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A Study on Pattern Recognition to Compute Guidelines Based on Evidence for Ecological Healing Environment at Agha Khan Hospital in Karachi

- Focused on Human Thermal Comfort Model (HTCM), for Karachi, using Climate Consultant Program

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ABSTRACT

Purpose: Healthcare is on the whole a personal and critical service that consumer's use, whereas hospitalization is as a rule painful, because nature nurtures and Sun Light Luminosity for healthcare settings is considered healing. The performance and design of climate responsive buildings such as AKU requires a detailed study of attributes of climate both at micro as well as macro level. The therapeutic value of contact with nature through window view, greenery and landscape is calculated there.

Method: A two prong strategy is been devised for this article, at micro level three typical morphologies are analysed by creating same environment of neighboring building on sun shading chart, radiation and temperature range. Since the analysis of local climate helps to determine the design strategies for hospital Healing Environment which is suitable for Karachi climate; in order to track the macro climatic behaviour, a considerable analysis of psychometrics chart for AKU Karachi are designed on Climate Consultant (CC) and analysed by Machine Learning. Climate Consultant proposes different design strategies suitable for Karachi. And on the other hand time wise illumination sources for clinical area which are then measured on psychrometric chart— according to singular space: multi patient admission, secondly: acute ambulatory ward, and tertiary: multi windowed space according to the mushrabiyah and sky light pattern.

Result: Our findings support the hypothesis that windowed wall is 75-80% more healing wall; an accelerated evidence was found for healing at macro level if the form of the hospital is designed according to the climatologically preferences, whereas at micro level: the light resource becomes the staff attentiveness determinant. In Conclusion evidence was provided that the actual form of luminosity results consequently in satisfaction while light entering from several set of windows and other sources might be valued if design according to the healing environment. The data added on the sun shading chart to calculate rays entraining into space in patient room equal to 124416.21 Watts/ meter m^2 is calculated as precise healing rate—and is confirmed by questionnaire from patients belonging from each clinical stage having different illnesses.

KEYWORD

Climate Consultant,
Human Thermal Comfort Model (HTCM),
Climate Responsive Design,
Architectural Orientation,
Natural Ventilation,
Envelope Design
Karachi AKU

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1. Introduction

The variety of analysing 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. The simplified explanation of each HTCM is prescribed before the selection. This paper gives a comparative analysis for the application of various HTCMs using weather file of Karachi city in Pakistan. The software results are analysed using an EPW (Energy Plus Weather) data file from online data base of US Department of Energy. The software list 20 guide lines based on the design strategies and criteria defined earlier for each model. Their comparative analysis helps in outlining commonalities in effective design methods.

Pattern recognition as determinants of illness and day light design for three wards has been identified in this study. For authentication a survey was conducted, where healing pattern was recognized using machine learning techniques through SVM and same was applied to recognize the pattern for the hospital plan and placement of the patient according to the illness classification. In this research, three distinctive clinical placement stages were considered such as —admission, acute, and post-treatment according to the healing rate— and then there is an application of potential AI-based estimating technique to create placement prediction models. To present the consequence of the windows of AKU healthcare design, first there is a calculation of the sun pattern on Energy Design Tool whether it is adequate for vitamin D, sunlight is the only source of creation; hence calculating healing environment for Relevance to Design Practice.

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There is a comparative analysis of morphology according to the shad chart in relation to the windows [1][2] for three types of wards at AKU hospital. Primarily there is a methodical analysis of an existing AKU hospital in Karachi that implement contemporary as well as traditional methods of achieving patient comfort via closed technique fewer windows and more energy expenditure where required, in the healthcare setting. The other alternative is to reach patients comfort by substitute measures, i.e. open towards external environment and natural surroundings. The patient comfort level is measured by data collection, questionnaire and interview[3][4].

1.1. Research Backgrounds: Proposed Approach

In order to apply Artificial Intelligence techniques for estimating healing acceleration with respect to light, an approach shown as follow was proposed:

a. Define the problem: Identify measures with the assistance of medical practitioners, nurses and staff at AKU hospital Karachi. Their inclusion would ensure the rechecking of the data extracted from this experiment on site by author.

b. Data post checking processing on the climate consultant software to enhance the quality of the data and mining outcomes.

c. Building the classifier model on space syntax software according to the UV light chart.

