RETHINKING CONSTRUCTION MANAGEMENT PRACTICES TO ATTAIN SUSTAINABLE DEVELOPMENT GOALS

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APPLICATION OF VALUE ENGINEERING IN RESIDENTIAL BUILDING CONSIDERING SUSTAINABILITY ASPECT

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Abstract

To increase the value of a project and minimizing its environmental impact, this study combines value engineering and environmental sustainability aspect together. Environmental sustainability is balancing the ecology and using the natural resources responsibly to conserve it for future generations. Value engineering is a methodical strategy to enhance the value of a project or its component by either enhancing its functionality and quality while keeping cost more or less same or by reducing the cost without compromising its functionality and quality. The traditional construction process, materials, and methods are the primary factor driving up project costs. Rapid advancement in construction materials and processes opened a window to reassess contemporary materials and processes used in the construction industry and replace it with most recent one to achieve the above objectives. In this paper various project items and process has been thoroughly analyzed based on their functionality. To full fill its functions other alternatives have been identified and compared. Our primary goal in making alternative suggestions is to reduce the project's life cycle cost, embodied carbon, environmental effect etc.

Keyword: Value engineering, value analysis, ve, sustainability, life cycle cost.

1. Introduction

The concept of value engineering has been started by General Electric Company (GE) during World War II when it had to deal with a major materials shortage to meet the demand of combat equipment. GE had to employ substitute materials for those that were in short supply to solve this issue. To lead the issue, a staff engineer of GE named Lawrence D. Miles created a variety of concepts and methods to choose alternatives. His primary philosophy was to determine a product's value first in order to suggest the alternative for it, and he created a function-based technique that was successfully tested. The new approach was so effective that goods could be produced with higher operational and production efficiency and at reduced costs. Due to its success, GE established a dedicated team under the direction of Lawrence Miles to further improve the process. This process was known as "Value Engineering." [1] The value engineering is also popular with other names i.e. value analysis and value management. Value of a product or process is the ratio of its price of functions to its cost; it can be raised by either enhancing the function or lowering the cost, or by both, since the VE methodology is generic in nature, it can be used for nearly any kind of building project. People occasionally confuse value engineering exercise with cost cutting exercise, but there is a big difference. The reduction of cost is the only goal in cost cutting exercise therefore during this process, quality and even functionality might be compromised. The objective of VE research, on the other hand, is to increase value without compromising the function or the quality. Furthermore studies shows that VE not only offers considerable benefits for functional enhancements, cost savings, and quality enhancement, but also for increased cooperation and stakeholder communication [4].

Environmental degradation and materials scarcity due to mass residential and mega infrastructure projects have contributed to the rise in popularity of sustainable and renewable solutions in the modern construction sector. Quality, dependability, durability, and better performance over the course of a project, are considered to be major deliverables in a construction project. These deliverables can be strengthened by applying sustainability and value engineering (VE) concepts together. Sustainable Construction (SC) can be utilized in construction projects to reach higher quality and performance requirements, while VE can be used as a tool to correctly achieve them [2]. Though VE is an old concept but due to fast changes in construction material and technology, new and better alternatives can be generated continuously.

According to [3], the building sector ecosystem contributes 13% to global GDP (GDP). Building and construction also account for 39% of energy-related carbon dioxide (CO_2) emissions and 36% of worldwide energy use. It is hardly surprise that sustainability in the construction sector is a top priority for the government, industry professionals, and academics alike. However in order to be sustainable, a project must also take into account issues of economic, social, and technical sustainability as well as ecological or environmental sustainability. The final pillar, "technical sustainability," discusses ideas pertaining to the functionality, value, and lifespan of a structure. It also needs systems for determining if sustainability in building projects is successful or not.

In this study, we apply the value engineering theory and approach to a residential construction project to lower life-cycle costs and enhance functionality by selecting different items and materials.

