International Journal of Civil and Structural Engineering Research ISSN 2348-7607 (Online)
Vol. 6, Issue 1, pp: (259-266), Month: April - September 2018, Available at: www.researchpublish.com

A NOVEL HYBRID ARCHITECTURE FOR BUILDINGS BY IMPARTING VALUE ENGINEERING

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Abstract: **Saving money and, at the same time, providing better value is a concept that everyone can support. The benefits of spreading our invested rupee, building more for less money, increasing efficiency and cutting down our dependency on energy-intensive buildings and plant facilities need to be recognized today and pursued in the future. Value Engineering (VE) is not just "good engineering", it is not a suggestion program or a routine plan review, but it is a new, fresh look at problems starting from basic functional requirements – an independent approach to the project. Keeping the costs low with traditional cost management has been a commonly applied measure to improve competitiveness. However, keeping cost down alone is not enough; there is an increasing need for not just efficiency but also for effectiveness. No matter how efficiently a product or service is provided, it will not be successful unless it is wanted, i.e. it is effective. VE is thus arguably of greater importance than cost management efforts. It is committed with the lowest life cycle cost and reliable completion of the functions required by the user. Finally analyzes the application of value engineering in various stages of lifecycle in construction projects.**

Keywords: **Value Engineering, life cycle.**

1. OBJECTIVE

There is always a scope to improve value, interms of materials value or the worth. The main objective is to provide all necessary functions at a lowest cost. It also includes:

I. To study for viable alternatives that can improve the value of the structure.

II. To understand and compare the cost saving attained after conducting value engineering study with that of conventional one.

III. Recommendation of best alternatives to the organization of case study.

IV. Experimental investigation on temperature variation inside the rooms.

V. Recommending the room which most energy efficient.

2. SCOPE OF STUDY

In this work, an attempt has been made to apply various value engineering techniques in the following areas:

I. Use of alternative materials

II. Energy efficiency

Apart from application in the above mentioned areas, value engineering techniques can be applied in logistics, material procurement, and design of services, construction methodology, and quality and inventory management. Thus, it is observed that the scope for application is present almost in every aspect of any industry.

3. PROJECT DETAILS

SP INFO CITY, IT PARK:

Project : **COMMERCIAL**

Location : **PERUNGUDI, CHENNAI**

Project Budget : **220 CRORES**

Total Area : **8.4 ACRES**

Figure 1

SITE LOCATION:

