

# SYNERGY BETWEEN LEAN AND VALUE ENGINEERING CONCEPTS: SRI LANKAN CONSTRUCTION INDUSTRY PERSPECTIVE

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## ABSTRACT

*The allied competitiveness and unpredictable nature of the construction industry forced to rethink on the performance enhancement tools in order to address the urgent matter of resource scarcity as a global dilemma. Hence, most of the construction firms highly concern about the customer's satisfaction by means of giving value for the client's money. The researchers established that Value Engineering (VE) and Lean concepts supersede all the other value achieving strategies since; both address the concept of Value in a greater extent. VE addresses the areas, which are not aligned with the methodological purview of Lean. In turn, Lean could enhance the effectiveness of VE efforts. Although there were some arguments on the above, there is lack of a research of investigating the synergy between Lean and VE concepts with related to the construction sector. Hence, this study investigates the synergy between Lean and VE concepts in order to explore the best value for client.*

*Accordingly, a qualitative research approach was followed to attain the research aim. A comprehensive literature review followed by expert opinion surveys were used to investigate the synergy between the concepts. The information gathered were subsequently subjected to a content analysis. This study revealed that, there is a synergy among customer value principle, pre study, information and presentation phases, value stream principle with functional analysis and presentation phases, flow principle with creativity, evaluation, development and presentation phases, pull principle with functional analysis, presentation and post study phases, perfection principle with presentation and post study phases. The findings would be very much effective for advanced value achieving strategy development purpose which achieve the best value for the client in the extremity.*

**Keywords:** Value for Client; Synergy; Construction Industry; Lean; Value Engineering.

## 1. INTRODUCTION

A barrage of remedial reforms and revisions of construction practices have been recently targeting enhanced value, superior performance, overall satisfaction and harmony (Palaneeswaran *et al.*, 2003). Hence, construction organisations are forced to rethink their construction for improving productivity, quality and efficiency in order to gain the best value for the client (Karna and Jonnonen, 2005).

Different researches have highlighted different value achieving strategies existing in the practice. Ismail *et al.* (2010) findings highlighted Value Engineering (VE) as a management tool that can be effectively used in the construction industry with an aim to produce innovative ideas and solutions for enhanced project value than in other value addressing techniques.

According to the findings of Perera *et al.* (2003), application of VE practices in Sri Lanka is relatively low. However, VE practices were done to the "World Trade Center" project during the project commencing and resulted energy saving and increased productivity in business etc. (Perera *et al.*, 2003). Finally the researchers concluded by highlighting that the construction industry in Sri Lanka exacerbates the need of proper VE practice due to the absence of proper cost controlling mechanism allied with the industry.

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Aziz and Hafez (2013) mentioned that Lean concept and Lean-based tools can be successfully applied to simple and complex construction projects, which effort to deliver better value to owners while making real profits. Apparently, Lean is an immense in reducing cost and achieving project value compared to the other techniques/strategies (Madanayake, 2015).

According to the findings of Senaratne and Wijesiri (2008), even though Lean construction is still new to Sri Lanka, it can be used as a strategic option in construction projects. The research revealed that domestic construction industry workforce neglect the waste and their causes which tend to inefficiency and high cost. Hence, Sri Lankan construction industry make public an urgent need of Lean construction to address the construction wastes in a proper manner. Hence, it should be highlighted that VE and Lean address the value achieving scenario in a greater extent and there is an urgent need for the strategies from Sri Lankan context.

According to Arratia and Cell (2003), integration of VE and Lean thinking offers an organisation the continuous improvement while enhancing the value in manufacturing/production process. Although, Arratia and Cell have mentioned that Lean and VE can be used together in production/manufacturing industry, there is a lack of an evidence in research on such an integration with related to the construction industry. There is therefore a need to investigate the synergy between Lean and VE concepts in order to find out the probable integration and its benefits. Thus, the aim of the research is to investigate the synergy between Lean principles and VE stages.

The paper structure begins with an introduction to the study and followed by a literature review on Lean and VE concepts in section 2. Section 3 presents the research methodology and section 4 presents the synergy between Lean and VE strategies. The final section summarises conclusions derived from the research findings and present recommendations.

