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Drivers and Critical Success Factors of Value Engineering in the Construction Industry

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Construction project can exhibit high cost and reducing this cost may affect project performance and quality expectation. With the increasing needs of project owners, it is key to prioritize cost, performance, and quality to obtain value. Value engineering (VE) is a potential tool for achieving value in projects. The Southwest Florida region in the United States of America (USA) experienced an influx of people with increased construction projects, but it was not apparent whether value was being obtained by the project owners. Therefore, research was conducted on VE use in various projects with specific aim of examining the critical success factors and drivers of VE in projects. An online survey questionnaire was administered to construction practitioners in the region to get their feedback about VE. Results showed that VE was used by experienced contractors who were in commercial projects. They benefited from VE use, and cost and quality were found to be the main drivers of using VE. However, VE knowledge was little with few people certified and qualified to provide value in projects and as such, the success of VE in projects was limited. The research contributed to the VE studies focusing on providing value in construction.

Keywords: Construction Industry, Critical Success Factors, Drivers, Value engineering

Introduction

According to the United States Bureau of Economic Analysis (2024), the construction industry contributes significantly to its economy, and it was estimated to be about 2.8% of the gross domestic product in the third quarter of the year 2024. With this positive contribution, it is also the industry that experiences a lack of skilled workers. Barrows et al. (2020) stated that there is a growing need for skilled and proficient construction professionals to ensure that project goals are met and delivered within budget, required performance and quality, safely and on time. The 2024 Construction Outlook Survey by the Associated General Contractors (AGC) of America found out that about 77% of construction firms have trouble filling both salaried and hourly craft positions, and about 81% of the firms foresee labor shortages to be the biggest problem and challenge in the years to come (AGC, 2024). This could result in overstretched skilled workers, delays in project completion and increased project costs which may impact project performance and quality requirements. Additionally, the construction industry is found to be labor intensive and high resource utilizing which could require a certain level of quality of resources, optimum level of performance, a high degree of safety and project requirements to be met at the lowest possible budget/cost (Wao et al., 2024). With labor shortages and high resource use, there is a need for project teams to find ways to ensure that the various projects are constructed and delivered in a manner that provides the best value. As such, VE could be a tool used to ensure that project owners' needs are met or delivered satisfactorily.

Initiated at General Electric in the 1950s after World War II by Lawrence D. Miles, VE, also called value analysis, was used to buy resources that were needed at the time. Miles was working at General Electric, a major defense contractor, where they faced a shortage of strategic materials needed to produce items. With value and management in mind, Miles constructed the concept of function analysis, later called value analysis or engineering (VA/VE). He stressed the idea that products needed to be bought for a specific purpose, namely, for what they could do best, including providing better aesthetic qualities to users (Miles, 1947). In developing the idea, Miles (1947) stressed that items or resources are sought and must be incorporated in areas where they are needed most, or where they can function best for better results.

VE is applied in projects that are costly, repetitive, large, complex, requiring design modifications, or those that need some desired performance or quality improvements as defined by 'value' to the owner (Wao, 2014). Essentially, VE can be applied anywhere to meet the owner/client's needs. In this regard, Southwest (SW) Florida had in the last 8 years (since 2017) experienced an influx of people moving into the region from other regions in the USA, and there had been an increase in the number of construction projects including residential and commercial projects to meet the increasing housing demands in the area. As such, it was prudent to ensure that the projects in the region were being delivered at the best value. VE was a tool that could be used to alleviate the challenges by ensuring that the value in projects are achieved with greater benefits. Therefore, this research explored the use of VE in projects in SW Florida with the aim of assessing the VE critical success factors and major drivers of VE in the region. Research questions revolved around implementation of VE in projects, the impact of VE to project owners and the future growth of VE. Literature review involved defining VE, overall usage of VE, leadership in VE and benefits of VE in projects.

