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Evaluation of Environmental Quality of Hospitals in Shillong based on Daylight and Thermal Comfort

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Abstract

This study aims to analyze the environmental quality of existing hospitals in Shillong based on Daylight (and view) and thermal comfort. Both Quantitative and qualitative methods are used to perform this research. Quantitative method is used to investigate the daylight, temperature and relative humidity in the selected hospitals which include statistical and graphical techniques using field investigations and computer simulations. Qualitative method is used through visual survey. The hypothesis is that maximizing the amount of daylight helps reduce the amount of artificial light and, depending on the climate also helps with temperature control to achieve thermal comfort for a more sustainable hospital and that older hospitals would have a higher level of daylighting and thermal comfort. This study has two major purposes, first is to investigate the daylight and thermal comfort parameters in the existing hospitals and second is to investigate the factors affecting these two parameters. The results indicate that older building does perform slightly better in the aspects of daylighting only. The immediate outcome of this study is a list of parameters affecting the daylighting and thermal comfort in the existing hospitals and based on this, generic guidelines are developed for architects to incorporate appropriate daylighting and achieve thermal comfort in the architectural design of hospital including to support architectural decisions. This study was created as a basis for the development of recommendations for designing healthcare facilities for a cold and humid climate of Shillong and, as a result, should be used to achieve more effective healing environments.

Keywords: Daylighting, Healing Environment; Sustainalbe Hospitals, Thermal Comfort

1. Introduction

The study of daylight availability in indoor environments is extremely important for lighting designers and building planners since it has the potential of improving the users' wellbeing and performance and it also allows to reduce energy consumption[1-3]. Daylight is especially very important for hospitals since most of the people spend their time indoors in the buildings, there is considerable concern about indoor environmental quality. Among the environmental quality components, views of nature through window with daylight and thermal comfort are recognized as significant factors in increasing indoor environmental quality[4-7]. These environmental trends have recently led researchers to study the beneficial aspects of indoor space that includes window views and daylight. Ulrich et al. investigated the importance of a window view of nature to generate positive physiological effects in people. Kuller et al. showed how class rooms with windows can improve children's physical and psychological conditions[8]. These conclusions are further supported by Heschong, who found that work efficiency/productivity could also be enhanced by windows and daylight[9].

Saving energy is also a very important issue these days due to critical environmental problems that include gas emissions and global warming. As a result, various environmental design techniques have been developed and are popularly used to increase the energy efficiency of buildings. One such strategy is the reduction of the amount of solar radiation that is admitted to indoor areas and a

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decrease in the cooling load through installation of tinting glass, shading devices, etc.[10, 7]. This is mostly the case in majority of places in India. As a result, generalization is done on designs to reduce the admission of daylight in indoor spaces. However for a cold climate within the Indian context, increase in solar radiation helps achieve thermal comfort especially in winters. Hence, when considering daylight and windows, and their interaction with thermal comfort (due to heat gain through windows), direct contribution of transmitted solar radiation (i.e. heat) to the occupants cannot be neglected. Thus, thermal comfort due to daylight is also one of the important physical aspects of indoor environment quality. It has been found that unfavourable temperatures affect patients in terms of recovery rates and also increase their stress levels[11].

Thermal discomfort also affects the quality of sleep. Therefore, hospitals need to be capable of supporting patients who may be particularly sensitive to high or cold temperatures: those with weak or impaired thermoregulatory systems (older people; those on multiple medications; on psychiatric medication affecting thermoregulation and sweating; with chronic or severe illness) and those who are unable to take reasonable adaptive action to ameliorate the effect of high or low temperatures[11]. Suboptimal thermal conditions can also affect the work performance of healthcare professionals. Uncomfortable temperatures have been shown to significantly reduce complex cognitive and perceptual-motor performance[12], motor tasks, and vigilance[13]. Thermal discomfort was also found to cause stress and anxiety for surgeons while they were performing surgical procedures[14].

Hence, daylighting (and view) and thermal comfort are two important physical aspects of a built environment which constitutes what is called a healing environment. Thus, this study aims to investigate the environmental quality of hospitals in Shillong based on daylight and thermal comfort. Also, this study aims to identify factors affecting these two: daylight and thermal comfort and the effect of climate on these factors. Daylight and thermal comfort measurements were carried for a period of two days in the month of February.

2. Methodology

2.1 Facilities

Two general hospitals in Shillong, India are selected for the purpose of this study. The city is located in the cold and humid climate with majority of the months fall below the comfort zones. The maximum temperature in Shillong is 28° C and minimum is 2° C, and is characterized by four distinct seasons: spring, summer, autumn and winter. The hospitals are selected based on the time of constructions for various architectural style existing in the region. The hospitals are indicated as hospital 1 (H1) and hospital 2 (H2). Figure 1 and 2 shows the layout of the two hospitals, H1 and H2 respectively. Hospital 1 (Figure 1) was built in the 1950s and expanded subsequently, it has three floors with a basement floor. The building has a double-comb like structure with a central corridor and the wings are accessed by singly-loaded corridor. The wards are located at the wings of the structure.

Figure 1. Showing ground floor (left) and first floor (right) layout of H1 with test points indicated as red dots.