Selecting best model based on performance measures and extracting the required data both at micro as well as macro level. Healing pattern calculation as a large prospective macro level investigation of site plan by application of climate consultant program at micro level space syntax pattern in relation to depth map: statistical risks for an elongation in healing process simultaneously with both high UV exposure, lack of appropriate UV light for healing [2][4][5][6] for cure of mild illness.

2. Objective

The objectives of this research are; firstly to examine climate responsive design strategies for Karachi. Secondly to evaluate the increased percentage of healing environment and its impact of various proposed design strategies of HTCMs in climate consultant.

An extensive experiments was conducted for quantifying the performance of proposed multidimenitonal pattern recognition scheme on healing chart Figure. 2, testing the effectiveness on the prototype of various patients healing pattern and simulation of UV light [1][2][3] via depth map analysis.

2.1. Background

Initially before 90's, the indoor suggested temperatures in

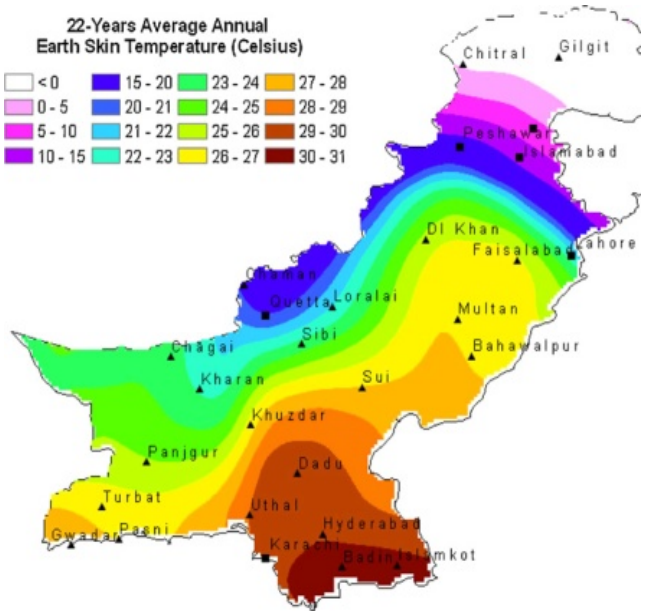


Fig. 1. Map of Pakistan with temperature, this site is located in area which is represented in red (30- 31) degree centigrade; an appropriate temperature for the healing patient

Pakistan were established on ASHRAE standards; 26 °C in cool weather and 21 °C in the hot weather irrespective of the building location in Pakistan. (Nicol and Raja 1997) These temperature standards were defined through laboratory studies. The new thermal comfort standards were proposed in 1996 based on transverse and longitudinal surveys conducted in five major climatic regions of Pakistan. Enercon in 1994 worked with a team of Oxford Brooks University, UK for setting standards for Pakistan as appropriate indoor temperature. Their surveys recognized that there is a explicit affiliation between indoor comfort and outdoor conditions in line with an adaptive methodology to thermal comfort. The result of this survey was incorporated in BECP 9). Nicol and Humphreys (2002) [7] study classifies the five cities of Pakistan as hot dry (hd), hot humid (hh) and temperate (temp) on the basis of their humidity condition to achieve thermal comfort.

This paper aims to assess how well buildings harmonize users' needs, and identifies ways for future improvement in healthcare design, performance and suitability for purpose according to the UV light [8][9][10].

Karachi is the largest and densely populated coastal city of Pakistan. Its geographical location is 24.9oN and 67.13oE with an elevation of 22MASL. The adverse impact of climate change is visible in Karachi due to the proximity of sea.

Here California energy code comfort model is (option 1) and ASHRAE standard 55 and current handbook of comfort model is (option 2). ASHRAE handbook of fundamental comfort model up through 2005 is (option 3) and Adaptive comfort model in ASHRAE standards 55-2010 is (option 4). For the purpose of

sizing residential heating and cooling systems, the indoor dry bulb design conditions should be between 68°F (20°C) to 75°F (23.9°C) and 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. (Building Energy Codes Program)

2.2. Macro level Ecological determinants at AKU

For this study at macro level Agha Khan Case is analysed where following ecological strategies are used as a evidence for healing environment.