2. Value Engineering

As discussed above, the Value Engineering is a well-organized methodology for enhancing value of projects, goods, services, and organizations. Value engineering, another name for VM, is used to examine and enhance services and operations provided by both the public and private sectors, as well as design and building projects. For conducting a successful value engineering research six consecutive steps or phases are usually adopted which are given below.

2.1 Information Phase

The first phase of VE comprises Information Phase. In order to get a better understanding of the issue and any potential solutions, a detailed study about the issue has been carried out in information phase. The relevant data related to the project such as information related to its location, architectural drawings, structural drawings, specification etc. has been collected. The level of effort and time committed to the Information Phase will depend on the project's complexity, the amount of information provided, and the available time. A VE study's success depends on obtaining reliable information that is pertinent to the project, goods, or service being studied. The primary goal of this stage is to make sure that everyone on the team is on the same page with regard to the project. This will help the team develop creative solutions more effectively and minimize mismatches in later phases.

2.2 Function Analysis Phase

In this phase, the actual functions of identified project, design, items or processes in which VE is to be applied, has been determined. Functions are two-word verb-noun sentences that specify the specifications of the project, goods or service under evaluation in function analysis, For example, one of the functions of exterior wall is to “Enhance Safety”. The two terms that are utilized to describe a function are an active verb and a measured noun. A measurable noun describes an item that can be both described and measured. After identifying, various functions, using numeral evolution of Function technique the primary or basic function and secondary functions has been sorted.

2.3 Creative Phase

Creating a variety of options to carry out the same functions is the goal of this phase. It is advised to apply several well-known approaches during this phase, such as brainstorming and nominal group technique. Brainstorming encourages creativity and gives the chance to consider all potential answers to the issues at hand or substitutes for the function. We must create a list of probable answers to the problem created by the verb-noun combination.

2.4 Evaluation Phase

The fourth stage of the Value Analysis process is the Evaluation Phase. Here, the concepts developed during the Creative Phase are methodically assessed, screened, prioritized, and short-listed for their potential to deliver cost- and/or value-saving effects. In this step, we assess the collected ideas and narrow down the number to a select group of suggestions that have the best chance of enhancing the project. Then, in the latter stages, one of the options on this short list will be thoroughly examined. As there are numerous ideas and many of them are not even good for the project value, it would be extremely inefficient to thoroughly examine each alternative right after the creative phase. This is why the evaluation step is necessary to weed out the unhelpful ideas.

2.5 Development Phase

At the development stage, each top choice is thoroughly examined to ascertain the life cycle costs and implementation requirements. It is possible to use technical analysis, cost projections, and other techniques to examine each possibility. The goal of this phase is to further analyse the list of suggestions with the best potential for becoming viable alternatives from the evaluation phase. The concepts are further developed into value alternatives that are spelt out in plain terms so that the stakeholders may comprehend their consequences, cost reductions, and effects on value.

2.6 Presentation Phase

In this phase the development phase data are presented to the decision-makers to help them fully comprehend the many VE possibilities and their advantages both in the short- and long-term. A projected implementation strategy is presented in this phase as well. We meet with management and other stakeholders during the presentation phase to present their final report. The task is to persuade the decision-makers that the final concepts from the development phase should be put into action by presenting their findings to them using reports, flowcharts, and other presentation tools. The concepts should be thoroughly explained, along with any associated expenses, advantages, and any drawbacks. The final report serves as a summary of the discussions and conclusions as well as a record of the accomplishments during the study. It can also be used by the business as a reference tool for upcoming projects.

3. Methodology

The value engineering has been applied in ongoing project of construction of faculty Apartments at integral university. The details of the project is given in table 1.

Table 1: Basic details of the project

Name of the project	Faculty Apartments construction project
Client	Integral University
Contractor	J R Constructions & Interiors
Architect	De- Design 19 Studio
Location	Integral University Campus, Dasauli, Kursi Road, Lucknow
Area	5581 sqft(100’3” x 55’8”)
No of Floor Proposed	7no.

