

# **Climate-responsive design guidelines for Karachi, using climate consultant software Focused on Healthcare Buildings**

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## **Abstract**

The aim is if the healthcare industry becomes a model for the larger world in developing an ecological approach to these environmental and health challenges. Central to these approaches to medicine is the axiom: "First not harm".

In developing a new hospital campus in urban sites ideas of therapeutic landscape merge with sustainable site planning principles in developing healing gardens, green roofs, and native planting. For the landscape design of Lyari Hospital, we developed a series of gardens using native and adopted planting strategies, permeable paving, water features in the campus forecourt, and an intimate healing garden on a rooftop nestled between inpatient wings.

Establishing sustainable goals: early in the process, evaluate the site under consideration for environmental opportunities and constraints. Development of an environmental management master plan during the first phase of site development to ensure the preservation of the site's ecologically significant areas. The above-shown environmental management master plan will inform design decisions so that the footprint of the proposed development does not overwhelm the capacity of the site.

The climate of Karachi has an additional challenge of humidity control, compared to the rest of the cities in Pakistan due to the proximity of the sea. For all codes and standards defined in climate consultant, the comfort zone of winter and summer temperature range lies between 20°C and 31°C respectively. The traditional passive house strategies are still the most popular in designing climatic responsive buildings for Karachi. It takes help from the existing

## **Keywords:**

Healthcare Ecological Architecture Healing Environment SPO (strengthening Participatory Organization) General Hospital site in Lyari, human thermal comfort models (HTCMs).

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## **1. Introduction**

At the same time, led by the nonprofit organization, Lyari, SPO (strengthening Participatory Organization, more focus has been given to 'patient-centered care' to foster a healing environment. This is truly one of the most

important paradigm shifts in the culture of hospital design, and provides architects an opportunity to explore their creativeness to achieve this challenge.

## 1.1. Research Backgrounds and Objectives

The objectives of the Project are to improve the quality of life and the accessibility to health services for the regional people in Sindh by establishing a specialized children's hospital in Lyari.

- a) To function as a tertiary hospital to cure the diseases of children including infants in Karachi
- b) To increase the health care coverage of children patients in Northern Sindh.
- c) To perform an education function for pediatrics interns and a re-education function for pediatricians
- d) To conduct research and prevention activities for young children's diseases in the region

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The site is located at heel hawk, it is designed for an NGO, above photo, in developing new hospital campuses on urban sites., ideas of therapeutic landscape merge with sustainable

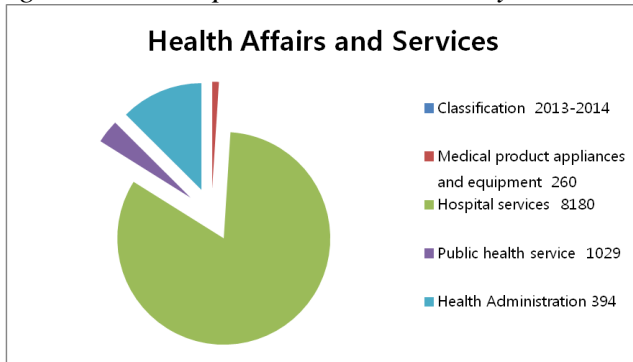
site-planning principles in developing healing gardens, green roofs, and native plantings.

The climate consultant software <sup>2)</sup> defines the criteria for each comfort model, using its specific details for 14 design strategies. This selection further figures out the percentage of comfort range in the psychometrics chart. The sun shading, thermal mass, and ventilation requirements are important passive cooling strategies for the hot humid climate of Karachi. These variables affect the summer cooling needs in particular.

The variety of analyzing climatic parameters for a particular location is facilitated with the help of available human thermal comfort models (HTCMs). Each model set particular criteria based on the descriptive study of a specific code and standard. A simplified explanation of each HTCM is prescribed before the selection. This paper gives a comparative analysis of the application of various HTCMs using a weather file of Karachi City in Pakistan.

