# Design strategy for sustainable hospital planning—a case study

P. Meena Kumari*

*Senior Lecturer, School of Architecture and Planning, Anna University, Chennai 600025, Tamil Nadu, India*

## ABSTRACT
Hospitals are major purchasers of goods and services, significant consumers of energy and large producers of a varied grade of wastes. In short, hospitals leave a large ecological footprint irrespective of size of the facilities. Their impacts on the surroundings are therefore vulnerable and prominent. The Indian healthcare industry looks upon the new and recent hospitals as a model for sustainability that the aged government hospitals can study from. The paper intends to discuss the sustainable healthcare considering: (a) the environmental implications through a case study of a recent medical college campus constituting a general hospital and academic facilities; (b) sustainable development considerations for hospital buildings dealing with planning, design, construction and operative phases; (c) key and primary steps, action and consideration of the aspects of sustainable healthcare approach to maximize the benefits gained from incorporating sustainable development into the planning programme; (d) sharing information, guidelines and practices related to sustainable healthcare design approach and its integration followed in hospitals with reference to a set of case studies of hospitals in Chennai.

## INTRODUCTION
Buildings form a unique type that appends serious environmental setback with the excessive utilization of energy/other natural resources and production of varied grades of wastes to the surroundings. Healthcare is a large industry continuously evolving and growing to be reshaped by internal and external forces, such as technology, privatization, and governmental reform. These changes have affected the way healthcare is rendered and has in turn influenced the surroundings in which it operates. For past 5 years, India has over 8% of total buildings constructed annually on healthcare construction (new or renovated), significantly daunting the environmental facet due to the construction and operation process of hospital buildings. These buildings use 40% of total energy, adding to local air pollution, local degradation of the surroundings and risk of global warming. This shows a clear evidence of reason, due to lack of clear policy dictating the need, lack of awareness, lack of technical expertise and infrastructure.

## CHENNAI HOSPITALS—A BRIEF
At present, India has a vast network of healthcare delivery across the nation with both private and public providers accounting for a hefty 730 billion rupees annually. In Chennai (capital of Tamil Nadu), the ratio of private/public owned hospital beds are 48 and 52%, respectively, with close to 400 private hospitals and 10 corporate hospitals for a population of nearly 8 million people and only 10 government hospitals to serve the same. At the tertiary care level, the recently built private hospitals exhibit a perceptive approach at accommodating sustainable design strategy than the century old government hospital though the latter's campus has the potential for sustainable implementation.

* E-mail: meenandavan@mail.yahoo.co.in

## PRIMARY STEPS IN DESIGN APPROACH

It is vital for healthcare buildings to perform supremely for the assigned complex function and for efficient operation. Yet the healthcare industry has been slow to embrace sustainability as it relates to building design. Apart from the being the place to promote healing, it is time to state the case for sustainable healthcare. To further certify the need, architectural solutions with sensitivity to energy-intensive solutions and sustainable environs are looked upon as the ultimate and appropriate intervention, observed especially in developing countries like India.

Fortunately, many of the concepts and technologies that may be employed to reduce environmental impact in construction and operation can be implemented at no extra cost. Life-cycle cost accounting, which looks at long-term cost and return on investment, as well as environmental costs, makes some design options look more attractive once they are evaluated on other than just first cost. Aspects inclusive of sustainable design are:

- site,
- water efficiency,
- energy and atmosphere,
- materials and resources,
- indoor air quality.

### Site

Sustainable design does not stop at the property line in the manner of the traditional design approach. Instead it takes on a more global meaning that encompasses both the ecosystem and its community resources. Sustainable design examines how local, regional and global conditions influence and shape the site. It also looks at how the site's design will enhance the standards of living of those environments.

### Water Efficiency

The amount of fresh water consumed by buildings and their landscape irrigation are key concerns since industry accounts for 20% of the world's water consumption. Tamil Nadu has a history of poor water availability especially in the capital town; hence, the government is keen on a strategy for water conservation and reutilization effort. As an initial step, water harvesting mechanism is made mandatory in existing/new buildings by the Corporation of Chennai. Sustainable design can answer these demands by reducing consumption of fresh water by specifying materials that do not waste excessive water in their manufacturing process, selecting water efficient fixtures and appliances, and selecting landscape vegetation that requires minimum irrigation.

