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Life Cycle Cost Analysis of Commercial Building (Collector Office Pune) with Sustainability Approach

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Abstract: ***The purpose of this is to highlight the role of life cycle cost (LCC) analysis in the feasibility study of construction projects, especially in the public sector. Feasibility study is usually conducted in the early phase of construction projects when the greatest benefit of LCC can be obtained. The commonly used construction cost minimization approach should be replaced with LCC optimization. In order to achieve the maximum value for money, all costs incurred over the whole life span must be evaluated. Life cycle costing is a method of economic analysis directed at all costs related to constructing, operating, and maintaining construction project over a defined period of time. The optimization of the LCC of a project, construction or equipment, inessential for the complex decision-making process. It is then at this point that the solution with the minimum value of LCC can be chosen. The public sector in the India is now beginning to require quantification of LCC when deciding on construction. In addition, LCC has become a criterion in public tenders. This summarizes the experience of assessing building designs in terms of LCC. Not only public sector benefits are identified and summarized but also some significant difficulties. Case studies are provided.***

Keywords: ***Pune Collector Office, LCCA, Life Cycle Cost, Solar Energy Construction project, feasibility study, life cycle cost, public sector.***

I. INTRODUCTION

Sustainable development and the protection of the environment are key issues in our society today. The international concern about CO_2. 6Rio de Janeiro Convention of 1992 and to the Kyoto protocol 1997. India contributed 6.3 per cent of all global CO_2 emissions in 2015 India's emission grew by 5.2 per cent in 2015.The building stock in India accounts for over 40% of the final energy consumption in the India of which dwellings represent 57% of the total energy consumption.. It is certainly clear that the building sector can improve a lot in order to reduce the greenhouse gas emission to embark the climate changes. India's construction sector is assessed at Rs.6000 billion or 100 billion dollars. As a result of government spending, private investments as well as foreign direct investment, has made India number one of the top ten spending nations on construction in the world. We manufacture more than 250 million tons of cement and are second only to China. A recent report "Global Construction 2020", estimates that India will be the third largest global construction market after China and USA. In order to improve the standard of living of her population, one of the key hurdles that face today's India is to overcome the challenge of infrastructure bottlenecks. Consequently the federal government has announced our 11th five years plan which allocates 9% of the GDP to infrastructure projects. The National Planning commission - an apex federal body has estimated an allocation of 515 billion dollars which is equivalent to Rs.23 trillion to infrastructure sectors over the next five years. This includes construction of Roads, Highways, Airports, Bridges, Ports, Railways as well as water supply and sanitation amongst few others. The 12th five years plan projects an investment of 10% of the national GDP into infrastructure which equates to 1 trillion dollars or equivalently Rs.45 trillion.

II. LITERATURE REVIEW

Many paper gives clear idea about Energy & Cradle to Grave Analysis. Most commonly, production cost is the main costfactor in construction and is often set to the minimum, which does not necessarily improve the lifetime performance of buildings. However, a higher production cost might decrease total life cycle cost (LCC). It is important, therefore, to show the construction client in the early design phase the relationship between design choices and the resulting lifetime cost. Today, LCC calculation is used extensively for industrial products to minimize production cost and increase profit. This paper presents a state of the art analysis in

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the area of LCC for construction. It offers a structural overview of theoretical economic methods for LCC analyses and their restrictions as described in the literature. The paper also reveals the primary data which are required to carry out a LCC analysis and discusses limitations in the application of life cycle costing from the client's perspective.

The objective of the conducted research was to investigate what kind of energy analyses are possible to carry out in the early design phase to give the decision makers a more holistic view of the energy performance of a building over its life cycle. This study shows that energy calculations usable for design decision can be made at different levels of information maturity. When the information maturity is higher and indoor climate simulations are possible to make at room level, the result gets more accurate. However, the use of more sophisticated energy simulations tools is time consuming and error prone since the amount of input data needed is much higher. The resulting life cycle costs of the different cases are strongly affected by the estimated energy consumption, the selected real rate of interest, the forecast of energy prices as well as the discount time. The study shows that energy calculations are usable for the decision making of design alternatives in the early design phase. Also, life cycle cost estimates can support the decision makers in the analysis of different financial scenarios.

III. METHOD

When undertaking research it is important to choose a s strategy, to ensure that the research objectives can be met and that the findings can be validated. Research design is a strategy for linking the research questions together in the research project. To find the right strategy for answering the research questions, different types of approach have been considered. There are three types of research strategies to be used for different types of research questions. Survey, History & Case study. The choice of research strategy depends on what kind of research questions there are. The research questions in this study are "what" and "how" questions. Research questions starting with "what", will give two possible approaches to the strategy.