- 1) Energy Design Tool:  
(<http://www.energy-design-tools.aud.ucla.edu/>)
- 2) Climate Consultant Graphic Based Computer Program: Climate Consultant 6.0 BETA (built 3) November 11, 2014  
(<http://www.energy-design-tools.aud.ucla.edu/climate-consultant/request-climate-consultant.php>)

Fig. 2 Million Rupees Pakistan currency.



Here we present two key observations in response to our set thesis, first, the clinical teams are facing increased demand to perform more efficiently, consistently, and safely in delivering improved outcomes. Second, they need to be able to stay up-to-date with clinical advances and communicate effectively with patients as well as an ever more networked Asian peer group (the table shows the classification for 2013 to 2015 health affairs).

Classification	2013-2014	2014-2015
Medical appliances equipment and product	260	100
Hospital services	8180	8306
Public service:	1029	356
Administration of Health	394	1255
Total	9863	10017

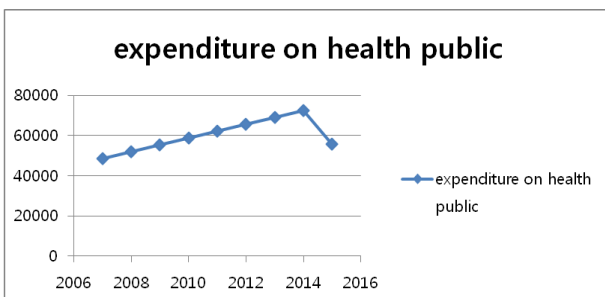
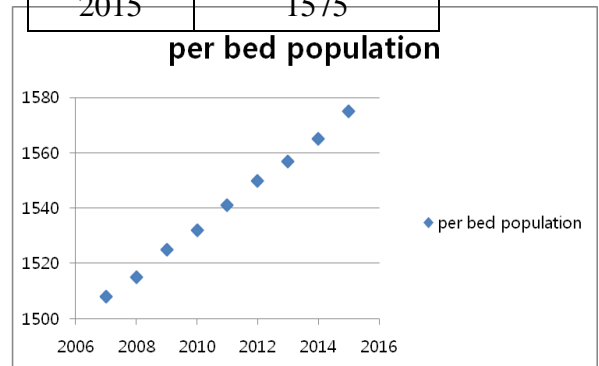


Fig.2 Health Services and Affairs

The hospital management team faces impossible choices to balance cost and quality of care. Medicine and public health institution will explicitly commit to promoting the health restoration of the natural, social, and built environments. These commitments will extend to the social determinants of health and disease. The project defined a series of goals to create a building and landscape that will integrate building purpose, program, and academics. Thus the project focused on energy performance and indoor environment quality (through abundant daylighting and the use of non-toxic material). Given the orientation of the restricted site, optimizing energy performance required the careful integration of exterior shading devices.

year	per bed population
2007	1508
2008	1515
2009	1525
2010	1532
2011	1541
2012	1550
2013	1557
2014	1565
2015	1575



Per bed population in Pakistan  
Human health cannot be treated separately from

the natural environment.

## **2. Literature Review**

The Lyari Hospital of project's central organizing principles evolved from four primary tenets, with associated benefits

A setting designed to use natural capital- sun, wind, and water to reduce operating costs and maintenance; uses renewable resources

The General Hospital site in Lyari, SPO (strengthening Participatory Organization): In developing a new hospital campus in urban site ideas of therapeutic landscape merges with sustainable site planning principles in developing healing gardens, green roofs, and native planting. For the landscape design of Lyari Hospital, we developed a series of gardens using native and adopted planting strategies, permeable paving, water features in the campus forecourt, and an intimate healing garden on a rooftop nestled between inpatient wings.

In the recent project of Lyari design, we applied EBD theory as far as we could. However, it was difficult to implement into the real project because it is rather a new concept in Karachi while it is prevalent in the practice of North American healthcare design.

