

COMPARING SPACE AND POWER CONSUMPTION PATTERN BETWEEN AN OLD AND MODERN OFFICE BUILDING

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Abstract: The flow of modernism is immense today and the scale of development is surely affecting the balance of the nature and ecology of our planet. The idea of sustainable buildings has emerged. Sustainability indicates to actions or developments that preserve the global environment and its non renewable resources for present and future generations. The energy crisis, the growing understanding of our limited resources and some major technological failures surely requires a fresh look at our culture of modern buildings. The building sector consumes around 33% of electricity consumption in India with the commercial sector accounting for 8%. The power consumption in commercial sector shows an annual rise of 7% in India today. So, this paper makes a curious attempt that initiates the study of an in use old functional office building, the KMC with a modern office building, the Technopolis of the same scale and typology. The comparisons in this paper are based on per head space consumption and assessing the power consumption pattern and simultaneously the Energy Performance Index (EnPI) is evaluated for both buildings. Both the findings are then observed as how close they are to the prescribed standards of per head office space consumption and EnPI. Based on the findings, the paper will also conclude about the balance that needs to be incorporated for the future buildings.

Keywords: Space, Power, Consumption Pattern, Old & Modern Buildings.

Introduction: Old office buildings in Kolkata that are still in active use surely catches one's attention for reasons like being historically narrative, structurally bold, functionally dynamic, aesthetically pleasing and so on. These buildings have remained as useful spaces within the city in their respective capacities and are examples of utility, preservation and sustainability. They cater to all modern days' requirements in their

own distinctive manner. The Kolkata Municipal Corporation (formerly Calcutta Municipal Corporation) was formed in 1876. The KMC is responsible for the civic infrastructure and administration of the city and is the first Municipal Corporation office of India. This civic administrative body has 40 different departments and administers an area of 185 sqkm. It is one of the most widely



recognized and extensively used public buildings of the city.

On the other hand, Modern buildings are direct results of people's taste, behavior and their

requirements under the present context. The Technopolis, Kolkata is situated in the IT hub of Kolkata, Sector - V of Salt Lake City, the Technopolis was the first green building to be constructed in

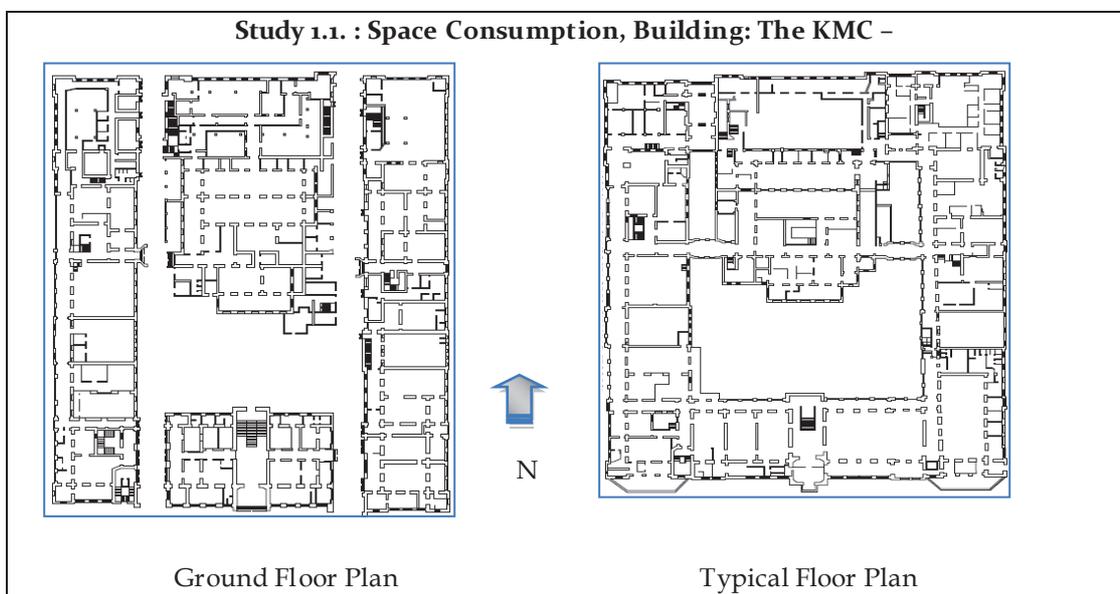
Kolkata and one of the first conceived in India. The 14 storey building, functional since 2006, is first IT infrastructure building in India that is gold rated and conforms to the United States Green Building Council's (USGBC) LEED certification systems. The building mainly comprises of IT support houses. It was initially designed for 7500 professionals but now