## 2. LITERATURE REVIEW

### 2.1. LEAN AS A VALUE ACHIEVING STRATEGY

The concept of Lean based on the Toyota Production System introduced by Japanese in 1950s (Spear and Bowen, 1999). Number of major companies in the world adopt Lean in order to remain competitive in rapidly globalised market (Perez and Sanchez, 2000). As per Arratia and Cell (2003), Lean tends to reduce cost, target customer wants, needs and finally improves the efficiency of production.

Lean Philosophy emerged to Lean Construction and Lean Project Management due to its strongest approach of achieving best performance, while maximising value and minimising waste (Ballard and Howell, 2003). Lean construction applies a new form of production management to construction sector which includes performance maximisation, concurrent design and construction and the proper project control throughout the project life cycle from design to delivery (Aziz and Hafez, 2013).

According to Madanayake (2015), there are five basic Lean principles in Lean implementation. The Lean Construction principles which were derived through the literature synthesis and used for this study is shown in Table 1.

Table 1: Definition of Lean Construction Principles

Lean Principles		
No	Principle	Description
1	Customer Value	Specify the value from the perspective of ultimate customer. It is essential to meet the required specifications and to deliver the value desired to the end customer. By clearly defining value for product or service, customer value becomes the common focus for parties involved in the project.
2	Value Stream	Identify all the steps necessary to design and construction across the whole value stream to highlight non value adding activities
3	Flow	Make those actions that create value flow without interruption, detours, backflows, waiting or scrap
4	Pull	Only make/provide what is pulled by the customer
5	Perfection	The elimination of non-value-adding elements (waste/muda)

Source: Madanayake (2015)

Although Lean is effective, it does not answer to all the problems (Arratia and Cell, 2003). Hence, there can be both benefits and drawbacks associated with the Lean Construction approach. Ballard *et al.*, (2002) further explained the benefits achievable in Lean construction as improved management of demand, reduced cycle time, greater productivity, heightened work force involvement, and increased revenue and profitability. However, Garbie (2010) highlighted that although Lean provides the benefits, it is still need more effort to explore ways to overcome the drawbacks associated with Lean.

## 2.2. VALUE ENGINEERING AS A VALUE ACHIEVING STRATEGY

Lawrence D. Miles, who is an Electrical Engineer and also the pioneer of the VE has proposed some alternatives to overcome the issue of material shortage (Cheah and Ting, 2005). VE is another systematic approach which seeks to achieve value for money by providing all necessary functions at the lowest total cost (Male *et al.*, 2007). According to Morgan (2003), VE is an intensive, interdisciplinary problem solving activity that focuses on improving the value of the goal objective functions in an organisation.

Value Management process involves three parts including pre-study, value-study and post-study (Shen *et al.*, 2004). In contrast, Kelly *et al.* (2004) and Shen *et al.* (2004) proposed six stage job plan for the implementation of VE as information phase, functional analysis phase, creativity phase, evaluation phase, development phase and presentation phase as shown in Table 2, which is used for this study due to its selection as the most applicable job plan.

Table 2: Value Engineering Job Plan

Value Engineering Job Plan		
Phase	Sub-phase	Related steps
<b>Pre-study</b>		Collect user / customer attitude, complete data file, determine evaluation factors, scope the study, build data models, determine team composition
<b>Value study</b>	Information phase	Complete data package, modify scope
	Function analysis phase	Identify functions, classify functions, develop function models, establish function worth
	Creativity phase	Create large quantity of ideas to achieve the functions specified
	Evaluation phase	Rank and rate alternative ideas, select ideas for development
	Development phase	Conduct cost benefit analysis, complete technical data package, create implementation plan, prepare final proposals
	Presentation phase	Present oral report
<b>Post study</b>		Complete changes, implement changes, monitor status

VE facilitates creativity, innovative ideas, alternative solutions, and generally indulge in some ‘out-of-the-box’ thinking in introducing proper changes to the construction procedures (Ellis *et al.*, 2005). Further, VE facilitates sustainability to the construction industry and holds a strategic position (Abidin and Pasquire, 2007). However, VE is not effective in low value low risk projects (Kelly *et al.*, 2004). Significant cost and time consumption of the process can be considered as other drawbacks associated with Value Engineering implementation (Kelly *et al.*, 2004). Hence there is a need of proper implementation of the VE practices in order to achieve the target benefits.