All the other relevant project information such as architectural drawings, structural drawings, services drawing, FAR, total carpet area, total covered area, total masonry work, plastering work etc. has been collected in the first phase i.e. information phase.

After data collection, in the investigation phase or function analysis phase, all the project data has been intensively reviewed and various items identified on which value engineering process to be applied. The table 2 comprises the items identified in which the value engineering to be applied has been identified. But in this paper only two items, external wall and plastering has been taken up for VE application.

Table 2: Area/items of study

S. No.	Areas/Items of Study
1.	External wall
2.	Internal wall
3.	Plastering
4.	Flooring
5.	Shuttering & Formwork
6.	Painting
7.	Project information flow (communication) process
8.	Procurement and inventory process
10.	Rebar cutting process

During the phase, various probable functions performed by the external wall and plastering have been determined and formulated in two word format i.e. an active verb and a measurable noun (Refer table 3).

Table 3: Probable Function of items/areas

Item/ Area	Probable Functions	Function code
External Wall	Control Privacy	a
	Enhance Safety	b
	Resist Weather	c
	Prevent Noise	d
	Protect Health	e
	Enhance Comfort	f
	Resist Heat	g
Plastering	Enhance appearance	a
	Increase Durability	b
	Protect Masonry	c
	Ease Painting	d
	Provide Insulation	e
	Resist Fire	f
	Conceal Defect	g
	Hide services	h

After determining various probable functions, the basic or primary function has been identified using numerical evaluation of functions technique (NEFT). This process has been completed through collection of thirty five valid responses from experienced experts in various domain such as construction managers, architects, project engineers and academicians. (Refer Table no 4, 5, 6, 7).

Table 4: Sample response for evaluation of basic function using Numerical Evaluation of Function Technique for external wall

	b	c	d	e	f	g	Total Score
a	b3	c3	a2	a3	a3	a1	9
	b	b2	b3	b3	b3	b2	16
		c	c2	c3	c2	c2	9
			d	d1	d2	g2	3
				e	e2	g2	2
					f	f2	2
						g	4

Table 5: Over all Response Sheet for external wall

Probable Functions	Function code	Cumulative Score
Control Privacy	a	9.3
Enhance Safety	**b**	**15.5**
Resist Weather	c	11.7
Prevent Noise	d	2.7
Protect Health	e	2.3
Enhance Comfort	f	3
Resist Heat	g	6

Table 6: Sample response for evaluation of basic function using Numerical Evaluation of Function Technique for plastering

	b	c	d	e	f	g	h	Total Score
a	a2	a3	a1	a3	a2	a2	a2	15
	b	b2	b1	b2	b2	b2	b2	11
		c	d2	c3	c1	c1	c1	6
			d	d3	d2	d1	d1	9
				e	e1	g3	h2	1
					f	g3	h2	0
						g	g2	8
							h	4

Table 7: Over all Response Sheet for plastering

Probable Functions	Function code	Cumulative Score
Enhance appearance	**a**	**16.3**
Increase Durability	b	8.9
Protect Masonry	c	6.0
Ease Painting	d	10.7
Provide Insulation	e	2.0
Resist Fire	f	1.7
Conceal Defect	g	9.9
Hide services	h	6.9

Since, for external wall, the highest cumulative scores is for “Enhance safety”, and for plastering, the highest score is for “Enhance appearance” (Refer table 5 and 7). Hence these are the basic function for external wall and plastering respectively.