it accommodates around 8500 employees with 100 as floating population per day. The building function as a three shift office building (24x7) and is centrally air conditioned. A typical floor in the Technopolis contains Lobby – Waiting, business centers (office spaces), conference rooms, food courts, reserved dining, kitchen, electrical rooms, toilets and



services. Besides, the support and service areas, the building has includes parking spaces as per requirements, AHU, battery load rooms, spaces for

cooling towers, transformer rooms, ATM, security rooms and stores.



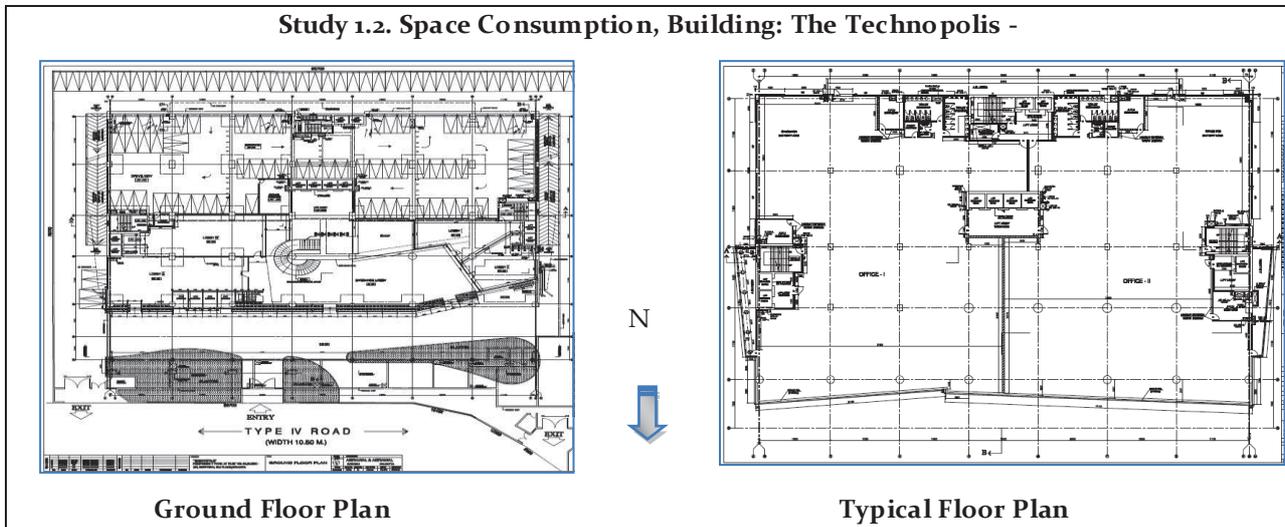
Floor wise area and per head space consumption:

- ▶ Ground Floor Area – 6870 sqm.
- ▶ First and Second Floor Area (Typical) – 15420 sqm.
- ▶ Third Floor area – 5020 sqm.
- ▶ Total Built up Area – 27310 sqm.
- ▶ Number of official employees in the KMC CMO building – 5,200
- ▶ Number of floating population – 4,000 – 6,000 (Average taken as 5,000)
- ▶ Total Number of users of the building everyday – 10,200

(Approximately-based on official records and hour wise counts)

So, area per person without floating population – $27310/5200 = 5.25 \text{ sqm}$