## 2.3. COMPARISON BETWEEN LEAN AND VALUE ENGINEERING

Different researchers have defined VE and Lean in different ways. However, there are some specific characteristics, issues, problems and objectives associated with the concepts and the different researchers views on the facts are shown in Table 3.

Table 3: Comparison between Lean and Value Engineering

<b>Characteristic/Issue/Problem/ Objective</b>	<b>Lean</b>	<b>Value Engineering</b>
Excellent quality	Can be achieved by perfection	Enhance the value by achieving optimum quality
On time delivery	Obtains by reducing unnecessary flow activities	Propose alternatives which accelerate the project
Superior customer service	Identify and address the customer requirements in customer value phase Based on customer pull situation	Identify customer requirements in pre study phase and address them during job plan
Reduce variable overhead costs	Reduce non value added activity costs	Achieve optimum cost even in materials
Potential savings other than cost reduction	Limited by underlying design characteristics	Obtainable by making design changes
Waste elimination	Continuous waste reduction	Spontaneous and quick response to the wastes
Transforming operations into alternative forms of visual information	Achieve end user satisfaction and understanding	Achieve end user satisfaction and understanding
Use of visual analytical tools	Spaghetti diagrams, flow diagrams , bar charts, standard work sheets and production control boards	Function analysis and FAST diagrams.
Systematic approach for problem identification and solving	Mainly focus on waste reduction not problem solving	Proactive problem identification and solving mechanism
Provide consistency in application	Due to various definitions consistency is limited	Yes, Job plan facilitates the consistency
Promote creative thinking and innovations	Yes, but there is no room for creative process improvement	Yes, facilitates creative process improvements
Vigorous and analytic methodology	Is not an analytical approach	Yes, FAST diagrams etc. used as analytic tools
Reduce cost and increase value	Reduce costs of waste and increase the value	Achieve optimum cost and enhance value
Offers great flexibility to the approach	Less flexibility due to standardisation process	Not a standardisation process hence, the process is flexible
Most effective with processes that involve high dollar value	High cost reduction is possible in expensive projects	Can used in variety of situations but VE cost is significant
Works best with processes that have low variation and effective cost	Not effective for the projects with large nr of variations	No. can effectively implemented for higher number of variations.
Long term process which require strong and consistent management support	Yes, requires longer duration for perfection	40 hour workshop is required for implementing
Require large financial investment	Significant cost is there	Significant cost is there
Depends on the management	Yes, mostly	Depends on the VE team
Can work as isolated study event	No, operational management process	Yes, an isolated study event
Provide cohesive set of operating principles and practices	Number of principles to be followed	No, just the phases to be followed
Operator support	Operator support is required to achieve objectives	Operator support is required to achieve objectives
Team dynamics	Team based approach together with the management	VE team based approach

Sources: Dixon (2004); Wixon (2004); Arratia and Cell (2003)

Generally, the major difference between two concepts is; Lean is a philosophy whereas VE is an analytical tool. Lean expects to improve performance in direct manner whereas VE tries to achieve essential functions and improve the functional performance. VE is proactive process which provides an innovative ideas and solutions for problematic situations. However, Lean provides perusing perfection.

However, both strategies focus on enhancing customer value, reduce unnecessary cost or wastage in a great manner. Final objectives of two aspects would be achieving value for client's money and enhancing the project performance.

### **3. RESEARCH METHODOLOGY**

Research design is a logical blueprint which can be explicit or implicit (Yin, 2013). The design of this research includes, literature survey, expert opinion survey, data analysis and validation of research findings respectively.

In depth expert opinion survey was used for the study since the research topic associated with detailed data requirement from the construction industry. On the other hand, the experts available with the specific knowledge related to Lean and VE were very less within the industry. Hence, obtainable sample size was less. Therefore, the research was conducted under the qualitative approach by considering its advantage over the quantitative approach. Further, the information gathered were mostly the opinion evidence and needed to be evaluated in a descriptive way. Hence, the research necessitated the qualitative research approach.

