VALUE ENGINEERING PRACTICES AND ITS IMPACT TO CONSTRUCTION INDUSTRY

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ABSTRACT

Value engineering (VE) is a systematic method to elevate the value of goods, products and services. Purpose of this paper is to investigate the current situation and real practice of VE technique in Sri Lankan construction sector and to give recommendations to construction organisations and national level construction regulatory bodies to standardize, VE practices toward achieving value for money for all stakeholders. A broad literature survey was carried out and seven case studies, thirty nine interviews and six expert interviews were conducted among construction professionals, who are having extensive knowledge on VE technique in Sri Lankan construction industry to gather facts. Content analysis and cognitive mapping were used in this research to analyze data and to identify the patterns of cases.

Findings of the research revealed that the application, knowledge and experience of construction professionals are not satisfactory in VE technique. Some recommendations can be mentioned as reduce contractor's design responsibility, introduce a proper VE guideline and regulate VE technique by law. This research is an ongoing research and a framework is going to build up which will help authorities to improve the applicability of VE technique. A formula is also going to form to determine a margin between contractor's portion due to VE technique and original profit of the contractor.

Keywords: *Construction Industry; Stakeholder; Value; Value Engineering.*

1. INTRODUCTION

"The construction industry can be differentiated from other industries by its organisation and products, its stakeholders, its projects, its processes, and its operating environment" (National Research Council, 2009, p.10). The development of construction industry is based on government decisions, procedures and regulations which have an obvious relationship between construction value for money (Wijewardana *et al.*, 2013).

By enhancing the value of a project can originate an affirmative collision on the economy of the country (Rameezdeen and De Silva, 2002). Zhang *et al.* (2009) reported that, Value Engineering (VE) is the most appropriate technique to regulate value in construction projects. It further described that, other techniques moreover focus on time and quality other than value. Altogether Miles (1972), Parker (2001) and Zar *et al.* (2011) contended that, VE is a systematic method to elevate the value of goods, products and services by undertaking an investigation of intention. Gudem *et al.* (2013) stated that, the project cost will be reduced up to 26%, enhance operational performance 40-50% and upgrade product quality 30-50% by implementing VE in projects.

In this context, this paper intends to examine prevailing VE practices in order to identify prevailing situation with intention of enhancing the standard value application in construction industry. Mainly scope of this paper is confined to major building and road construction projects, which practices VE techniques.

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2. LITERATURE SYNTHESIS

2.1. VALUE AND ITS IMPORTANT IN CONSTRUCTION INDUSTRY

Value is a subjective term and is conspicuous in various ways such as desire, attitude, preference need, criteria and belief (Leung and Liu, 2003). Thiry (1997) stated that, value is a very subjective concept which has several definitions for various people, "best buy" for a customer, "the lowest cost" for a manufacturer and "highest functionality" for a designer.

A fundamental issue for construction firms is to guarantee value creation within and across projects (Lozon and Jergeas, 2008). Kliniotou (2004) stated that, various value measuring techniques can be found in plenty of industrial sectors such as value management (VM), bench marking, total quality management (TQM), financial management techniques (FMT), cost benefit analysis (CBA), supply chain management, project management, whole life cycle costing (WLCC) and earned value management (EVM).

Among these techniques VM is the unique application which assign throughout the stages of Royal Institute of British Architects (RIBA) plan and it is the most preferred value measuring technique among other value measuring techniques (Stenstrom *et al.*, 2013). VM has great accuracy over other techniques because all the factors which affect to the value of the product are considered in VM (Kelly *et al.*, 2004).

According to Potts (2008) and Male *et al.* (1998), the systematic operation of VM can be simply separated into three prime techniques, specifically Value Planning (VP), Value Engineering (VE) and Value Analysis (VA) to certify that the value is conveyed to the project in the most adequate manner.

