A decision-making formula for value engineering applications in the Sri Lankan construction industry

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Abstract

Purpose – The construction industry in many developing countries is reluctant to apply value engineering (VE) due to uncertainty of outcomes. The purpose of this paper is to examine the existing practices of VE techniques and make recommendations to organisations and national construction regulatory bodies, to standardise VE practices. A decision-making formula is introduced to determine profitability of VE applications prior to implementation.

Design/methodology/approach – A broad literature review and six case study projects that applied VE were selected. Thirty-nine semi-structured interviews were conducted to gather data within cases. Six expert interviews were conducted as confirmatory interviews to clarify and validate research outcome. Content analysis and cognitive mapping were used to analyse data among case studies.

Findings – Application, knowledge and experience on VE techniques among construction professionals are unsatisfactory. Recommendations include reducing contractor's design responsibility, introducing proper VE guidelines and statutory regulations. A framework is introduced to assist authorities to standardise application of VE techniques. A decision-making formula is suggested to determine margins of contractor's portion due to VE techniques and original profits gained.

Originality/value – The formula can be used as a decision-making tool by construction industry practitioners to determine successfulness of proposed VE techniques, and the proposed framework can be used to guide construction professional bodies to standardise VE practices.

Keywords Construction industry, Value, Value engineering, Framework, Decision making formula

Paper type Research paper

1. Introduction

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

Enhancing the value of construction projects can create a positive impact on the economy of a country (Rameezdeen and De Silva, 2002). Zhang *et al.* (2009) said that value engineering (VE) is the most appropriate technique to regulate value in construction projects, as other techniques focus on time and quality rather than value. Many researchers contend that VE is a systematic method to elevate the value of goods, products and services by undertaking an investigation of intention (Miles, 1972; Parker, 2001; Zar *et al.*, 2011). Gudem *et al.* (2013)

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stated that implementing VE in projects can bring about numerous benefits, such as reducing costs by around 26 per cent, enhancing operational performance by 40-50 per cent and upgrading product quality by 30-50 per cent. However, literature reveals that the construction sector of many countries, including Sri Lanka, are reluctant to implement VE due to a lack of awareness among clients, uncertainty of outcomes, additional costs involved, lack of government support, time consumed, lack of expertise, lack of regulations and policy applications (Kosala and Karunasena, 2015; Mansour and Abueusef, 2015; Senarathne *et al.*, 2014; Atmo and Duffield, 2014; Iran and Iyer, 1984).

In this context, this paper presents an overview of VE techniques in the Sri Lankan construction sector and provides recommendations to standardise VE practices to facilitate achievement of value for money by all stakeholders. The research data were limited to building projects, which applied VE techniques in Sri Lanka. The paper first presents the literature findings and describes the research methodology. It goes on to discuss the findings of VE applications, decision-making formula and recommendations to standardise VE practices in the construction industry.

2. Literature synthesis: value engineering and construction industry

Value is a subjective term and can be defined using different words, such as desire, attitude, preference need, criteria and belief (Leung and Liu, 2003). Thiry (2001) stated that value has several definitions for various people including "best buy" for a customer, "the lowest cost" for a manufacturer and "highest functionality" for a designer. As Bertelsen and Emmitt (2005, p.74) note, "without understanding the customer, the concept of value is undefined, and without a tangible concept of value, waste is even more intangible".

A fundamental issue for construction firms is to guarantee value in projects (Lozon and Jergeas, 2008). Kliniotou (2004) stated that various value measuring techniques can be found in industrial sectors, such as value management (VM), benchmarking, total quality management, financial management techniques, cost-benefit analysis, supply chain management, project management, whole life-cycle costing and earned VM. Among these, VM is a unique application designed through the process of a project value measuring technique (Stenstrom *et al.*, 2013). VM has greater accuracy over other techniques, as it considers all factors that affect the value of a product (Kelly *et al.*, 2004). It helps ensure the construction value wanted by the client along with many processes, such as public relations, timeline and good neighbourship (Salvatierra-Garrido and Pasquire, 2011). According to Potts (2008) and Male *et al.* (1998), to certify that value is conveyed to the project in an adequate manner, systematic operation of VM can be simply separated into three prime techniques, specifically value planning, VE and value analysis.