1. If windows are skillfully shaded and oriented to prevailing breezes; this can result in good natural ventilation which can diminish or eliminate air conditioning in warm climatic zone.

2. Long narrow building floor plan can help maximize the cross ventilation in the temperate and hot humid climates.

3. Ceiling fans or indoor air movement on hot days, can make it feel cooler by 5°F (2.8°C) or more, thus less air conditioning is needed.

2.3. Micro level Ecological Determinants

The chart shown in Figure. 2 presents the quantity of sun necessary in human body for the Vitamin D assembly [11][12][13]. It represents the latitude according to the country on Y-axis and since the location of Karachi is 24.5 latitude therefore there is a need of 1.6 hours of direct sun light radiation for the fabrication of adequate Vitamin D [14][15][16].

To incorporate 1.6 hours sun without glare the following ecological techniques are incorporated at AKU:

a. Overhang window (designed according to the latitude) or sunshades which are operable (extendable awnings when required in summer) can lessen or eliminate air condition or HVAC requirement.

b. Cost effective and high performance glazing on each and every orientation with Low-E (insulated frames) for both hot clear summers and dark overcast winters.

c. Outdoor buffer zones shaded by patio, porch, and lanai oriented to allow prevailing breezes which can be extended in waiting and working areas in warm or humid weather 12).

Traditional passive buildings in hot dry climates use high mass construction with small recessed shaded openings as shown in Figure. 3 , these are operable for night ventilation to cool the mass.

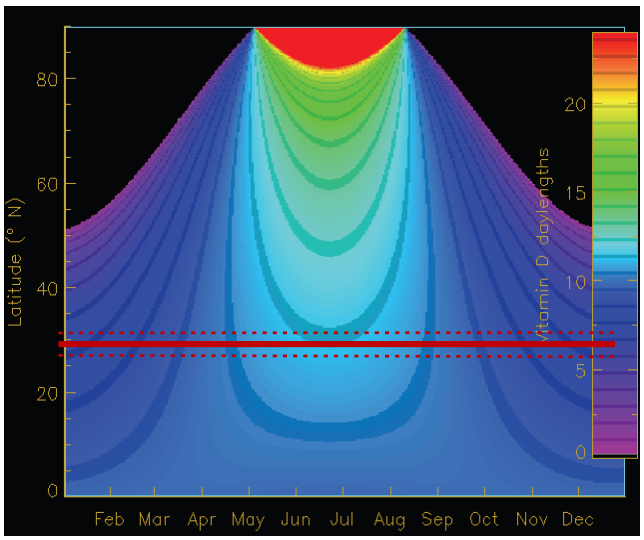


Fig. 2. The horizontal scale presents Karachi 24°53'N the month, and the curve represents the amount of hours (Source: data from Global Solar UV INDEX, 2002)[2]

3. Literature review

Evidence gathering which classifies the impact of day lighting- or its lacking on healthcare settings outcomes and patient well-being [1][9][17][18] is an issue, combined with general research on day lighting's effect on staff productivity. These two aspects are considered sufficient to warrant a precautionary approach in setting day lighting requirements for new healthcare projects. There is a need to significantly increase day lighting in Karachi healthcare facilities [19][20][21].

The hospital is an organization for health care supplying cure by specialized workforce and equipment, and frequently grant for prolonged patient lodge. The nomenclature is driven from Latin hopes (host); other terminologies originating from this English word are hotel, hostel, and hospitality.

3.1. Ecological Healing Environment in Hospital

A space and the events within that space can be designed so that occupants witness more thorough interaction with their resource and life cycle that creates it. The design principles outlined below represent a distillation of the above hypothesis, the launch of "ecology of mind" (Bateson 1972) [22]

a. Screened veranda and patios can offer passive comfort cooling by means of ventilation in warm weather and is able to avoid insect problems.

b. Orient a good number of the glass to the north, shaded by means of vertical fins, in very hot climates, because there are essentially no passive solar needs.

