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HOSPITAL DESIGNS IN TROPICAL MALAYSIA - TOWARDS A GREEN AGENDA

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Abstract

'Sustainability' as a terminology, is a broad concept and a requirement in building designs with a tendency of being abuse through trendy and over commercialisation. In the arena of hospital design, new is usually associated to being modern and therefore, green. In the quest of getting to know the "tree" from "the forest" from among the hundreds of existing hospitals, ranged from colonial, early independence to the new hospital designs, a yardstick, to measure those that is actually "green" and "sustainable" need to be set. This study intends to provide a qualitative definition and provide recommended criteria of a green hospital designs in the context of tropical climate of Malaysia and its people. A qualitative method of approach through case studies of hospital designs from pre-colonial to the present were made. Aspects studied include the physical architecture that significantly affect health i.e. the building configuration, form, space quality, material use and culture. Findings indicated that there is a variety of degree and factors to the implementation of the green qualities in all the designs. The range includes intuitive and regulatory approach to green considerations in the design. Conditions of the site, cost, construction time, planning time, expertise, experience and procurement methods are among the constraints where compromises had to be made as a priority. Significance of the findings will contribute to the qualitative criteria for healthcare building Green requirement especially for tropical climate of Malaysia.

Keywords: *Tropical, Hospital, Design, Green*

INTRODUCTION

The meaning of sustainability, may provide a variety of understandings and perspectives, depending on the context it is used. Buildings, as physical entities of the built environment, do have its share of connotations in which many literatures translated the meaning of sustainability to mean building in the context of its physical environment,that deals with climate, and stipulated human comfort. Architecture, on the other hand, embedded extra dimensions to the meaning of sustainability that encompasses reading the "building" in time, place, with its people and the aesthetic influence of the culture. Sustainability in architecture, thus go beyond the physical elements of walls, floors and facades. It has a spiritual significance and meaning which derive from the architecture of the place for continuity to the overall built heritage.

For healthcare buildings and design, the main priority for sustainability is in its ability to function, support operation, and serve the users-i.e. patients, staffs, relatives, visitors and equipment around the clock, efficiently. The building, as a shelter and a structure, must be so designed with fundamental precaution to the underlying principle of ability to be kept and stay clean from the onslaught of various diseases and microbes

always. Healthcare buildings has to be designed for hygienic control; control infection; of adequate space and capacity for the function; ease of circulation; adequate ventilation; safe and comfortable environment; and having supportive healing environment among its design attributes.

Ideal location to place new hospitals in meeting the above criteria would be away from the hustle and bustle of the town or city, of a pleasing environment and yet at ease in its accessibility for the people it serves. In tropical countries like Malaysia, the natural location of hospitals had been the idyllic location by the sea coast and or by hillsides, with open-able windows, high ceilings and wide *verandah*[1] all around. The description conjured nostalgic images of the past colonial hospitals which were built as isolation shelters for the sick and infirm away from the community in an environment where fresh air, gardens and daylight were plenty (refer Figure.1) even in the urban areas.

Figure. 1 An image of the single storey colonial hospital architecture of a tropical hospital in the garden. (Source: Balik Pulau Hospital, Penang website)

Today, some of these facilities are still in existent in most part of the country. Although some of these buildings were replaced, there are others being reused and constantly in the state of renovations, expansions and refurbishments to meet the current medical needs and demands. Hence the original design intentions of tropical hospital amidst the greeneries and fresh air were either ignored due to pressing priority of functional adjacencies of spaces and circulation or being mishandled in its renovation work.

Currently existing sites that locate these tropical hospitals are endangered. With each new wave of structural planning of urban sites, the land are subjected to new land uses due to its commercial viability for resorts, residential apartments or any other facility that would bring more economic dues to the city or town as part of its sustainability agenda. Replacement site for old hospitals are subjected to availability of land and funds. They were usually relocated either within the existing site, existing urban framework, at the outskirt ,or at a new township.