VE is a disciplined and creative method which examines to submit the client a trustworthy opportunity for cost savings without detriment to quality or performance (Miles, 1972). According to Othman (2008) and Fan and Shen (2011), VE investigates, analyses, compares and selects amidst the various alternatives to generate the desired function and encounter or surpasses the customer goals and expectations. Each and every job plan phases, procedures and activities under the phases are clearly explained by Norton and McElligot (1995), Thiry (1997), Leung *et al.* (2002) and Othman (2008) as pre-study phase, information phase, objectives phase, functional analysis phase, consensus phase, development phase, evaluation phase and creativity phase.

2.2. VALUE ENGINEERING (VE) AND ITS IMPACT TO CONSTRUCTION

Value impulse clauses have been compounded into building contracts and statutory legislation could be institute to encourage the use of VE (Fong and Shen, 2000). Abidin and Pasquire (2007) reported that, VE had extensively acknowledged as a paramount contrivance in the management of construction projects in all over the world.

Dell'Isola (1997) advances typical VE savings as follows:

- In construction programmes to a value of €10 million, savings typically range from 3 to 10 times the value engineering effort.
- In programmes from €10-75 million, savings range from 5 to 15 times the effort.
- In programmes over €75 million, savings range from 10 to 20 times the effort.

According to Luu *et al.* (2003) and Ashworth (2002), factors affecting the VE selection can be categorized under following four main categories.

- Client Requirements
- Client Characteristics
- Project Characteristics
- External Environmental Factors

According to the Society of American Value Engineers (SAVE) (2006), as every technique, VE also have lot of benefits and some drawbacks, which limit the performance of the technique. Bowman and

Ambrosini (2010) have introduced several benefits of VE for construction projects such as, elevated competitiveness and profitability, can get a full authorized review of the total project, can generate a continuous improvements in quality and performance and quantum increases in productivity of the project. According to Hamilton (2002), improved identification of merits of VE has caused for the affluence of market level in worldwide. Lack of flexibility, lack of support and lack of knowledge and awareness of VE in some regions are basis for its minimal implementation (Cheah and Ting, 2005).

3. RESEARCH METHODOLOGY

This study is adopted qualitative research approach because, qualitative research describes a situation as it exists, without involving formal hypotheses, however focusing on explaining social processes intensely. Therefore, among various approaches available in the qualitative approach, case study is selected. The unit of analysis or the case in this paper is construction projects which applied VE in Sri Lanka. Number of cases increased up to seven and they are further divided to seventeen items to get a broad picture about VE applications which were done in those selected cases.

The cases were selected from building projects and road projects due to the abundance of such projects and also to avoid complexities which may occur when evaluating building and civil projects simultaneously. Cases are vary from super luxury residents to low cost housing projects and used different procurement methods as design and build, lump sum and measure and pay. Since this study is based on importance of VE technique in construction, had to select projects which use VE for their project. These projects are well known in construction industry due to the applicability of VE technique. For more details refer Table 1.

Table 1: Case Study Description

Project	Type	Contract Sum (Rs. million)	Duration	Procurement Method
Project A	Super luxury residential building	4,455	26 months	Lump sum
Project B	Low cost housing residential building	1) 915 2) 2,890 3) 2,180 4) 1,360	24 months	Design and build lump sum
Project C	Super luxury office complex	90,000	48 months	Design and build lump sum
Project D	Low cost housing residential building	1,070	24 months	Design and build lump sum
Project E	Super luxury office complex	7,550	36 months	Design and build lump sum
Project F	Expressway project	18,700	24 months	Measure and pay
Project G	Hostel building	196	12 months	Design and build lump sum

The interviews were carried out face-to-face in semi structured manner. Thirty nine case study interviews were carried out to collect data. Six expert interviews were conducted to clarify and validate research outcomes gathered through case studies. The interviews were carried out with three significant participants of the construction project team: client's representative, consultant's representative and contractor's representative. Content analysis and cognitive mapping were used in this paper to analyse data.