VE is a disciplined and creative method, which intends to provide a client with a trustworthy opportunity for cost savings, without any detrimental impacts on quality or performance (Miles, 1972). According to Othman (2008) and Fan and Shen (2011), VE investigates, analyses, compares and selects amidst various alternatives to generate the desired function and encounter or surpasses customer goals and expectations. Abidin and Pasquire (2007) said that VE is acknowledged as a paramount contrivance in the management of construction projects all over the world.

VE has been progressively implemented in UK and Malaysian construction industries since 1980 and 1986, respectively, expanding and adjusting direction of its objectives over the years (Kelly *et al.*, 2004). The application of VE in the USA became famous in 1993 with the introduction of two bills that made the process mandatory for all government programmes (Fong and Shen, 2000). In 1996, President Clinton signed into law an act requiring all executive agencies to establish VE procedures and the estimated savings due to this measure were forecasted at US$2.19bn for 1996 alone (Thiry, 2001).

Chen *et al.* (2010) observed that VE studies frequently result in a 10 to 30 per cent diminution in total cost of a project. Vorakulpipat *et al.* (2010) concur noting that when VE is carried out during the early phase of design, a 10 to 30 per cent reduction in total costs may be observed. A research by Dell'Isola (1997) yielded the following results as typical savings due to VE:

- In construction, programmes to a value of €10m, savings typically range from three to ten times the VE effort.
- In programmes from €10-75m, savings range from five to fifteen times the effort.
- In programmes over €75m, savings range from ten to twenty times the effort.

Bone and Law (2002) indicated that there are a number of merits that a project can attain by implementing VE during its life. Bowman and Ambrosini (2010) also introduced several benefits of VE for construction projects. Such as: parties can get an opportunity to engage in advancement of a project; elevated competitiveness and profitability; ability to get a fully authorised review of the total project; generating continuous improvements in quality and performance; quantum increases in productivity of a project; diagnosing and accommodating project betterments and crystallising an organiser's brief or project predominance.

Lack of flexibility, support, knowledge and awareness of VE in some regions are the basis for its minimal implementation (Cheah and Ting, 2005). Zhang *et al.* (2009) stated that participants can get a negative and sometimes argumentative impression of VE with engineers searching to avoid the obligation of design modifications proposed by contractors and non-engineers. There is also a tendency to only develop suggestions with a particularly high cost reduction capability, thereby resulting in the high cumulative impact of minor savings to be lost (Vorakulpipat *et al.*, 2010). When price becomes the differentiator, all contractors want to be the lowest bidder, regardless of the original scope of work (Kashiwagi, 2011). A transparent, fair and open procurement system can attract contractors that can provide optimum arrangement of quality and whole life cost (Phillips *et al.*, 2007).

Kashiwagi *et al.* (2009) stated that if a contractor is forced and pressured to submit the lowest possible price, the level of performance would in turn be affected by the tendency to use lowest cost labour, material and tighter inspection. For better VE proposals, authorities should have in place clear procedures, procurement strategies and policies (Phillips *et al.*, 2007). Further, clients and consultants should provide freedom to contractors by bearing risk (Ratnasabapathy and Rameezdeen, 2007). In general, clients and consultants minimise risk by using a price-based environment and a value-based environment (Kashiwagi and Kashiwagi, 2011). The latter includes involvement of fewer parties and more efficiency, transparency, maximum accountability, minimisation of project cost and time deviation where price-based environment take the opposite.

According to Luu *et al.* (2003) client requirements, client characteristics, project characteristics and the external environment influence VE applications. Of these, client requirements can be considered the major criterion, where it will certainly help a client to make a project successful by satisfying needs and priorities (Ratnasabapathy and Rameezdeen, 2007). Chan *et al.* (2001) argued that as a client is the ultimate owner of a project, not only client's requirements but also characteristics should be considered. In addition, due to unique characteristics of each construction project, most researchers have emphasised that project characteristics should also be considered (Alhazmi and McCaffer, 2000). The rationale is that different projects will have varying degrees of complexity (Chan *et al.*, 2001).

Similarly, projects operate in different external environments (Ratnasabapathy and Rameezdeen, 2007), and the selection of a VE technique is directly influenced by these external factors (Luu *et al.*, 2003).