Literature Review

Defining Value Engineering

The term 'value' is subjective in that what one person considers to be of value might not necessarily be the same as the other person. Lin et al. (2023) defined value as the balance on what to gain (benefits) and what to give (costs). In reference to the construction project, Lin et al. (2023) posited that value, value management (VM) and VE originated from the term value analysis at General Electric by Lawrence Miles in the 1940s. They held that VM seeks to maximize functions at the lowest overall cost without sacrificing quality and performance to provide clients with the maximum benefits and value for money. The Society of American Value Engineers International Value Management Body of Knowledge (VM guide, 2020) defined VE as a systematic application of recognized techniques which identify the function of a project, product, or service at the lowest overall cost (VM guide, 2020). The technique employs a structured creative team of experienced professionals coming together in an organized workshop to realize the success of the VE process. Hence, Wao (2014) defined VE by injecting the human factor into it and defined it as an organized application of skills which is aimed at removing unnecessary project costs and providing the best value in projects, products, services, and processes. This value is realized by identifying the function of a system, product, or service, determining the worth for that function, generating realistic alternatives by using creative thinking of the VE team, and providing required functions, reliably at the lowest overall cost (Wao, 2014). The structured team makes clear decisions through continuously referring to the value needs of the project owner. Male et al. (2007) supported the idea and said that VE and VM gets its strength from being a team-oriented methodology and that it uses function analysis to study and deliver project at the lowest overall life cycle performance and cost without devaluing the overall quality.

It is evident that VE has many definitions. The common aspects are multi-disciplinary team, structured approach, function orientation, and creative thinking. VE is not just a cost cutting methodology but rather a decision-making, consensus-based problem solving and value improvement methodology by a multidisciplinary team (Wao et al., 2016).

Critical Success Factors (CSF) and Leadership in Value Engineering

As expected, the multidisciplinary team needs a leader to guide the VE process. Usually, the success of a VE process depends on the action of VE team leader [who is a certified value specialist (CVS)], the support of upper management who needs to have buy-in to the effort, active participation of project clients/owners, and enlisting a senior manager as a champion and program leader of the project (Wao, 2014). Critical success factors (CSF) need to be well understood so that VE team can enhance them for better project outcomes. Thneibat and Al-Shattarat (2021) investigated CSF for VM techniques in construction projects through surveys and interviews. They found that the CSF from highest to lowest were owners support, support for implementation, adequate time for VM study, and cost saving. Male et al. (2007) posed that VE success in project can be through the VE elements being integrated in a project and these may include the study process or job plan, commitment of team members to the VE effort, team leader management skills of the VE workshop, upper management (executive) commitment to VE effort, and overall efficient facilitation in the process. Maximum creation of ideas and good communication were also major features of the success of VE.

Closer examination of these studies showed some factors that were commonplace and some needing enforcing for a successful VE study. In all, there needed to be a CVS in projects to streamline the VE processes as well as having team members who have at least Value Management Associate (VMA) which is the first VE certification showing basic understanding of VE process in project.

VE Job Plan

With the definition of VE, it is quite important to understand the VE job plan which comprises of pre-workshop phase, workshop phase and post-workshop phase. The workshop phase, also called the VE job plan, is the most significant. The following is what takes place in the workshop stage.

- Information phase - collection of project information, e.g., commitments and constraints.
- Function analysis phase - analysis of the project systems to understand the functions.
- Creativity phase - ideas are generated on ways to meet the required functions which improve the performance, quality, and lower project costs.
- Evaluation phase – evaluating alternatives and selection of feasible ideas for development.

- Development phase - development of the selected alternative(s) into fully supported recommendations.
- Presentation phase - presentation of the VE recommendation to the project owner.

Application of Value Engineering in Construction Projects

VE can be applied in every aspect of a project. SAVE International (2024) states that the terms VM, VA, VE and Value change are applied depending on the project phase. Figure 1 depicts those areas.

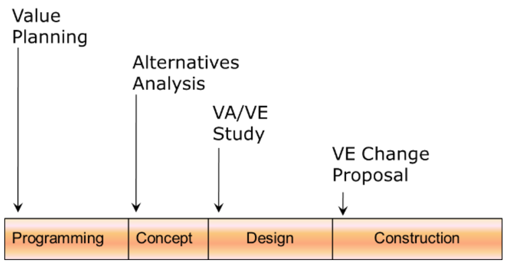

Figure 1. VE study timing for design/build project (SAVE International, 2024).