4. RESEARCH FINDINGS

4.1. IMPORTANCE OF VE TO CONSTRUCTION INDUSTRY

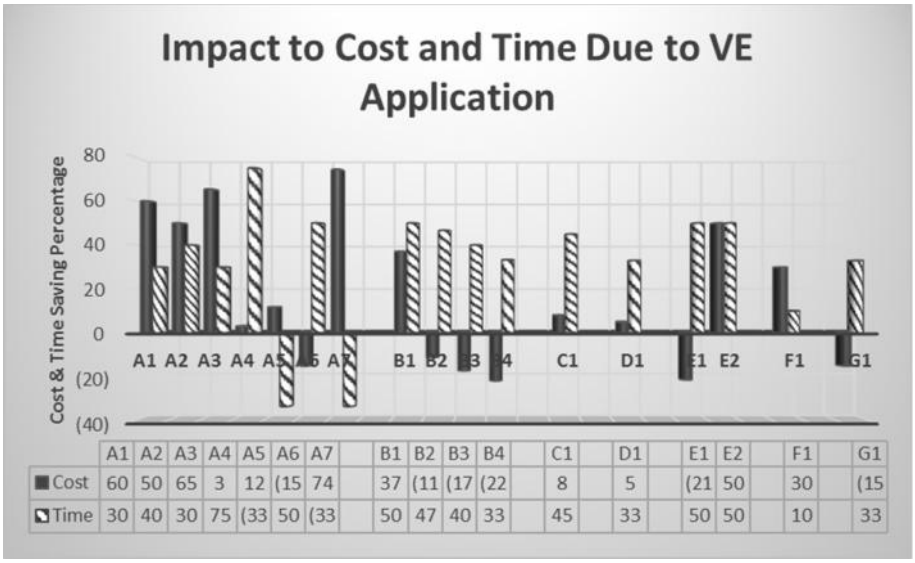
Respondents stated that every project is unique to one another and one factor will not affect to another in a same way. Thus according to respondents' view, VE proposals must be carried out with broader understanding about project requirement and outcome from VE technique. That includes type of the project, government rules and regulations, perspectives of client, consultant and contractor. Selected case studies revealed that some projects were used VE technique to reduce cost and another set of projects used VE technique to reduce time for completion. In construction projects almost all clients are looking for cost reduction of the project due to budget constraints in the project.

4.2. REAL VE PRACTICE IN THE CONSTRUCTION INDUSTRY

In the process of application, there are some limitations in projects and according to respondents, those limitations need to be identified prior to think about VE application. Otherwise there would be errors in the final output or in the process of application. Respondents stated that, contractors suggest VE proposals after considering these limitations and after giving the proposal, consultants also evaluate that proposal considering limitations in the process of application.

Basically a project is a requirement of the client and client is the person who is investing the project. Client's requirements play a significant role in construction industry. There are factors which need to be accepted, such as political factors, government rules and regulations, economical and environmental factors. Stakeholders need to take necessary precautions to reduce the impact of these factors. According to empirical findings almost all the respondents mentioned that there is no any predefined way to apply VE technique in construction industry. When they are applying VE technique, it is revealed that, in most of the time stakeholders do not consider about the life cycle cost of the project before application of VE technique.

According to respondents, stakeholders are required to accept, avoid, share or transfer those considered factors to have better outputs through projects. Stakeholders are always trying to balance market requirements and demand. To fulfil the demand, there are other factors which need to satisfy. Some of them are availability of material, labour, plant and equipment. Figure 1 will give a brief amplification about impact to cost and time due to VE application of the projects.