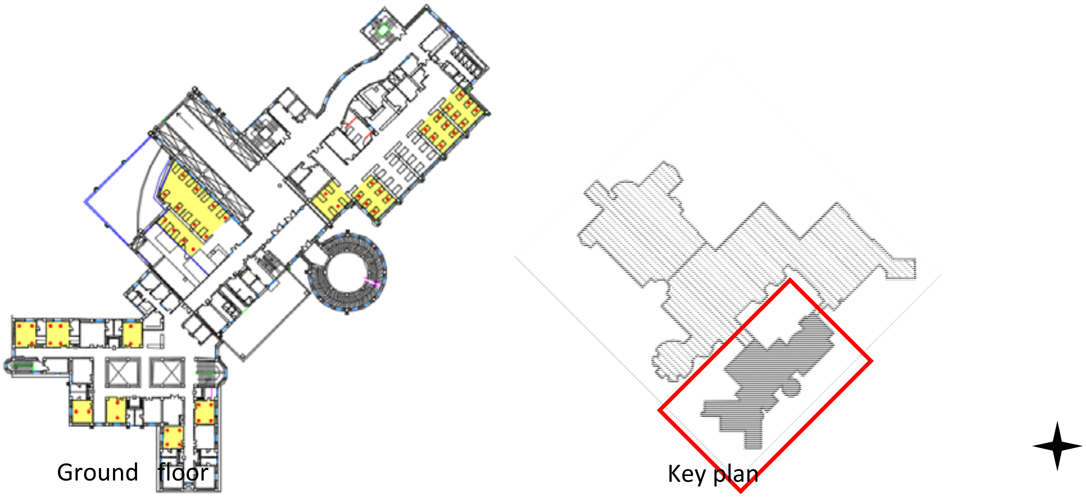


Figure 2. (Left) Showing the ground floor layout of IPD in H2 and (right) Showing key plan and location of IPD block in H2.

Hospital 2was completed in 2007 and has an axial planning with several blocks connected by the central spine like corridor and it has multiple floor levels. The wards are located at the In-patient department [IPD] block (Figure 2) with all floors being uniform. The IPD block has an open-end plan with larger exposed surfaces and it is located towards the opposite end of the hospital building with respect to its main entrance. It is connected to the main building by a central spine like corridor which is open on both the sides creating open spaces in between the IPD and the rest of the hospital building. The open spaces created some sort of barriers from the public spaces which give privacy to the wards. It has doubly loaded corridors to access the wards and two covered courtyards are provided towards the south corner to lit the centrally located circulation spaces.

2.2 Selection of Variables

Variable selected for analysis of indoor environmental quality were: Environmental and architectural variables which includes illuminance (daylight intensity in lux), room temperature, relative humidity (RH), room type (e.g. single deluxe, single standard, semi private-double bed room, and general ward) and provision of outdoor view.

2.3 On site Measurements and Instruments

On site measurements were made in wards of the two hospitals with different orientations and layouts, and similar wards were not considered. The physical environments including the room layout, windows design, shading devices, internal finishes, glazing type, locations of the wards, overshadowing and outdoor obstructions were investigated. Several reference points at 0.9m above the ground were taken at a distance of 1m from the window and also opposite the widows depending upon the room layout in the sampled wards, and illuminance levels were measured. On-site case study of the existing hospitals is performed with the help of environmental meter (*EN300: 5-in-1 Environmental Meter)* to measure the instantaneous lux levels, temperature and humidity.

3. Results

3.1 Physical Environment of Wards

Wards in the hospitals are indicated as H1W1, H1W2, H1W3, H1W4, H1W5 and H1W6 respectively. Wards in H1 have maximum orientations facing North east and some oriented facing southwest and west due to the orientations of the main building (65° of E-W). Due to its open-end layout in H2, wards are oriented facing north, east, southeast, south, west and Northwest with maximum windows oriented along southeast. The beds in these wards are either placed: 1). Parallel to the windows or,2).Perpendicular to the windows. These ward features create different illuminance levels even with the same orientations depending on various factors discussed as follows. The wards will be grouped based on the orientations of the wards and comparisons will be done in groups. The wards oriented along N will be Type 1, E-Type 2, S-Type

3, W-Type 4, NE-Type 5, SE-Type 6, SW-Type 7 and NW-Type 8.

3.2 Daylight Availability

Depending on the orientations, configurations of the hospitals, and location of wards there is a difference in the daylight and thermal comfort conditions.

3.2.1 Effect of Orientation and Planning

In hospital building, orientation plays a major part in the early process of the design. In fact, it can be argued that is the highest priority in the design decision for achieving climate responsive and sustainable hospital environment. The orientation of H1 is 65° along E-W axis which is fairly acceptable, since the 65° orientation has reduced the angle of incident solar radiation on the vertical surfaces. Although H2 is oriented 135° along E-W axis, H2 has poor orientation in terms of thermal comfort, since the longer façade of the buildings are along the NE which is the prominent wind direction in winters. However, the IPD block due to its open-end plan, it has larger surface area of external wall exposed to the outdoor environment. Hence, increase heat gain along the vertical surfaces.In hospital design, where creating a healing environment is the primary concern, time factor and orientation of the building do influence the design of the windows directly affecting the quality of daylighting (i.e. glare effect and daylight distribution) and access to outside view (i.e. optimise the surrounding scenery). Orientation also influences the amount of heat gain in the building. Hence, it would have a significant impact on the end users' (i.e. patients, medical staff and visitors) experience and well-being.