And, area per person with floating population – $27310/10200 = 2.67 \text{ sqm}$



Floor wise area and per head space consumption –

- ▶ Ground Floor – 5212.65 sqm
- ▶ Mezzanine Floor – 2067.49 sqm
- ▶ First Floor – 3359.01sqm
- ▶ Second, Third & Fourth Floor – 3456.90 sqm (each) (*3)
- ▶ Fifth & Sixth Floor – 3527.60 sqm (each) (*2)
- ▶ Seventh to Thirteenth Floor – 3754.78 sqm (*7)
- ▶ Fourteenth Floor – 2356.73 sqm
- ▶ 30% of area is used as office in G.F. – 5212.65 sqm
- ▶ 10% of area is used as office in Mezzanine – 206.74 sqm

So, Total Built up Area – 51195.63 sqm

- ▶ Initially designed for – 7,500
- ▶ Latest occupancy level – 8,500
- ▶ Floating population – 100
- ▶ Total Influx everyday – 8600

So, area per person without floating population – $51195.63/8500 = 6.02\text{sqm}$

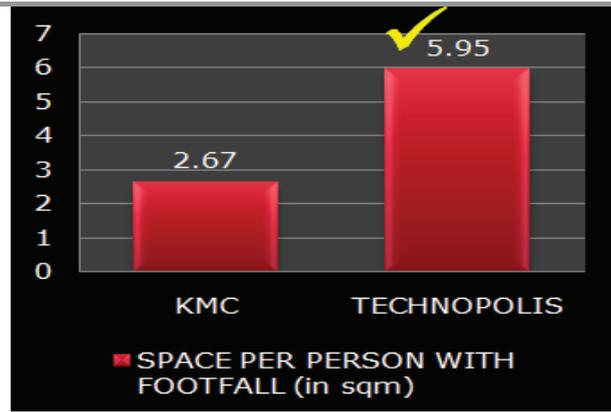
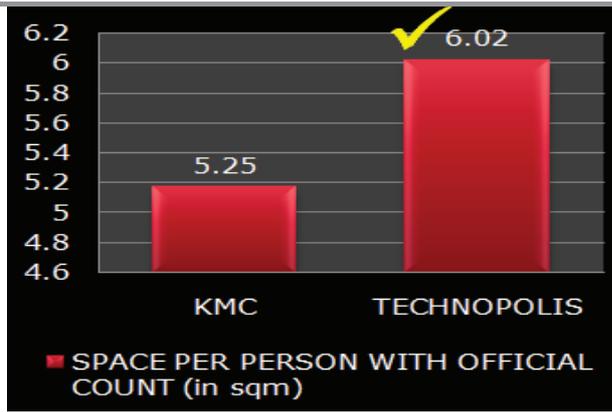
And area per person with floating population – $51195.63/8600 = 5.95 \text{ sqm}$

Note –

1. Basement, 70% of Ground Floor Area and 90% of Mezzanine Floor Area is used as Parking.
2. The **Technopolis** is designed for an occupancy level of **7500** professionals per shift.

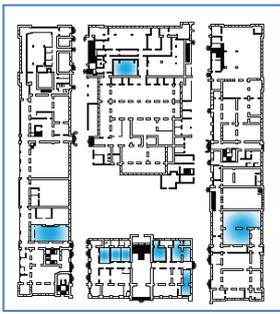
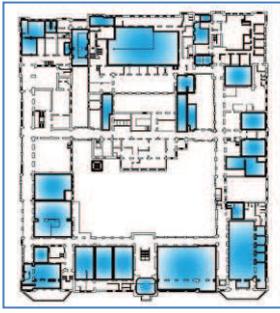
Observations: Space Consumption, Both Buildings: The floating population is highly variable in Municipal offices. Hence, the standard minimum space requirement with floating population is not specified anywhere and is based on assumption for providing optimum comfort conditions to the users. Area of 5.25 sqm per person for office employees is little more than the recommended standard of 5sqm per person.