	A1	A2	A3	A4	A5	A6	A7		B1	B2	B3	B4		C1		D1		E1	E2		F1		G1
Cost	60	50	65	3	12	(15	74		37	(11	(17	(22		8		5		(21	50		30		(15
Time	30	40	30	75	(33	50	(33		50	47	40	33		45		33		50	50		10		33

Figure 1: Impact to Cost and Time due to VE Application

Figure 1 is created from empirical data collected from case studies and VE applied items. Altogether 17 items were considered in 7 projects. Plain colour and downward diagonal pattern columns indicate cost

and time reduction while columns below "0" percentage level indicate cost and time addition due to VE applications in the projects. According to objectives of the construction projects, time saving to the project was considered mainly in Projects C, D, E, G and both cost and time saving to the project was considered in Projects A and F.

In Project B there were four contractors in different construction sites constructing low cost houses for low income people. Construction methods, experience, labour force, plant and equipment, construction cost and time got varied among contractors.

There is a huge cost and time saving due to usage of Aluminium system formworks. Among selected cases Project A, item A2, Project B, Project C and Project E, item E1 indicated cost and time saving in Figure 1. According to findings, all Aluminium system formwork projects other than Projects B and E achieved both cost and time saving. In Project C, the contractor imported new set of Aluminium system formworks for the project. Not like Project B, Project C was a large scale project and the contractor used system formworks for all typical buildings. Project A reduced its cost by reusing previously used Aluminium system formworks. In Project E, item E1 the contractor BB used newly imported set of Aluminium system formwork and due to that cost was increased and subsequently time for completion was reduced.

In Project G, cost was increased due to the usage of precast concrete sections instead of in-situ concrete. Contractor got more advantages like reduction of construction time, less impact from weather, less labour force and plant requirements and got the chance to use products from their subsidiaries.

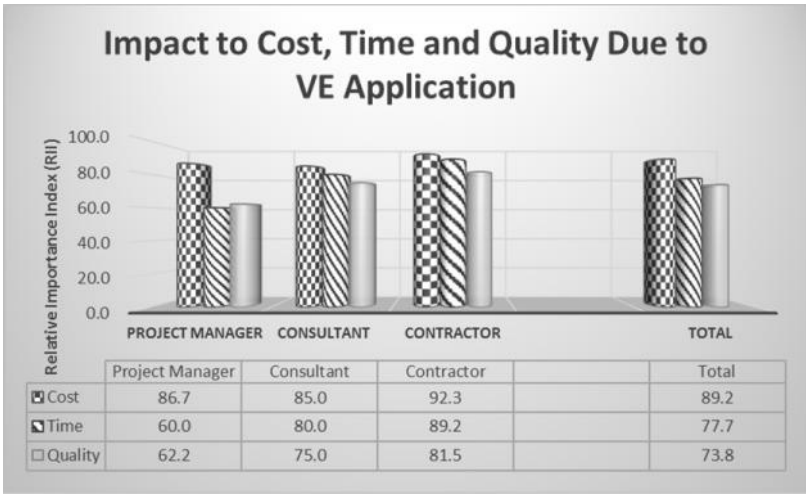
Most of respondents declared that, intangible benefits which are hard to achieve in normal construction process can be achieved by VE technique which leads the end product more compatible with surroundings and also with occupants. Then client can get higher value for money. When there are need of VE proposals in the project, contractors use his experience and latest technology available with him to suggest better VE proposals which will compatible with project requirements. From this VE proposals, client will get a project with latest technology while contractor will try to achieve cost and time benefits. Contractors can also use his subsidiary products in the project with prior approval of the consultant.

According to empirical findings, every technique has drawbacks and necessary actions need to be taken to mitigate those drawbacks. Respondents stated that VE is a technique which has less number of drawbacks compared to benefits which can be achieved. Main reason for these drawbacks is less awareness of the VE technique and its applicability. Experts review this problem and stated that after giving good knowledge to construction stakeholders, this problem can be mitigated. Then government clients will also encourage contractors to give VE proposals prior to construction stage and in the construction stage.