H1 and H2 have similar type of planning, with centrally located corridor acting like a spine which is mostly doubly loaded and require artificial lighting. Several pockets of open spaces are created in between the building blocks which allow penetration of sunlight to some extent. The widths of the open spaces in H1 are too less considering the height of the building, which create mutual shadings and reduce direct sunlight into the wards. However, although H2 has multiple floor levels, the widths of the open spaces created in between the blocks are large enough to prevent mutual shading and hence, no reduction of direct sunlight into the wards.

3.2.2 Effect of Windows Placement and Typology

The provisions of windows in wards of the two hospitals are different in terms of windows profile and placement. Three types of window profiles and placements have been identified in these wards as shown in Figure 3.

Type-A: *Centre grouping with skylights* - they are quite common and are found in H1. They are usually placed at the centre of every structural grid in a ward. They provide lesser amount of daylight, but sometimes create dark spaces at the corners and cause visual discomfort in the wards. Type-B: *Centre grouping without skylights* – they are found in H2 and they are centrally placed in the room. They provide lesser penetration of daylight than Type-A windows and hence lesser amount of daylight, but sometimes create dark spaces at the corners and cause visual discomfort.Type-C: *Symmetrically placed windows* – these are mostly found in general wards of H2 where the two windows are placed symmetrically with a blank wall at the centre in between the two windows. They provided better distribution of daylight as compared to Type-A and Type-B. They can be both with and without skylights or ventilator. They create less dark corners and hence reduce contrast which causes glare and visual discomfort in the wards.

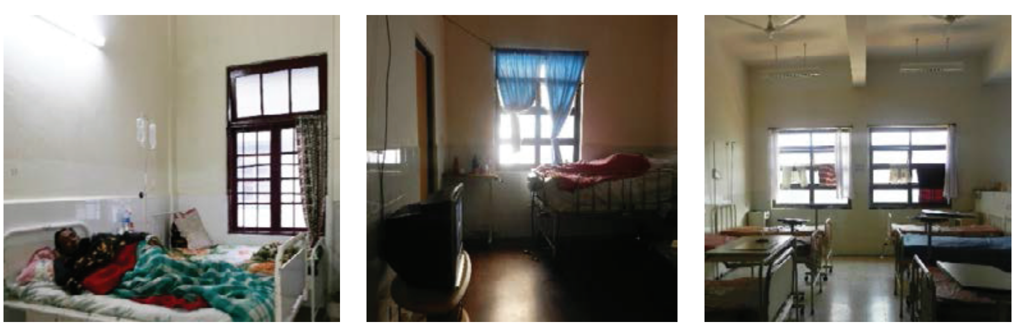


Figure 3 showing Type A windows (left), Type B windows (middle) and Type C windows (right)

3.2.3 Effect of Glazing Used

The windows and glazing physical properties do not affect only the building energy needs or visual comfort but also the indoor thermal sensation of occupants. H1 uses transparent glasses but are painted with oil paint up to 1.2-1.5m in some of the wards at ground floor levels in order to provide visual privacy. The rest of the wards are provided with transparent glasses. H2 uses transparent glasses throughout the buildings.

3.2.4 Effect of Window to Floor Area Ratio and Window to Wall Area Ratio

Standards like ECBC and NBC have specified the minimum and maximum requirements for provision of windows in a room as per the climate type. As per NBC 2005, the window-to-floor area ratio for a *cold and humid climate*, i.e. the minimum aggregate area of openings excluding doors and inclusive of frames should not be less than one-twelve of the floor area i.e. 25% of the floor area to achieve thermal comfort through direct heat gain. Whereas as per ECBC, vertical fenestration should be less than 40% of the total wall area i.e. thewindow-to- wall ratio (WWR) should be less than 40% for energy efficiency.

Hence, WWR and window-to-floor area ratio in wards need to be analyze and check if they are in compliance with the prescribed standard and its effect on the daylighting and thermal comfort. The WWR and window-to-floor area ratio in wards of the four hospitals are shown in Table 1.

From Table 1, the provision of windows in the wards of the two hospitals are mostly not in compliance with the standards and it is reflected in the daylight and thermal comfort of the wards. H1 has higher window-to-floor areas as well as WWR than H2. This is achieved due to the provision of Type-A windows in H1 and hence higher amount of daylight penetration. H2 has lesser values due to the provision of Type-B windows and hence lower amount of daylight. Higher values are seen in H2 only with the provision of Type-C windows which allows higher amount of daylight penetration. Detail analysis of WWR and window-to-floor area ratio could be done for different percentages by trying out some permutations and combinations to be able to determine the best combination for wards for this type of climate which is beyond the scope of this study.