Studies have investigated the use of VE in projects including stating the geographical regions where it is used, benefits and related barriers experienced in its usages. As such, Lin et al. (2023) study on the status of VM studies in construction revealed that VE had been practiced widely in the construction industry. They found that the markets where VM studies were prominent were in Asia and the Middle East, with less of it in the USA and European markets. African markets showed less applications and that could be explained by the late arrival of VM in the continent due to less awareness of VM/VE use. With the goal of VE and related benefits, it was recommended to be adopted in construction.

VE needs to motivate teams to develop alternatives that meet project goals appropriately. With this, Sharma and Srikonda (2021) examined the application of VE in affordable housing in India with the goal to optimize cost, time, and quality. It was evident that employing VE helped in proposing the right project system's alternatives that resulted in 8% cost reduction and 52% overall time reduction on the project schedule.

VE could be applied in specific systems of a project. As such, Khodeir and Ghandour (2019) examined the role of VM in controlling cost overruns in residential construction projects. The 21-55% cost overruns experienced were on a serious level which needed VM studies to be conducted for cost control. They found out that the alternatives developed and employed in the project resulted in 40% cost saving for the roof layer installed, 55% improvement on the thermal insulation, and an overall cost saving of 15% from all the original architectural work. Mainly, they found that VM improves cost control, aids in cost reductions without compromising value, adds in more value for the client, enhances quality, and results in successful teams (Khodeir and Ghandour, 2019). Abdulkareem and Naimi (2022) investigated the importance of VE in product development and construction where VE was good to optimize cost, maintain high quality and improve productivity.

The studies showed the significant benefits of using VE in projects, and so it is also useful to understand the drivers of VE as they may not be obvious. It can be assumed that the drivers of VE in projects can be many as the various projects. Madushika et al. (2020) examined key performance indicators of VM in the Sri Lankan construction industry where they surveyed 70 professionals in the preconstruction phase. The goal was to find VM techniques most suitable for each stage of a project. They found that target costing, functional analysis, and value for money were most suitable for the inception stage, concept design stage, schematic design stage, elemental designs stage and procurement stage. The highest ranked key performance indicators were support received from stakeholders as well as reduced costs and ROI. Mehta and Pitroda (2020) conducted a study about application of VE in construction projects which found that VE can be applied in any stage of a project, but greater results can be achieved when it is done in the conceptual and development stage.

As such, value can only be achieved when VE is applied correctly when following the job plan. These include better function analysis techniques (Wao, 2017), better creativity approaches (Wao, 2018, Mousa and Albasyouni, 2021) and evaluation techniques (Wao, 2017).

Research Methods

Aim and Objectives

The aim of the research was to assess the VE use with specific objectives of finding the critical success factors and drivers of VE. A survey questionnaire was used to collect the data. This type of data collection method was considered useful especially when focusing on quantitative research since it allowed standard question items to be given to a larger number of participants in the research (Bhattacherjee, 2012). Therefore, this research utilized the survey questionnaire and construction industry personnel in the SW Florida region to get data for eventual research methods, analysis and generalization.

Survey Questionnaire Design and Administration

To meet the aim and objectives of the research, an online survey questionnaire was administered to the construction professionals via Qualtrics survey software. Before its administration, four (n = 4) constructors in the region were requested to be a part of a pilot study that focused on testing the validity and reliability of the survey questionnaire items. Cronbach's alpha tested the reliability of the items, and the result of data analysis showed an estimate of 0.91 implying that the questionnaire was well understood. As such, the survey items were slightly revised based on this result, and in addition to the open-ended part of the question items that were not captured by Cronbach's alpha statistical analysis and estimate. The revision was to improve accuracy in the feedback and overall data.

As part of the research methods, consent to conduct research with human subjects was sought and granted by the Institutional Review Board (IRB) at the Florida Gulf Coast University (FGCU). The first section of the survey questionnaire required the respondents to fully understand the consent form and then agree (or not) to it by appending their signatures. Their acceptance would allow them to begin the survey otherwise not able to proceed if they declined the consent form.

