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ENHANCING VALUE ENGINEERING APPLICATION IN THE SRI LANKAN BUILDING CONSTRUCTION INDUSTRY: A FRAMEWORK

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ABSTRACT

The concept of value engineering (VE) is used to optimise the cost, time, quality, and functional performance toward achieving the best value for client money. However, the application of VE in construction industries is limited as there are differences in the use of the VE concept to developing economies, application of cost-oriented procurement systems, and lack of a practically applicable framework. In the local construction context, VE is practiced in an ad hoc manner. Therefore, the current study aimed to develop a framework including a tailored approach to enhance the VE application in the building construction industry. A qualitative approach was adapted to solicit views of twenty-two (22) construction professionals who involved in the six (6) high-rise building construction projects and practiced the VE concept. Views of professionals were synthesised using content analysis and finally developed a framework including a tailored VE approach. The findings conclude that cost and time as the main value criteria which motivate the VE application. Further, VE application in the construction industry is initiated mostly in the construction stages while professionals' preference is laid on the initial project phases. Consequently, the contractor change proposal was identified as the sound approach to deliver VE since motivations emerge during physical construction. Finally, a tailored VE approach was developed considering concept design, developed design, and construction stages with related VE motivations to enhance the VE application in the Sri Lankan building construction context in a simplified manner.

Keywords: *Building construction; Strategies; Value criteria; Value engineering.*

1. INTRODUCTION

Theoretically, Value Engineering (VE) is implemented as an innovative field for project performance optimisation (Chen and Su, 2017). Applying VE establishes a clear project objective and provides creative thinking for design improvement (Ahmed *et al*., 2016). Further, it contributes to reduces project cost by up to 26%, enhances operational performance by 40-50%, and upgrades product quality by 30-50% (Gudem *et al*., 2013). Tohidi (2011) stated that the VE process enhances ways to deal with resource shortages,

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minimise additional costs, and uses modern methods and practices. In addition, the VE application in the different stages of the construction works namely, feasibility study, design, construction, and maintenance throughout the life cycle generates optimum value (Shahhosseini *et al.*, 2017). Reciprocally, Windapo (2013) stated the VE applies at any stage of the construction procedure since the generic requirement is to gain higher return through cost, time, and quality perspectives.

In the local context, the VE practices have not encouraged the theoretical aspects, practiced in an ad hoc manner without proper application of theoretical knowledge (Navarupan, 2004). Similarly, Senarathna (2013) stated that only a few instances had been reported on VE applications in the Sri Lankan context. Importantly, in several countries, there is a separate professional body; SAVE Local chapters or VE institutional bodies to establish the VE practices (Cheah and Ting, 2005). However, in the Sri Lankan construction industry, such requirement is not casted. Further, Sri Lankan VE practitioners consider VE as a cost-cutting mechanism initially used at the construction stage of a project, which is a common misconception on VE (Karunasena and Gamage, 2017). In addition, lack of client support, a misconception regarding the cost of implementation, lack of expert knowledge, unfamiliarity with the VE culture within public firms, and lack of construction framework and guidance to the practical application of the VE concept limits the VE application in Sri Lanka (Perera *et al.*, 2003). Therefore, this study gives due consideration to facilitate construction professionals who work in building projects to identify value-enhancing gateways and simply understandable procedure to conduct VE study to enhance the application of VE practices in the Sri Lankan construction industry.

2. LITERATURE REVIEW

2.1 VALUE ENGINEERING CONCEPT

VE is considered an innovative and strategic approach used to achieve optimised value for money without reducing the quality, capabilities of operation, capabilities of maintenance, and aesthetic appearance (Othman, 2008; Yan *et al.*, 2015). In addition, VE is considered as a subset of the Value Management (VM) process which focused on the technical process by translating built facility requirements using design and construction (Kelly *et al.*, 2004). VM evolved through value analysis (VA), which caused the origination of the VE concept in the construction and industrial sectors (Shen and Liu, 2004). Further, the VM process can be illustrated in three stages as VA, VE, and value review (VR) respectively as illustrated in Figure 1.