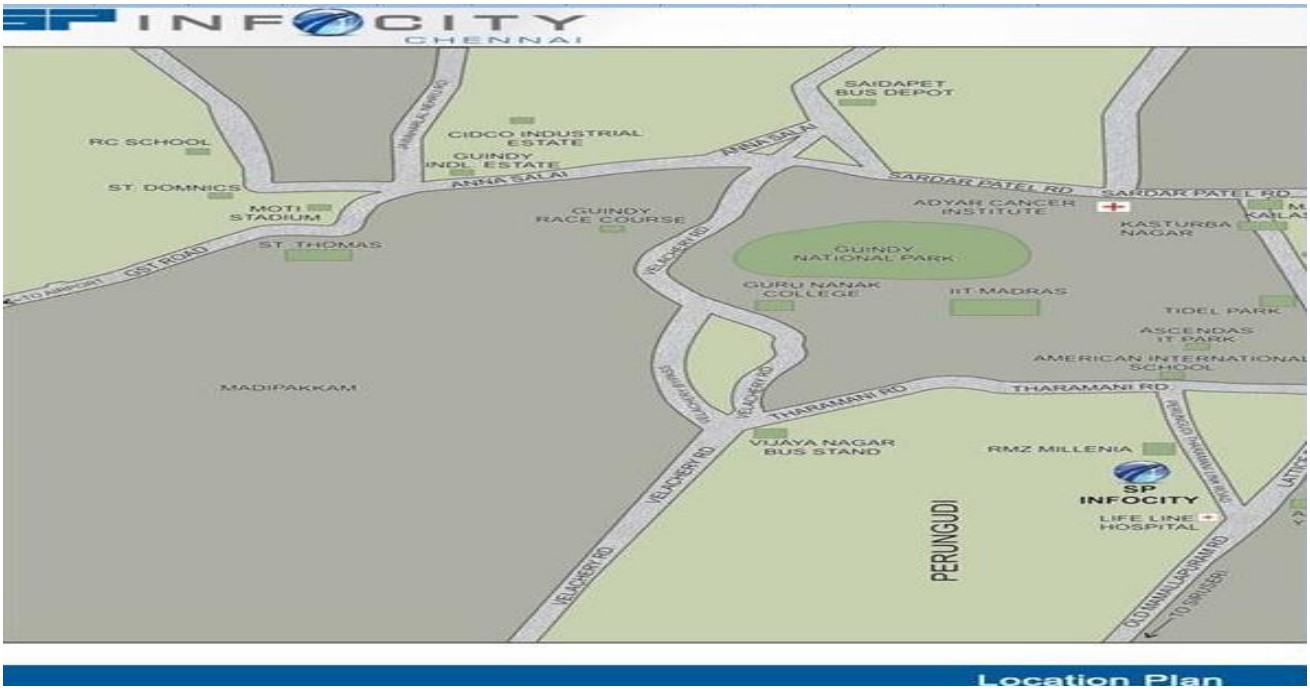

Figure 2: PROJECT LOCATION

Figure 2 explains the project location of SP Info City IT Park has been designed as a green building as per world – class systems and procedures. Design features considered will have an impact on energy efficiency levels and will result in tangible and intangible benefits for the occupants.

SP Info City IT Park:

The following world-class systems & procedures are being considered in SP Info City:

- Energy Efficiency of Equipment & Systems – ASHARE 90.1
- Lighting – IESNA standards
- Indoor Air Quality – ASHRAE 62
- Thermal comfort - ASHRAE 55

The performance of the building will also be monitored by an Intelligent Building Management System (IBMS)

The SP Info City IT Park at Chennai is aiming for a LEED certification. This building had a total floor area of 1,015,436 sq.ft.

4. PROJECT DETAILS OF CASE STUDY

SP Info City IT Park at Perungudi has been designed as a green building as per world class systems & procedures

4.1 Construction

Wall construction: The building uses autoclaved aerated (AAC) blocks with a U-value of 0.12, which has a very high insulation property. Their high fly ash content (55%) further helps the building to address environmental concerns.

Roof construction and finish: The building uses over deck R-15 extruded polystyrene insulation. In addition to the insulation, the building roof has a high – albedo finish. The high reflectivity and emissivity of the finish ensures that a large percentage of the incident heat energy is not absorbed by the roof.

High performance glazing: Most of the glazing area is on the north façade of the building – the shading coefficient and light transmittance for this glass were developed very carefully in order to enhance available daylight in the space and maintain visual comfort for the occupants without comprising on energy – efficiency.

4.2 Indoor Environmental Quality

Temperature and Humidity: The equipment and systems are designed in such a way that the air-conditioned space will be maintained at 24^{o} C and 50-60% RH, throughout the operation of the building, irrespective of the occupancy levels and outside ambient condition.

CO2 Monitoring: CO2 levels in the conditioned space will also be continuously monitored and maintained at a pre-determined value. This will further enhance the productivity of the building occupants.

Finishes: Adhesives, sealants, paints, resins used in finishes are selected with low volatile organic carbon (VOC) content. These features will also enhance the human comfort levels.

Efficient Lighting: Efficient fluorescent lamps (T5s) and luminaries with high coefficient of utilization have been used in most of the zones to achieve efficient lighting.

Daylight sensors: The common spaces like lobbies, lounges and the food court are amply day lit. This has been achieved with the selection of glass with optimum visible transmittance. This has been integrated into IBMS by using daylight sensors, which continuously dim interior lights depending on the available quantum of daylight.

5. DATA COLLECTION

Table 5.1: FUNCTIONAL DEFINITION WORKSHEET

Sl. No	Description	Quantity	Unit	Cost Rs.	Function
1	Total RCC work	38500	Cu.m	20,72,05,763	Facilitate Function
2	Total brick masonry work	22830	Sq.m	2,02,06,230	Exclude Elements Divide Space

					Facilitate Use
3	Internal Plastering	48000	Sq.m	48,00,000	Hide Defects Improve aesthetics Prevent Water
4	External Plastering	42273	Sq.m	80,31,870	Hide Defects Improve aesthetics Prevent Water
5	Doors (MS Frame with glass shutter, fittings & joinery)			2,35,67,300	Control Access Connect Spaces
6	Waterproofing work			75,25,000	Prevent Water
7	Flooring	55740	Sq.m.	5,21,49,377	Increase Life Facilitate Use Improve Aesthetics
8	Painting (Internal)	48000	Sq.m.	62,34,400	Improve Appearance Hide Defects
9	Painting (External)	42273	Sq.m.	54,90,550	Improve Appearance Hide Defects
10	Windows & Glazing			3,56,75,450	Provide Ventilation Provide Light
11	Grills & Railings			1,25,34,545	Provide Safety Provide Appearance
12	Plumbing Works		L.S	83,55,750	Convey Fluid
13	Electrical Works		L.S	1,12,56,834	Provide Light Provide Points Improve Safety
14	Fire fighting Works		L.S	54,00,000	Provide safety
15	Solar Unit Works		L.S	2,24,56,789	Harness Renewable Source
16	Lift Works	8	Nos	35,00,000	Transport Vertically Increased Comfort Provide safety