3. Research methodology

This study adopted a qualitative research approach to describe a situation, as it exists without formal hypotheses, focusing on social processes intensely. Case study approach was selected, as it facilitates in-depth investigation and the investigation of attitudes, emerging thinking and perceptions of consultants and contractors on VE concepts. Further, it allows the research to subjectively examine and evaluate the need for, and potential benefits of VE services. The unit of analysis is construction projects that have applied VE techniques. Thirty-nine interviews were conducted within the six selected case studies to gather information on VE applications in Sri Lanka.

The cases were selected from building projects due to an abundance of such projects and to avoid complexities that may occur when evaluating building and civil engineering projects simultaneously. Cases vary from a super luxury residential apartments to low-cost housing projects and shopping complexes; all procured under the design – build method and lump sum method. Details of the six case studies are provided in Table I.

The 39 semi-structured interviews were conducted face-to-face (refer Table II). The interviewees represent the three significant groups in each project team, i.e. client's representative, consultant's representative and contractor's representative. The interviews were tape-recorded (with permission of interviewees) to ensure accurate reporting of conversations and avert the loss of data. An interview guideline was prepared to gather data on impacts of VE applications on projects as well as stakeholders, its benefits and suggestions for regulatory bodies.

In addition, six confirmatory interviews were conducted to clarify and validate research outcomes gathered through the case studies, specifically, on suggestions made to standardise VE applications. Herein, semi-structured interviews were conducted with representative professionals from client, consultant, contractor organisations and academia, each possessing more than 20 years of experience (refer Table III).

Perry (1998) suggested that case study findings should be justified by using "cross-case analysis" to identify interrelationships and differences between each case, to draw conclusions. Content analysis was used to codify qualitative information into predefined categories (codes), to derive patterns in presentation and reporting (Guthrie *et al.*, 2004). Coding searches similar cognitions under a same concept or about its meaning rather than the actual content of data segments. Key themes (codes) emerging from the findings were identified in each case. The software program NVivo (NUD*IST Vivo Version 10.0.281.0) produced by QSR (Qualitative Solutions and Research Ltd). was selected to facilitate the coding function. Coding represented the real VE applications in the construction industry as

Case	Type	Contract sum (US$m)	Duration (months)	Procurement method	Public/private sector
A	Super luxury residential project	35	26	D&B/LS	Private
B	Low-cost housing project	7-23	24	D&B/LS	Public
C	Super luxury office complex	695	48	D&B/LS	Public
D	Low-cost housing project	8	24	D&B/LS	Public
E	Super luxury office complex	60	36	D&B/LS	Public
F	Hostel building	1.5	12	D&B/LS	Public

Table I.
Case study description

Case	Organisation type	Designation	Experience (years)
A	Client/consultant-mix organisation	General Manager	35
		Project QS	14
		Senior QS	22
		QS	07
		Project Architect	14
		Engineer	12
		Engineer	08
		Engineer	06
	Contractor	Engineer	25
		General Manager	37
		Chief QS	08
		Engineer	14
		Engineer	22
		Senior Site QS	10
B	Contractor I	QS	03
		QS	09
	Contractor II	Site Project Engineer	13
		Site QS	05
		Site Technical Officer	07
		Site Technical Officer	06
		Site Technical Officer	09
	Contractor III	Project QS	05
		Site Engineer	11
		Site QS	08
		Site Technical Officer	06
	Contractor IV	Site QS	09
		Site Manager	14
C	Consultant	Senior QS	21
		Site Senior QS	08
		QS	06
		QS	05
D	Contractor	Site Senior QS	14
	Contractor	General Manager	08
E	Contractor	Site Engineer	13
		Site QS	05
F	Contractor	Chief QS	08
		Project QS	14
	Institute	Director of Development	21
		Assistant Director	16

Table II. Interview profile – case studies

Organisation type	Designation	Experience (years)
Client/consultant	General Manager	35
Consultant	Director	22
Consultant	Project Manager	22
Contractor	Senior QS	37
Contractor	Senior QS	42
University	Senior Lecturer	22

Table III. Interview profile – experienced professionals' opinions illustrated at Figure 1. Accordingly, process, factors affecting, benefits, drawbacks and impacts of VE applications to stakeholders were identified and analysed in detail.