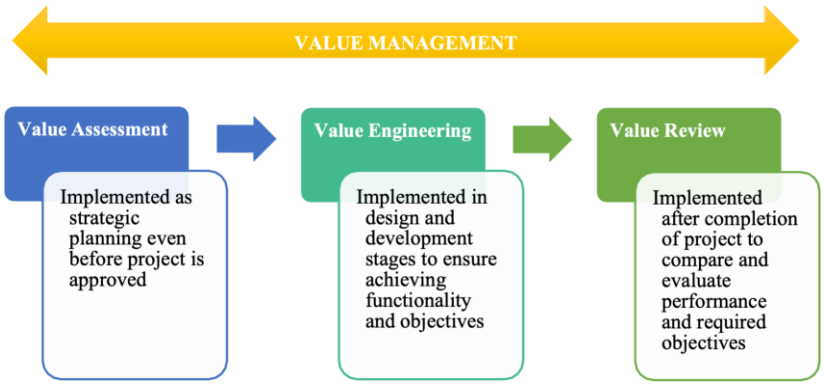

Figure 1: VM process (Adapted from Jaapar et al., 2012)

Table 1 illustrates the common VE job plans that apply in the construction industry.

Table 1: VE approaches in the global context

VE Approach	Description
Charette job plan	This is used primarily for function analysis on requirements of space to reasoning the client's brief. Considering the allocation of time this study can be enhanced with other problems concerned in the client's brief. This is not an expensive method of briefing the design team and providing solutions to their requirements effectively and in a shorter duration of two days
SAVE 40-hour Workshop	This job plan is conducted over five days. This job plan is considered a widely accepted formal approach comprised of three stages namely, pre-workshop stage, workshop stage, and post-workshop stage.
Contractor's change proposal	This job plan is a well-established form of carrying out the VM in the construction industry and projects.
VE audit	In this approach, the external VE team engaged in the project to identify VE proposals by reviewing the designs.

(Source: Kelly and Male, 2001)

Value attributes in VE concerned in the building construction industry evolved from the concept of the product to process as illustrates in Figure 2.

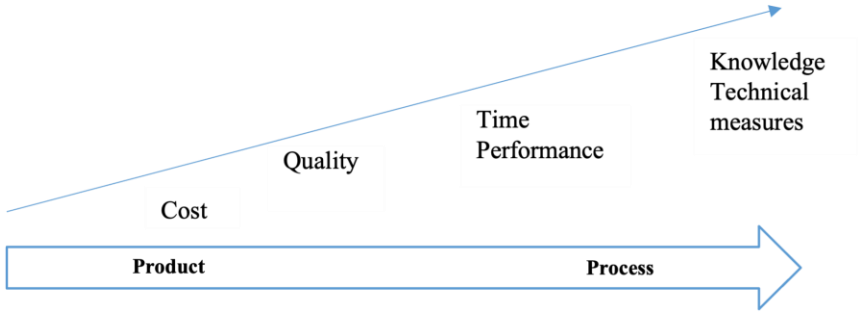

Figure 2: Value focus evolved over time (Adapted from: Dallas, 2006)

2.2 BARRIERS AND CHALLENGES FOR IMPLEMENTING VALUE ENGINEERING

According to Kosala and Karunasena (2015), one of the main objectives of Sri Lankan construction practitioners is to reduce the cost but not to enhance the value of the construction work. Thus, there is a requirement of redesigning due to the final design is mostly laid towards cost overruns (Perera *et al.*, 2003). Other than the above poor perception of construction practitioners regarding the VE concept, the general application of VE to practical situations is restricted due to many reasons, which can be categorised as in Table 2.