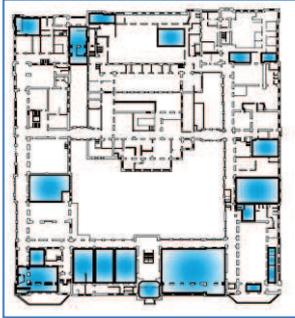
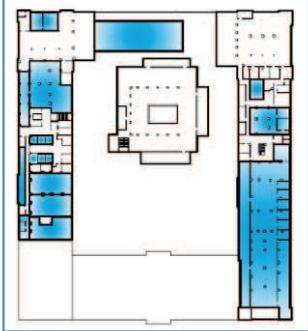
And with additional footfall of around 5000 per day, i.e. with 2.67 sqm per person. But the building is found to be functioning with great ease. The semi open spaces, the internal courtyard and the broad long corridors help in easing the load of additional footfall every day. On the other hand its modern counterpart, the Technopolis with floating population is 5.95sqm per person is better placed and appropriately functional.



Study 2.1. Power Consumption, Building: The KMC: The KMC building is a non air conditioned single shift office building. There are in all 40 departments operational in the building. On average, each department has 2 to 3 air conditioned rooms. The room of the head of the respective departments/sections and a computer or appliances section which requires air conditioning. However, the air conditioned spaces were found to be quite unevenly distributed when the physical survey of the building was made. And there are approximately 20

VIP suites/rooms of Mayor, Deputy Mayors, various councilors and other heads of the administrative body which are air conditioned. And also a few departments which were in the making of centrally air conditioned spaces. The AC areas for both the buildings in the following tables are based on the physical survey of the building. Total built up area of the KMC building – 27310 sqm. So, approximately air conditioned area in KMC building (AC areas in blue) –

S No.	Floors	AC Portions	Floor Area (In Sqm)	AC Area (In Sqm)	%
1.	Ground Floor		6870	436	6.3
2.	First Floor		7710	2476	32.1

3.	Second Floor		7710	1412	18.3
4.	Third Floor		5020	2204	44
Total Area			27310	6528	24

Non air Conditioned area (all floors) - (27310 - 6528) = 20782 sqm (76 %)

Power consumption in KMC building - (source - Director General, Electricals, KMC)

▶ Summer months (March, April, May, June) - 1200 KW

▶ Monsoon months (July, August, September, October) - 900 KW

▶ Winter months (November, December, January & February) - 600 KW

Sl. No.	Particulars	Summer	Monsoon	Winter
1.	Power Consumed (In Kw)	1200	900	600
2.	Power Consumed by AC - 70% of Power (in Kw)	840	630	420
3.	AC Space (in sqm)	6528	6528	6528
4.	Power for all Appliances in AC & Non AC Space - 30% (in Kw)	(1200 - 840) = 360	(900 - 630) = 270	(600 - 420) = 180
5.	24 % = AC Areas (Power Consumed by Appliances in AC Areas) (in Kw)	86.4	64.8	43.2
6.	Total Power Consumed In AC Spaces (in Kw)	(840+86.4) = 926.4	(630+64.8) = 695	(420+43.2) = 463.2
7.	Non AC Area (in sqm) - 76%	20782	20782	20782
8.	Power Consumed In Non AC Space (in Kw)	(1200 - 926.4) = 273.6	(900 - 695) = 205	(600 - 463.2) = 136.8

Final figure with Peak Load consideration -

Total Built Up Areas (in sqm)	Peak Average Consumed Power (in Kw)	AC Areas (in sqm)	Non AC Areas (in sqm)	Power Consumed In AC Areas (in Kw)	Power Consumed In Non - AC Areas (in Kw)
27310	1200	6528	20782	926.4 (77.16%)	273.6 (22.8%)

Energy Performance Index (EnPI): EnPI = i.e. (Summer Consumption x 10 x 20 x 4) + (Monsoon Consumption x 10 x 20 x 4) + Winter Consumption x 10 x 20 x 4) / Total Built up Area
 (1200 x 10 x 20 x 4) + (900 x 10 x 20 x 4) + (600 x 10 x 20 x 4) / 27310

= **79.03 kWh/sqm/year**

The total connected load is not the load that is total load that is utilized.

Hence, a Diversity Factor (DF) of 0.8 is considered.

