, 383–398.

Zolin, R., Cheung, Y.K.F., Turner, J.R., 2012. Project Managers's understanding of Stakeholder's satisfaction. Proj. Perspect. Annu. Publ. Int. Proj. Manag. Assoc. XXXIV, 10–15.