The main reason is that, in Karachi, there is little existing research on EBD or even POE (post-occupancy evaluation) of existing hospitals which is the most basic material for EBD research. Though we as researchers planned to design based on resources and available research. Moreover evaluating the research based on the adaptability to Karachi's unique culture and medical environment.

We designed the healthcare environment with natural daylighting, meditative space for workers and staff, healthy materials, and visual inspiration. Therefore, the prospect of establishing green building protocols for the healthcare sector is daunting, given the technical

sophistication of its building. The motto of quantifying performance benefits, however, makes such a tool essential.

Lyari Hospital is a 300-bed hospital designed in 2013, this project is a new expansion of a 300-bed hospital next to the existing hospital making total of 600-bed general hospital and the 37<sup>th</sup> acute-bed hospital in the region. The total floor area of the new building is 300x400 feet with 3 floors above and one below ground. The design will be finished in September 2014 and its construction will be completed by the year 2015 through fast tract construction.

The program consists of the following main components

- 100 acute bed PCUs ( Patient Care Unites) and ICUs
- Neuro Center: outpatient clinics
- Emergency
- Surgery extension of 25 new operating rooms
- Health Screening Center

## **2. Planning and Design of the New Hospital**

### **2.1. Site Planning and Massing**

One of the client's goals for the new hospital is that it should function together with the existing context, as a operational facility. It was essential to connect lower podiums as close as possible so that, the service zone of the two buildings can operate as a single department. It became crucial to secure a wide space that is uninterrupted by "cores" such as elevators, stairways, and mechanical shafts, and large enough to accommodate the size of surgery or ICUs on the same floor. Among many massing options, the "Central Spine Linear Street Core"

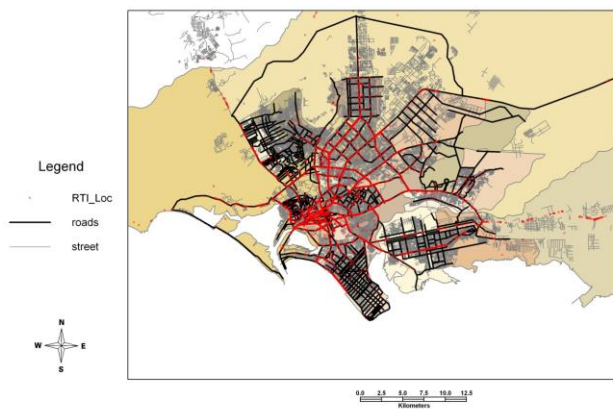


Fig. 3 Red concentration shows the Lyari area in Karachi

The living building site is based on responsible site selection, limits to growth, and habitat exchange, here following the green guide. Healthcare has deep roots and successes in both the policy and implementation arenas associated with toxic and waste reduction, and ecological footprint responding to the layered ecological urges of our time.

In healthcare, sustainable building represents a bold move towards precaution and prevention. The building stands for health. In creating it, the organization is essentially investing in keeping people healthier. It is merely not a sickness treatment place anymore but a representation of mindset and culture from the traditional idea. In the discussion session, we measured and tested it and were convinced that it has a tremendous impact on a person's ability to attain health.

## 1.2. Climate Consultant Methods and Scopes

Key building performance strategy

### Site

- Mold free environment safeguards sensitive patients
- Green roof

### Energy

- Double skin façade
- Metal elements avoided in the room for the electromagnetically sensitive patients: electronic equipment housed elsewhere,

and metal-free furniture used where possible

- Wood floors instead of carpet in all areas
- Hard materials are preferred to soft ones to eliminate off-gassing

The aim is if the healthcare industry becomes a model for the larger world in developing an ecological approach to these environmental and health challenges. Central to these approaches to medicine is the axiom: "First not harm".

3) California energy code comfort model (option 1)

4) ASHRAE standard 55 and current handbook of comfort model (option 2)

5) ASHRAE handbook of fundamental comfort model up through 2005 (option 3)

6) Adaptive comfort model in ASHRAE standards 55-2010 (option 4)

7) To size residential heating and cooling systems, the indoor dry bulb design conditions should be between 68°F (20°C) to 75°F (23.9°C)

8) 80% relative humidity and 66°F (18.9°C) wet bulb is used as the upper limit and 27°F (-2.8°C) dew point is used as the lower limit.