Table 2: Challenges to implement VE in developing countries

Component	Specific factors contain
Obstructions of VE team	Lack of Client support Difficulties to implementation Misconception regarding the cost of implementation Less teamwork spirits
Obstructions of VE study	Lack of expert knowledge Overestimation of VE by stakeholders Reluctance to resource utilization efficiently Lack of construction framework and guidance to practical application Unfamiliarity with the VE culture within public firms
Difficulties of implementing VE	Use of procurement systems that are cost-oriented No willingness to apply VE The impression that VE is not a worthy application Conceptual provisions are inflexible Lack of support from the strategic management and government Lack of awareness of VE
Conceptual problems	Complicatedness and theoretical contents in VE Consider VE is not required when the project is designed by the best designers Unsoundness to allocate time for VE
Obstructions due to developing economies	VE is not being tallied with concepts of developing countries Lack of awareness and knowledge on methodology Insensitivity to take a risk and be creative

(Sources: Perera *et al.*, 2003; Cheah and Ting, 2005; Chen and Su, 2017)

2.3 VALUE ENGINEERING PRACTICE IN THE CONSTRUCTION INDUSTRY

Table 3 provides the international VE practices.

Table 3. The international practice of VE

Item	International practice
Objectives of VE studies	Existing and/or proposed projects or products related to both strategic and tactical problems
VE studies facilitator	Independent external or internal VE expert
VE studies timing	From the conceptual stage to completion of a project or product
Composition of VE team	Stakeholders relative and often many personnel are involved
The workshop-style of VE	Preferred continuous and concentrated workshops
Functional analysis	Purpose of clarifying client's requirements and to identify poor value by understanding the value system
Duration	Generally, takes only a few days

(Adapted from: Shen and Liu, 2004)

3. RESEARCH METHODS

In order to achieve the aim of this study, which is to develop a framework including a tailored approach to enhance the VE application in the Sri Lankan building construction context, a qualitative approach has been undertaken. Six (6) case studies have been conducted in high-rise building construction (above 4 storeys) projects where VE was applied within its project lifetime by giving the constraints of time and accessibility. All these identified cases were based on the traditional procurement methods. Subsequently, semi-structured interviews were conducted with the three or more respondents from each project from different professional disciplines. All together twenty-two (22) semi-structured interviews were conducted (identified as I01 to I22). Figure 3 demonstrates the professional profile and experience of interviewees.

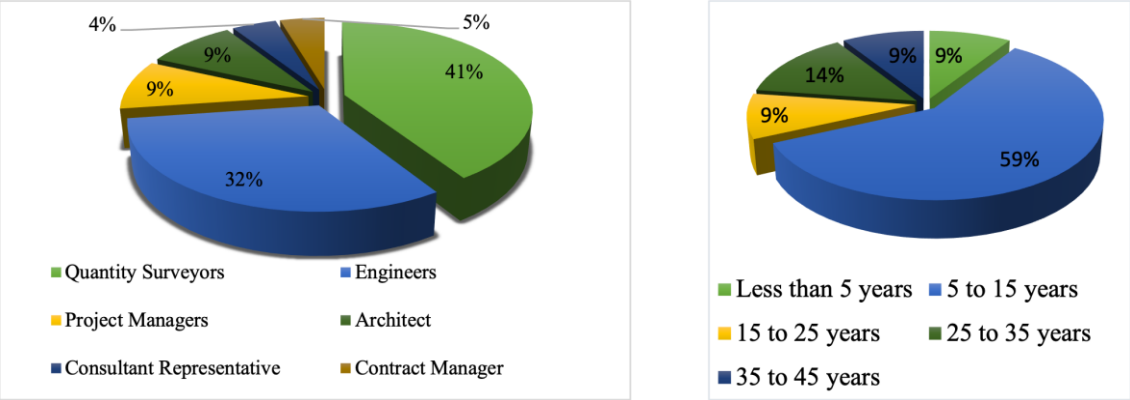

Figure 3: Profiles of professions and construction experience of interviewees

As seen in Figure 3, the majority of the respondents were Quantity Surveyors (41%) and Engineers (32%). In addition, most of the respondents had construction experience of around 5 to 15 years including VE practices.

Data analysis has been undertaken by using manual content analysis and NVivo 12 software. Ultimately, a framework has been developed including a tailored VE approach to enhance the VE application in the Sri Lankan building construction context through a comprehensive literature review and case study findings.