= (79.03 x 0.8) kWh/sqm/year = **63.22 kWh/sqm/year**

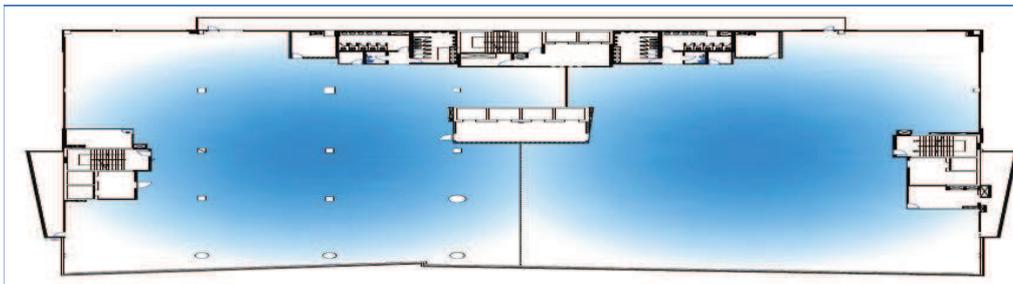
Note -

* Considered operational for 10 hours a day for 20 days a month on average annually.

* Consumption is peak connected load. Hence, DF was considered.

Study 2.2. Power Consumption, Building: The Technopolis -

Technopolis is centrally air conditioned building functioning in three shift 24x7. Not much of seasonal variations are seen in the pattern of power consumption as their contracted load with the electricity provider is fixed.



The following are the of AC and non - AC spaces in Technopolis (in a typical floor) (AC areas in blue) -

Description	Non AC Spaces	Size (in metre)	Nos	Area (in sqm)	No. of floors	TOTAL AREA
2 nd to 14 th floor	Staircase	4 x 6.75	3	81	13	1053
	Toilet - I	5.86 x 3.7	2	43.36	13	1127
	Toilet - II	3.7 x 6.15	1	22.75	13	296
	Toilet - III	1.68 x 2.32	2	7.84	13	204
	Toilet - IV	3.78 x 6.15	1	23.29	13	303
	Pantry	2 x 2.32	2	9.30	13	242
	Electrical Room	4.225 x 2.4	1	10.4	13	135
First Floor	Toilet - I	5.5 x 6.12	1	31.54	1	32
	Toilet - II	5.4 x 6.12	1	33.07	1	33
	Toilet - III	5.92 x 6.12	1	36.29	1	36
Basement, Ground & First	Staircase	4 x 6.75	3	81	3	243
Basement	Parking			5288.57	1	5289
Ground Floor	Parking			1992.45	1	1992
Mezzanine	Parking			1709.88	1	1710
Total						12695

Thus, the total non air conditioned area in the Building is – 12,695 sqm. (24.8%)

Total area of the building = 51195 sqm

Air Conditioned Area = (51195 – 12695) = 38500 sqm (75.2%)

Power consumption in the building (Source – WBSEB)

- ▶ Contracted Load with WBSEB – 3000 KVA
 - ▶ Monthly Power Consumption of the building – 2550 KVA
 - ▶ Power consumed in KW = KVA x pf = 2550 x 0.8 = 2040 KW
 - ▶ Power consumed by Air Conditioning (70% of 2040 KW)
- = 1428 KW (totally for AC areas) i.e. 1428 KW power is consumed in 38500 sqm
- ▶ Rest of power – (2040 – 1428) KW = 612 KW (consumed by lighting & all appliances)
 - ▶ 75.2% of 612 KW = 460KW
 - ▶ So, total power consumed in the AC area = (1428 + 460)KW = 1888 KW
 - ▶ Power consumed by Non Air Conditioned Spaces – (2040 - 1888) KW = 152 KW

Energy Performance Index (EnPI) –

EnPI = Energy Consumed / Floor Area = (2040 x 24 x 26 x 12) / 51195
 = 298.37 kWh/sqm/year