Karachi is the largest and most densely populated coastal city in Pakistan. Its geographical location is 24.9°N and 67.13°E with an elevation of 22MASL. The adverse impact of climate change is visible in Karachi due to the proximity of the sea. The urban morphology of a typical house is based on private and semi-private zones. A typical area for an urban hospital ranges between 75-500 m<sup>2</sup>, with a significant number of middle-income houses having an approximate area of 200m<sup>2</sup> (Khalid and Raza 2013). Energy conservational techniques and passive design methods are not so common throughout the country. The lifestyle of inhabitants and

construction pattern in the building sector of Karachi has led to inefficient energy consumption. To address the summer cooling demands, split air conditioners are widely used.

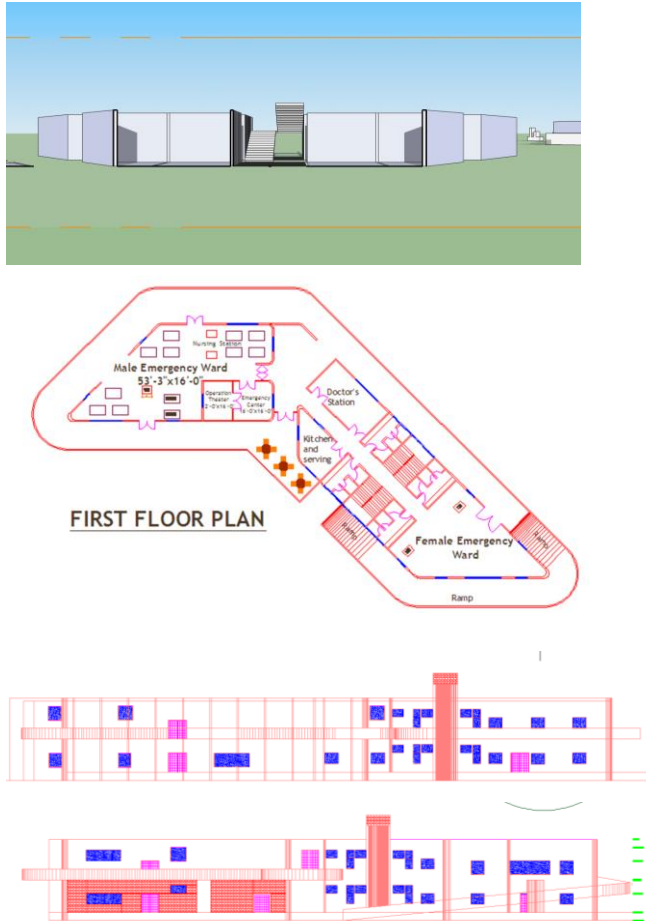


Fig. The plan and section of the hospital

The climate-responsive building can be an effective cost-efficient strategy for the residential building sector requiring an in-depth analysis of Karachi's climate. A better understanding of temperature, humidity conditions, and various other climatic elements can help in designing energy-efficient buildings. The performance, comfort, and energy use in residential buildings are influenced by the climatic conditions and how a particular residence responds to and develops the local micro-climate. The reduced need for air conditioners in the residential sector can also effectively minimize CO<sub>2</sub> emissions specifically.

9) The Enercon in 1994 worked with a team from Oxford Brooks University, UK for setting appropriate indoor

temperature standards for Pakistan.

## 2.2. Envelope design

The architectural elements like walls, roofs, and windows must have a required minimum level of thermal resistance. It can be made possible with the use of locally available insulating materials, increased thickness, and double-glazed pan windows. The right choice of material and the correct selection for each envelope component must be a high priority. Keeping the building size small with appropriate floor area, will have less cooling needs. This concept also supports Karachi's social structure of housing where apartment buildings are equally popular as compared to the rest of the country.