[1] Veranda or verandah in architecture, as defined by Encyclopedia Britannica, most frequently described an open-walled roofed porch attached to the exterior of a domestic structure and usually surrounded by a railing. The word, veranda, according to Encyclopedia Britannica came into the English language through the Hindi word *varandā,* but it is related to the Spanish *baranda,* meaning "railing," and thus most likely entered Hindi via Portuguese explorers of India.

Hospitals, by its very nature, is recognised and understood as a facility that converge all kinds of diseases; provide as much and wide range of diagnostic services, and incur appropriate treatment where possible, centrally or vice versa. The circumstances are either due to shortage of staff and equipment or optimising the efficiency of specialise human resources and use of expensive equipment in accordance to the economics of its existence and the community it serves. In short, hospitals itself, with its conflicting roles of centrality and isolation, bringing multi-faceted supplies and disposals in huge quantities, layers of building services, range of technologies and energy consumption, contribute to the environmental issue. As cited by Ziqi Wu (2011) in his master of science thesis, *'Evaluation of A Sustainable Hospital Design Based on Its Social And Environmental Outcomes'* for Cornel University, although health care facilities represent only a small percentage of the total building stock, they have a disproportionate impact on the environment because of their unique operational requirements (e.g., 24-hour operations, energy-intensive advanced medical equipment and higher ventilation requirements). Hospitals, as reported by Department of Energy, 2003 cited by Ziqi Wu (2011) are the second highest energy consumers on a per square foot basis after the food service industry.

Designing new healthcare facilities is not an easy task. Professional architects and health facility planners found planning and designing hospitals which itself a daunting task, need to consider the facility GREEN and SUSTAINABLE as added criteria to the matrix. However, with the varied perceptions and interpretations of what make the facility GREEN and SUSTAINABLE, the simple requirements of passive designs architects are trained in context of the site seems no longer adequate. Is that true?

In the light of these 'movements' across the globe, Malaysia had formulated its own green index under Malaysian Green Building Index (GBI) for residential, non-residential and industrial buildings to date. In Malaysia, the GBI and sustainability means more than just sustaining or optimizing energy consumption, but to include Energy Efficiency, Indoor Environment Quality, Sustainable Site Planning & Management, Materials & Resources, Water Efficiency, and Innovation. As Malaysia is located in the tropics, the GBI is formulated to consider specifically for the Malaysian tropical climate, environmental and developmental context, cultural and social needs. However, as GBI for hospital building is yet to be formulated, Malaysian healthcare service provider had opted for adapted foreign standards of LEED, BREAM or nearest, Singapore Green Mark in their building contract brief of requirements. The question remains; isn't 'green' part of professional architect's services? Do we need 'green specialist' to ascertain the projects viability? Does 'Green' building specialists understand the needs of clinical sustainability in engaging architectural and engineering sustainability?

All hospital designs are subjected to the Uniform Building By-Laws (UBBL) 1984. UBBL incorporated the minimum requirement on passive design considerations for the users for the purpose of health and safety. The design of private hospitals in Malaysia are also governed by the Private Healthcare and Services Act 1998 apart from the UBBL. The UBBL, however, do not provide mandatory requirements on energy consumption nor intangible sustainable issues of culture or clinical procedures required in the holistic make up of a healthcare environment. Specialise buildings such as hospitals requires specific design requirements from knowledgeable clients or their advisors. Thus, the planning and

design decisions to include the additional 'GREEN' elements for hospitals to achieve certain ratings remained with the respective client management.

Objectives of this paper thus aimed to:

- Ascertain the meaning of "green" and "sustainability" in the provision of hospital architecture in the tropical climate of Malaysia in view of its architectural sustainability and clinical functionality; and
- Provide a direction towards qualitative design guidelines as rule of thumb in recognising the good and practical green hospital designs,

towards the green agenda for hospital in the tropics;

For the purpose of this paper the scope of the study involves

- Identifying available standards or criteria of "green" and "sustainability" for hospital building designs in tropical climate of Malaysia; and
- Examining the physical and non-physical or humanistic development of selected hospital designs through case studies of hospitals built in Malaysia from colonial period to present.