4. Research findings

4.1 Overview of value engineering applications in the Sri Lankan construction industry

Almost all respondents mentioned that there is no predefined way to apply VE techniques in construction. It is revealed that most stakeholders do not consider life cycle cost of a project before application of VE techniques. Further, construction stakeholders understand and apply VE techniques in projects as compatible with their knowledge and experience. Accordingly, they prefer different stages of VE application based on their expertise. It was revealed that key objective of VE applications for contractors is to reduce cost while time and quality is given relatively less consideration. Consultants and contractors preferred cost and time reductions while maintaining quality of a project. Most stakeholders believe the client is the most significant person affected by VE proposals.

Most respondents said that intangible benefits, which are hard to achieve in normal construction processes, can be achieved through VE techniques. These include making the end product more compatible with surroundings, and occupants achieving better value for money invested by the client. When there is a need for VE proposals for a project, contractors use experience and latest technology to suggest better VE proposals compatible with project requirements. Ultimately, a client gets a project with latest technology while the contractor gains cost and time benefits. Contractors can also use his subsidiary products in a project with prior approval of consultant to reduce the cost.

Some respondents mentioned the impact of the management system on performance. More management control, rules and regulations will not increase efficiency, quality and production; but to do so the entire system will need to undergo change. It is the responsibility of the client and consultants to achieve this because they are the determiners of the current system, but they can be reluctant to change the system due to the fear of losing control over contractors.

Risk is another key factor influencing VE. When a contractor makes a VE proposal, they have to bear the associated risk. Non-transparency, more bureaucracy, lack of accountability, more documentation and number of decision-makers on the client's side were all identified as factors that can cause inefficiency. In this context, government, clients and consultants need to:

Nodes

Name	Sources	References
Real VE Practice in the Construction Industry	31	388
The Process of Application	22	55
Factors Affecting for VE Consideration	27	219
Benefits Gained by Applying VE Technique	20	92
Drawbacks in VE Technique	12	22
Impacts to Construction Stakeholders	14	51
Client (Employer)	10	19
Consultant (Engineer)	7	13
Contractor	11	19

Figure 1.
Coding structure used for analysing empirical data

- Minimise client's decision-making, management, direction and control.
- Identify the contractor as the expert and not the client's representative.
- Use a contractor proposed contract as a risk management tool instead of a control mechanism.
- Increase transparency which in turn will increase accountability.
- Encourage quality assurance instead of quality control.
- Minimise deviations in project cost and project duration.
- Identify the client's intent, but allow the contractor to determine the final deliverable.
- Change ideas from reactive, price-based to proactive and value-based.
- Lower cost and increase value and quality efficiently by minimising transactions and alignment of resources.
- Utilise expertise instead of management, direction and control to minimise risk.
- Convert a "win–lose" environment to a "win–win" environment.

Experienced professionals stated that it is difficult to change the environment of the construction industry. For example, a client with a construction idea having strict restrictions on time, cost and quality will assist the designer to translate this expectation into a constructed project. The design firm realises that if they disagree with the client's perception of initial conditions (e.g. cost, time and expected construction quality), the firm will not be selected. Thus, the firm designs the project without informing the client of any misalignment or over-expectations. During the design process, a client makes alterations and the design team is forced to make further decisions. After the design is completed, the firm advises the client to select a contractor through tendering. Finally, the designer attempts to manage, control and direct the contractor to make the client's expectations a reality. Applying VE into such project arrangements would be useless, because clients and consultants try to dictate all actions. Thus, most contractors attempt to use more technical personnel, to increase management and control. However, experienced professionals clearly stated that this would never increase the contractor's performance.

Experienced professionals with overseas exposure mentioned that most developing countries (e.g. Sri Lanka, India, Bangladesh and Malaysia) are faced with the problem of low performance of contractors. Nihas *et al.* (2013) highlighted a research conducted in India using the Construction Industry Structure (CIS) model, to move from an inefficient price-based environment to an efficient best-value environment. A similar research was carried out in The Netherlands, using Performance Information Procurement System (PIPS) and achieved good results. According to Kashiwagi and Kashiwagi (2011), PIPS can increase value and quality and minimise delivery cost and time. Perera *et al.* (2011) stated that Northern Ireland has made good use of VM processes, but the lack of formality in execution effects performance and efficiency of a country.