Table 1. Showing window to floor area ratio and window to wall area ratio

Hospital type	Ward Type	Window to floor ratio % [>25%]	Window to wall ratio % [<40%]
H1	Type 4	16 %	19 %
	Type 5	16-19 %	20-30 %
	Type 7	12 %	17 %
H2	Type 1	9 %	13 %
	Type 2	10 %	13%
	Type 3	10 %	15 %
	Type 4	10 %	12 %
	Type 6	13 %	23 %
	Type 8	6 %, 21 %	7 %, 28 %

3.2.5 Overshadowing and Shading Masks

The location of wards also affect the daylight quality in the wards for example, H1W0 is located at the open-end of the wings, it gets more daylight than ward H1W1 which is located at the corner of the building even though both the wards have same orientations (Figure 4). These wards are facing southwest and has higher exposure to direct sunlight, but because of overshadowing provided by the wings on the next row of the hospital building and the provision of shading devices, direct sunlight is obstructed and the façade remains shaded especially in winters.

The daylight levels in H1 vary as per the floor levels as well due to mutual shading and obstructions of external features. In H1, the reduction in daylight levels is almost by 50% when there is an obstruction due to the building self-shading, as shown in Figure 5.

The provision of landscape features like trees (especially evergreen trees e.g. Pine) near the buildings and its openings has reduced the daylight levels to a very large extent (up to 40% in H1) as shown in Figure 6. Provision of deciduous trees is preferable near the windows or adjacent to the building to reduce heat gain in summers while allow the winter sun to enter into the building to achieve thermal comfort.

Shading devices are provided in H1 whereas in H2, recessed windows of 600 mm are provided. H1 has various type of of shading devices, they vary in size, shape and as per the orientations. As per ECBC, shading devices should be reduced in this type of climate, therefore overshadowing of shading devices should be analysed properly in order to be able to achieve good daylight and thermal comfort while at the same time they should be able to provide visual comfort and views.

Figure 4. Type of wards and the name given to a ward.

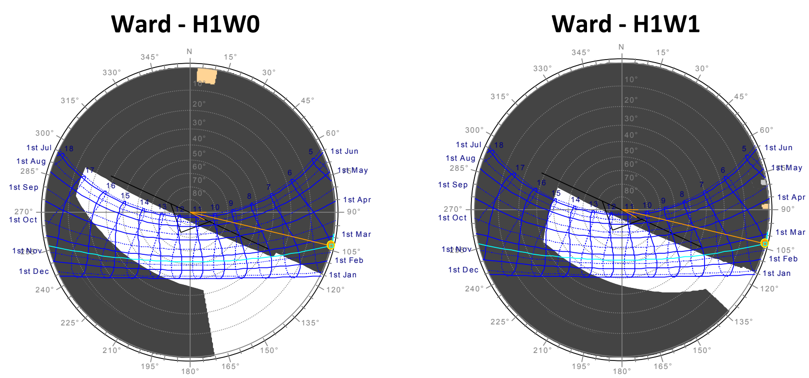


Figure 5. Overshadowing and shading mask of wards in Hospital 1 along Southwest direction.

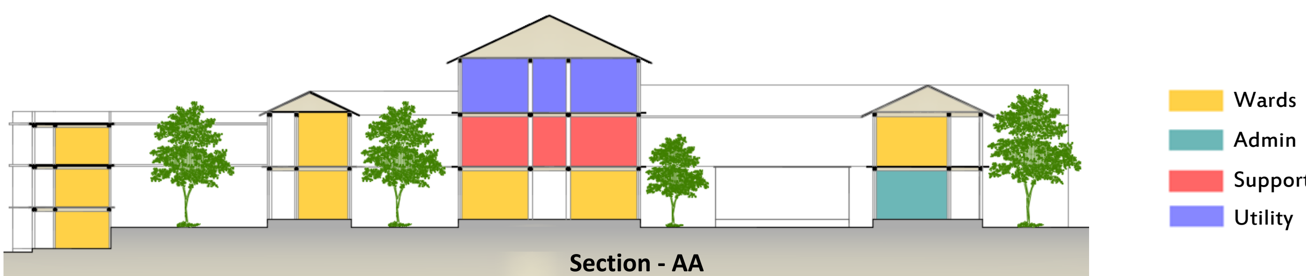


Figure 6. Site section of H1 with location of wards and pine trees adjacent to the building.

3.3 Illuminance Levels

As per the literature study, Nabil et al. provided a detailed classification of daylight intensities, based on the data from field studies on occupant preferences and behaviour.

Table 2 shows a summary of the findings. Nabil et al. (2006) concluded that, daylight illuminance in the range 100–2000 lux are potentially useful for the inhabitant of a room. The illuminance levels recorded in both the