Qualitative method adopted for the study involved the following process within a limited time frame. Data collection were made through secondary data via content analysis of available literature covering study of old and new photographs and previous study field notes; and through primary data via observation, field visits of selected hospital facilities, random interview of professionals (architects, engineers and green specialist), clients as well as personal experiences in planning and design of hospitals.

Analyses and findings on these hospitals for the 'green' and 'sustainability' elements were based on selected site location, building layout and configuration, built form, internal planning strategy or space quality, material use and construction, as well as culture. The tangible and intangible green elements assessed includes each facility's general orientation on site; each building structure's access to natural ventilation, view and daylight; layout or planning that signify specific area of the building requirement for controlled condition; internal space planning strategies for infection control; for natural ventilation; access to view, daylight and family members in and outside clinical area; adequate human circulation and orientation; and respect to local culture and context.

Limitations of the Study due to time and availability of information, this paper limits to the study that dwells only on the physical and available non-physical data of the hospitals and its attributes within the stipulated period. Significance and benefit of the study, as Malaysia formulate its green criteria based on types of building typology in its green building guidelines series, this paper intend to contribute aspects of qualitative considerations in the green planning and design of hospitals for tropical climate of Malaysia.

ISSUE AND DISCUSSION

This paper discusses on exemplar hospital architecture as a universal attributes with a question of its implication being located in the tropics. The issue was brought forth on

claims that new hospitals are design with green and sustainable considerations, the past hospitals were not. The hypothesis is that these remarks were made without understanding that the concept of green and sustainability for a hospital goes beyond the passive and active design attributes of a physical structure performances but those that embrace the clinical functionality and the humane consideration for an environment that heals.

Hospital Architecture in the tropics

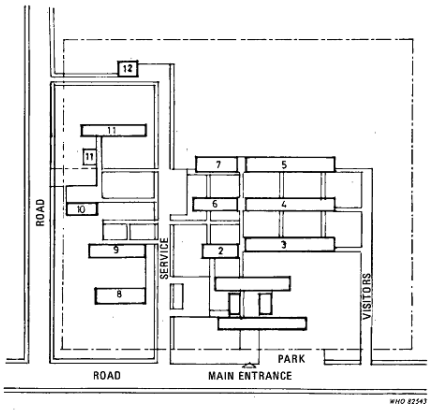
Each community, depending where they are located had different terms for their built facilities, built forms and way of addressing the sick in accordance to their culture, belief systems and traditions. Not many evidences were left behind from the Asian cultures of hospitals or healthcare buildings, especially in the tropics, to be studied or emulated. Built structures or shelter to place the sick, as hospitals, we know today, are advent of the West and the Middle Eastern evolution from house of charities, churches, palaces and secular buildings for the sick or '*Bimaristan*', as well as for the training of the medical and health professions. Building typology for hospitals in the tropics, is relatively new. Even in the tropics, as the source of early 'pavilion plan' hospital designs inadvertently came from the same source, i.e. France of the 18th Century (Cook. G.C. (2002)), hospital building designs are almost universal worldwide. So what can hospital built in the tropics differ to be sustainable and effective?

Hospital design, no matter where it is located, as cited by Florence Nightingale (1859) in her "Notes for Hospitals", that,

> *"The very first condition to be sought in planning a building is that it shall be fit for its purpose, and the first architectural law is, that fitness is the foundation of beauty. The hospital architect may feel assured that, only when he has planned a building which will afford the best chance of a speedy recovery to sick and maimed people, will his architecture and economy which he seeks, be realized"*

Understanding the statement above, implies the need to know what kind of diseases or ailments the tropics harbours. Who would be the inhabitant and user of this facility? Why does this happen? How long and how to treat the ailments? How should the facilities be designed? Where should these facilities be located to appropriately serve the people?