6. RESULTS AND DISCUSSIONS

After using the technique of Brainstorming, various alternatives were evaluated in this phase using Complex Democratic Approach.

Table 6.1: WEIGHTED MATRIX SHEET FOR STAIRCASE FOYER

Criteria	**A**	**B**	**C**	**D**	**E**	**F**	**G**	
Raw Score	7	11	3	2	7	8	16	
Weighted Score	4.38	6.75	1.88	1	4.38	5	10	
Alternatives								**Total score**
Separating the staircase and the lift and putting them adjacent flush with each other at the entry points.	5	5	5	5	5	5	5	166.95
	21.9	33.75	9.4	5	21.9	25	50	
Separating the staircase and the lift and putting them adjacent flush with the external wall.	5	3	4	4	4	5	5	146.19
	21.9	20.25	7.52	4	17.52	25	50	
Separating the staircase and the lift and putting them opposite to each other, with the lift enclosure being retained in the current location.	1	4	2	3	2	5	1	81.9
	4.38	27.0	3.76	3	8.76	25	10	
Separating the staircase and the lift and putting them opposite to each other, with the staircase enclosure being retained in the current location.	2	4	2	4	2	5	4	117.28
	8.76	27.0	3.76	4	8.76	25	40	

Separating the staircase and the lift and putting them adjacent flush with each other at the entry points is selected having a total score of 166.95 after the evaluation.

Table 6.2: WEIGHTED MATRIX SHEET FOR SERVICE DUCTS COVER

Criteria	A	B	C	D	E	F	G	H	
Raw Score	12	22	8	5	10	7	3	5	
Weighted Score	5.45	10	3.63	2.27	4.54	3.18	1	2.72	
Alternatives									**Total Score**
Concrete and Brickwork	2	4	3	4	3	4	3	4	111.09
	10.9	40.0	10.89	9.08	13.62	12.72	3.0	10.88	
Jalli work	3	3	3	3	2	3	3	3	93.83
	16.35	30.0	10.89	6.81	9.08	9.54	3.0	8.16	
Kadappa slabs	4	1	4	2	3	3	4	4	88.9
	21.8	10.0	14.52	4.54	13.62	9.54	4.0	10.88	
Glazing	4	5	4	3	5	3	5	4	141.25
	21.8	50.0	14.52	6.81	22.7	9.54	5.0	10.88	
Brickwork and Kadappa	3	2	3	4	3	3	4	3	91.64
	16.35	20.0	10.89	9.08	13.62	9.54	4.0	8.16	

Table 6.3: WEIGHTED MATRIX SHEET FOR VENTILATION

Criteria	A	B	C	D	E	F	G	H	
Raw Score	13	14	11	5	5	7	2	3	
Weighted Score	7.64	8.23	6.47	2.94	2.94	10	1	1.76	
Alternatives									Total Score
No window or ventilator	5	3	4	4	4	1	4	2	129.81
	38.2	24.69	25.88	11.76	11.76	10	4	3.52	
Only window (openable)	2	3	3	3	3	2	2	3	104.3
	15.28	24.69	19.41	8.82	8.82	20	2	5.28	
Fixed window and louvered ventilator	1	3	3	3	3	2	2	3	96.66
	7.64	24.69	19.41	8.82	8.82	20	2	5.28	
Retaining Ventilator and removing window	5	4	4	4	3	5	3	4	177.62
	38.2	32.92	25.88	11.76	8.82	50	3	7.04	

After analyzing the alternative of Retaining ventilator and removing window is selected as it does not hamper ventilation and at the same time satisfies the other criterion with a total score of **177.62**. The rate is Rs. 140/Sft