In the next phase which is creative or speculation phase, various alternatives for external wall and plastering has been identified (Refer table 8) which will be able to perform the identified basic function. This process has been done using brain storming technique accompanied with literature review. For this a five member focused team consisting personals from industry and academics has been constituted. In the first step during the process, all the alternatives suggested has noted down without bothering about its feasibility. This concept increased the horizon of thinking of persons involved in the brain storming process and improved creativity. After completion of the process, feasibility of all the identified alternative has been ascertained and only feasible alternative are selected for further study. Following feasible alternatives for external wall and plastering have been identified (refer Table 8) after the process –

Table 8: Alternatives for external wall and plastering

Item/Area	Original Material	Alternatives
External Wall	Red Brick masonry work	Aerated Concrete Blocks
		Fly ash Brick
		Red Mud Brick
		Compressed earth block
		Aerocon Panels
		Hollow concrete Block
Plastering	Cement sand Plaster	Gypsum Board
		Rice husk Gypsum Board
		Laminated Bagasse Cement Board
		Bamboo Board
		Agricultural Fiber cement composite board

In order to select the best alternative(s) among all, the alternatives been evaluated based on the evaluation criteria given in Table 9 and 10. These criteria are then compared with each other to calculate the weights first (refer Table 11, 12, 13 and 14).

Table 9: Evaluation criteria for External Wall

S. No	Parameters	Parameter Code
1	Initial cost	A
2	Maintenance	B
3	Aesthetics	C
4	Durability	D
5	Strength to weight ratio	E
6	Damp proofing	F
7	Rate of construction	G
8	Material Availability	H
9	Consistency in availability	I
10	Sound insulation	J
11	Heat Insulation	K
12	Embodied carbon	L
13	Recyclability/ Reuse	M

Table 10: Evaluation criteria for Plastering

S. No	Parameters	Parameter Code
1	Initial cost	A
2	Maintenance	B
3	Aesthetics	C
4	Durability	D
5	Damp proofing	E
6	Rate of construction	F
7	Material Availability	G
8	Consistency in availability	H
9	Heat Insulation	I
10	Embodied carbon	J
11	Recyclability/reuse	K

Table 11: Sample sheet for comparing the evaluation criteria for weight determination – External Wall

	B	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**Total Score**
A	A2	A3	D3	E3	F3	A2	H1	I2	J2	K3	L2	M2	7
B		B3	D1	E2	F2	B2	H2	I2	J1	K3	L1	M1	5
C			D3	E3	F2	G2	H2	I1	J1	K2	L2	M2	0
D				D1	D1	D2	D2	D1	D2	D1	D1	M1	18
E					F1	E3	E3	E3	E3	E1	E1	E1	23
F						F2	F1	F1	F1	K1	L1	M1	13

	H	I	J	K	L	M	Total Score
G	H1	I1	J2	K3	L3	M3	2
	H	I2	H1	K2	L2	M2	7
		I	I1	K2	L2	M2	6
			J	K2	L2	M2	6
				K	K2	K2	22
					L	L2	17
						M	16

Table 12: Calculation of weights for evaluation criteria – External Wall

Evaluation Criteria	Criteria Code	Average Score	Weightage
Initial cost	A	8.9	1.8
Maintenance	B	7.6	1.6
Aesthetics	C	1.1	0.2
Durability	D	19.1	3.9
Strength to weight ratio	E	24.3	5.0
Damp proofing	F	13.7	2.8
Rate of construction	G	1.6	0.3
Material Availability	H	5.1	1.0
Consistency in availability	I	5.4	1.1
Sound insulation	J	6.9	1.4
Heat Insulation	K	22.9	4.7
Embodied carbon	L	18.6	3.8
Recyclability/Reuse	M	19.4	4.0

Table 13: Sample sheet for comparing the evaluation criteria for weight determination – Plastering

	B	C	D	E	F	G	H	I	J	K	Total Score
A	A2	A1	D2	E2	A1	A2	A1	A2	J1	K2	9
	B	C2	D2	E2	B1	B1	B1	B2	J2	K2	5
		C	D1	E1	C2	C2	C1	C2	J1	K2	9
			D	D1	D2	D2	D1	D2	D1	D1	15
				E	E1	E1	E1	E2	J1	K1	10
					F	G1	H1	F1	J1	K1	1
						G	H1	G2	J1	K1	3
							H	H1	J1	K1	3
								I	J2	K2	0
									J	K1	10
										K	13