Physically, as a shelter for the sick, Kleczkowski, B.M. and Pibouleau, R. (ed.) (1983), in WHO's OFFSET 72 (Part 1), in 'Approaches to planning and design of health care facilities in developing areas' described in the Annex 2, Clause 5.2 and 6, pp.19, that the planning and design of hospitals should consider the local climate with typical approach to its architecture, i.e. by providing simple low rise buildings connected by corridors as shown in Figure 2 and 3; utilising local building materials and method of constructions; designed that encompassing local customs and habits: at affordable cost; reliability of operation and maintenance: apart from serving the functions and users of the facility.



1. Outpatients; 2. Administration; 3, 4, and 5. Wards;
6. Theatre block; 7. Delivery; 8. Stores and workshops;
9. Kitchen; 10. Laundry; 11. Isolation ward; 12. Mortuary.

Figure 2: Typical Developing Countries Tropical hospitals layout plan (Source: Kleczkowski et al (1983), Figure 9:Rural and District Hospital Type Plan, pp 34.)

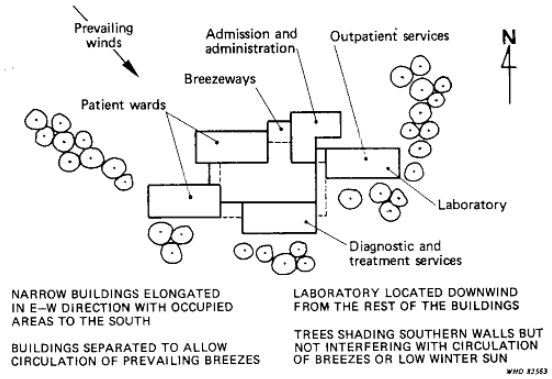
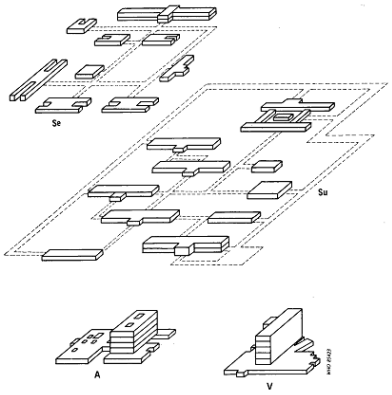


Figure 3:Typical Hospital Layout for Countries with Hot Humid Climate (Source: Kleczkowski et al (1983), Figure 5: Typical Hospital Compound: Hot Humid Climate, pp 57.)

WHO, in continuation of the study edited by Kleczkowski et al (1985), *'Approaches to planning and design of health care facilities in developing areas. Vol. 5'*, described the different implementation of 'standard designs' and 'type plans' through case studies of selected healthcare facilities of countries through their income level. In the study of acceptable internal micro-climate in the physical planning of hospitals in the selected countries i.e. Venezuela, Cuba, Senegal, Sudan, Zambia and Algeria, which are located within the tropics, most of the facilities designed allow for artificial ventilation at essential areas with majority oriented their buildings to capture the prevailing winds. However, most facilities in these countries, except for Cuba, find difficulty in maintaining the artificial ventilation or air conditioned at sensitive areas to acceptable level due several reasons including to inadequate maintenance and located within too small courtyards with less air circulation. Figure 4 provides a visual differentiation of physical

outcome based on country's priority on efficiency. Although energy efficiency points at Venezuelan model (v), both Sudan (Su) and Senegal (Se) model offers other priorities. The study also accounts the importance of site selection as a priority, in its compliance with the prevailing local socio-culture and preferences in the making of the design.



[a] A = Algeria, 240 beds; Se = Senegal, 210 beds; Su = Sudan, 120 beds; V = Venezuela, 200 beds.

Figure 4: Comparative evaluation of efficiency in design – horizontal and vertical (Source: Kleczkowski et al (1991), Figure 9: Types of 200 bed hospitals, pp 32)

Studies of internal layout of respective functional facilities were made by WHO in the same study on the 'types' and 'standard designs' of healthcare facilities. For this study, extract of the discussion on method of construction and the use of building material in hot-humid countries had highlighted problems where the need to consider, among others, the following, in the overall set up which is invariably important:

- durability and strength of the building materials used in extreme weather conditions of heat, rain and flood;
- workmanship due to un-skilled labour;
- maintenance culture and skill apart from the passive design discussed earlier;
- availability of constant supplies of water, electricity; and
- Waste treatment.