Table 6.4: WEIGHTED MATRIX SHEET FOR EXTERNAL WALLS

Criteria	A	B	C	D	E	F	G	H	I	J	K	L	
Raw Score	6	2	10	22	17	7	14	13	13	9	4	16	
Weighted Score	2.72	1	4.54	10	7.72	3.18	6.36	5.9	5.9	4.09	6.36	2.72	
Alternatives													Total Score
'Siporex' block	2	4	3	4	4	4	5	4	4	2	4	5	232.88
	5.44	4	13.62	40	30.88	12.72	31.8	23.6	23.6	8.18	25.44	13.6	
Solid concrete block	3	3	3	3	2	4	2	3	4	3	4	3	182.93
	8.16	3	13.62	30	15.44	12.72	12.7	17.7	23.6	12.7	25.44	8.16	
Hollow concrete block	3	3	3	3	3	3	3	3	3	3	4	3	187.83
	8.16	3	13.62	30	23.16	9.54	19.0	17.7	17.7	12.2	25.44	8.16	
Plywood	4	4	1	1	5	1	4	3	2	3	3	1	160.21
	10.8	4	4.54	10	38.6	3.18	25.4	17.7	11.8	12.2	19.08	2.72	
Burnt Brick	5	2	2	2	3	3	3	2	3	4	2	3	161.7
	13.6	2	9.08	20	23.16	9.54	19.0	11.8	17.7	16.3	12.72	8.16	

After analyzing the alternatives of "Siporex" blocks are considered for development. It is considered as it performs all the functions required with high thermal efficiency and high pace of construction. It gains a total score of **232.88.** The rate is Rs. 74/block.

Table 6.5: WEIGHTED MATRIX SHEET FOR PARKING SPACE & DRIVEWAY ALTERNATIVES FOR PARKING SPACE

Criteria	A	B	C	D	E	F	G	H	
Raw Score	9	11	9	10	2	8	2	10	
Weighted Score	8.1	10	8.1	9	1	7.2	1.8	9	
Alternatives									Total Score
IPS Flooring	2	3	3	3	3	4	3	3	161.7
	16.2	30	24.3	27	3	28.8	5.4	27	
Shahbad Tiles	3	4	4	3	3	3	3	3	180.7
	24.3	40	32.4	27	3	21.6	5.4	27	
Cement Concrete Flooring	2	2	3	3	3	4	3	3	151.7
	16.2	20	24.3	27	3	28.8	5.4	27	
Interlocking Blocks	3	4	2	2	3	3	3	2	146.3
	24.3	40	16.2	18	3	21.6	5.4	18	

After analyzing the alternatives, Shahbad tiles are selected as it serves the purpose of facilitating use. Moreover, if arranged properly, the aesthetics is also increased. It gains a total score of 180.7. The rate is Rs.110/sqmt.

Table 6.6: WEIGHTED MATRIX SHEET FOR WINDOWS

Criteria	A	B	C	D	E	F	G	H	
Raw Score	5	12	11	10	5	10	3	9	
Weighted Score	4.16	10	9.16	8.33	4.16	8.33	1	7.5	
Alternatives									Total Score
MS Window	4	2	2	3	3	3	3	2	135.42
	16.64	20	18.32	24.99	12.48	24.99	3	15	
'NCL Seccolor' Window	3	5	4	5	4	5	3	4	232.06
	12.48	50	36.64	41.65	16.64	41.65	3	30	
Aluminum Sliding Window	3	3	4	4	4	4	3	3	187.9
	12.48	30	36.64	33.32	16.64	33.32	3	22.5	

After analyzing the alternative of 'NCL Seccolor' Window is considered as not hamper ventilation and at the same time, is aesthetically excellent and provides 100% opening satisfies the other criterion with a total score of 232.06. The rate is Rs. 1500/sqmt.

Table 6.7: WEIGHTED MATRIX SHEET FOR CEILING PLASTERING

Criteria	A	B	C	D	E	F	G	H	
Raw Score	5	1	11	8	8	13	3	8	
Weighted Score	3.84	1	8.46	6.15	6.15	10	2.30	6.15	
Alternatives									Total Score
Cement Mortor Plastering	2	3	2	3	2	3	3	3	122.16
	7.68	3	25.38	18.45	12.3	30	6.9	18.45	
No Plastering	5	2	4	4	3	4	4	4	164.21
	11.52	2	33.84	24.6	18.45	40	9.2	24.6	

The alternative to POP plastering as underside of ceiling without plastering is considered. With increased supervision and better quality formwork, a considerable saving in terms of time, material and cost is observed. The rating obtained by the alternative is 164.21