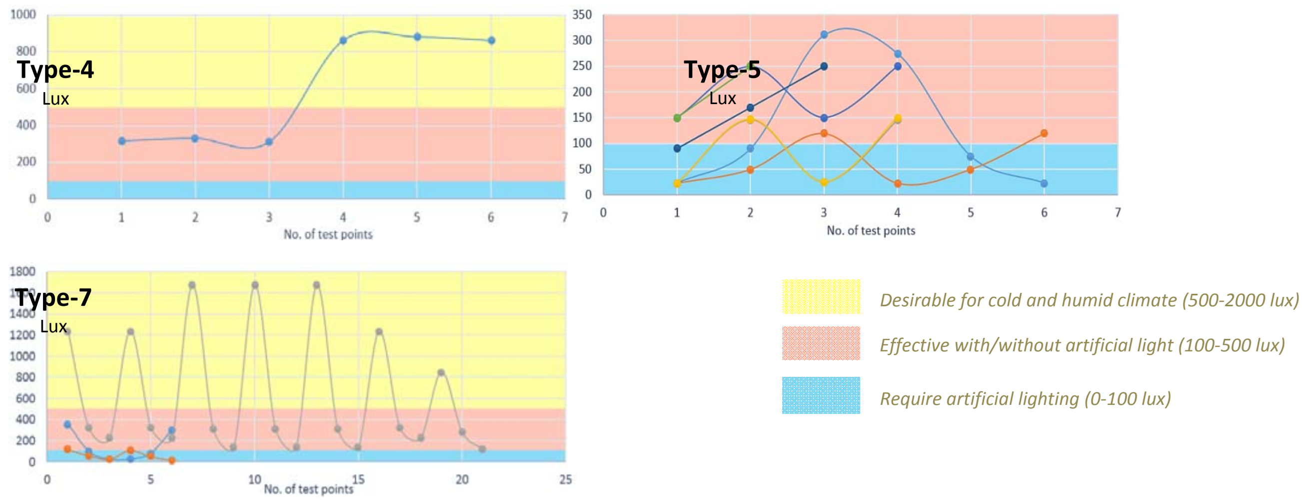


Figure 7. Showing lux levels of type of Type-4, 5 & 7 wards in H1.

hospitals are then compared according to Nabil et al. classification of daylight intensities[15].

3.3.1 H1

Figure 7, shows the illuminance levels of wards in H1. It can be noted that the maximumnumbers of wards are-Type 5 (facing northeast); as a result, the illuminance levels are in between 10 lux to 320 lux. Maximum levels are observed near the window and a considerable numbers of artificial lights are required in these wards away from the window.The wards do not have any lux levels above 500 lux which is desirable for this type of climate. Type 4 ward has higher lux levels ranging from 300 lux to 1000 lux and maximum levels are recorded near the window. Type 7 wards which are located on the ground floor have lower illuminance levels ranging from 0 lux to 400 lux, whereas the wards located on the upper floor have higher lux levels ranging from 100 lux to 1700 lux. The lower illuminance levels indicate away from the windows whereas the higher illuminance levels indicate near the windows. Type 4 &7 orientations of the wards allow for higher illuminance levels in H1. The illuminance levels near the window are above 500 lux which is desirable. H1 has Type A windows with 300-600 mm lintel projections.

Table 2. Classification of daylight intensities based on occupants' preferences & behaviour (Nabil et al., 2006)

Daylight illuminance:	Occupant's preferences
Less than 100 lux	Insufficient daylight as sole source and needs significant amount of additional artificial light
100-500 lux	Effective daylight as sole source and can be used in conjunction with artificial light
500–2000 lux	Desirable or at least tolerable level of daylight higher than 2000 likely to produce visual and/or thermal discomfort
More than 2000 lux	Likely to produce visual or thermal discomfort, or both

3.3.2 H2

Figure 8, shows the illuminance levels of wards in H2. Due to its open-end plan, H2 has wards oriented in six different directions.Type 1 ward has illuminance levels ranging from 40 lux to 170 lux and required artificial light for most part of the day. High illuminance is seen only near the window. Type 2 ward has illuminance ranging from 25 lux to 100 lux and it has high illuminance only in the morning up to 9am when there is direct sunlight. It requires artificial lighting throughout the day. Type 3 and 4 has larger exposure to direct sunlight throughout the day and hence higher range of illuminance which ranges from 100 lux to 600 lux.Higher illuminance levels are seen near the window.Type 6 wards have illuminance levels ranging from 100 lux to 1200 lux and higher illuminance levels are seen near the windows. They have Type C windows which are recessed by 600 mm. Type 8 wards have illuminance levels ranging from 25 lux to 300 lux. The low illuminance level in Type 6, is due to the