The survey questionnaire data were gathered from April 2023 to May 2024 with repeated reminders in between so there could be high response rate in completing the survey questionnaire. This window was considered enough for collecting the data that was needed since some projects required some time before they were completed within the given window. The questionnaire items consisted of open-ended and multiple-choice questions. The questionnaire items focused on the respondents' demographic data such as the number of years in construction, familiarity and knowledge of VE, drivers of VE, and certifications in VE. Understanding and knowledge (or definition) of VE were the main open ended questions Also, the project sizes were in focus.

Sample Size and Data Analysis

About 200 construction professionals were targeted and this was considered sufficient for parametric or univariate statistical tests and analyses. The quantitative data analysis utilized SAS on Demand statistical analysis software for academics (SAS, 2025) for descriptive statistics. The descriptive statistics utilized the measures of central tendency and dispersion that consisted of frequencies and percentages. Qualitative data themes were also identified from the open ended question items and the feedback were analyzed using content analysis. Content analysis facilitated the review and analysis of the open-ended questionnaire feedback by identifying the focus of the subject matter being responded to and capturing evolving patterns or themes in the feedback items.

Results and Discussion

Demographics and Level of Experience

The feedback from the survey questionnaire showed that 140 people responded and so the sample size (N=140) was considered adequate with a response rate of 70% (140/200). Results showed that 85% (N=119) of the respondents were males while 15% (N=21) were females. They were consultants, directors, project managers, project executives, presidents, senior vice presidents and construction managers of their companies. This showed that the sample was from a population that held leadership and managerial roles in the construction field which could provide reliable data for better research generalizability. Their experiences in the construction industry were summarized in Table 1 as shown below.

Table 1. Level of experience in the construction industry (N = 140).

Years	2-10 years	11-20 years	21-30 years	Over 30 years
Frequencies(*f*)	20	34	45	42
Percent (%)	14	24	32	30

Considering their experiences, most of the respondents (N=87, 62%) were those who had over 20 years of construction industry experience, and so their feedback was construed to be rooted in many years of construction experience. Their business lines were in general contracting (N=62, 44%), construction management (N=55, 39%), roofing, mechanical, electrical and plumbing (N=15, 11%) and sustainable design and construction (N=8, 6%) with majority of them involved in commercial construction projects (N=56, 40%) followed by residential construction projects (N=49, 35%), industrial construction projects (N=14, 10%) while the rest (N=21, 15%) engaged in healthcare construction projects, higher education projects and consultancy. These showed a high level of engagement in construction with many years of using VE in projects which implied greater reliability of the data they provided because the many years of experience could mean greater knowledge in the construction field.

Assessing the Knowledge and Goal of VE in Project

About 100% (N=140) of them were familiar with VE. To examine their knowledge of VE through reviewing the specific themes of the feedback through content analysis, the feedback was categorized into three content areas as shown in Table 2.

Table 2. Understanding and knowledge of VE in project (from content analysis of feedback).

Content areas	Responses
Definition of VE	Reduced cost for products/procedures without reducing overall job quality or design.
Process of VE	Process by which the general contractor reviews the plans and specifications for buildability, potential cost savings generated by substituting products and design alternatives.
Goal of VE	Providing alternative systems or methods to provide the client with the best items that their budget and long-term objectives can allow.

The definition, process, and goal of VE in Table 2 captured the critical reasons for applying VE in projects, i.e., cost saving or lowering cost while improving performance, quality, and safety. It would be noteworthy to mention that life cycle cost (LCC) needs to be the focus so that the cost aspect is not limited to initial or first cost but always examining the cost from the beginning of a project (initial/first cost) until the end of its life hence the LCC. Also, the three content areas must focus on functional analysis in the process because that is what separates VE from other decision-making tools.

To understand the drivers (or triggers) of VE in projects, some factors were identified, and respondents asked to state what came to their mind when they first heard about VE. Table 3 summarizes these factors with their related frequencies.

Table 3. Drivers/triggers of VE in Project (N = 140).