### Energy and Atmosphere

Improving energy efficiency is the best way to meet energy demands without adding to air and water pollution. This is one sustainability element on which the healthcare industry has not fallen behind the curve. Working in tandem with governmental programmes, such as the Ministry of Non-conventional Energy Sources (MNES) and Pollution Control Board, and local utility conservation guidelines, the healthcare industry has realized the needs and has made effective improvements in its facilities to reduce consumption and pollution.

### Materials and Resources

Based on the requirement stated by the Pollution Control Board, hospitals around the country have implemented procedures to eliminate the use of PVC products used during treatment, such as IV bags, vinyl gloves, plasma collection bags and sharp containers to name a few. PVC is thought to account for 45% of dioxin emissions from the healthcare industry.

**Indoor Air Quality**

Indoor air quality (IAQ) has emerged as a key issue in sustainable design due to its relationship to occupant health and productivity, as well as to energy conservation, building materials and HVAC system design. Healthcare building utilizes 70% of the energy resources at providing comfortable interior environment (cooling, ventilation and lighting and heating) which could be obtained by incorporating solar passive techniques in a building design to reduce the load in convectional system, energy efficient lighting and HVAC system, usage of renewable energy system and passive architectural solutions. IAQ is especially vital in healthcare facilities, not only for infection control, but also, as mentioned, for enhanced occupant health and productivity.

**CASE STUDY—A DETAILED REVIEW**

Sri Ramachandra Medical College & Research Institution (Deemed University), Porur, Chennai—a medical college established in 1985 of total site area of 180 acres. The college comprises the main hospital block interlinked to the academic block, OP clinic, administrative building, staff quarters and hostels, and constitutes a total of 90 acres of the built-up area leaving the balance for outdoor spaces like landscape and parking facilities. From 1998, the research cell on Health Engineering of the institution had pivoted the adoption of sustainable approach in the campus at the operation level. For past 5 years, the institution has taken a green approach towards the construction of newer blocks and operation and maintenance of existing building system.

| | |
|---|---|
| Architects | First phase—Ar. Govinda Rao consultants, Chennai<br>Second phase—Technikalaya consultants, Chennai |
| Stage | Construction completion—1985<br>Sustainable adaptation in campus—1998–to date |
| Site area | 722 520 $m^2$<br>Built-up area = 361 260 $m^2$, landscape area = 321 120 $m^2$ |
| Description | 930 25 $m^2$ area comprising academic, hospital, quarters, hostels blocks |
| Climatic condition | (WH) Warm and humid with mean monthly temperature more than 30°C, relative humidity more than 55%, precipitation more than 5 mm<br>Comfortable % for year = 33%<br>Cooling % for a year = 67% |

*Site*

- Vacant wasteland adjacent to Porur Lake on the highway route Chennai to Bangalore at outskirt of Chennai city.
- Clay-loam soil with high water table—3 m below ground level.
- Natural water drain from the core site towards the sediment basin located at the periphery of the site for settling of sediment. Excess water of 20% collected during rainy season is drained into Coovum River behind the site.
- Buildings surrounded by permanent seedlings of deciduous trees and lawns (extent: 321 120 $m^2$) to avoid summer heat gains.
- Provided separate vegetative shading for two and four wheeler parking at the entry level and at the periphery road level and avoid automobile movement closer to the hospital and academic area.
- New additions of building are on closer to existing buildings thus leaving the posterior part of the site (120 420 $m^2$) undisturbed with native vegetation.
- Porous pedestrian walkways with plant interpretation to provide chance for groundwater recharge and removal efficiency.