Table 14: Calculation of weights for evaluation criteria – Plastering

Evaluation Criteria	Criteria Code	Average Score	Weightage
Initial cost	A	10.6	3.2
Maintenance	B	6.9	2.1
Aesthetics	C	12.3	3.7
Durability	D	16.6	5.0
Damp proofing	E	10.9	3.3
Rate of construction	F	2.6	0.8
Material Availability	G	4.6	1.4
Consistency in availability	H	5.4	1.6
Heat Insulation	I	1.7	0.5
Embodied carbon	J	12.0	3.6
Recyclability/Reuse	K	14.6	4.4

After calculation of evaluation criteria weightage, each alternatives are then evaluated with respect to the evaluation criteria to calculate the scores (refer table 15 and 16).

Table 15: Comparison of alternatives with each evaluation criteria and assigning of average score for evaluation criteria against each alternative – External Wall. The score are on 1 to 5 scale.

	A	B	C	D	E	F	G	H	I	J	K	L	M
Red Brick masonry work	3.8	4.9	1.8	4.8	3.2	3.9	3.2	4.9	4.9	3.1	4.1	2.9	4.5
Aerated Concrete Blocks	2.5	4.8	2.5	3.7	4.2	3.2	4.5	4.2	3.5	4.8	4.9	2.9	3.5
Fly ash Brick	4.9	4.9	2.1	4.8	3.1	4.1	3.1	4.6	3.9	3.1	3.9	4.7	4.2
Red Mud Brick	4.9	4.9	1.8	4.6	3.0	4.1	3.1	2.5	2.5	3.2	4.2	4.7	4.2
Compressed earth block	4.9	4.0	1.5	4.0	2.4	1.5	3.5	4.9	4.9	3.5	4.2	4.9	2.0
Aerocon Panels	1.7	4.9	4.8	4.9	4.7	4.8	4.5	3.9	3.5	4.2	4.8	3.5	4.8
Hollow concrete Block	2.4	4.7	2.8	4.5	4.2	4.8	4.5	4.4	4.0	4.5	4.9	3.5	3.5

1 Alternate scoring **very Poor** on a particular evaluation criteria

2 Alternate scoring **Poor** on a particular evaluation criteria

3 Alternate scoring **Average** on a particular evaluation criteria

4 Alternate scoring **Good** on a particular evaluation criteria

5 Alternate scoring **very Good** on a particular evaluation criteria

Table 16: Comparison of alternatives with each evaluation criteria and assigning of average score for evaluation criteria against each alternative – Plastering

	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
Gypsum Board	4.3	4.0	3.5	3.7	2.0	4.5	4.8	4.8	3.8	3.8	4.6
Rice husk Gypsum Board	4.9	4.0	3.3	3.5	2.0	4.5	3.9	3.5	4.0	4.3	4.7
Laminated Bagasse Cement Board	1.8	4.3	4.0	4.0	3.0	4.2	3.9	3.7	4.2	4.2	4.2
Bamboo Board	1.5	4.9	4.5	4.5	4.0	4.2	4.0	3.7	3.5	4.2	4.8
Agricultural Fiber cement composite board	3.1	4.1	3.7	3.8	3.5	4.2	3.8	3.5	4.0	4.3	3.5

After calculating the weights of evaluation criteria (say X1, X2,…) (Table 12 and 14) and scoring of each alternative against evaluation criteria (Say Y1, Y2,…), final scores of alternatives against each criteria (say Z1,Z2…) have been calculated by multiplying X1,X2… with Y1, Y2… respectively (Z1=X1 x Y1). Then total scores of each alternatives has been calculated by adding Z1, Z2 and so on. Refer table 17 and 18.

