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

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DECISION MAKING FORMULA FOR VALUE ENGINEERING APPLICATIONS

ABSTRACT

Purpose - Construction industry in many developing countries is reluctant to apply Value Engineering (VE) due to uncertainty of outcomes. Thus, the purpose of this paper is to examine existing practices of VE techniques and make recommendations to organisations and national construction regulatory bodies to standardise VE practices to achieve value for money for all stakeholders. Further, a decision making formula is introduced to determine profitability of VE applications prior to implementation.

Methodology - A broad literature review consisting of six case studies with 39 semi structured interviews and six experienced professional’s interviews were conducted with construction professionals having extensive knowledge on VE techniques in Sri Lanka, to gather data. Building projects which applied VE were selected as case studies. Content analysis and cognitive mapping were used to analyse data within case studies.

Findings - Findings revealed that application, knowledge and experience on VE techniques among construction professionals is unsatisfactory. Recommendations include reducing contractor’s design responsibility, introducing proper VE guidelines and statutory regulations. Accordingly, a framework is introduced with recommendations to assist authorities to standardise application of VE techniques. Finally, a decision making formula is suggested to determine margins of contractor’s portion due to VE techniques and original profits gained.

Value - The formula can be used as a decision making tool by construction industry practitioners to determine successfulness of proposed VE techniques and proposed framework can be used to guide construction professional bodies to standardise VE practices to achieve value for money.

Keywords: Construction Industry; Decision making formula; Framework; Value; Value Engineering.

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,
Enhancing value of a project can create a worthy positive impact on the economy of a country (Rameezdeen and De Silva, 2002). Zhang et al (2009) said that VE is the most appropriate technique to regulate value in construction projects, as other techniques focus on time and quality than value. Many researchers contend that VE is a systematic method to elevate value of goods, products and services by undertaking an investigation of intention (Miles 1972; Parker 2001; Zar et al., 2011). Gudem et al (2013) stated that by implementing VE in projects cost can be reduced up to 26%, enhance operational performance by 40-50% and upgrade product quality by 30-50%. However, literature revealed that construction sector of most countries including Sri Lanka are reluctant to implement VE in projects due to lack of awareness among clients, uncertainty of outcomes, additional costs involved, lack of government support, more time consumed, lack of expertise, lack of regulations and policy applications (Kosala and Karunasena, 2015; Senarathne et al., 2014; Atmo and Duffield, 2014; Iran and Iyer, 1984; Mansour and Abueusef, 2015).

In this context, this paper presents an overview of real practices of VE techniques in Sri Lankan construction sector and provide recommendations to standardise VE practices to facilitate achievement of value for money by all stakeholders. The research data was limited to building projects which applied VE techniques in Sri Lanka and the paper consists of literature findings, details on research methodology adopted and findings of real practices of VE applications, recommendations to standardise and decision making formula.

2. LITERATURE SYNTHESIS: VALUE ENGINEERING AND 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 (2001) stated that value has several definitions for various people, “best buy” for a customer, “the lowest cost” for a manufacturer and “highest functionality” for a designer. “Without understanding the customer, the concept of value is undefined, and without a tangible concept of value, waste is even more intangible” (Bertelsen and Emmitt, 2005, p.74).

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 value management.

Among these, VM is a unique application designed through the process of project value measuring technique (Stenstrom et al, 2013). VM has great accuracy over other techniques because all factors which affect value of a product are considered (Kelly et al, 2004). VM ensures that 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), systematic operation of VM can be simply separated into three prime techniques, specifically Value Planning, VE and Value Analysis to certify that value is conveyed to the project in an adequate manner.

VE is a disciplined and creative method which intends to submit a client with 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 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 construction industry since 1980 and in Malaysian since 1986, expanding and adjusting direction of its objectives over the years (Kelly et al., 2004). The application of VE in 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 accommodating all executive agencies to establish VE procedures and estimated savings were forecasted at $2.19 billion for 1996 (Thiry, 2001), according to Shen and Liu (2004) when VE was introduced to Chinese construction industry in 1978.