Architecture which is ecological at AKU is not a future predicted on less, but rather one inspired by doing more- and doing better- with less. To move building design towards this vision formed in 1985 in a merger of two smaller facilities, Agha Khan Hospital is a large teaching hospital with a staff of 2,000. Some of the hospital new facilities are under construction on the site. The project's design focuses on energy efficiency, driven primarily by AKU

Federation pledge to reduce facility energy consumption by 30% below 1988 levels. Designers anticipated that the energy efficiency measures will result in annual emission.

3.2. Patient ward

The benefits of providing a healthy indoor healing environment for patients, families and staff are well documented [23].

Extending the healing concept to the landscape and the site − results in an environment that reduces stress and increases health benefits [24][25] − and will provide a healthy physical environment that nurtures the human spirit. To start, the facility itself must not pollute, contaminate, or destroy the site on which it is built .

The landscape can play an important educational and aesthetic role in preserving and celebrating the local and regional character; people here are able to enjoy nature world in a serene and tranquil atmosphere (Figure.3).

3.3. Space Syntax

The scheme of hospital plan if considerably compact concentric is considered more systematic and efficient. Although exterior shape is less an indicator than the internal core organization and layout [26][27]. Currently very methodological plans have been achieved with combination of concentric pods, and with upcoming bedside.

3.4. Data mining

Literature advocates that sufficient contact to environmental sun light offers an optimistic influence on personal health and welfare of patient and medical team in a healthcare setting [5][8]. AKU is planned to provide patients, visitors and staff get to be touch with environment this perhaps is a theme of physical ecological access. Landscape panoramic view of nature is acknowledged to be healing. Gardens in hospital atmosphere are soothing in themselves. Views from windows are systems for nurturing access to community sustenance and as long as there are possible occasions for optimistic escape and [28] sense of managing tense clinical settings (Ulrich 2002). A passive nature sight [28] is exceptional in inducing opinion of tranquility and protection (Ulrich 1984).

4. Research Flow Chart: Conceptual Frame work

The research is designed such that it calculates healing pattern on both levels micro as well as macro architecture.

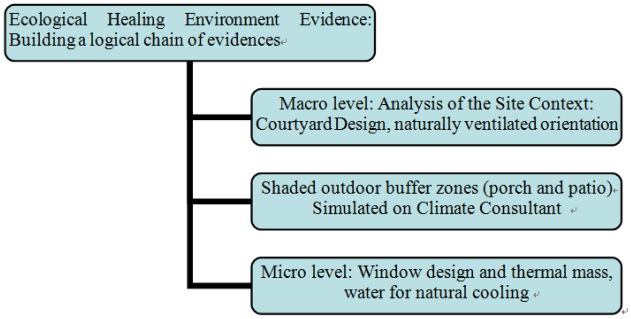


Diagram: showing research flow as a funnel from macro analysis to micro analysis

4.1. Influence of sun illumination on person health and routine tasks

Here is an evaluation for a model hospital, considered as an Eco-Hospital design which benefits from green landscapes for acquiring different gradation of comfort quantity as with the controlled environmental systems. Opinion poll from survey scrutinized that bedridden patients designate particularly higher inclination to having a hospital ward or patient room window view of nature [1][30][31], which is achieved here at micro level.