As cited by Hardy and Lammers, in Robert F. Carr (2011), 'Hospital' by WBDG Health Care, hospital design is *"A functional design can promote skill, economy, conveniences, and comforts; a non-functional design can impede activities of all types, detract from quality of care, and raise costs to intolerable levels"*.

Describing impression of tropical living, Stagno, B. (n.d.).in his essay, 'Designing and Building In The Tropics', depicted typical human behavioural of the tropics as follows:-

> "*In tropical latitudes people live out their relationships with the environment in a particular way. Living in a benevolent climate, but where coolness is a*

sought-after relief, the body becomes sensitive to slight changes of temperature and humidity. If someone wants to rest he or she will move their chair to take advantage of any breeze, until the most favourable spot has been found. This constant search for breeze and shade means that there is no a unique place in the house set aside for social meetings. This close relationship of dependency between people and the natural elements has given them a fund of natural wisdom which, as their surroundings become more artificial, has gradually disappeared."

In line with Stagno, B., findings by Ziqi Wu (2011), informed that performance of thermal comfort via sophistication in design as found in the newly completed hospital building in comparison to simple hospital designs, does not correspond as claimed:

"The results indicate that sophisticated sustainable hospital designs can improve the ambient thermal environment and occupant thermal comfort but not all those features were necessary. The study also suggests the need for adopting an integrated sustainable design strategy to prevent or mitigate some of the facility operation challenges encountered. Additionally, the study proposes for a shift in thermal comfort standards and green building rating tools to meet the unique thermal comfort needs of hospital users."

Apart from vector borne diseases for which tropical hospitals has to equip with, the climatic conditions of a place, building orientation, use of material and design to meet functional requirements to address issues of mould has been a constant battle to date.

In summary, the utilitarian architecture of yesteryear hospital designs did address both the functional aspects as well as the climatic considerations so as to ensure less maintenance. Attention to details was evident. Old hospital designs are provided, designed and maintained centrally by the state. Today, hospitals are generally designed independently by different architects for different service providers with different philosophies. Hence, hospital designs we have today are not uniform. Old hospitals may not be sustainable in the like of the new requirements in healthcare buildings. Whether the new hospital buildings are sustainable or green as claimed is yet to be evaluated.

Hospital Designs: Towards A Green Agenda

For hospitals, as a building typology with ever conflicting attributes in one cauldron, towards a Green Agenda, the questions of 'architectural sustainability versus clinical functionality' arise.

- Definition of Sustainability in Context of Hospitals : Architectural Functionality

Sustainability, as defined by Verderber, S. (2010) in his book, 'Innovation in Hospital Architecture', in architecture, for architects, involves more than ecological context or economic terms of interpretations. It is a holistic approach that include supply-demand tensions and priorities over limited resources such as clean air and water, livable

climate, healthy standard of living, community, spiritual and psychological health, meaningful work, intellectual openness, individual and social empowerment, a sense of heritage and history, cultural diversity, art, music and everyday life dimensions.

Yeang, K., (2012) in his keynote address 'Green Design and Planning' informed designers not to mistaken green design as simply eco-engineering systems, and the use of rating systems as comprehensive, although it is an important part of the process to green design as generic checklist. Yeang reiterated that achieving effective green design is much more complex and involved many design strategies. To achieve the goal where the built environment will be in balance as close as possible with the natural environment, Yeang proposed design strategies as follows:

1. Four Strands of Ecoinfrastructures[2], from masterplan to micro aspects;
2. Seamless & Benign Biointegration[3], effectively and seamlessly integrating man made and nature;
3. Ecomimesis[4]
4. Ecodesign as Restoring Impaired Environments
5. Ecodesign as a self-monitoring system

All the five (5) strategies are important in the total development where man's edifice as artificial product being laid for sustenance within a natural environment that has life in itself. In context to building a hospital, Yeang's principle that lays importance in understanding the very nature of the building, as an artificial element, function, operation, outcome and impact on the environment will undoubtedly provide insight from selection of appropriate site, current and future growth, inter and intra spaces, shapes and configurations. Yeang concluded that a totally green building or green eco-city does not exist and hence research in pursuit of the balance environment need to be continued, tested, interpreted and reviewed.