4. DATA ANALYSIS AND FINDINGS

4.1 DETAILS OF VE PROPOSALS

Table 4 shows the VE proposals that have been carried out within the selected cases. Nature, motivation, and achievements in terms of cost and time saving through the VE proposal in each project are drawn in Table 3.

According to the findings, identified VE proposals named PA1, PA3, PC3, PD1, PE3 were conducted with the main motivation of initial cost saving. In addition, PC1 and PC2 were considered the LCC concerned as major motivational factors. Further, VE proposals PA1, PA2, PA3, PB1, PE1, and PE2 were influenced to reduce the time consumption of the construction.

Table 4: Details of VE proposals

Case	Proposal Code	Motivation(s) for VE proposal	Description	Cost before	Cost after	Cost	Time
				Application of VE (US$ Mn)		Saving	
A	PA1	Initial cost-saving/ Contractor identified an opportunity to optimise project value	Replacement of natural marble and granite tiles with porcelain tiles	0.30	0.10	67%	√
	PA2	Reuse usage/ Contractor's familiarisation to the design	Use MFE Aluminium formwork system instead of traditional formwork	0.067	0.044	34%	√
	PA3	Cost-saving/ Enhance construction efficiency	Stainless steel handrail to mild steel handrail	0.51	0.35	32%	√
B	PB1	Time saving/ Space optimisation/Construction efficiency	Changing the vent pipe size from 150mm to 100mm	0.089	0.05	43%	√
C	PC1	LCC consideration/ New technologies	Replacement of traditional chiller system to Smart magnetic bearing chiller system	1.26	0.90	28.5%	-
	PC2	LCC consideration/ New technologies	Changing the electrical system - Power generation	This proposal was not implemented			
	PC3	Cost-saving/New technologies	Changing the interior decoration	This proposal was not implemented			
D	PD1	Cost-saving/New technologies	Changing the internal wall cladding thickness from 10mm to 8mm	1.72	1.20	10.98%	-
E	PE1	Optimise project Budget/Contractor identified opportunity to optimise project value	Use skim coat special finishing instead of granite cladding	0.74	0.26	65%	√
	PE2	Due to regulation requirements	Change the sprinkler system design according to the requirement	7.44	7.22	3%	√
	PE3	Initial cost-saving/ Construction efficiency	Electrical Aluminium cables instead of Copper cables	1.65	1.46	12%	×
F	PF1	Land restrictions/Due to adjacent constructions/ Unnecessary indirect cost in construction	Changing the piling foundation to raft foundation	0.31	0.22	31%	-

Interviewee I07 who stated that PB1 was motivated to implement excess time requirements due to constructability issues facilitated that statement. However, as identified through the VE proposal PF1, that it was not motivated to minimise the time for construction, but the VE proposal indirectly causes to reduce construction time consumption. Even though any of these selected cases were not motivated to increase

quality, interviewee I18 stated that cheap material options could not be considered as VE proposals because they can influence quality reductions. In other terms, I19 stated VE could be used adhering to the regulations and standards related to the building construction to maintain the quality requirements.

4.2 VALUE ENGINEERING IN DIFFERENT PROJECT PHASES

Figures 4 and 5 demonstrate the project phases that applied the VE concept in the selected cases and the results of the interviews, respectively.