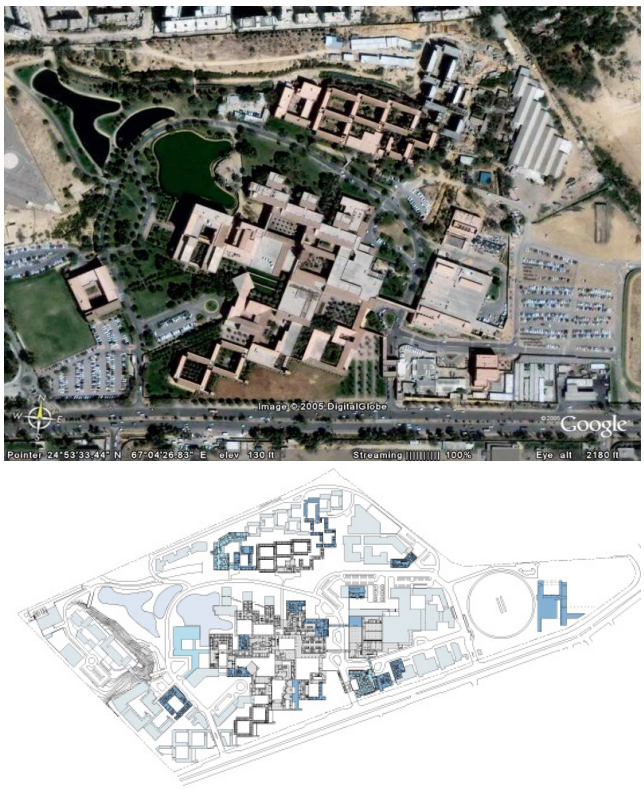


Fig. 3. contextual analysis of hospital google image (www.payette .com used with permission)

The impacts of Sun Light on human health and performance can be attained by two main mechanisms:

1. Calculating the body's circadian system
2. Influencing mood and alertness

In this segment of paper, above two mechanisms is illustrate and the specific impacts on human health and functioning are summarize based on Climate consultant aid of psychrometric chart.

5. Case description

Based on the idea of a humanizing hospital, the design considers the individual's confidence and security as well as the functional requirements on building and treatment. Therefore a glazed internal roof studded with balconies, greenery and bridges provides overall organization and inpatient units which are located perpendicular to this main circulation core. Parallel organization minimizes vertical circulation travel time. The hospital houses the largest public amenity in the balcony. (Figure. 3).

5.1. Case Analysis

Traditionally, Karachi has a convincing preference for westward wart bedrooms orientation. This is observed here on the Figure. 4 below and the section in Figure 5 shows the prevailing wind movement. That is authenticated by the temperature range chart on CC tool.

The percentage impact of the following cooling design strategies is alike:

a) Sun shade for Windows

b) Two stage evaporative cooling

Fig.4. shows site plan showing west word orientation at macro level. With clear definition of courtyard type planning.

Fig.5. The Analysis of the patient ward (used with permission)

c) Fan forced ventilation

Similarly, the most popular heating design strategies that are common in the options 1, 2 and 3 are:

a) Internal heat gain

b) Passive solar direct gain high mass

In spite of many people's preconception, study have revealed that eastern or western daylight have additional benign impression on patients, such as eastern morning light decrease anxiety of patients with SAD (seasonal effective disorder) [32][33] and suffering from bipolar disorder. Furthermore western evening sunlight is described to ease sleep interruption appearing in dementia patients. Figure. 5 shows the spaces at micro level with core traced in red and L-shaped wings.

The Table 2 gives a comparative analysis of the design strategies defined in the selection criteria. It is obvious that the option 3 has highest comfort hours with an increased percentage impact. The criteria for achieving thermal comfort have been established using the options 1, 2, 3 and 4 individually. In case of option 3, the

Table 1. Temperature Range on Climate Consultant

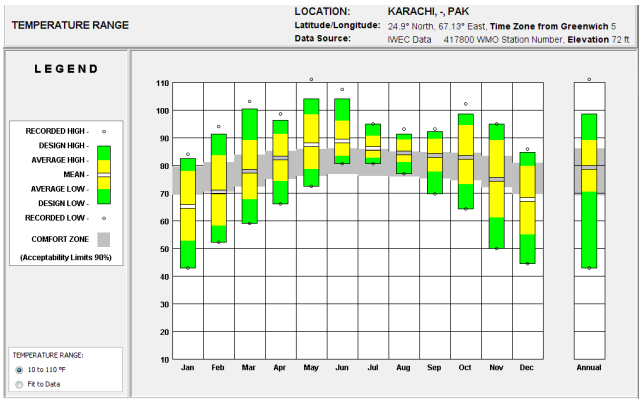
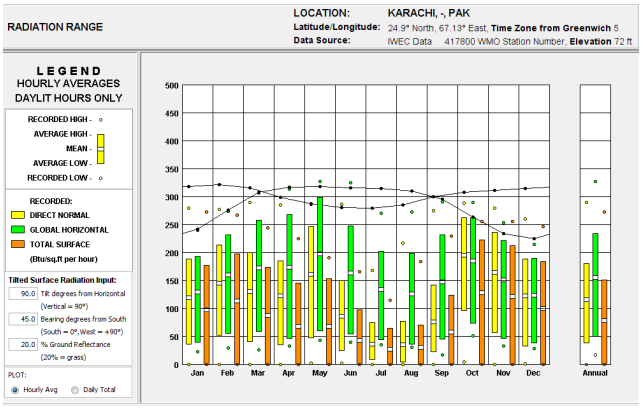