Both Verderber, S., and Yeang, K., viewpoints concur with the Islamic perspective of the environment in keeping with whatever man made edifices, be it a hospital, in 'balance'. The concept of Man, as stakeholders of the development, as vicegerent on Earth, has a duty of care in managing the limited resources so as not to waste but beneficial to Man and the environment in a holistic sense, as an act of submission to the Creator for sustainability.

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[2] Four Strands of Ecoinfrastructure, according to Yeang (2012), is to view green design in terms of weaving of four strands of ecoinfrastructures, colour coded as follows:

- The 'grey' represent the engineering infrastructure being the eco sustainable cleantech engineering systems and utilities;
- The 'blue' represent water management and closing of the water cycle by design with sustainable drainage;
- The 'green' represent the green ecoinfrastructure of nature's own utilities which must be linked; and
- The 'red' represent our human built systems, spaces, hardscapes, society, legislative and regulatory systems.

[3] Seamless & Benign Biointegration, explained Yeang (2012) is biointegrate the artificial or human made with the natural environment. Yeang's analogy of this concept to prosthetic design in surgery where human as organic host must be successfully integrated organically and mechanically. Yeang's sums up this concept amount to 3 aspects i.e. physically, systematically and temporally.

[4] *Ecomimesis*, in architecture, according to Yeang, should imitate the natural ecosystem from its structure, process, recycle, operation, among others acquired energy from nature itself, without needing any extra. Nature, can live without human being but not vice versa.

- Clinical Functionality: Healthcare requirements for hospitals

Clinical functionality of a hospital is based on environment that place 'pathogenic' criteria as it is based. WHO (1985), described 'essential spaces' of a hospital design as essential clinical spaces that needed special or controlled environment. These spaces place infection control and safety of the patient through spatial configuration layout and sustainability of the bio-medical equipment as priority environment. Pathogenic criteria require the environment of the space where a patient suffering from certain diseases or undergoing diagnoses or treatment to be provided with the following "must do" considerations:

1. Air space and distances that will allow effective flow of air for good ventilation to prevent infection control apart from filters and availability of clinical hand-wash basin;
2. Medical equipment to diagnose and tools for treatment which itself requires certain environmental conditions;
3. Medical supplies with its own environmental requirement
4. Medical personnel with required clinical procedure that includes circulation, capacity, clothing types;
5. Appropriate general and task lighting to support procedures and avoids medical error; and
6. Building services i.e. medical gases, electrical socket outlets, lighting, etc as emergency and functional support.

As cited in Indoor Air. (2009), if an architectural, bioengineering and operational strategies be applied in an integrated way as well as with suitable encouragement for culture change on the part of the user, the architecture can expect to overcome many cross-infection issues and allow patients to be treated more predictably and cost effectively.

WHO, in its discussion draft on 'healthy hospitals, healthy people and healthy planet' (n.d) in collaboration with Health Care Without Harm (HCWH) organisation, in its preface recognised hospitals as being one of the energy and resource intensive enterprises, that as they operate today will contribute substantially to climate change as well as inadvertently contribute to respiratory and other illnesses. Among others, WHO recognises that procurement, resource use, transportation and other policies and practices contribute to the health sector's significant climate footprint. Hence, by reducing this footprint and moving toward carbon neutrality, the health sector can demonstrate the path forward in response to climate change, thereby playing a leadership role in advocating for a healthy and sustainable future. The discussion recommended seven elements for a climate–friendly hospitals as follows:

1. Energy efficiency: Reduce hospital energy consumption and costs through efficiency and conservation measures.
2. Green building design: Build hospitals that are responsive to local climate conditions and optimized for reduced energy and resource demands.