Chen et al. (2010) has observed that, VE studies frequently result in a 10% to 30% diminution in total cost of a project and often have an intense outcome on ultimate design. Vorakulpipat et al. (2010) concurs noting that, when VE is carried out during the early phase of design, it can see a 10% to 30% reduction in total costs. For an example, taxpayers were released in the order of $1 billion alone in US Highways and Transportation Departments due to the application of VE techniques (Jaapar et al., 2012). Dell’Isola (1997) yields typical VE savings as follows:

- In construction programmes to a value of €10 million, savings typically range from 3 to 10 times the VE 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.

Bone and Law (2002) indicated that there are number of merits which a project can attain by implementing VE during its project life. Bowman and Ambrosini (2010) have 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, can get a full authorised review of the total project, can generate a continuous improvements in quality and performance,
quantum increases in productivity of a project, diagnose and accommodate with project betterments and crystalizes an organiser’s brief or project predominance. According to Hamilton (2002), improved identification of merits of VE has caused for the affluence of market level in worldwide.

Lack of flexibility, support, knowledge and awareness of VE in some regions are basis for its minimal implementation (Cheah & 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 by contractors and non-engineers, assuming the expenditure and time of developing. The effect is that, they only suppose developing suggestions with a particularly high cost reduction capability thereby reasoning 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 in bid, 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 proposal, which will not raise the level of performance with lowest labour, material and tighter inspection. For better VE proposals authorities should have clear procedures, procurement strategies and policies (Phillips et al., 2007). Further, client and consultant should provide freedom by bearing risk (Ratnasabapathy and Rameezdeen, 2007). In general, clients and consultants minimise risk by using price based environment and value based environment (Kashiwagi and Kashiwagi, 2011). Value based environment include involvement of less 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) VE applications is influenced by client requirements, client characteristics, project characteristics and external environment. Client requirements can be considered as the major criteria, where it will certainly help a client to make a project successful by satisfying client needs and priorities (Ratnasabapathy and Rameezdeen, 2007). Chan et al. (2001) argued that since 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 characteristic should also be considered (Alhazmi and McCaffer, 2000). The rationale is different projects will have varying degrees of complexity (Chan et al., 2001). Similarly, projects operate in different external
environments (Ratnasabapathy and Rameezdeen, 2007) and selection of a VE technique is directly influenced by external environment factors (Luu et al., 2003).

With overview of VE applications in construction, next paragraphs will present detailed procedure adopted for data collection and analysis.

3. RESEARCH METHODOLOGY

This study adopted qualitative research approach as it describes a situation as it exists without formal hypotheses, focusing on social processes intensely. Under qualitative phenomenon, case study was selected as it facilitates in-depth investigation. Further, it facilitates constituting attitudes, emerged thinking and perceptions of body of engineering consultants and contractors on VE concepts and subjectively examine and evaluate the need for, and potential benefits of, VE services. The unit of analysis or case in this study is construction projects which applied VE technique. 39 interviews were conducted within six selected case studies to gather information on VE applications in Sri Lanka.

The cases were selected from building projects due to abundance of such projects and also to avoid complexities which may occur when evaluating building and civil projects simultaneously. Cases vary from super luxury residential to low cost housing projects and shopping complexes procured under Design and Build and Lump Sum methods. Details of six case studies are illustrated at Table 1.

Table 1: Case Study Description

<table>
<thead>
<tr>
<th>Case</th>
<th>Type</th>
<th>Contract Sum (US$ million)</th>
<th>Duration (Months)</th>
<th>Procurement Method</th>
<th>Public/ Private Sector</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Super luxury residential project</td>
<td>35</td>
<td>26</td>
<td>D&amp;B/ LS</td>
<td>Private</td>
</tr>
<tr>
<td>B</td>
<td>Low cost housing project</td>
<td>7-23</td>
<td>24</td>
<td>D&amp;B/ LS</td>
<td>Public</td>
</tr>
<tr>
<td>C</td>
<td>Super luxury office complex</td>
<td>695</td>
<td>48</td>
<td>D&amp;B/ LS</td>
<td>Public</td>
</tr>
<tr>
<td>D</td>
<td>Low cost housing project</td>
<td>8</td>
<td>24</td>
<td>D&amp;B/ LS</td>
<td>Public</td>
</tr>
<tr>
<td>E</td>
<td>Super luxury office complex</td>
<td>60</td>
<td>36</td>
<td>D&amp;B/ LS</td>
<td>Public</td>
</tr>
</tbody>
</table>
39 semi-structured interviews were conducted face to face, as illustrated at Table 2. The interviewees represent three significant groups of each project team: client’s representative, consultant’s representative and contractor’s representative. The interviews were tape-recorded (with permission of interviewees) to ensure a faultless reporting of conversations and avert loss of data. Interview guideline was prepared to gather data on impacts of VE applications on projects as well as stakeholders, benefits and suggestions for regulatory bodies. Ultimately, interview transcripts were developed to form a sensible adaptation of interview data.