*Water efficiency*

- 13 lakh litres of water requirement are met with 20 wells located around the site with two time/day supply. The supply to buildings is from the wells closer to the building and filling of overhead tanks through natural gravity method—results in reducing the consumption of energy.
- Building wastewater and disinfected waste are directed to on-site wastewater treatment at the rear of the site treated by the system stipulated by the Pollution Control Board of the state.
- Water purified from the wastewater treatment totally serves the irrigation of landscape, artificial pond and fountains.
- Solid waste from buildings are directed to sewage treatment plant, hazardous waste of medical waste to incinerator, while the waste from food outlets are directed to piggery located at the rear of site to avoid air pollution to the campus.

*Energy and atmosphere*

- Consumption of 10 lakh units/month is observed with 50% demand on cooling and lighting the interior.
- 1000 ton AC requirement with use of HEPA air handlers in certain areas and green cleaning service trained by the designers.
- Upgraded efficiency of lighting in existing facilities as well as new construction.
- Passive architectural technique adopted
    1. Use of internal skylight at the core of the building to light and vent the interior of the block.
    2. Use of daylight through recess window opening occupying 20% of wall area (approx. size 1.2 m × 1.5 m each) and 6 m wide internal corridors.
    3. The polygonal form of the building has less surface-to-volume ratio leading to less wastefulness in gaining/losing heat.
    4. The internal court doubled with the form of the building has enhanced the ventilation and natural daylight of the interior by considerably reducing the precipitation and humidity level of the inside.
    5. External building fenestration on the three storied building accounts to 30% of the facade reducing the heat gain and humid wind entry inside.

*Materials and resources*

- Flooring—no PVC, linoleum, cork minimal carpeting (recycled carpet tiles and organic wool).
- Painting—durable fast curing paints as the stains used having low VOC content, ammonia, ethylene glycol.
- Ceiling finishes of rapidly renewable aspen fibres serving as acoustical panels.
- PVC excluded from construction specification and furniture specification.
- Heavy duty floor area (service and housekeeping areas)—use of terrazzo flooring.
- Pedestrian walkway and outdoors seating and landscape features laid using construction waste materials with limited use of mortar.

*Indoor air quality*

- Mechanized air conditioning is done on ICU, OP and special ward area by using split air-conditioning, thus controlling the energy used based on the internal needs.
- Passive architectural technique adopted
    1. Movable opaque (roller blinds, curtains, etc.) to block the transmission of solar radiation through glazed east and west side windows.
    2. Overhangs and louvers located on the side of staircase core reduce the heat entry and effects an 'stack effect' ventilation through the open well of the staircase.
    3. The interior has lighter colour surface wall to have high emissivity and reflectiveness of the heat and in turn make the interior bright.

## CONCLUSION

In spite of a hospital's constant change and evolution in its implementations the environmental performance of the hospital has come into limelight recently and altering dimension of change. Public demand has increased in recent years for hospitals and healthcare buildings of varied type to prove that they take a responsible approach in their action with the environment. Also, in the perspective of the client/owner's affordability and comprehensibility with consideration to operative cost factor for future, the sustainable approach provides the ultimatum. Though Chennai has most of the aged public hospitals ruinous to the natural environment through its growth across the century, the awareness and knowledge is to be implored through existing cases with intense sincerity.

## REFERENCES

Bansal, N.K. and Cook, J. (2001). *Sustainability through Buildings*. New Delhi: Omega Scientific Publisher.

Chamam, L.G. (1998). *Renewable Energy—Basics and Technology*. Auroville, India: Auroville Foundation.

EHEC, Sri Ramachandra Medical College and Research Institute (2001). *Bio Medical Waste Management—A Practical Guide for Regulators and Healthcare Administrators*.

Hughes, R. (1992). *Building a Future: a Guide to Green Buildings Design*. Penrith: Nichol Armstrong Lowe.

*Leed Green Building*, Rating system, ver. 2.1 (june 2001).

Maiden and Poluta (1999). Affordable and sustainable healthcare technologies. *Background Papers from South African Federation of Hospital Engineering Conference*.

Mili, M. (2001). *Energy Efficient Buildings in India*. New Delhi: TERI, Thomson Press (India) Limited.

Vale, B. and Vale, V. (1991). *Green Architecture: Design for an Energy Conscious Future*, 1st edn. Boston, UK: Thames and Hudson.