4.3. IMPACT TO CONSTRUCTION STAKEHOLDERS DUE TO VE TECHNIQUE

Construction stakeholders understand and apply VE technique in projects as their knowledge and experience. In Sri Lankan construction industry, professionals use VE technique as their own way which is compatible with Sri Lankan context. According to respondents VE application stage govern project aims and objectives. Stakeholders in the construction industry prefer different stages of VE application. Project managers (client, consultant mix) and consultants prefer pre contract stage for VE application and contractors prefer post contract stage. Most of stakeholders prefer VE technique in pre contract stage due to high amount of benefits. But, contractors prefer VE in post contract stage, because it is the stage which contractor can directly involve in the design and get a fee for VE work.

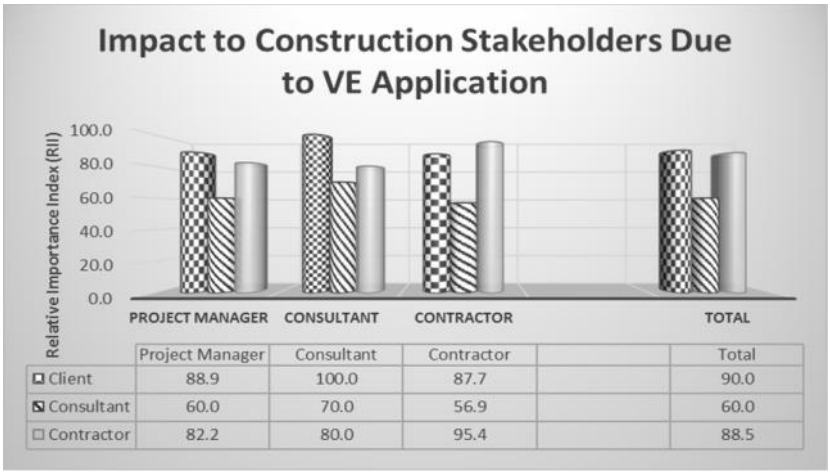
Case study findings revealed that most stakeholders prefer cost reduction VE proposals than time reduction VE proposals. Figure 2 indicate those findings according to relative importance index (RII).



	Project Manager	Consultant	Contractor		Total
Cost	86.7	85.0	92.3		89.2
Time	60.0	80.0	89.2		77.7
Quality	62.2	75.0	81.5		73.8

Figure 2: Impact to Cost, Time and Quality due to VE Application

As Figure 2 indicated, Sri Lankan stakeholders mostly consider about cost reduction in the project. Time comes to second and quality is the least. That can be grasped from the total section in Figure 2. According to RII, project manager organisation also give priority for the cost but offer same consideration for construction time and quality. Client's consideration more on quality is the reason for same level priority for time and quality. But, when consider about consultants and contractors, they want more cost and time reduction while maintaining quality of the project. RII figures indicated that consultants and contractors are keener on cost than time. They do not compromise quality due to the requirement of maintaining standards of the project. Case study findings revealed that most stakeholders consider client as the most significant person affected from VE proposals than contractor. Figure 3 indicate those findings according to RII.



	Project Manager	Consultant	Contractor		Total
Client	88.9	100.0	87.7		90.0
Consultant	60.0	70.0	56.9		60.0
Contractor	82.2	80.0	95.4		88.5

Figure 3: Impact to Construction Stakeholders due to VE Application

As indicated in Figure 3, both project managers (client, consultant mix) and consultants considered about impact to client than contractor and considered least impact to consultant. Altogether stakeholders considered that there is huge impact to both client and contractor due to VE technique and that can be grasped from total section in Figure 3.

According to respondents view, client is the foundation of the project. Client needs to have a good vision about the project, limitations and impacts to the project, methods of marketing the project and value additions to the project. There are both pros and cons for a client due to VE technique. One party getting benefit means other party gets less profit knowingly or unknowingly. Therefore clients need to beware of hidden ambitions of the contractor. In Sri Lanka, for government clients it is still not possible to achieve

quick approvals for VE proposals and alternative proposals. Thus both clients and consultants in government projects do not encourage contractors for VE proposals.