Table 2: Interview profile – case studies

<table>
<thead>
<tr>
<th>Case</th>
<th>Organisation</th>
<th>Designation</th>
<th>Experience(Y)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Client/Consultant-Mix Organisation</td>
<td>General Manager</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>Contractor</td>
<td>Project QS</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Senior QS</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td></td>
<td>QS</td>
<td>07</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Project Architect</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Engineer</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Engineer</td>
<td>08</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Engineer</td>
<td>06</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Engineer</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>General Manager</td>
<td>37</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Chief QS</td>
<td>08</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Engineer</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Engineer</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Senior Site QS</td>
<td>10</td>
</tr>
<tr>
<td>B</td>
<td>Contractor I</td>
<td>QS</td>
<td>03</td>
</tr>
<tr>
<td></td>
<td>Contractor II</td>
<td>QS</td>
<td>09</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Site Project Engineer</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Site QS</td>
<td>05</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Site Technical Officer</td>
<td>07</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Site Technical Officer</td>
<td>06</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Site Technical Officer</td>
<td>09</td>
</tr>
</tbody>
</table>
In addition, 06 interviews were conducted as confirmatory interviews to clarify and validate research outcomes gathered through case studies, specifically on suggestions made to standardise VE applications. 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 3).

Table 3: Interview profile – Experienced professional’s opinions

<table>
<thead>
<tr>
<th>Organisation Type</th>
<th>Designation</th>
<th>Experience (Y)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Client/Consultant</td>
<td>General Manager</td>
<td>35</td>
</tr>
<tr>
<td>Consultant</td>
<td>Director</td>
<td>22</td>
</tr>
<tr>
<td>Consultant</td>
<td>Project Manager</td>
<td>22</td>
</tr>
<tr>
<td>Contractor</td>
<td>Senior QS</td>
<td>37</td>
</tr>
<tr>
<td>Contractor</td>
<td>Senior QS</td>
<td>42</td>
</tr>
<tr>
<td>Institute</td>
<td>Director of Development</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>Assistant Director</td>
<td>16</td>
</tr>
</tbody>
</table>
Perry (1998) said that these findings should be justified by using ‘cross-case analysis’ to identify interrelationships and differences between each case and afterwards, conclusions shall be made. Content analysis, a technique to gather data, involves codifying qualitative information into pre-defined categories (codes) to derive patterns in presentation and reporting (Guthrie et al., 2004). In other words it attempts to find similar cognitions under a same concept or about its meaning rather than actual content of segment. After developing interview transcripts, key themes (codes) emerging from findings were identified in each case. Study selected the software program NVivo (NUD*IST Vivo Version 10.0.281.0) produced by QSR (Qualitative Solutions and Research Ltd.) for coding function. Coding structure consists of the codes to presents the real VE applications in the construction industry as illustrated at figure 1. Accordingly, process, factors affecting, benefits, drawbacks and impacts of VE applications to stakeholders are analysed in details.

![Figure 1: Coding structure used in analysing empirical data](image)

This presents an overview of VE applications in Sri Lankan construction industry, recommendations for standardised VE applications and decision making formula derived through empirical data analysis.

4. **RESEARCH FINDINGS**

4.1 **OVERVIEW OF VE APPLICATIONS IN SRI LANKAN CONSTRUCTION INDUSTRY**

Almost all respondents mentioned that there is no predefined way to apply VE techniques in construction industry. 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, stakeholders of construction industry prefer different stages of VE application based on their expertise. However, it was revealed that key objective of VE applications is to reduce cost while time and quality is considered less. Consultants and contractors preferred cost and time reductions while maintaining quality of a project. Most stakeholders believe client as the most significant person affected by VE proposals than contractors.