Table. 2 Radiation range



comfort criteria is based on temperature condition, clothing level and activity specified as already shown in the Figure 4 [34][35][36].

The dehumidification could also be considered design strategy found common in first three options but it is relatively influential in the option 3. (Table 2)

The following observations have been interpreted from the table 3 and 4;

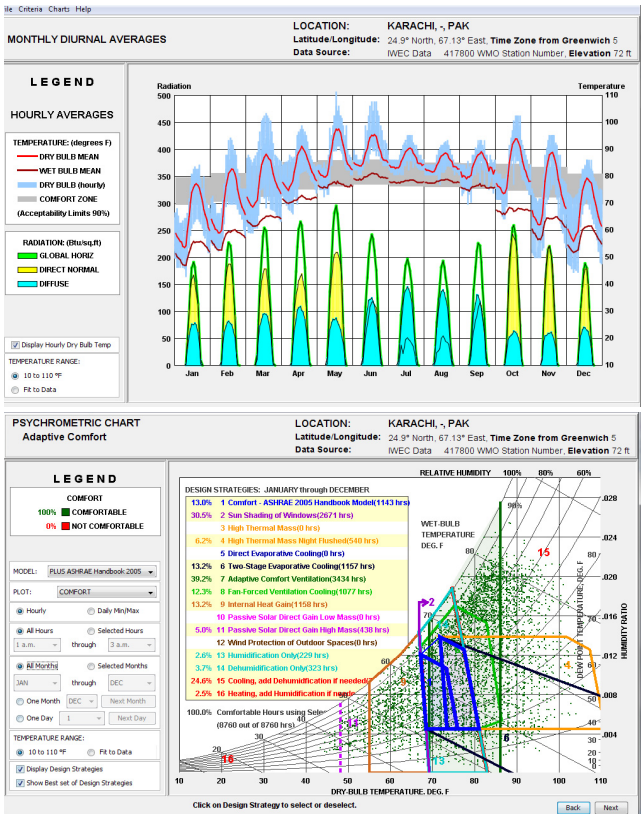
1. The design strategies for AKU in each option 1, 2, and 3 have varying percentage contribution. (Table 2) The selection of best set of design strategies on the psychrometric chart will give 100% comfortable hours.

2. The ASHRAE adaptive comfort (options 4) gives 39.1% of the hours to be comfortable by applying the proposed design strategies and guidelines. (Table 2)

The natural cross ventilation strategy effectively. But the west facing orientation can also be protected through increased vegetation and to minimize glazing as observed for the wall in following Table 4. The high ceiling in occupied public zones specifically lounge (where visitors spent most of their time) can also encourages natural ventilation [37][38][39].

Looking out of the courtyard window, the building that is enclosing the viewer is seen, so the architecture- is present in the patient experience.

Table 3. psychrometric chart and monthly average

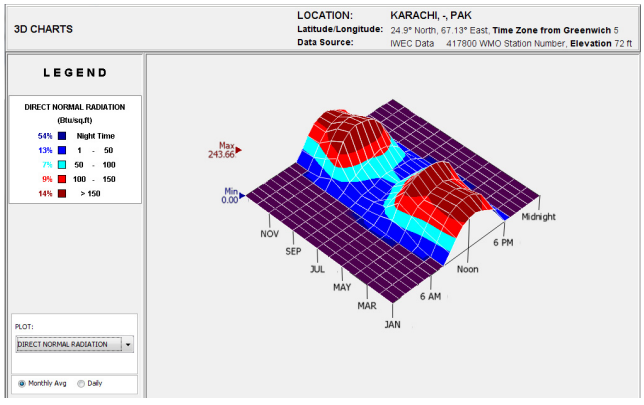


5.2. Micro Analysis of Envelope design

The architectural elements like wall, roof and window have required minimum level of thermal resistance as Figure 26represents. It is made possible here with the use of locally available insulating materials, increased thickness, and double glazed pan windows for AKU. The right choice of material and their correct selection for each envelope component is the high priority. Keeping the block building size small with appropriate floor area, have less cooling needs as shown in plan and section Figure.5. This concept also supports the Karachi's social structure of healthy setting for healthcare where these hospital buildings are equally popular as compared to rest of the country.