Unstructured interview was selected as the most appropriate method of data collection from experts for this research by considering above facts. Hence, six (06) experts were interviewed using unstructured interview guideline as the major data collection technique. The interviews were conducted until the data saturation among the industry experts who belong to consultant, contractor and client organizations. Content analysis, which is a qualitative data analysis technique was used in this research study to analyse the collected data by considering its merits over the other techniques. Further, unstructured interviewing method necessitated the tool content analysis for analysing its findings. There are several data analysis software to support the content analysis and this study selected NVivo (2010) for content analysis which contained graphical presentation of interpreting relationships.

Data validation facilitates the verification of the validity of research outcome. The final outcome developed under this research was validated by conducting two (02) expert interviews.

### **4. RESEARCH FINDINGS AND DISCUSSION**

First question of the Interview Guideline was to identify the existing industry practices to achieve value for the money. All the six respondents have selected VE and Lean as value achieving strategies. However, they all explained that Lean and VE both are practicing in the industry in an ad-hoc manner, which they have derived, would limit the real benefits allied with the strategies. All the respondents agreed that Lean and Value Engineering can make significant contribution to the Sri Lankan context as separated strategies. Further, greater value achievement and unnecessary cost reduction is imaginable with both strategies. It has been showing the benefits for large number of years in Sri Lanka and become popular among the industry.

Both the strategies are with their own benefits and drawbacks. Hence, the industry is seeking for an advanced value achieving strategy where the drawbacks can be minimized. Experts suggest that the associated drawbacks could be overcome by synergising the concepts. The interview questions were prepared accordingly to find out the synergy of the concepts since the relevant findings of researches and applications are less in the industry.

Hence, third section of the interview guideline was developed accordingly to identify the synergy between Lean and VE. Five basic principles of Lean and eight stages of VE job plan were considered in finding out the synergy between the concepts. All respondents (R1-R6) presented their opinions and there were similarities in their answers. The synergies that respondents have mapped are shown in Table 4.