Table 17: Calculation of weighted score for alternatives– External Wall

	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**Total Score**
Evaluation criteria Weightage	1.8	1.6	0.2	3.9	5.0	2.8	0.3	1.0	1.1	1.4	4.7	3.8	4.0	
Red Brick masonry work	3.8	4.9	1.8	4.8	3.2	3.9	3.2	4.9	4.9	3.1	4.1	2.9	4.5	
	6.9	7.7	0.4	18.9	16.0	11.0	1.1	5.1	5.4	4.4	19.3	11.1	18.0	125.2
Aerated Concrete Blocks	2.5	4.8	2.5	3.7	4.2	3.2	4.5	4.2	3.5	4.8	4.9	2.9	3.5	
	4.6	7.5	0.6	14.5	21.0	9.0	1.5	4.4	3.9	6.8	23.1	11.1	14.0	122.0
Fly ash Brick	4.9	4.9	2.1	4.8	3.1	4.1	3.1	4.6	3.9	3.1	3.9	4.7	4.2	
	9.0	7.7	0.5	18.9	15.5	11.6	1.0	4.8	4.3	4.4	18.4	18.0	16.8	130.7
Red Mud Brick	4.9	4.9	1.8	4.6	3.0	4.1	3.1	2.5	2.5	3.2	4.2	4.7	4.2	
	9.0	7.7	0.4	18.1	15.0	11.6	1.0	2.6	2.8	4.5	19.8	18.0	16.8	127.2
Compressed earth block	4.9	4.0	1.5	4.0	2.4	1.5	3.5	4.9	4.9	3.5	4.2	4.9	2.0	
	9.0	6.3	0.3	15.7	12.0	4.2	1.2	5.1	5.4	5.0	19.8	18.8	8.0	110.8
Aerocon Panels	1.7	4.9	4.8	4.9	4.7	4.8	4.5	3.9	3.5	4.2	4.8	3.5	4.8	

	3.1	7.7	1.1	19.3	23.5	13.5	1.5	4.1	3.9	6.0	22.6	13.4	19.2	138.7
Hollow concrete Block	2.4	4.7	2.8	4.5	4.2	4.8	4.5	4.4	4.0	4.5	4.9	3.5	3.5	
	4.4	7.3	0.6	17.7	21.0	13.5	1.5	4.6	4.4	6.4	23.1	13.4	14.0	132.0

Table 18: Calculation of weighted score for alternatives– Plastering

	A	B	C	D	E	F	G	H	I	J	K	Total Score
Evaluation criteria weightage	3.2	2.1	3.7	5.0	3.3	0.8	1.4	1.6	0.5	3.6	4.4	
Gypsum Board	4.3	4	3.5	3.7	2	4.5	4.8	4.8	3.8	3.8	4.6	
	13.7	8.3	13.0	18.5	6.6	3.5	6.7	7.8	1.9	13.7	20.2	113.97
Rice husk Gypsum Board	4.9	4.0	3.3	3.5	2	4.5	3.9	3.5	4	4.3	4.7	
	15.6	8.3	12.2	17.5	6.6	3.5	5.4	5.7	2.0	15.5	20.7	113.13
Laminated Bagasse Cement Board	1.8	4.3	4	4	3	4.2	3.9	3.7	4.2	4.2	4.2	
	5.7	8.9	14.8	20.0	9.8	3.3	5.4	6.0	2.2	15.2	18.5	109.86
Bamboo Board	1.5	4.9	4.5	4.5	4	4.2	4.0	3.7	3.5	4.2	4.8	
	4.8	10.2	16.7	22.5	13.1	3.3	5.5	6.0	1.8	15.2	21.1	120.21
Agricultural Fiber cement composite board	3.1	4.1	3.7	3.8	3.5	4.2	3.8	3.5	4	4.3	3.5	
	9.9	8.5	13.7	19.0	11.5	3.3	5.3	5.7	2.0	15.5	15.4	109.85

From the above tables (Table 17 and 18), the maximum scores are achieved by Aerocon panels for item “external wall” item and by bamboo board for item “plastering”. Hence these items has been the best alternative the item.