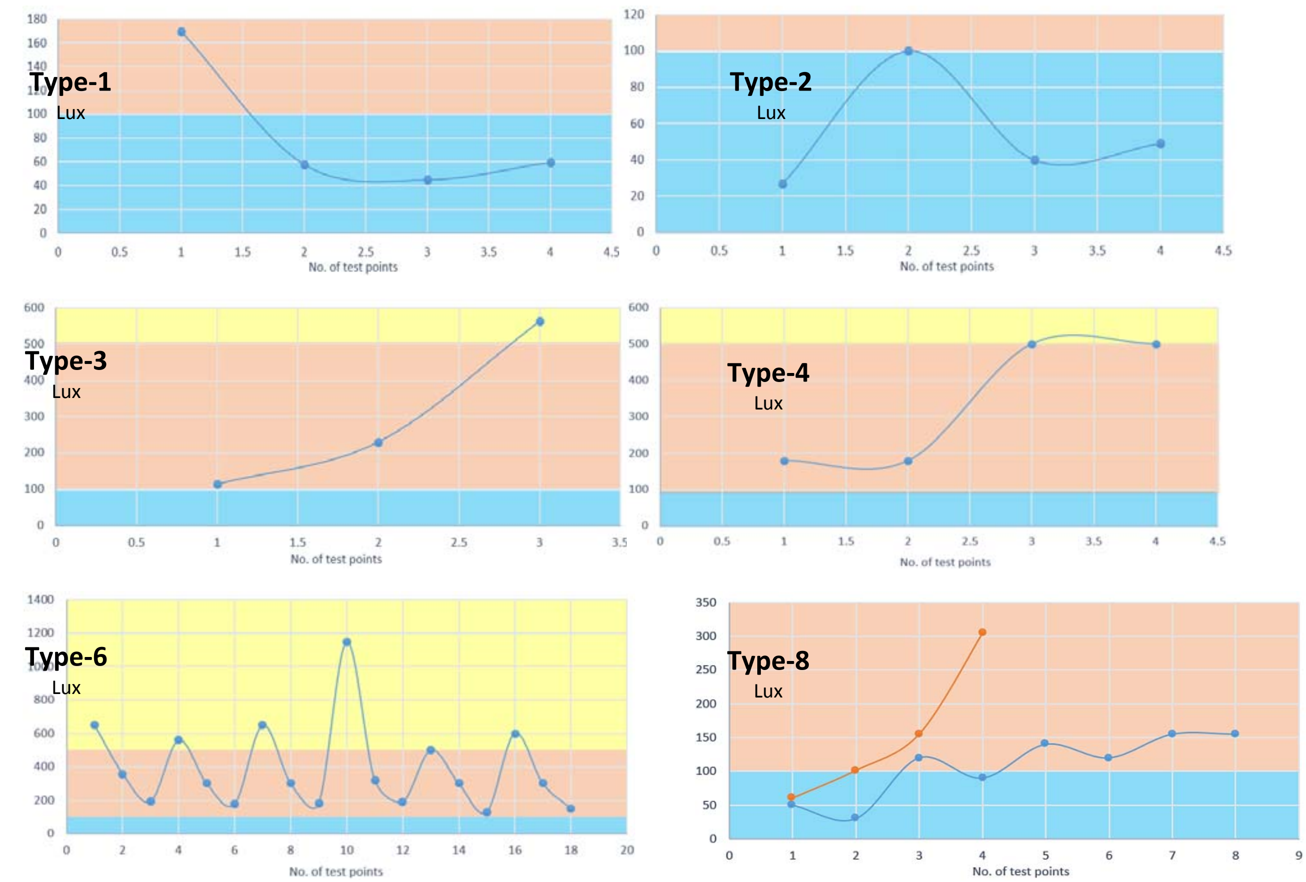


Figure 8. Showing lux levels of type 1, 2, 3, 4, 6 & 8 wards in H2.

low window-to-floor area ratio as compared to the specified standards. Type 1, 2, 3, 4 and 6 have Type B windows which are recessed by 600 mm which reduced the amount of daylight into the wards.

3.4 Temperature and Relative Humidity

Temperature is one of the most important environmental parameters in hospital environment because of its direct impact on thermal comfort of its occupants. From the graphs below, temperatures for the naturally ventilated wards of H1 converged with the outdoor temperatures and even lesser (Figure 9). The temperatures in the H2 are a little higher than the outdoor temperature almost in the comfort zone (Figure 10).

The temperature difference between the indoor and outdoor areas is very small, as a result of heat fluctuations (thermal mass/insulation and solar heat gain), internal heat sources and probably other factors. The temperature for the month February ranges from 16-24 °C. The highest temperature is recorded from H2 in Type 7 wards which are facing the southwest directions. The wards located on the lower floors especially the ground with no heat gain from vertical and horizontal surface have recorded the lowest temperature. The wards in H2 has 600mm thick cavity wall which has good thermal mass properties, hence recorded higher temperature than the outdoor temperature. The temperature in these wards remains relatively constant and not much variations is seen as per the outdoor temperature. But due to its multi-floor levels, there is no exposed horizontal surface and hence less heat gain. The walls of H1 are made up of half brick thick wall, hence less thermal storage capacity. This is reflected in the temperatures of the spaces. The temperature of these wards are also affected by the location, orientation of the rooms, the roof type (sloping roof with false ceiling, rcc flat slab, etc.), the amount of glazing and the surrounding environments.

Since, Shillong has a cold and humid climate, the humidity level is generally high throughout the year. All the wards have similar humidity which ranges from 35-54