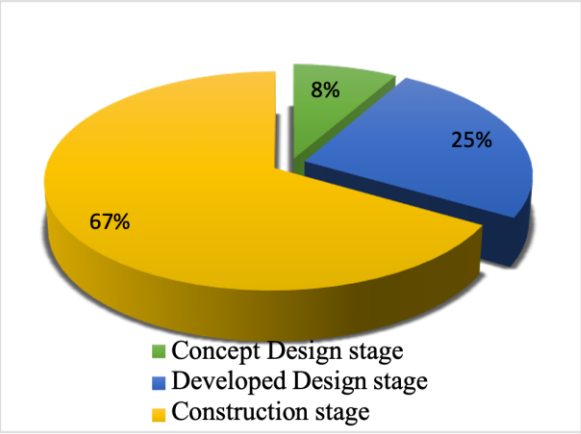

Figure 4: Project phases of VE applied

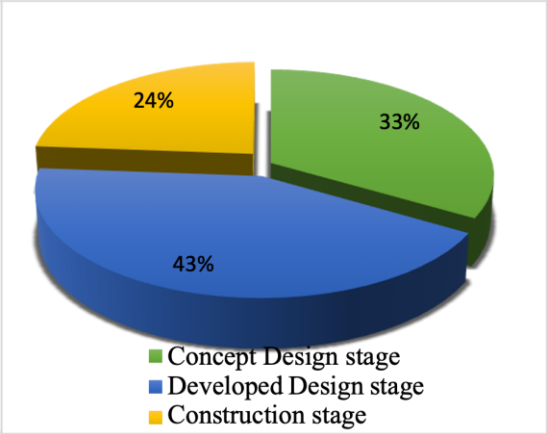

Figure 5: Preferred VE applicable phases

The majority of the VE proposals (67%) selected for the study carried out in the construction stage and 25% and 8% of VE proposals were applicable in the developing design stage and concept design stages, respectively. However, according to the views of respondents (44%), the developed design stage was identified as the most preferable project phase to apply VE proposals while the least preference (24%) was laid on the construction stage.

4.3 VALUE ENGINEERING APPROACHES IN THE LOCAL CONTEXT

Figures 6 and 7 demonstrate the VE approaches applied in the selected VE proposals and the results of the interviews, respectively.

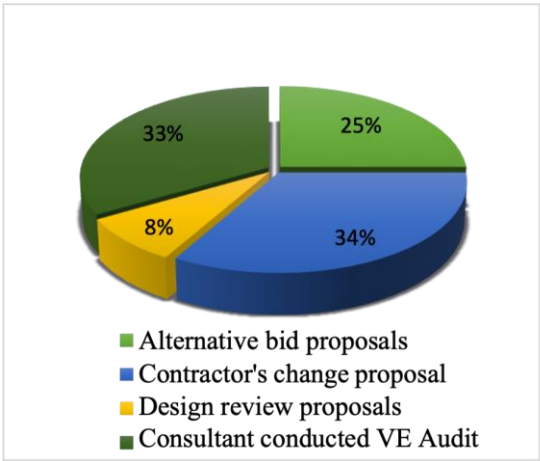

Figure 6: Applied VE approaches

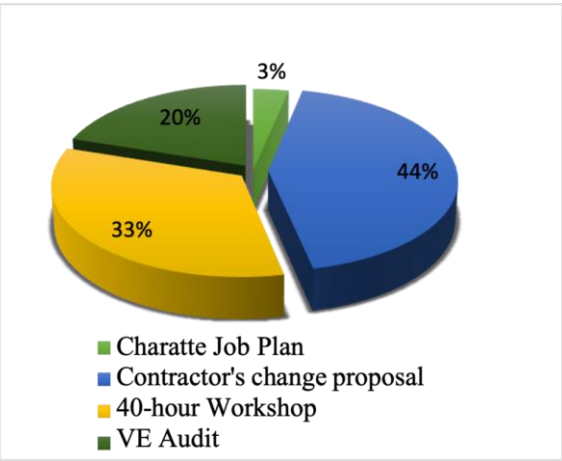

Figure 7: Preferred applicable VE approaches

According to the respondents, contractor's change proposals were most applicable (34%) and most preferable (44%) to the local construction industry. Most of the theoretical VE approaches were unaware of by the construction professionals. However, nearly half of the interviewees were aware of the VE workshop, and they recommended VE 40-hour workshop (33%) as one of the preferred approaches to the Sri Lankan construction industry. Above a quarter of the respondents stated, the risk resistance is very high in Sri Lanka due to the professionals' traditional thinking pattern. Therefore, implementing VE required considerably high force. Even though, selecting a preferred VE approach would be very obstructive within such background. Nevertheless, currently, the construction practice can easily implement the contractor's change proposal method. Following are the causations to the selection of the contractor's change proposal as the sound approach to deliver VE in the local construction context:

- Local construction is mostly cost concerned and when contracts identify any cost overrun within the project can use VE as a tool to reduce such budget overrun from another dimension.
- Generally, separate time is not allowed to practice VE.
- Consultancy services were not used to crave the optimum facilities required for the building constructions.