Accordingly, findings revealed that VE proposals must be executed with broader understanding of project requirements and viewpoints of the client, consultant and contractor. VE proposals have to fit with both the needs of the project and its stakeholders. Further, it is influenced by external factors such as political, government rules and regulations, economic and environmental. According to respondents, stakeholders are required to accept, avoid, share or transfer details of factors to have better outputs through VE applications. The next section presents the decision-making formula derived through the cost data gathered from case studies.

4.2 Decision-making formula for value engineering application

Reduction of construction cost will affect the profit margin of a contractor. Both consultant and contractor need to be aware of the VE technique and its profitability. To ease this process, a formula as given below was developed:

Original construction cost of the item = A
Actual overhead and profit percentage = b
Original profit of the contractor = Ab

Revised construction cost of the item = C
Overhead and profit percentage given by the consultant = d
Revised profit of the contractor = Cd

Amount due to original work can be calculated by adding original construction cost of the item and original profit of the contractor ($A + Ab$). Similarly, the amount due to VE proposal can be calculated by adding revised construction cost of the item and overhead and profit percentage given by the consultant ($C + Cd$). When there is a VE proposal, the profit will be shared between the client and the contractor. To get the contractor's portion due to VE application, it is needed to get 50 per cent (win–win situation of profit sharing) from the difference of cost + profit of original work and VE proposal $[(A + Ab) - (C + Cd)]/2$. When a contractor applies this VE proposal into actual construction, he will get a profit (Cd) (VE proposal is a variation and for variations, a contractor claims overheads and profit for their revised construction cost), and the profit percentage (d) will be predetermined by both parties or given by the consultant. According to above elaboration, the formula should be:

$$\textit{Contractor's portion due to VE technique} = \frac{(A + Ab - C - Cd)}{2} + Cd = \frac{(A + Ab - C + Cd)}{2}$$

However, for a contractor to get a profit, their portion due to VE technique > original profit of the contractor.

$$\frac{(A + Ab - C + Cd)}{2} > Ab$$

$$A + Ab - C + Cd > 2Ab$$

$$C(d - 1) > A(b - 1)$$

$$C < A\frac{(1 - b)}{(1 - d)}$$

The above formula has very basic requirements, that is the original construction cost of the item (A), actual overhead and profit percentage (b), overhead and profit percentage given by the consultant (d) and revised construction cost of the item (C). With these required figures, stakeholders can easily understand whether the proposed VE technique is profitable or not. This formula helps the project to flow smoothly without much disturbance despite alterations to the project.

Case study A is a super luxury residential project and there were many VE applications due to a failure in the design. The project needed an effective way to calculate the profitability of VE proposals against the original construction design. There were many variations in that construction project and most of them ended up as a VE application. Among these, some seemed to give a loss to the contractor. For such construction projects, this formula could be used very effectively to calculate the profitability of the VE proposals.

Above formula can be demonstrated by applying actual figures of case A, as follows:

Original construction cost of the item = US$.396,825.40 (*A*)
Actual overhead and profit percentage = 34 per cent (*b*)
Overhead and profit percentage given by the consultant = 10 per cent (*d*)
Revised construction cost of the item = US$.158,730.16 (*C*)

$$C < A\frac{(1-b)}{(1-d)}$$

$$C < 396,825.40 \quad \frac{(1-34\%)}{(1-10\%)}$$

$$C < 396,825.40 \quad \frac{(0.66)}{(0.9)}$$

$$C < 396,825.40 \times 0.73$$

$$\mathrm{C} < 289,682.54$$

To obtain real profit for a stakeholder, the revised construction cost of an item should be lower than (*C*). In the above calculation, *C* = US$158,730.16, so this VE proposal is beneficial to stakeholders.

The formula will be useful to both contractors and consultants. This formula is to determine a margin between the contractor's portion due to VE technique and the original profit of the contractor. If actual figures satisfy the above formula, it is proposed to adopt such VE proposals. Professionals can easily calculate the feasibility of a VE proposal, as per above formula.