Aerocon panels are the inorganic bonded sandwich panels made of two fiber reinforced cement sheets sandwiching a light-weight core consisting of Portland cement, binders and a mix of siliceous aggregates. Though Aerocon board have higher initial cost but other advantages such as low maintenance, lower sound and thermal conductivity, higher durability, higher strength to weight ratio, higher rate of construction and reusability make it better alternative for construction of external wall. Due to high strength to weight ratio, there will less dead weight on the building which consequently minimizes earthquake load which ultimately results in material saving. The high durability, low maintenance and low thermal conductivity of the panel minimizes it life cycle cost. Low thermal conductivity not only ensures saving in HVAC cost but also save considerable amount of fuel to be consumed for generating electricity throughout its life and hence reduces significant carbon emission.

It can be further noted that if we use Aerocon panel than there is no need of plastering. This is a great advantage and results in a huge reduction of cost and material, making it not only economical but highly environmentally sustainable and justified its initial cost.

4. Conclusion

Value engineering is a potent methodology for increasing value, cutting costs, and improving quality. The purpose of this study is to demonstrate the benefits of applying value engineering in the construction industry and to draw conclusions about how the technique functions. It is not properly used in India and is conflated with the idea of cost-cutting. One can utilize a variety of cost-cutting strategies, including material management, budgetary control, waste management, and value engineering, to solve the value, cost, and quality problems. Value Engineering is the most popular technique that has a significant impact on cost reduction. The primary goal of using VE in sustainable building construction projects has been to maximize benefit or value. The advantages can take many different forms, such as design enhancements, cost savings, ongoing improvement, the use of new materials, improved construction techniques, employee engagement in decision-making processes, enhanced skills gained from teamwork, optimized quality and performance requirements, and improved functional reliability and system performance. A well-organized VE job plan can help in developing alternatives for building systems that improve performance and quality outcomes while being less expensive from a life cycle assessment or analysis perspective. It is significant to emphasize that initiatives using VE may have better sustainability outcomes when system functions are well understood.

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References

1. Gohil, Pooja, and Shaishav Patel. "Review of value engineering in Indian construction industry." International Journal of Advanced in Management, Technology and Engineering Sciences 8 (2018): 1080-1085.
2. Gunarathne, A. S., N. Zainudeen, C. S. R. Perera, and B. A. K. S. Perera. "A framework of an integrated sustainability and value engineering concepts for construction projects." International Journal of Construction Management 22, no. 11 (2022): 2178-2190.
3. KianiMavi, Reza, Denise Gengatharen, Neda KianiMavi, Richard Hughes, Alistair Campbell, and Ross Yates. "Sustainability in construction projects: a systematic literature review." Sustainability 13, no. 4 (2021): 1932.
4. Abdelghany, Mohamed, RachaRachwan, Ibrahim Abotaleb, and A. Albughdadi. "Value engineering applications to improve value in residential projects." In Proceedings of the Annual Conference–Canadian Society for Civil Engineering, Regina, SK, Canada, pp. 27-30. 2015.
5. MeselhyElsaeed, Mohamed Said, and Amira HamdiAbdelhamedGomaa. "INTEGRATION OF VALUE MANAGEMENT AND RISK ANALYSIS IN THE CONSTRUCTION PROJECT." Engineering Research Journal-Faculty of Engineering (Shoubra) 51, no. 3 (2022): 218-227.
6. Rosłon, Jerzy, MariolaKsiążek-Nowak, and Paweł Nowak. "Schedules optimization with the use of value engineering and NPV maximization." Sustainability 12, no. 18 (2020): 7454.
7. Al Amri, Tariq, and Manuel Marey-Pérez. "Value engineering as a tool for sustainability in the construction industry of Oman." Value Eng 29 (2020): 7433-7444.
8. Janani, R., P. K. Chakravarthy, and Dr R. Rathan Raj. "A study on value engineering & green building in residential construction." International Journal of Civil Engineering and Technology 9, no. 1 (2018): 900-907.
9. Gohil, Pooja, and Shaishav Patel. "Review of value engineering in Indian construction industry." International Journal of Advanced in Management, Technology and Engineering Sciences 8 (2018): 1080-1085.
10. Achieving Sustainability in Construction through Value Management, International Conference on Industrial Engineering and Operations Management Paris