4.4 CHALLENGES AND STRATEGIES TO ENHANCE VALUE ENGINEERING APPLICATION IN SRI LANKA

Table 5 presents the specific challenges in implementing VE in project phases of selected cases.

Table 5: VE application challenges identified in each project phases

Project Phase	Challenges to applying VE
Strategic definition and preparation of client brief stages	The opinion of professionals is these changes are initial changes to the original design (I03, I06, I11, I15, I17)
Concept design stage	Generally, Architect does not agree to change their design (I02, I03, I07, I10, I19, I21)
	The client will not approve these value-adding opportunities while resisting to take risks (I01, I05, I11, I12, I16, I18, I20, I22)
Developed design stage	In some projects, bidders were called to submit alternative proposals, which has the potential of VE. Eventhough this is not conducted properly due to unethical practices (I07, I12, I13, I15, I16)
Construction stage	Contractor's do not tend to take the responsibility (I01, I10, I12, I14, I17)

Interviewees I09, I12, I18 and I22 expressed that in most of the building construction projects conducted in the Sri Lankan context, the main stakeholder or the client is a non-professional who does not aware about the tools and techniques that used to optimise the value of the construction facility.

According to the majority of the interviewees (36%), improve the awareness among construction professionals identified as the critical requirement to enhance the VE

application in the Sri Lankan construction industry. Thereafter, most of the responses (32%) accept that initial insist through advantages of the VE practices as a secondly suitable way to enhance the VE approach. Then three strategies were identified which are enhance rules and regulations by the government, promote long-term benefits, and reviewing the design throughout design and construction stages as the third most important through the opinions of the professionals (27%). In addition, VE encouragement through current practices, enhance client end technology in the construction sector, ensure VE approaches not effecting time expansions, conducting brainstorming sessions, integrate separate VE team to construction projects, and introduce clear mechanism to reward parties who identify VE are also identified as the strategies to enhance VE application through findings.

4.5 DEVELOPMENT OF THE FRAMEWORK

The framework was developed to enhance the VE application in the Sri Lankan construction industry (see Figure 8). The framework identifies the motivations in the current construction industry and the most applicable project phases to implement VE due to the identified motivations or value criteria in this research study. Other than that, simplified tailored VE job plans were implemented using the analysis to enhance the construction professionals' attraction towards the standard VE practices. Moreover, barriers of VE application in standard and enhance focuses were addressed to mitigate with the suggestions. The framework was developed to distil the VE applications from a simplified perspective.

5. DISCUSSION

From the research findings, cost and time were identified as the main value criteria which were motivated the VE application. The results of Kim and Luu-Truong (2016) coincide with this finding. Though the quality aspect was not motivated by the VE application in the selected cases, interviewees stated that quality is a compulsory requirement. With a similar perspective, Dallas (2006) stated that quality performance is one of the value criteria which evolvedover the value focus in the construction industry. In terms of the application of VE proposals, literature identified in most of the circumstances VE is better to apply inthe initial project phases to obtain more benefits (Abidin and Pasquire, 2007). However, the research findings identified that interviewees mostly preferred to apply VE at the design stages because it minimises the changes that occurred to the design at later stages.

6. CONCLUSIONS

This research identified that the VE application in the local context is narrow to the standard VE practices. However, about the standard VE professionals were more or less knowledgeable due to conventional trends and conceptual problems in construction activities, professionals tend to informal VE practices. Therefore, the theoretical job plan is indirectly followed in an unstructured manner is the common feature identified from all the selected cases. Through this study identified the motivations in the current construction industry and the most applicable project phases to implement VE due to the identified motivations or value criteria.