4.3 Framework for recommendations to standardise value engineering applications

Figure 2 presents recommendations to construction organisations and national construction regulatory bodies to standardise VE practice in Sri Lankan construction industry. Recommendations which are suitable for construction organisations and national level construction regulatory bodies are presented in three main levels as project level, organisational level and national level. The framework provides support for professionals to measure value of a project and apply VE techniques in various forms to achieve value where ordinary procedures cannot be met. Thus, it can lead to increased application of VE techniques in construction projects.

Outdated standards and specifications, over and inaccurate designs (e.g. concrete and reinforcement), inadequate information (mechanical and electrical), failures of VE proposals due to concealing of real impacts, unavailability of skilled labour, plant and equipment were identified as project-level barriers. Economic status (e.g. high price fluctuation), social culture, political influence and local standards were identified as barriers at national level.

4.3.1 Recommendations to construction organisations. Stakeholders look for profit through projects, and they will not perform if there are no incentives. There must be an incentive system to encourage consultants and contractors to propose VE techniques in

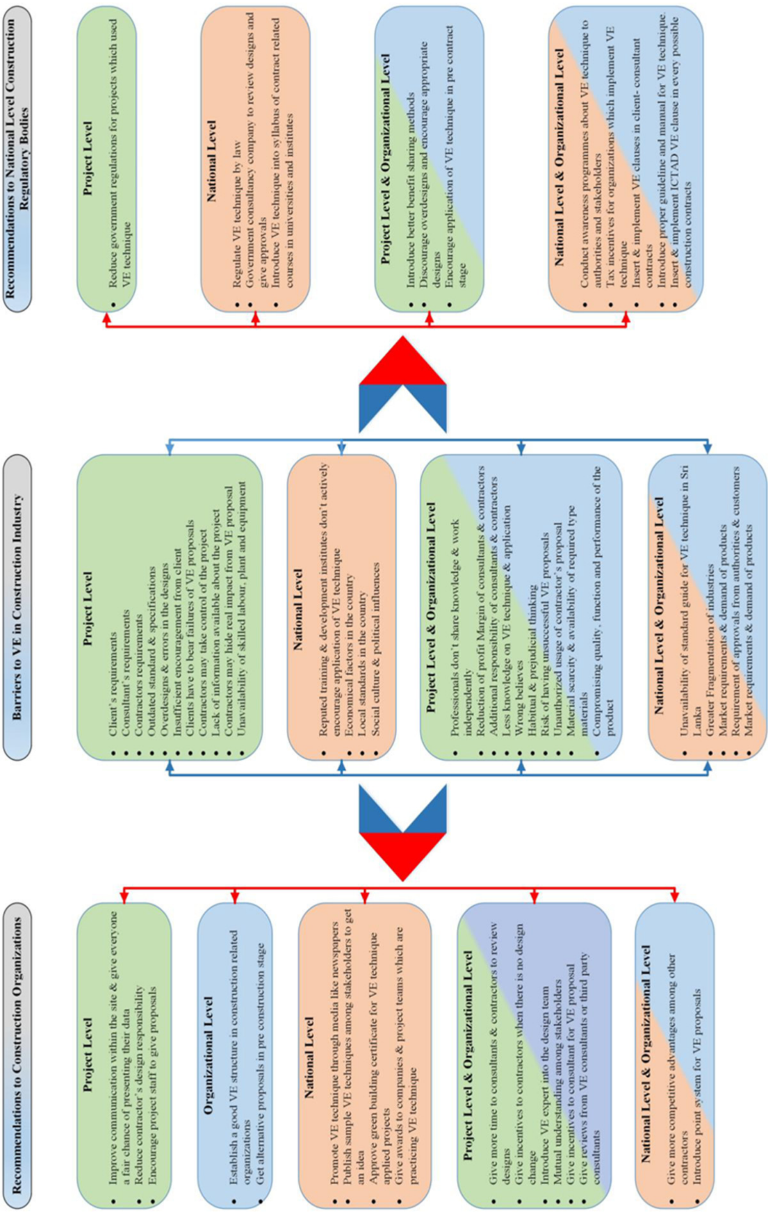

Figure 2.
Framework for recommendations

projects. Most respondents stated that consultants and contractors are bound by contract to the client and due to that, there are many cost, time, quality and responsibility constraints. Reduction of these constraints will help consultants and contractors propose more flexible VE proposals.