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

Some respondents mentioned about the management system is impacting the performance. As noted more management, control, rules and regulations will not increase the efficiency, quality and production. To increase efficiency, quality and production, the entire system has to be changed. It is the responsibility of the client and consultants to change the system because they are the determiners of current system. Clients and consultants are reluctant to change the system, due to fear of losing control over contractors and.

Risk is another key factor influencing VE. When a contractor makes a VE proposal that contractor has to bear the risk. Non-transparency, more bureaucratic, lack of accountability, more documentation and number of decision makers on client's side cause inefficiency. In this context, government, clients and consultants have to;

- Minimise client’s decision making, management, direction and control.
- Identify the contractor as the expert and not the client's representative.
- Uses 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
• Utilises expertise instead of management, direction and control to minimise risk
• Conversion of a ‘win lose’ environment to a ‘win-win’ environment

Experienced professionals stated that it is difficult to change the environment of construction industry.
For an example, a client with a construction idea having strict restrictions on time, cost and quality will assist design firm to translate his expectation into a constructed project. The design firm realises that if they disagree with the client’s perception of initial conditions (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, client makes alterations and 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 client’s expectations a reality. In this context, applying VE into that project is useless with clients and consultants who try to dictate. Thus, most contractors attempt to use more technical personnel to increase management and control. However, experienced professionals clearly stated that this will never increase the contractor’s performance.

Experienced professionals with overseas exposure mentioned that most developing countries (Eg. Sri Lanka, India, Bangladesh, Malaysia) are faced with the problem of contractors’ low performances. Nihas et al (1992) highlighted a research conducted in India using Construction Industry Structure Model (CISM) which move from inefficient price based environment to efficient best value environment. In the Netherlands also a research team has conducted a similar research 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 process but 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 client, consultant and contractor. VE proposals have to fit with the needs of the project and its’ stakeholders. Further, it is influenced by external factors such as political, government rules and regulations, economical and environmental. According to
respondents, stakeholders are required to accept, avoid, share or transfer details of factors to have better outputs through VE applications.

4.2 **FRAMEWORK FOR RECOMMENDATIONS TO STANDARDISE VE 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 meet. Thus, it can lead to increased application of VE techniques in construction projects.
Figure 2: Framework for recommendations
Outdated standards and specifications, over and inaccurate designs (Eg. 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. Economical status (Eg. high price fluctuation), social culture, political influence and local standards were identified as barriers at national level.

- **Recommendations to construction organisations**

  Stakeholders look for profit through projects and they will not perform if there are no incentives. There must be some incentive system to encourage consultants and contractors to propose VE techniques in projects. Most respondents stated that consultants and contractors are bound by contract to the client and due to such there are many cost, time, quality and responsibility constraints in projects. Reduction of those constraints will comfort consultants and contractors to 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 and reducing contractor’s responsibility for design will encourage doing more VE proposals at 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 organisational level. Ultimately this will increase competitive VE proposals reducing defective proposals and contractors also will get a fair chance and more competitive advantage among other contractors.

  Media is a powerful source which can create awareness through programmes and discussions (Eg: television, newspaper and radio) about VE techniques and its benefits and further through dissemination of real data on benefits gained by stakeholders. In addition, promote green building certificates to gain for projects which apply VE techniques which eventually reduce energy consumption, wastage and increase ease of maintenance. Along with that introduction of point system or award system to select the best VE proposals which eventually push construction companies to do more and more VE in their projects.

  According to research findings minimum involvement of client and his representatives will allow more efficiency and performance in the project. Using minimum standards, using quality assurance instead of quality control, minimise transactions (direction, meetings, management, negotiations, inspection and direction) can reduce the pressure of contractor resulting more performance. According to Kashiwagi et al (2009), when the value environment process was separated from construction industry and run on $1.5B of services at Arizona State University
and the research team saved over $100M as efficiency. It is 6.67% saving to the construction industry and to the country.