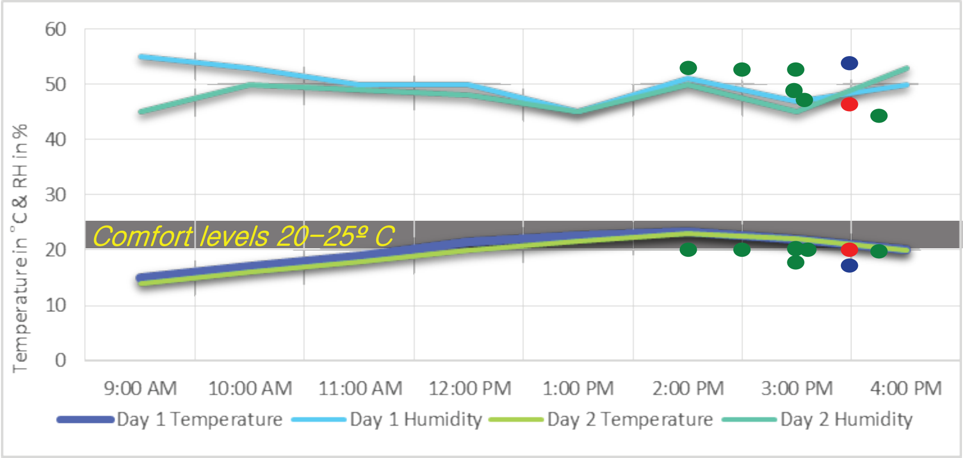
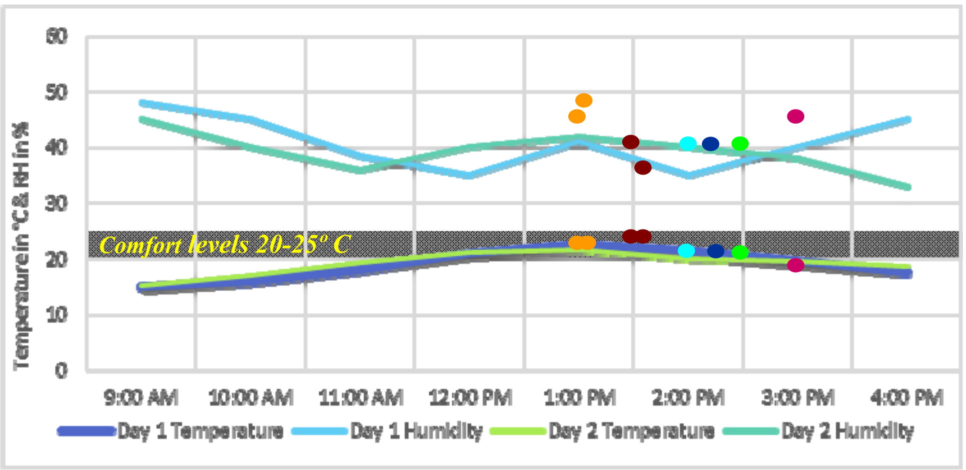


Figure 9. Showing the recorded temperature and relative humidity readings of different wards with respect to the ambient temperature taken within two days for H1.



Ward Type	1	2	3	4	5	6	7	8
Orientation	**N**	**E**	**S**	**W**	**NE**	**SE**	**SW**	**NW**
T [ºC]								
RH [%]								

Figure 10. Showing the recorded temperature and relative humidity readings of different wards with respect to the ambient temperature taken within two days for H2.

%. High humidity level is recorded in the morning which goes on decreasing at noon and it increase again towards the evening. H2 has lower level of humidity which ranges from 35-40 %. H1 has the highest humidity which ranges from 43-56 %.

Comparison of environmental parameters by hospital wards showed no significant difference for temperature and relative humidity for both the hospitals. Indoor relative humidity depends on many factors including ventilation rate, outdoor humidity and occupant behaviour and building materials. The measured data indicates lower range of building performance, since the temperature and the relative humidity are way below the comfort levels. The thermal performances of these hospital buildings can still be optimize. The differences in moisture content may be due to local differences in air tightness of building envelopes, design of building façades, etc. However, the most obvious explanation is the orientation and exposure of the buildings, thermal properties of the building facade and effect of solar radiation on the building envelope.

3.5 Internal Finishes

In this study, pastel colour scheme is used in almost all the walls of the wards and no strong contrast is seen in these wards environment creating a comfortable surfaces. All the wards in both the hospitals painted their ceiling white, this ensure maximum distribution of light in the wards environment. Colour scheme and internal finishes do have an impact on the daylight quality in a room, for example: in H1, the white and smooth floor finishes in the wards sometimes causes glare due to reflections and hence visual discomfort.

3.6 Access to Views

There is growing research evidence that access to view in the ward environment would provide a positive impact on patients physically, psychologically and mentally[16]. Evidently, research by Ulrich (1984)[17]of surgical patients with a view through a window may provide shorter length of stay. This evidence and findings by others send a clear message to the professionals involved in the healthcare services that coordinated effort must be taken beyond the requirements of the project briefs. However, the quality of the outside view has to be positively promoted and based on the availability of outside view; the study arrives at three different types of outside views. The following are the three View type: Type 1: Panoramic view which includes greenery & surrounding development, Type 2: Building facades own view and Type 3: Blank wall.The bed layout affects access to view by the patients in a ward. Parallel layout provided more access to view especially at the window side beds. However, access to view from the beds placed away from the window may be reduced considerably depending on the window type. Perpendicular layout do not provide a convenient line of sight especially to the beds located near the window. However, the beds located away from the window get only the upper level of the outside view. Hence, in order to provide access to view, the bed layouts are also important to be considered.