IV. RESULT

Figure 1: Figure of District Collector Office, Pune

Table 1 - Energy Consumption & Operation & Maintenance Costs For The Collector Office, Pune In 2017

Particular	Before EEA (2017)	After EEA (2018)
Investment cost	Rs. 66,30,00,000	Rs. 66,30,00,000+1,50,00,000
Electricity consumption	16kW-h approx 192 kWh per year	16kW-h approx 192 kWh per year (NO COST)
Repair & maintenance	98,000 per month	1,20,000 per month
Water	$5m^3$ per day	$5m^3$ per day

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Fuel	110kVa DG set - 330 Liters Diesel/month	60kVa DG set - 100 Liters Diesel/month
Water proofing	Rs 3,37,000	Rs 3,37,000
Coloring	Rs 492000	Rs 492000
Plumbing/Piping-fire pipe/drainage	Rs 779500	Rs 779500

A. LCCA Applied To Collector Office, Pune

As the building of Collector Office, Pune is constructed in year 2017 as it's has been fully in operation & in future at least giving service for 20 more years till 2038. The comparative study of LCCA calculation with & without Energy efficient Approach is given below.

Table 2 - Lcc For Collector Office, Pune Without Energy Efficiency Approach

No of Year	Year	Capital	Energy	Maintenance	Repair/ Replace	Total Cost
0	2017	663000000	2867160	854400	0	666721560
1	2018	0	3053525	909936	0	3963461
2	2019	0	3252005	969082	0	4221087
3	2020	0	3463385	1032072	9945000	14440457
4	2021	0	3688505	1099157	0	4787662
5	2022	0	3928258	1170602	0	5098860
6	2023	0	4183594	1246691	8619000	14049285
7	2024	0	4455528	1327726	0	5783254
8	2025	0	4745137	1414028	0	6159165
9	2026	0	5053571	1505940	7293000	13852511
10	2027	0	5382053	1603826	0	6985879
11	2028	0	5731887	1708075	0	7439962
12	2029	0	6104460	1819100	5967000	13890560
13	2030	0	6501249	1937341	0	8438590
14	2031	0	6923831	2063269	0	8987100
15	2032	0	7373880	2197381	4641000	14212261
16	2033	0	7853182	2340211	0	10193393
17	2034	0	8363639	2492324	0	10855963

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18	2035	0	8907275	2654326	3315000	14876601
19	2036	0	9486248	2826857	0	12313105
20	2037	0	10102854	3010602	0	13113456
21	2038	0	10759540	3206291	1989000	15954831
Total		663000000	132180766	39389237	41769000	876339003

Table 3 - Lcc For Collector Office, Pune With Energy Efficiency Approach

No of Year	Year	Capital	Energy	Maintenance	Repair/ Replace	Total Cost
0	2017	663000000	116574	991037	0	664107611
1	2018	5000000	124151	1055454	0	6179605
2	2019	5000000	132221	1124059	0	6256280
3	2020	5000000	140816	1197123	0	6337939
4	2021	0	149969	1274936	0	1424905
5	2022	0	159716	1357807	0	1517523
6	2023	0	170098	1446064	6630000	8246162
7	2024	0	181154	1540058	0	1721212
8	2025	0	192929	1640162	0	1833091
9	2026	0	205470	1746772	0	1952242
10	2027	0	218825	1860313	0	2079138
11	2028	0	233049	1981233	4972500	7186782
12	2029	0	248197	2110013	0	2358210
13	2030	0	264330	2247164	0	2511494
14	2031	0	281512	2393230	0	2674742
15	2032	0	299810	2548790	0	2848600
16	2033	0	319297	2714461	3315000	6348758
17	2034	0	340052	2890901	0	3230953
18	2035	0	362155	3078809	0	3440964
19	2036	0	385695	3278932	0	3664627
20	2037	0	410765	3492063	0	3902828
21	2038	0	437465	3719047	1657500	5814012
Total		**678000000**	**5374250**	**45688428**	**16575000**	**745637678**

B. LCCA Results for Collector Office, Pune

Life cycle cost calculation for Collector Office, Pune and savings are calculated as follows:

1) Capital cost of Energy Efficient Systems = 1,50,00,000 INR
2) LCC without EE approach = 87,63,39,003 INR
3) LCC O&M Energy-Efficient approach = 74,56,37,678 INR
4) Total Cost Saved = 13,07,01,325 INR

LCC Calculation Results

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Energy efficient approach with above describe system requires initial investment in the range of 2.26 % of the building cost. With this minimum investment the company can save 14.91%of total cost can be saved over span of 20 years.