Table 6.8: PROPOSALS OF VALUE ENGINEERING FOR THE CASE STUDY

Sl.No	Proposed idea	(-)Reduction / (+) Increase in cost (Rs)	Remarks
1	Providing M35 grade concrete in columns from 2^{nd} to 9^{th} floor	- 660000	The loads imposed on upper columns are less compared to the lower ones.
2	M30 grade concrete in slabs and beams of all floors	-31089400	M25 satisfies the requirements of structural requirement.
3	Separating the staircase and the lift and putting them adjacent, flush with each other	-3542960	Development Authority requirements

	at the entry points.		
4	High performance glazing for service duct	+219200	Aesthetically pleasing
5	Providing an aluminum beading between the skirting and plastering	+379032	Increased in cost is justified as aesthetically being more appealing
6	Retaining the ventilator and removing the window part	-235100	Allows light but not wind.
7	Providing Ramps to access Entrance of building	Not Quantifiable	Ramps will enable both physically and old people to use the facility
8	"Siporex" blocks masonry for all external walls	+1218200	2/3rd weight of AAC blocks, uniform dimension, thermal resistant, eliminates leaching
9	"NCL Seccolor" windows with 100% opening	No Change	Facilitate better use, increased life and aesthetically excellent.
10	Terracotta tiles in terrace area	-543790	Cost effective, breaks monotony, Aesthetically pleasing
11	Underside roof plastering	-942385	Use of high quality formwork
12	Use of Shahbad tiles in parking and drive way area	-1023229	Shahbad tiles provide all the functions of Interlocking Blocks.
Total Savings		Rs 3,62,20,432	

7. CONCLUSION

It is observed that Value Engineering aims to deliver measurable value improvements through cost reduction and to improve quality and enhance design features for the customer. This has been systematically applied in the architectural, structural and material components of the building. During the study, the alternatives and currently existing facilities were evaluated by conducting a fairly detailed rate analysis, technical feasibility and aesthetic survey.

The key areas where Value Engineering has been applied are Column, beam and slab designs are Safety to lift and staircase users, Use of new and better technology materials for walls, windows, Use of aesthetically pleasing and more durable materials without increase in cost,Making the building more user-friendly for physically challenged and old citizens, adding a touch of humanity. With the development of the proposals and by projecting the increased values, the Value Engineering study comes to an end.

The enhancement in value as a result of VE can be seen in better arrangement of lift and foyer area providing better utility. The walls have been replaced by high quality, durable and light weight "Siporex" blocks. The provides increased comfort to user of the building as they are thermal resistant, meaning the temperature inside is lesser (upto 7 degree C) compared to external temperature. The requirements of the user were kept in mind during the study, and hence ramps are provide in the entrance area so that physically challenged and old people can use the facilitate independently. "NCL Seccolor" windows have been recommended as they have increased life, provide 100% opening and are extremely beautiful compared to aluminum windows. The requirements of structural aspects have been looked into M30 grade concrete has been suggested in place of M35, as it was found to be sufficient to transfer the loads effectively. These are some of the value-engineered elements that are believed to provide more comfort to the ultimate user without compromising on the quality, time or cost. This proves the scope and application of Value Engineering in building construction is tremendous, from both the developers and buyers point of view. Until recent times, VE was applied only in large turnkey projects like waste water treatment plants. It is sincerely hoped that this study opens new dimensions in the construction industry for the purpose of providing the best facility ultimately to the end user.

REFERENCES

[1] Ahuja., Hira, N., and Michael A Walsh (2000), *Successful Methods in Cost Engineering*, A Wiley Interscience Publication, New York.

[2] Best., Rick., and Gerard De Valence (1999), *Building in value – Pre-design issues*, Hodder Headline Group, London.

[3] Brayant, J (1992), *Managing Value—Model II Seminar Notes*, Value Management Associates, Massachusetts.

[4] Fallon., and Carlos (1991), *Value Analysis to Increase Productivity*, John Wiley & Sons Inc, New York.

[5] Gage,WL (2000), *Value Analysis*, Mc Graw Hills Publishers, London.

[6] Gokhram,P.R (1998), *Value Engineering*, National Productivity Council, New Delhi.

[7] Green, SD., and Popper, PA (1990), *Value Engineering – The Search for Unnecessary Cost*, CIOB Occasional Paper, London.

[8] Heller,E, (1971), *Value Management and Cost Reduction*, Addition Willey Publishing Company, Philippines.

[9] Kelly,J., and Male,S (1993), *Value Management in Design and Construction*, E&F.N.Spon, London.

[10] Krishnan, P., and Saxena, KR (1994), *Value Engineering in Project Management*, Oxford IBH Publications, Oxford.

[11] Norton,R Brain., William,C., Mc Elligot (1995), *Value Management Construction*, McMillan Press Ltd, London.