Table 4: Summary of Research Findings

LEAN PRINCIPLES VE JOB PLAN	CUSTOMER VALUE L1	VALUE STREAM L2	FLOW L3	PULL L4	PERFECTION L5
<b>PRE STUDY PHASE V1</b>	R1, R2, R3: These two phases can be mapped. R4, R6: There is a synergy R5: Identifying & Specifying the clients perception is achievable in pre study phase	R1, R2, R3, R4, R5, R6: No Synergy	R1, R2, R3, R4, R5, R6: No Synergy	R1, R2, R3, R4, R5, R6: No Synergy	R2: Perfection can be defined here
<b>INFORMATION PHASE V2</b>	R1, R3: There is a link between these two phases R5: Value can be established with actual customer requirements at this phase R4: These phases can be mapped R6: There is a Synergy	R1, R2, R3, R4, R5, R6: No Synergy	R1, R2, R3, R4, R5, R6: No Synergy	R1, R2, R3, R4, R5, R6: No Synergy	R1, R2, R3, R4, R5, R6: No Synergy
<b>FUNCTIONAL ANALYSIS PHASE V3</b>	R1, R2, R3, R4, R5, R6: No Synergy	R1, R2: There is a synergy R3: An attempt to derive functionality of the value stream R6: It is possible to add functional requirements to Lean implementation in this stage	R1, R2, R3, R4, R5, R6: No Synergy	R1, R3, R4, R6: There is a synergy R2: Add the functional requirements for the pull	R1, R2, R3, R4, R5, R6: No Synergy
<b>CREATIVITY PHASE V4</b>	R1, R2, R3, R4, R5, R6: No Synergy	R1, R2, R3, R4, R5, R6: No Synergy	R2: Adding innovations to the Flow is possible at creativity phase R3, R4: There is a synergy R5: Value flow can be sharpened by the creativity involvements	R1, R2, R3, R4, R5, R6: No Synergy	R1, R2, R3, R4, R5, R6: No Synergy
<b>EVALUATION PHASE V5</b>	R1, R2, R3, R4, R5, R6: No Synergy	R1, R2, R3, R4, R5, R6: No Synergy	R1, R3: There is a synergy R2: Flow could be further evaluated for waste elimination in evaluation phase R5, R6: Value flow can be evaluated	R1, R2, R3, R4, R5, R6: No Synergy	R1, R2, R3, R4, R5, R6: No Synergy
<b>DEVELOPMENT PHASE V6</b>	R1, R2, R3, R4, R5, R6: No Synergy	R1, R2, R3, R4, R5, R6: No Synergy	R1, R3: There is a synergy R2: Value flow can be further developed in development phase	R1, R2, R3, R4, R5, R6: No Synergy	R1, R2, R3, R4, R5, R6: No Synergy
<b>PRESENTATION PHASE V7</b>	R1, R3: There is a synergy R2: An attempt to verify actual requirements of the customer R4: It can be checked weather the objectives are achieved or not R6: Findings can be presented to the client and can get confirmed	R1, R3: There is a synergy R2: An attempt to verify value stream R4: It can be checked weather the objectives are achieved or not R6: Findings can be presented to the client and can get confirmed	R1, R3: There is a synergy R2: An attempt to verify value flow R4: It can be checked weather the objectives are achieved or not R6: Findings can be presented to the client and can get confirmed	R1, R3: There is a synergy R2: An attempt to verify the things pulled by the customer R4: It can be checked weather the objectives are achieved or not R6: Findings can be presented to the client and can get confirmed	R1, R3: There is a synergy R2: An attempt to verification of perfection R4: It can be checked weather the objectives are achieved or not R6: Findings can be presented to the client and can get confirmed
<b>POST STUDY PHASE V8</b>	R1, R2, R3, R4, R5, R6: No Synergy	R1, R2, R3, R4, R5, R6: No Synergy	R1, R2, R3, R4, R5, R6: No Synergy	R1, R3: There is a synergy R4: These two phases can be mapped R5: Building end users perception which is always targeted. Can be achieved at post study phase R6: Pull can be further developed at post study phase	R1, R3: There is a synergy R4: Continuous improvement process is possible with post study phase R5: Continual focus on mitigating deficiencies while ensuring optimum usage is possible R6: It is providing a place to achieve perfection with a clear reviewing process
<b>SUMMARY OF THE FINDINGS</b>	<b>Value can be specified from the perspective of customer at Pre Study and Presentation stages</b>	<b>Value Stream and waste activities can be derived at the stages of Functional Analysis and Presentation stages.</b>	<b>Value Flow can be created with use of stage Creativity, Evaluation, Development &amp; Presentation.</b>	<b>What is pulled by the customer can be provided within the stages of Functional Analysis, Presentation &amp; Post Study.</b>	<b>Elimination of waste is achievable at the stages of Presentation &amp; Post Study.</b>

Findings of literature review stated that combining Lean and VE would provide a better output. The respondents' opinion further reinforced the literature (as stated by Arratia and Cell, 2003) while stating these two concepts could be merged. Hence, as the first stage of synergising the concepts, experts were on their views by linking the five basic principles of Lean and all the Value Engineering stages. The final outcome of the research is shown in Figure 1 based on the data analysis, which explains the synergy between Lean and VE.