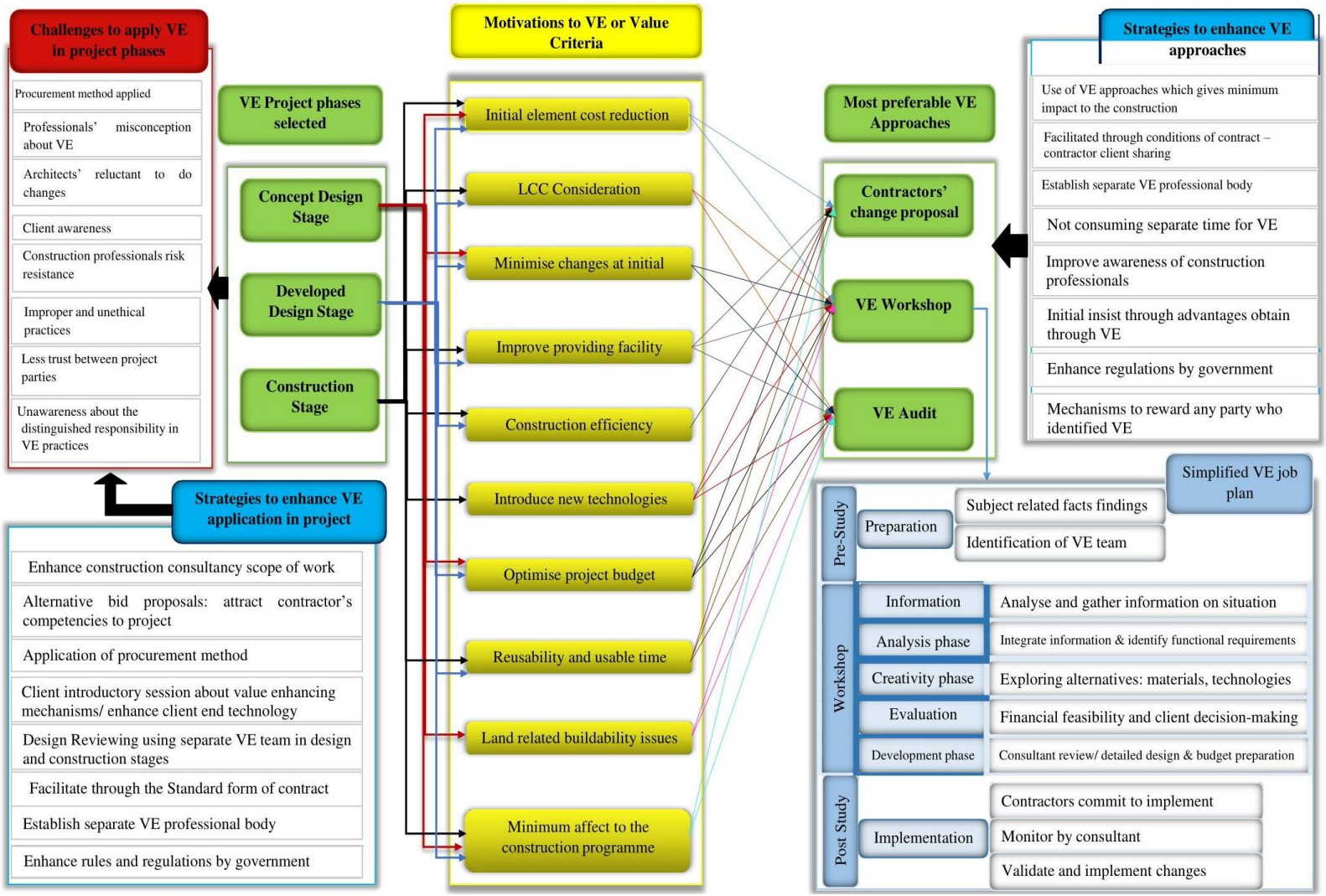

Figure 8: The framework to enhance the VE application in the Sri Lankan building construction context

Considering these VE motivations and attractions of the professionals above tailored VE approach were designed compared to the theoretical VE job plan. Further, this study recommends that they should take actions to enhance construction professional's knowledge on VE while minimising the misconceptions on the VE objectives by conducting knowledge transfer sessions. Currently, VE applications mostly can be seen in the construction industry, however, steps should be taken to promote the VE application in the design stages to minimise the changes and cost incurred to such changes due to VE applications through the national intervention.

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