The simultaneity of being sheltered while seeing the building

Table 4. 3D chart for radiation



providing that shelter magnifies the psychological and social dimensions of dwelling.

The room is situated (Figure. 5) in the building, its occupant is situated in the building community; and the hidden labyrinth of corridor (Figure. 3) and stairs that choreograph the connection among its members is imagined. The kind of building patient see will inform their perception of the character of its community.

5.3. Psychrometric chart

The psychrometric chart is a combination of various dots, representing temperature and humidity of each 8760 hours per year. The above figure demonstrates indoor or outdoor environment and their comparison to human thermal comfort. The psychrometric charts are based on the selection criteria defined earlier for each comfort model as option 1, 2, 3 and 4. The climate consultant analyses the spreading of this psychrometric data in all design approach region to create an exclusive catalog of design guide lines.

The green boxes shows the effect of courtyard and window fins the angle of the summer sun is measured from true south the mask is shifted, vertical fin is marked by circle, the obstruction is flanked building [40][41].

Table 5: determinants of micro and macro analysis

	Micro level	Macro Level
Ecological Design elements	Courtyard	Fins
Passive techniques	Thermal mass	Humidifier

35% of reduction was evident: under the technique of Evidence Based Design; while incorporating ecological approaches in design for healing environment at AKU.

5.4. Approach, hypotheses and choice of machine

The hypothesis utilized here comprises of famous the Ulrich's project of sun and healing environment. However for this study the

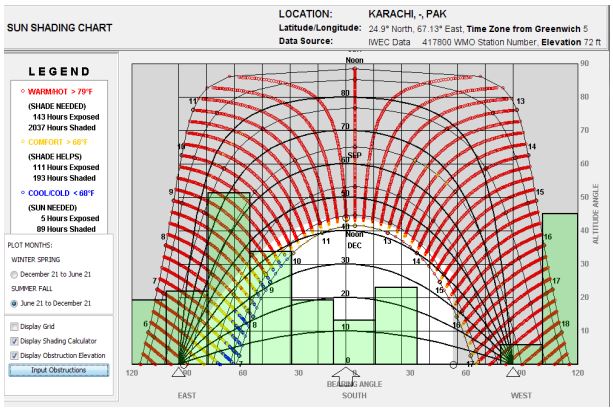


Fig 6. The formation of the courtyard on Climate Consultant

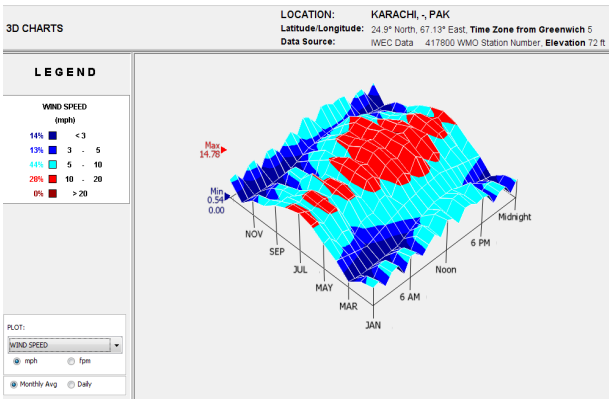


Fig. 7. 3D radiation chart

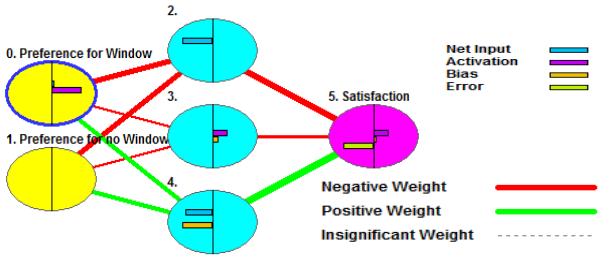


Fig.8 ANN results of questionnaire

popular approach is quantified by the evidence based for specific region of Karachi on Intelligent software.