The following conclusions have been drawn from the above discussion:

The formulation of energy conservation codes and standards can be one of the effective strategies for the residential sector's extra energy consumption control.

The California code gives some similarity to ASHRAE standards when applying Karachi's contextual climatic conditions and vice versa. The climate of Karachi has an additional challenge of humidity control, compared to the rest of the cities in Pakistan due to the proximity of the sea. For all codes and standards defined in climate consultant, the comfort zone of winter and summer temperature range lies between 20°C and 31°C respectively. The traditional passive house strategies are still the most popular in designing climatic responsive buildings for Karachi.

## 2.3 Phase 1:

- a) Site survey for the target area for the medical treatment of the hospital including existing hospitals;
- b) Analysis of the requirement for the project including the function of the hospital, medical plan, layout plan, operating and maintenance plan, and so on;

- c) Finalizing the medical plan by the function of the hospital
- d) Preparation of the Project Implementation Plan including the Employer's scope of work to be done in advance of the commencement of the construction including site preparation, and infrastructure necessary to construct and operate the hospital;
- e) Preparation of schematic, basic, and detailed design for Hospital Building;
- f) Preparation of the specifications of the facilities such as, but not limited to, mechanical and electric machinery and facilities, to be installed in the hospital;
- g) Preparation of the list and specifications of the medical equipment and facilities;
- h) Analysis of the Operation and Management Plan, if exists; and
- i) Assistance in the preparation of the bidding documents and issuing the bids.

Space syntax is used to reduce while planning horizontal circulation for the nurse

Site 300x 400 feet

- 30 % circulation + 200'x200' diagnosis
- 10 % site for spine circulation
- 300 bed 200'x200' + 30% circulation
- Emergency 100'x100'+ 50% circulation
- Outpatient unit 100'x200'+ 50% circulation

Thus air quality gradation, increased daylighting, high-performance ceiling, work path planning and support distribution, communication system, standardized, non-handed rooms, single, acuity, adaptable rooms.

Perhaps the bottom line on the health and human performance benefits of green building comes from this

- a) If we know from personal and anecdotal experience that having a thermally comfortable, well-lit, properly ventilated work space, preferably with daylight and a view of nature, is likely to have a positive effect on our well-being and morale, and

therefore would inspire greater work performance; and

- b) If sustainable physical elements, such as adequate air exchange produce any positive in employee health and well-being; and
- c) If we can build green hospitals to a high standard at little or no extra cost

## **Conclusion**

The design posed two fundamental questions

1. What specific innovations could be made to improve care delivery- and at what cost
2. Translated into currency how much more productive, and how much less dangerous to patients, would healthcare delivery be?

The design innovations and their costs were organized into four categories

1. Energy and Environment
  2. Indoor environmental quality (IEQ)
  3. Operational efficiency
  4. Infection Control
- Building operation for reduced energy consumption: includes in terms of energy and environment primarily sustainable systems- energy, water, secondly, sustainable system management, and tertiary automatic controlled operable window.
  - Indoor Environmental Quality includes the following variables: air quality upgrade, increased perimeter wall, and daylighting, under slab ducting for perimeter displacement system diffusers, ceiling system for movable walls, high performing ceilings, interior landscaping atria, Diurnal (daily activity) rhythm interior lighting.

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<http://apps.who.int/gho/data/view.main.CM1320R?lang=en>

WHO DALY description

[http://www.who.int/healthinfo/global\\_burden\\_disease/metrics\\_daly/en/](http://www.who.int/healthinfo/global_burden_disease/metrics_daly/en/)

WHO list of disability weights for the DALYs

[http://www.who.int/healthinfo/global\\_burden\\_disease/GBD2004\\_DisabilityWeights.pdf?ua=1](http://www.who.int/healthinfo/global_burden_disease/GBD2004_DisabilityWeights.pdf?ua=1)

**Kumar, et. Al.**

IHME Data Visualizations

[sualizations/gbd-cause-patterns](#)

<http://www.healthmetricsandevaluation.org/gbd/vi>

Skewness comparison.