Consultant is the person who takes care of works instead of the client. Consultant is accountable for loss of money, not achieving client requirements and project objectives. Therefore the consultant required to be very careful when reviewing and approving VE proposals given by the contractor. Otherwise the consultant needs to be responsible for the failure of the project. Due to reduction of consultancy fee, consultants do not like VE proposals. There must be a proper method to share benefits gained from VE technique among all stakeholders. Then all parties will be encouraged to suggest VE proposals.

Contractor is the person who do the construction part of the project according to scope and specifications. He is responsible to complete the project within the budget and time while achieving project objectives and client requirements. When the contractor gives a VE proposal, the design responsibility passes to the contractor and there onwards the contractor is responsible for the design and construction. That is a huge burden to the contractor. According to respondents, contractors are the people who gain more advantages in cost and time by applying VE technique in projects. Contractors hide their real objectives and promote other benefits which are not much important to contractors.

4.4. RECOMMENDATIONS TO IMPROVE AND ENCOURAGE VE APPLICATION

Research findings in this study can be summarized and demonstrated by using Table 2.

Table 2: Recommendations to Improve and Encourage VE Application

Recommendations to Construction Organisations	Recommendations to National Level Construction Regulatory Bodies
▪ Give incentives to consultant for VE proposals ▪ Give incentives to contractors when there is no design change ▪ Reduce contractor's design responsibility ▪ Give more competitive advantages among other contractors ▪ Give awards to organisations and project teams which are practicing VE technique ▪ Approve green building certificate for VE technique applied projects ▪ Get reviews from VE consultants or third party consultants ▪ Get alternative proposals in pre-construction stage ▪ Give more time to consultants and contractors to review designs ▪ Improve communication within the site and give everyone a fair chance of presenting their idea ▪ Mutual understanding among stakeholders ▪ Publish sample VE techniques among stakeholders to get an idea ▪ Promote VE technique through media like newspaper and TV ▪ Establish a good VE structure in construction related organisations ▪ Introduce point system for VE proposals ▪ Introduce VE expert into the design team ▪ Encourage project staff to give proposals	▪ Regulate VE technique by a law ▪ Introduce proper guideline and manual for VE technique ▪ Conduct awareness programs about VE technique to authorities and stakeholders (E.g. lectures, seminars and workshops) ▪ Insert and implement ICTAD VE clause in every possible construction contract ▪ Insert and implement VE clauses in client – consultant contracts ▪ Introduce VE technique into syllabus of contract related courses in universities and institutes ▪ Reduce government regulations for projects which used VE technique ▪ Tax incentives for organisations which implement VE technique ▪ Encourage application of VE technique in pre-contract stage ▪ Discourage overdesigns and encourage appropriate designs ▪ Introduce better benefit sharing methods ▪ Government consultancy company to review designs and give approvals

Recommendations which are suitable for construction organisations and national level construction regulatory bodies can be categorized into three main sectors and they are project level, organisational level and national level. There are related solutions for barriers to VE in construction industry and sometimes there are more than one solution for a barrier. For example "introduce proper guideline and manual for VE technique" is a common solution which is a solution to many barriers.

5. CONCLUSIONS

Recommendations which were emerged through analyses of empirical data can be used for implementation of regulations in the construction industry. Through this research it is identified that there is no any predefined way to apply VE technique in construction industry. When stakeholders identify the need of VE technique, they directly apply VE proposals to the project. Although Consultants consider quality of the original product and quality stated in specifications when they are going to measure the quality of the product for evaluation. It is revealed that in most of the time stakeholders do not consider about the life cycle cost of the project before application of VE technique. Lack of awareness of stakeholders and lack of government support are appeared to be the improper practice of VE technique within construction industry. As mentioned in literature synthesis, experts in construction industry highly believe that VE technique has significant importance to the industry. Findings of this research and literature findings of other researches revealed that the requirement of VE technique in projects is essential to construction industry.

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