ANN software is used to simulate the answers from questioners. The analysis of window wall is demonstrated based on solar azimuth angle and Karachi on solar chat. The UV average is operative as shown in Figure 7.

6. Discussion

Correct exposure and sufficient daylight is critically essential for well-being and healthful healing environment for employees over and above for patients at AKU Karachi hospital design. Daylight that is normal brightness is introduces here in form of courtyard and special section design to allow the light and wind come in, in a measured form as humidity should be entering in a controlled manner.

Passive Cooling Guidelines are applied from Climate Consultant Climate Consultant 4.0 it Develops Design Guidelines for East wall as shown in Table 5.

7. Results

The following observations have been interpreted from the Table 5 and 6;

1. The ASHRAE adaptive comfort (options 4) gives 39.1% of the hours to be comfortable by applying the proposed design

Table 5. The window dimension according to the sun

Elevation	Area of Glass window (m^2)	Timings	Wall Azimuth (degrees)	Altitude (angle degree)	Solar Azimuth (angle)	Wall Solar Azimuth	Angle of Incidence	Direct Radiation 850 W/m^2	Direct Radiation through Window Watts per meter m^2	Diffused Rad. 350 W/m^2	Total Radiation Watt per metre m^2
East	0.54	6:00 AM	90	13	70	20.00	0.92	778.27	315.20	141.75	456.95
	0.54	7:00 AM	90	25	77	13.00	0.88	750.62	304.00	141.75	445.75
	0.54	8:00 AM	90	39	85	5.00	0.77	658.06	266.51	141.75	408.26
	0.54	9:00 AM	90	51	90	0.00	0.63	534.92	216.64	141.75	358.39
	0.54	10:00 AM	90	63	101	11.00	0.45	378.80	153.41	141.75	295.16
	0.54	11:00 AM	90	75	120	30.00	0.22	190.52	77.16	141.75	218.91
	0.54	12:00 PM	90	82	180	90.00	0.00	0.00	0.00	141.75	141.75
	0.54	1:00 PM	90	75	240	90.00	0.00	0.00	0.00	141.75	141.75
	0.54	2:00 PM	90	63	259	90.00	0.00	0.00	0.00	141.75	141.75
	0.54	3:00 PM	90	51	270	90.00	0.00	0.00	0.00	141.75	141.75
	0.54	4:00 PM	90	39	275	90.00	0.00	0.00	0.00	141.75	141.75
	0.54	5:00 PM	90	25	283	90.00	0.00	0.00	0.00	141.75	141.75
	0.54	6:00 PM	90	13	290	90.00	0.00	0.00	0.00	141.75	141.75
									1332.93	1842.75	3175.68

strategies and guidelines. (Table 2)

2. Amongst 38 hospital based guidline, only 7 Design gilding s are common in all the four options. (Table 3 & 4) for AKU.

It has also been found that ASHRAE adaptive comfort options have largest dissimilarities. Amongst the 14 dissimilar guidelines in various four options.

8. Conclusion

In each four options, there are sequential of 20 Design Guidelines proposed by the climate consultant software. These guidelines are specific to the climate of Karachi so each guideline must be considered in a defined order, starting with the first as most important and so on. Combining all the four options provided in the climate consultant, there are total of 38 design guidelines which can be considered for climate responsive building envelope design in Karachi.

1. There are 12 guidelines that are similar in any two combinations of climateconsultant. So, California energy codes (CEC) and ASHRAE Standards 55 have largest similarities compared to other options of climate consultant.

2. There are 5 guidline which are similar in any 3 options. The CEC, ASHRAE 55 and the ASHRAE 2005 have 4 options in similar.

The design strategies in each option 1, 2, and 3 have varying percentage contribution. The selection of best set of design strategies on the psychrometric chart will give 100% comfortable hours.

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