- **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 technique. Most respondents stated that it is better to have such kind of law; otherwise stakeholders will not use VE techniques in projects, specially by government. However, most experts stated that it will not be possible to regulate VE directly in construction, but regulatory bodies can regulate other things such as energy efficiency, wastage reduction and green building concept which need VE techniques to meet those goals.

Government projects need to be more transparent than private sector as it involves public money. However, government projects are influenced by factors such as rigid rules and regulations, audit queries and political influences. Thus, procedures need to reduce rigidity and have more flexibility to practice VE applications. In parallel, government must regulate VE techniques by law to succeed in procedures. As an example, request 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 in said endeavour.

Thus, regulatory bodies are required to take necessary actions to satisfy stakeholder interest in VE techniques through incorporation of relevant clauses in Standard Conditions of Contracts to eventually reduce country’s burden and ensure protection of national interests.

According to Kashiwagi and Kashiwagi (2011), Netherland government is politically involved to increase value in the construction projects by issuing a political Action Agenda in November 2003, based on five main objectives as follows;

- Restoring trust between the government and the sector
- Developing effective markets and a properly functioning sector
- Enhancing professionalism in procurement
- Instilling high standards in the supply chain
- Less, but more effective, regulation

These objectives minimised the unnecessary involvement of clients and client’s representatives and thereafter Netherland gradually achieved high efficiency and high performance. This scenario is possible in any country with the willingness of the government of that country. Perera
et al (2011) stated that there is a skill gap in VE, resulting 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 process.

4.3 **DECISION MAKING FORMULA FOR VE APPLICATION**

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

\[
\begin{align*}
\text{Original construction cost of the item} & = A \\
\text{Actual overhead and profit percentage} & = b \\
\text{Original profit of the Contractor} & = Ab \\
\text{Revised construction cost of the item} & = C \\
\text{Overhead and profit percentage given by the consultant} & = d \\
\text{Revised profit of the contractor} & = Cd
\end{align*}
\]

According to general practice in the industry, the formula should be;

\[
\begin{align*}
\text{Contractor’s portion due to VE technique} & = \frac{(A+Ab-C-Cd)+ Cd}{2} \\
& = \frac{(A+Ab-C+Cd)}{2}
\end{align*}
\]

But for contractor to get a profit

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

\[
A+Ab-C+Cd > 2Ab
\]

\[
C (d-1) > A (b-1)
\]

\[
C < \frac{A (1-b)}{(1-d)}
\]
Above formula validated by applying actual figures of case A is as follows.

Original construction cost of the item = $396,825.40 (A)
Actual overhead and profit percentage = 34% (b)
Overhead and profit percentage given by the consultant = 10% (d)

Revised construction cost of the item = $158,730.16 (C)

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

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

\[
C < 396,825.40 \times 0.66
\]

\[
C < 396,825.40 \times 0.73
\]

\[
C < 289,682.54
\]

To obtain a real profit to a stakeholder, revised construction cost of item should be lower than the answer (C). In above calculation, \(C = $158,730.16\), and it is lower than the answer \(S.289,682.54\). Therefore, 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 contractor’s portion due to VE technique and original profit of the contractor. As actual figures satisfy above formula, it is proposed to adopt such VE proposals. Professionals can easily calculate and figure out the feasibility of a VE proposal, as per above.

5. CONCLUSIONS

The formula is based on research findings to facilitate professionals to understand real VE practices in the construction industry. Further, the framework provides VE techniques to apply in various forms in achieving value where ordinary procedures cannot meet. The formula is simply
trying to determine a margin between contractor’s portion due to VE techniques and original profit of contractor. Professionals can easily calculate and figure out feasibility of a VE proposal. Findings revealed that the main reason for less performance and inefficiency is unawareness of VE techniques and processes. Other researchers also conveyed the same conclusion that VE technology has to reach every professional in the construction industry. Government of a country has a major role in establishing more favourable grounds for VE. Recommendations to construct organisations and national level construction regulatory bodies suggest general requirements and improvements to construction industry. This study can be further extended to civil construction projects as well as possibilities of integrating VE to new trends in construction, such as Building Information Modelling.

REFERENCES