The height of the window or the sill from the finished floor level is important to provide access to the outside view in the hospital wards. The two hospitals have low sill levels ranging from 0.7m to 0.9m. Since the patients spent most of their time sleeping or sitting on the bed, outside view needs to be analyzed at this level. Bed size observed in these hospital ranges from 0.6m to 0.8m. Hence, the sill levels in these hospital wards are at the proper height to access the outside view. The window type and its glazing also affect access to view by the patients in a ward.

4. Discussion

The results reported in the previous sections showed that there are various factors which affect the illuminance levels in the wards in a hospital. The most important factor is the orientation of the buildings and fenestrations which helpin achieving good daylight as well as determining the direct solar radiation entering the rooms. This also has an impact on the thermal comfort in a room through heat gain. The amount of daylight available in the wards, vary as per the orientation of fenestrations. *North:* the orientations of the windows along north, provided very less to no direct illumination and solar radiation. Hence, it is the worst orientation for this type of climate. *East and Northeast:* The orientation of the windows alongeast and northeast allow early morning sun after a cold night, however since there is less direct solar radiation through the windows, hence less illumination and heat gain for the rest of the day. *Southeast, south, southwest and northwest:* These orientations allow the windows to get exposed to direct solar radiation to a large extent. Hence higher illumination and heat gain. These orientations are the best if incorporated properly in the design along with the shading devices. *West:* The orientation of the windows along west can cause visual discomfort, since windows are exposed to high illumination and direct sunlight at low angle.

Window type: The type of windows and its placement are important factor that affect the daylight and thermal quality in a space. The windows can be divided to serve its purposes as the viewing window, which at low height and for daylight they can be at higher level.*Type of glazing used:* The type of glasses used affect the quality of light in the wards, the privacy as well as the view to the outside environment. The wards with transparent glasses has better light quality, however translucent glasses provide better privacy. Thus, the type of glasses considered in a hospitals should best suited the requirements of the room.

Shading devices: They should be optimize to serve its purposed. It should not obstruct the daylight and direct solar radiation, but enhance its quality. The design of shading devices can be the same in all the orientations to give an aesthetic appeal to the hospital building. Light material curtains could be provided to provide shading like the west directions.*Overshadowing*: Overshadowing or mutual shading of building components could be beneficial if located in a hot climate type. However, for cold and humid climate it should be avoided and proper shadow analysis needs to be done.

*Illuminance:*From the results discussed in the previous section, the illuminance levels of wards in both the hospitals are low and do not meet the requirements for this type of climate. In order to achieve good illuminance levels, considerations of window-to-floor area is more crucial than window-to-wall area for this type of climate to achieve good daylight and thermal comfort. However, none of the wards in the two hospitals comply with the specified requirements as per standards. Provision of windows as per the standard requirements will help achieve a basic level of understanding of the window design and the obtained levels of daylight, visual and thermal comfort.

Thermal comfort: Thermal comfort in a space is affected by the orientation, location, exposure of the buildings, thermal properties of the building façade and the effect of solar radiation on the building envelope. In naturally ventilated wards, simply provision of openings is not sufficient to achieve thermal comfort; proper thought process, climate and site study need to be done while designing hospitals.

Internal finishes: It is important to have proper considerations when deciding the colour scheme and internal finishes as they have an impact on the daylight quality in a room. It is also important to note that this requires further analysis on the aspect of reflectance of daylight which is beyond the scope of this study.

Access to view: The building configurations and orientations play a very important role in providing access to view in a ward. But, the quality of the view available outside should be such that it should have a positive impacts on the patients and staff. In order to provide access to view, the bed layouts, the height of the sill and the window type are important to be considered.It has been found from this study that this aspect (access to view) was not given any importance in the designing of these hospitals. This convey a clear message to the professionals involved in the healthcare services that coordinated effort must be taken beyond the requirements of the project briefs to incorporate this aspect in hospital design.

5. Conclusion

This studyevaluated the environmental quality of a hospital building for a cold and humid climate of Shillong based on its daylighting and thermal comfort. Overall, the older hospital with more traditional settings, i.e. H1, performed better than itssuccessor with respect to daylighting in wards. However, the newer hospital with more sophisticated design features, H2, performed better than its predecessor with respect to thermal comfort in wards.

The study also identified several design factors which affects the daylight and thermal quality of these hospital wards. Proper design considerations of these factors should be done by designing for better performance to provide good daylight and thermal comfort which are of primary concerns. The study was carried only in the month of February, however to obtain a better understanding on the performances of these hospitals, it would be interesting to carry out the same study in the other seasons as well to investigate if the results are similar.

The study demonstrates that these hospitals do not have any proper design considerations to achieve good daylighting and views, and thermal comfort; raising questions if the newer hospitals do not performed better than the predecessor then what holds for the future hospital design in this area. Thus, it can be concluded that provision of good daylight (& view) and thermal comfort in the hospital buildings will create a more suitable healing environment for the patients and the staff and hence move one step forward to achieve sustainability in the hospitals of Shillong. The findings in this study confirm the potential of design features in improving the daylighting and thermal comfort in hospital buildings. Incorporating good daylight (& view) and thermal comfort elements can be a complex process, and is a strategy that requires careful planning and systematic thinking, taking into account many factors. If these are incorporated properly in the hospital building design, other than providing a healing environment there could be a significant reduction in energy.

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