Drivers/Triggers	Frequency (*f*)	Percent (%)
Cost/Budget	39	28
Quality	31	22
Time/Schedule	28	20
Safety	20	14
Performance	14	10
Sustainability	8	6
	N =140	100%

Table 3 shows that the cost/budget was the main driver or trigger of applying VE in projects (N=39, 28%). Sustainability was the least which is contrary to the current wave in sustainable construction.

When the respondents were asked about the most important among the given drivers or triggers of VE in projects, cost/budget was mentioned by the majority (N=84, 60%) as the most prioritized objective, then performance (N=35, 25%) while the rest (N=21, 15%) felt that priority is set by the owner, and as such, the owner project objectives drive the VE process. All these viewpoints tend to support the fact that cost is the main VE driver as was shown by studies (Lin et al., 2023; Sharma & Srikonda, 2021; Wao, 2018 and Wao et al., 2016).

Application of VE in Construction Project and related Certification

Everyone had used VE with about 78% (N=109) using it for over 20 years in over 20 projects mostly located in SW Florida (N=126, 90%). Table 4 shows the VE usage in various project sizes ($).

Table 4. Usage of VE in projects (N =140).

Project Value on Average ($)	350,000	800,000	6 million	50 million	Over 100 million
Frequency (f)	20	25	28	28	39
Percent (%)	14	18	20	20	28

On average, it can be seen from Table 4 that VE was used in the different projects, and that it was used mostly in relatively larger projects of over $100 million because of high cost and possibly complex types typical of federal highway projects which require VE studies for greater ROI and savings. This aligns with Wao (2014) which stated that VE can be applied in projects that are costly, large, complex, require design changes, and those which can obtain high ROI for better benefits.

Certification and Leadership in VE

Even though a few practitioners were professionally recognized through VE certifications, the vast majority were not even aware that VE could be a profession with its line of certification. Ideally, a professional value engineer starts by being VMA which is the basic level of certification and then becomes a CVS who has many years of experience in VE/VA/VM and leading teams in VE workshops. Nobody was a CVS which implied that there was no leadership in VE in projects unless they outsourced it from SAVE International as the leading body for all value engineers. With certification in VE, about 93% (N=130) of the respondents were not certified and unaware of any benefit of VE certification.

Comparing the outcome of using VE in projects with the outcome of certification in VE implied that practitioners were more inclined to use VE and not get certified. These results showed lack of awareness and a gap in knowledge of VE which needed to be bridged through further research, training, and professional development so VE could be implemented better for greater value.

Conclusion

This study examined VE use, the drivers and critical success factors in the SW Florida construction industry. It depicted varied uses of VE in the area where most contractors used it in large commercial construction projects and majority of them were leaders in the field who had been using it for over 20 years in these large projects. Cost and quality in the outcome of projects were found to be the top drivers of VE which also had sustainability as the least driver. This was quite contrary to the notion that projects in the current wave of construction systems need to have sustainable construction as one the main items of focus and VE need to integrate sustainability principles in its process for better value in projects.

The success factors of VE depicted a negative connotation regarding the expectation of full awareness and growth of professional use of VE in providing value to project owners in the region. The outcome on certification showed little to no awareness of VE certifications with few certified in VE showing few leaders of VE in the area. With the outcome of VE certifications, it was recommended that training in VE was needed for the constructors in the region. This would streamline efforts to obtain VMA and CVS certifications that would provide many construction professionals with a defined path to ensure more value addition in the construction field and enhanced leadership in VE. As such, more success of VE in projects will be experienced and projects owners will get the needed value.

This study contributed to the wider VE body of knowledge focusing on providing value in construction as well as providing the project owners with information that could advance their knowledge in the construction field especially in this age of technological advances and digitalization under Industry 4.0, Industry 5.0 and now Industry 6.0.

The limitation of the study was that it focused on a small region which may not be generalizable to other larger areas due to different regional economic climate as well as differing factors driving value in projects. It would be worthwhile to conduct a larger study incorporating many regions and focusing on a longer period. Future research may also investigate the motivation and barriers to VE certification for better value in projects.

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