11. ATABAY, Şenay. "Determination of exterior material in sustainable buildings by value engineering method according to LEED criteria." Journal of Sustainable Construction Materials and Technologies 8, no. 1 (2023): 1-11.
12. Marut, Johnson Josiah, John OkweAlaezi, and C. O. Igwe. "A Review of Alternative Building Materials for Sustainable Construction towards Sustainable Development." (2020).
13. Bumanis, Girts, Laura Vitola, Ina Pundiene, Maris Sinka, and Diana Bajare. "Gypsum, Geopolymers, and starch Alternative binders for bio-based building materials: A review and life-cycle assessment." Sustainability 12, no. 14 (2020): 5666.
14. Khoshnava, SeyedMeysam, RahelehRostami, AlirezaValipour, Mohammad Ismail, and Abdul Razak Rahmat. "Rank of green building material criteria based on the three pillars of sustainability using the hybrid multi criteria decision making method." Journal of Cleaner Production 173 (2018): 82-99.
15. Tam, Vivian WY, MahfoozSoomro, and Ana Catarina Jorge Evangelista. "A review of recycled aggregate in concrete applications (2000–2017)." Construction and Building materials 172 (2018): 272-292.
16. Islam, Hamidul, Margaret Jollands, and SujeevaSetunge. "Life cycle assessment and life cycle cost implication of residential buildings A review." Renewable and Sustainable Energy Reviews 42 (2015): 129-140.
17. Kamali, Mohammad, and KasunHewage. "Life cycle performance of modular buildings: A critical review." Renewable and sustainable energy reviews 62 (2016): 1171-1183.
18. Eleftheriadis, Stathis, DejanMumovic, and Paul Greening. "Life cycle energy efficiency in building structures: A review of current developments and future outlooks based on BIM capabilities." Renewable and Sustainable Energy Reviews 67 (2017): 811-825.
19. Chau, Chi Kwan, T. M. Leung, and W. Y. Ng. "A review on life cycle assessment, life cycle energy assessment and life cycle carbon emissions assessment on buildings." Applied energy 143 (2015): 395-413.
20. Abu-Jdayil, Basim, Abdel-Hamid Mourad, Waseem Hittini, Muzamil Hassan, and SuhaibHameedi. "Traditional, state-of-the-art and renewable thermal building insulation materials: An overview." Construction and Building Materials 214 (2019): 709-735.

21. Orsini, Federico, and Paola Marrone. "Approaches for a low-carbon production of building materials: A review." Journal of Cleaner Production 241 (2019): 118380.
22. Rad, KavehMiladi, and Omid AminoroayaieYamini. "The methodology of using value engineering in construction projects management." Civil Engineering Journal 2, no. 6 (2016): 262.
23. Kissi, Ernest, E. BannorBoateng, TheophilusAdjei-Kumi, and Edward Badu. "Principal component analysis of challenges facing the implementation of value engineering in public projects in developing countries." International Journal of Construction Management 17, no. 2 (2017): 142-150.
24. Ilayaraja, K., and Zafar Eqyaabal. "Value engineering in construction." Indian Journal of Science and Technology 8, no. 32 (2015): 1-8.
25. Chen, Wei Tong, Hew Cameron Merrett, Shu-Shun Liu, Nida Fauzia, and FerdinanNiksonLiem. "A Decade of Value Engineering in Construction Projects." Advances in Civil Engineering 2022 (2022).
26. Rachwan, Racha, Ibrahim Abotaleb, and Mohamed Elgazouli. "The influence of value engineering and sustainability considerations on the project value." Procedia Environmental Sciences 34 (2016): 431-438.