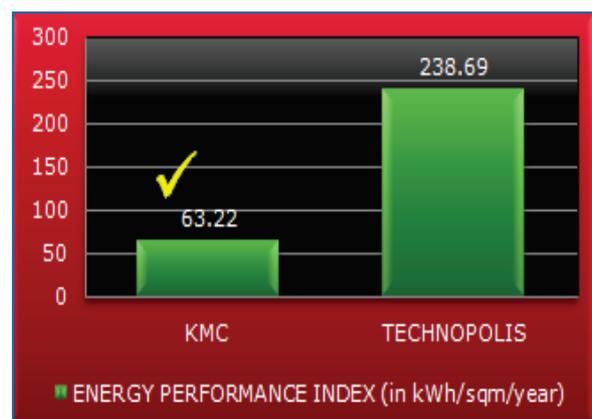
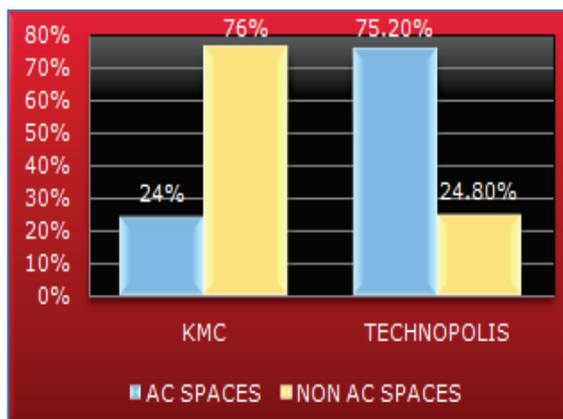
Similarly in this case too, the total connected load is not total load that is utilized. The Diversity Factor (DF) had to be taken into account. Hence, a Diversity Factor (DF) of 0.8 is considered.

= (298.37 x 0.8) kWh/sqm/year
 = 238.69 kWh/sqm/year.

Note –

- * Considered operational for 24 hours a day for 26days a month on average annually.
- * Consumption is peak connected load. Hence, DF was considered.

Observations, Power Consumption, Both Buildings : Most commercial buildings have Energy Performance Index (EnPI) of 200 to 400 kWh/sqm/year and Technopolis was found to be no exception. As per BEE, office building benchmark for warm and humid climate for less than 50% AC areas, the EnPI should be between 45 to 85 kWh/sqm/year and for buildings having more than 50% AC Areas, the EnPI should be between 100 to 200 kWh/sqm/year. In this study, with the Diversity Factor (DF), the KMC shows an EnPI of 63.22kWh/sqm/year whereas the Technopolis shows an EnPI of 238.69 kWh/sqm/year. KMC having AC areas of less than 50% falls under the EnPI range of BEE, whereas the Technopolis having AC areas of more than 50% with EnPI of 238.69kWh/sqm/year don't qualify.



Conclusions: The idea of planning and designing is to create an environment suited to the needs of the individuals who are using it. Designers should take care in recommending each component of a building. For example the proper use of open areas and transport corridors within the building premises can

be multifunctional for optimum space usage in case of public buildings. The reduction of total power consumption in a building especially through passive means is one of the key aspects of a sustainable building design. A continuous use of air conditioned

spaces also deprives the end users of the natural environment over a long period of time.

The comparative studies carried here, establishes a fact that old functional building despite outliving their intended use have responded well with changing circumstances under the present parameters of study. As found, the per head space and power consumption holds well as per the recommended standards. The seasonal variations of temperatures in a city like Kolkata has to be seen considered before proposing a centrally air conditioned building. It should be proposed only when it's extremely recommended. ECBC studies suggest that energy-conscious building design can reduce EnPI to 100 to 150 kWh/sqm/year which is

reducing 40 to 60% less energy than in conventional buildings. GRIHA recommends a total air conditioning of work spaces only when the indoor temperatures are in excess of 32°C in a warm and humid climatic zone. It may be concluded that the power consumption pattern should be forethought to sum a balance towards saving energy and meet the required comfort conditions in future buildings.

Acknowledgements:

- ▶ Estate Section, KMC.
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- ▶ Deputy Engineer, Maintenance Section, Technopolis.
- ▶ Property In Charge, Technopolis.

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