Providing more opportunities to site staff to share their ideas through meetings, workshops and discussions will lead to development of better VE applications. Moreover, reducing a contractor's responsibility for design will encourage more VE proposals at the project level.

Establishment of proper procedures with adequate power and encouraging alternative proposals at pre-construction stage will be more competitive and beneficial to a client at the organisational level. Ultimately, this will encourage competitive VE proposals and reduce defective proposals, and the contractors may get a fair chance and more competitive advantage among other contractors.

Media (e.g. television, newspaper and radio) is a powerful source that can create awareness through programmes and discussions on VE techniques, their benefits and further facilitate the dissemination of real data on benefits to be gained by stakeholders. In addition, promoting the award of green building certificates to projects that have reduced energy consumption, wastage and achieved ease of maintenance through the application of VE techniques is also recommended. The introduction of a "point system" or award system, to select the best VE proposals is another recommendation that can eventually push construction companies to do more VE in their projects. Further, all professionals can make use of the decision-making formula presented here, to more easily ascertain the feasibility of the VE proposals

Research findings suggest that minimum involvement of client and their representatives will encourage more efficiency and performance in the project. Using minimum standards, using quality assurance instead of quality control, and minimising transactions (direction, meetings, management, negotiations, inspection etc). can reduce pressure on the contractor resulting in higher performance. According to Kashiwagi *et al.* (2009), when the value environment process was separated from the construction industry and run on US$1.5bn of services at Arizona State University, a saving of over US$100m was achieved (approximately seven per cent saving to the construction industry and the country).

4.3.2 Recommendations to national construction regulatory bodies. National construction regulatory bodies are the governing party in Sri Lanka, who have authority to regulate VE techniques by law. Respondents gave contradictory suggestions about regulating VE techniques. Most stated that it is better to have such kinds of law, otherwise stakeholders, especially the government, will not use VE techniques in projects. However, most experts stated that it would not be possible to regulate VE directly in construction although regulatory bodies can regulate other aspects, such as energy efficiency, wastage reduction and green building, which need VE techniques to meet their goals.

Government projects need to be more transparent than the private sector as they involve public money. However, government projects are influenced by factors such as rigid rules and regulations, audit queries and political influences. Thus, to practice VE applications, procedures need to be more flexible. In parallel, government must regulate VE techniques by law. As an example, a requirement can be made for submission of a VE report to get permission for design prior to actual construction for selected projects. Along with that, awareness and knowledge on VE techniques is necessary for regulatory bodies to be successful.

Thus, regulatory bodies should take necessary actions to satisfy stakeholder interest in VE techniques through incorporation of relevant clauses in the Standard Conditions of

Contracts to eventually reduce a country's burden and ensure protection of national interests. According to Kashiwagi and Kashiwagi (2011), the Netherland Government is politically involved in increasing value in the construction projects by issuing a political Action Agenda in November 2003, based on five main objectives as follows:

(1) Restoring trust between the Government and the sector.
(2) Developing effective markets and a properly functioning sector.
(3) Enhancing professionalism in procurement.
(4) Instilling high standards in the supply chain.
(5) Less, but more effective, regulation.

These objectives minimised the unnecessary involvement of clients and client's representatives and thereafter, The Netherlands gradually achieved improved efficiency and performance. This scenario is possible in any country with the willingness of its government. Perera *et al.* (2011) stated that there is a skill gap in VE, resulting in limited usage of VE in projects. Academic institutions and professional bodies have to take action for greater awareness and training to the construction industry authorities and stakeholders on VE processes.

5. Conclusions

The VE formula is based on research findings to facilitate professionals to understand real VE practices in the construction industry. It determines a margin between contractor's profit due to VE techniques and original profit of the contractor. Professionals can calculate and consider feasibility of a VE proposal. Further, the framework provides VE techniques to apply in various forms in achieving value where ordinary procedures may not. Findings revealed that the main reason for less performance and inefficiency is unawareness of VE techniques and processes.

Other researchers have concluded similarly. The VE technology has to reach every professional in the construction industry. Government has a major role in establishing grounds that are more favourable for VE. Recommendations to construct organisations and national-level construction regulatory bodies suggest general requirements and improvements to the construction industry. This study could be extended to civil construction projects, as well as possibilities of integrating VE to new trends in construction, such as Building Information Modelling.

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