V. CONCLUSION

A. In a construction projects more importance is to place the up-front costs, with less attention to future cost. In order to improve long term decision making in construction sector life cycle cost analysis is very important.
B. LCCA have highlighted the opportunity for overall saving in the life of building that can be achieved by investing in more cost efficient solutions initially.
C. LCCA provide future impact of decision which has been taken at the initial stage.
D. Cost saving can be achieved by comparing alternative options.
E. Lowest life cycle cost alternative will be the best alternative.
F. Comparative study of various methods of LCCA shows that NPV method is more appropriate.
G. Life Cycle Cost Analysis (LCCA) as applied to the O&M costs of a building can aid to foresee the future impact of the decision made at initial stage.
H. In the above case study the organization could have deployed the energy efficient system at the construction stage itself.
I. The capital cost incurred is just 5-10 % of the total building cost, but the savings in energy & operations & maintenance cost over the span of 30 years is near 60-70%.
J. The cash flow statements of each year along with the LCCA data can assist in arriving at payback period of money invested.
K. Comparative study of LCC considering building without energy efficient approach for existing & new building and with energy efficient approach has-been carried out. Following conclusions are determined from the project study
L. Life cycle cost analysis is an effective tool.
M. the use of sustainable materials and energy efficient approach in early construction stage could minimizes initial investment cost results maximum benefits over the life span of building
N. Energy efficient approach using hybrid energy system of wind mill & solar power panels can reduce LCC of existing building effectively.
O. Sustainable heat insulating material with smart implementation could reduce energy requirement of building in considerable amount.
P. Rainwater harvesting, efficient use of water, and natural shading of trees to reduce heat gain also pays important role in reducing energy cost as well as operations & maintenance cost.
Q. Natural recourses & its use during construction & operational phase gives maximum benefits in LCC.

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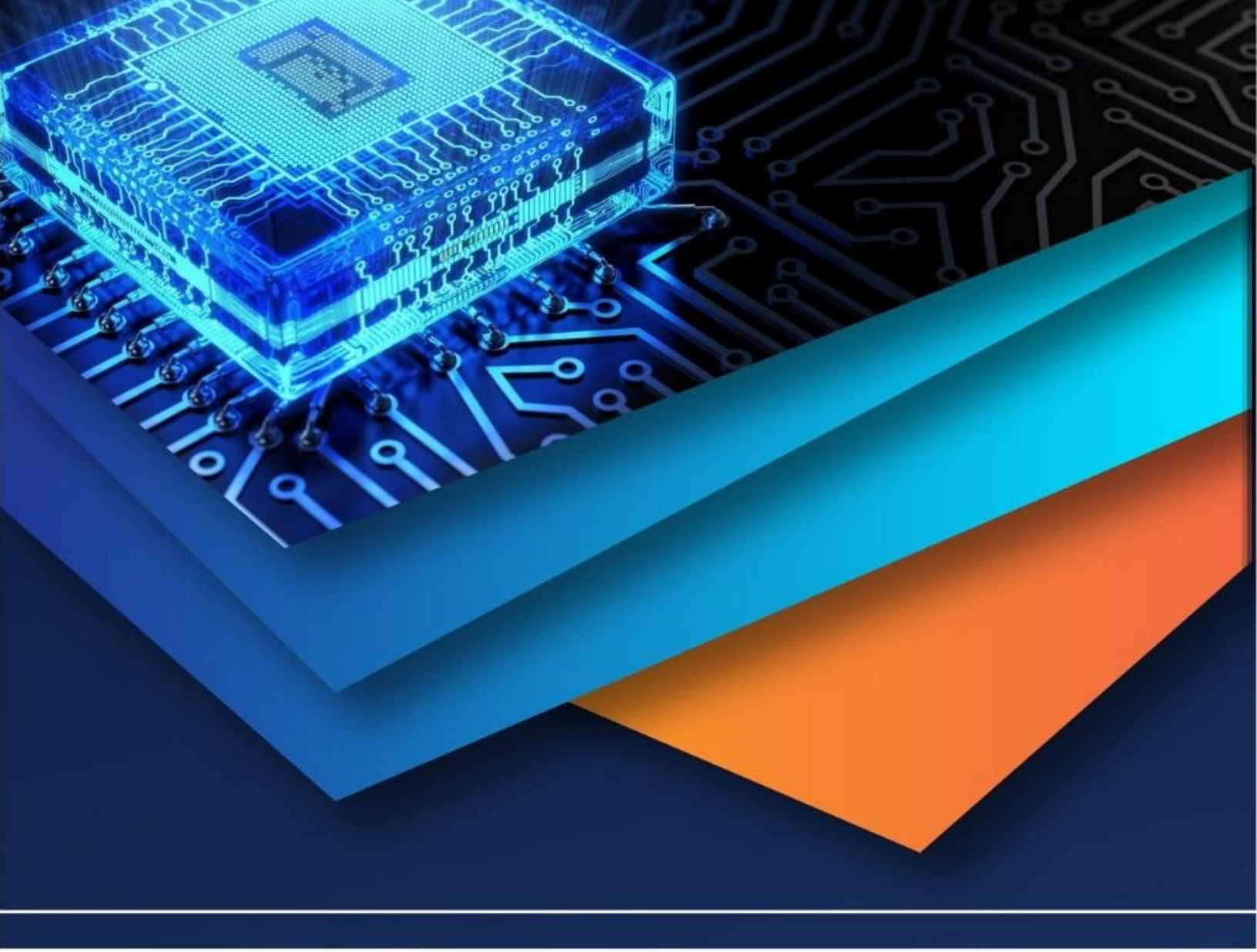

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