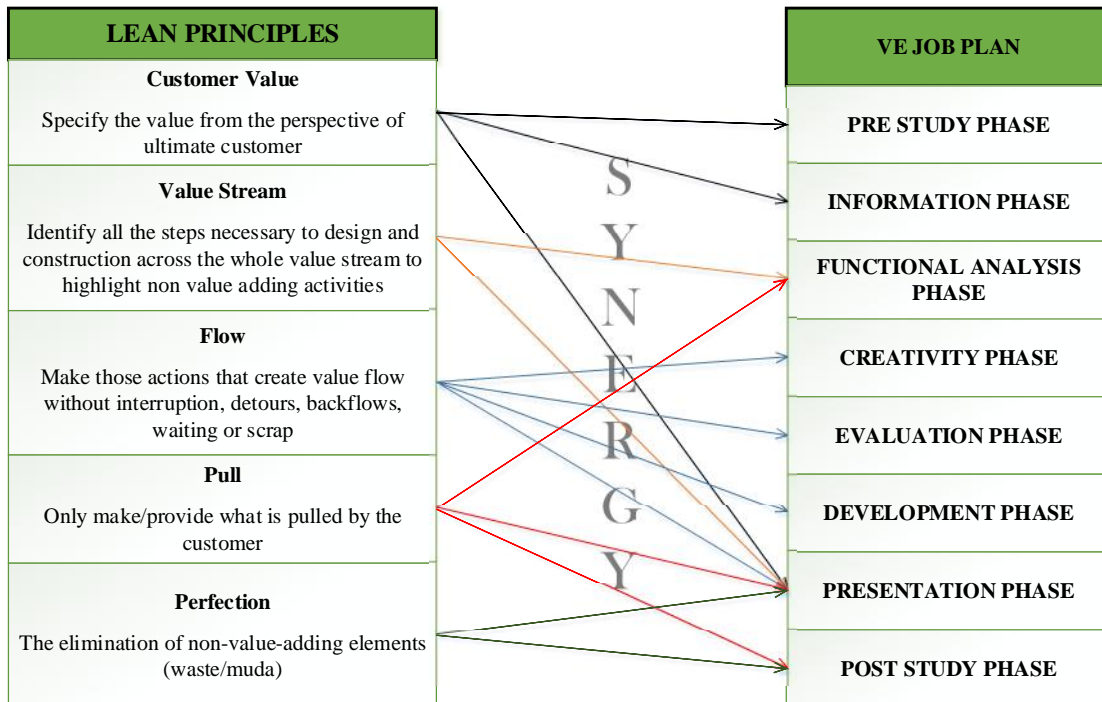


Figure 1: Synergy between Lean and Value Engineering

Customer value principle can be linked with pre study phase, information phase and presentation phase of the VE job plan where the principle can be realised. Value stream phase can be linked with functional analysis and presentation phases whereas flow can be linked with creativity, evaluation, development and presentation phases. There are links in between Pull principle and functional analysis, presentation, post study phases. Finally there is a synergy of perfection principle with presentation and post study phases. The synergy outcome was validated by two (02) industry and academic experts and thereby the synergy was accepted.

Therefore, five Lean principles can be achieved with the relevant phases of the VE job plan which finally provides Lean-Value Engineered outcome. Hence, the synergies can be used for further advanced value achieving strategy development purposes. The synergies may facilitate for a multiple value achieving strategy in time to come according to the views of the experts.

## 5. CONCLUSIONS

The dynamic nature of construction industry has forced the firms to find out relevant strategies in achieving best value for the client. The concept of value is not a novel concept which inherent a long history. Different researchers have defined value with related to their own points of views. However, value is not which measure the financial performance and value is depending on the interpreter who interprets it. Value is related to function, quality and cost by means of construction industry.

Many researches reveal the fact that construction industry is striving for construction process improvement in order to give best value to the client. Several holistic strategies being utilised in construction sector as the value achieving strategies. Initially the cost consideration was given prior concern whilst the modern era is rather concern over the value. Hence, the industry adhered to the value

achieving strategies and the researchers exaggerated that VE and Lean supersede all the other strategies since, they address the concept value in a greater extent.

Although both the concepts are consisted with their own merits, they have their own drawbacks to overcome as separated strategies. Hence, the synergisation is the suggestion by the industry since the research findings facilitate a great synergy between the concepts. Basically, the industry entails a holistic multiple value achieving strategy apart from the rational single value achieving strategies. Since these two concepts supersede in the value arena, probably these two will address the concept in a greater manner. Therefore, there was a need of finding out the synergy and probable links between the strategies in order to develop an advanced strategy in time to come.

This research presents to the industry the basic synergy between Lean and VE as Customer value principle can be linked with pre study phase, information phase and presentation phase of the VE job plan, value stream phase can be linked with functional analysis and presentation phases whereas flow can be linked with creativity, evaluation, development and presentation phases. There are links in between pull principle and functional analysis, presentation, post study phases. Finally there is a synergy of perfection principle with presentation and post study phases in order to proceed further and finally realizing the best value for the client. Hence, the synergy findings could lead to a robust approach in enhancing the value of construction projects.

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