3. Alternative energy generation: Produce and/or consume clean, renewable energy onsite to ensure reliable and resilient operation.
4. Transportation: Use alternative fuels for hospital vehicle fleets; encourage walking and cycling to the facility; promote staff, patient and community use of public transport; site health-care buildings to minimize the need for staff and patient transportation.
5. Food: Provide sustainably grown local food for staff and patients.
6. Waste: Reduce, re-use, recycle, compost; employ alternatives to waste incineration.
7. Water: Conserve water; avoid bottled water when safe alternatives exist.

Hospitals as described above include various functions that requires different working environment that relates to people, equipment, and the pathogens. While there are areas that require low energy and environmental control such as general wards, waiting areas, cafeteria and corridors, due to its location within a bigger envelop, these areas are subjected to environmental control as well. On simplification, areas in a hospital that requires control are, among other special others, as follows:

1. 'clean' and 'sterile' areas, eg. Drug manufacturing, sterile supplies;
2. infectious disease management area;
3. areas with bio medical equipment heavy;
4. areas with short life medicines and vaccines;
5. conditions that require reverse isolation, and areas
6. with the need for invasive surgery;

WHO had issued several hospital design guidelines based on case studies for developing countries whom are themselves located in the tropical zone. Table 1, described the ventilation provision in a laboratory that requires a controlled environment in a natural tropical setting.

Table 1 : Planning and Design of Laboratory Facilities (Source: Excerpts on ventilation requirements from Barker, J.H., & Huang, L., 'Planning and Design of Laboratory Facilities' in Kleczkowski (ed) (1983), WHO reports, pp 56-59)

Complete control of air circulation can best be achieved by taking advantage of natural ventilation, shading, and thermal barriers.

The use of natural ventilation includes the following measures:

- providing windows with screens for maximum flow of air and protection from insects;
- providing vents in the upper portion of the roof to allow hotter air to escape from the building through ceiling vents;
- providing an open "crawl" space under the floor to allow air to circulate and to decrease humidity;
- providing pressure walls, hedges, etc., on the outside of the building to direct air into windows or doors;
- separating various elements of a building operation into several connecting buildings to take full advantage of the natural airflow;
- orienting the building to take full advantage of prevailing winds.

The use of shading includes the following:

- providing wide roof overhangs to protect windows from direct sunlight;
- planting trees or building screens to provide shade to buildings during the hottest period of the day;
- orienting or designing the building to decrease the amount of afternoon exposure.

The use of thermal barriers includes the following:

- providing insulation in the roof and exterior walls to decrease the transmission of heat into the building;
- providing reflective material on windows that cannot be shaded, in order to redirect the rays of the sun;
- providing a body of earth adjacent to a building: this earth can serve to insulate a masonry wall;
- using lighter colours on the building exterior, especially on the roof, which is the most exposed area of the building.

- Hospital's Humanistic Function

Pellitteri, G., and Belvedere, F., (n.d.) in their article '*Characteristics of The Hospital Buildings: Changes, Processes and Quality*' introduced the aspects rarely brought up in hospital design that related to the role hospitals plays within the city and the community. The role which includes a recovery of values that are different from those of quantity and function characterized of modern hospitals in the first half of the twentieth century. These 'new values' recovered from the past agrees to a humane and humanistic vision of reality, for which, together with the recent technological discoveries and new ways of treatment and care, influence the design choices in latter hospitals. The same article cited *Architectural Psychology* in the humanization of physical space, where in the case of the hospital buildings the attention should be focused first of all on the patient as a completely person, with his physical and emotional needs. The proposed research on *Architectural of hospital space: Changes and Design Methods* by Pellitteri, G and Belvedere, F., mentioned in the above article defines the features and the architectonic qualities of the contemporary hospital as a care centre and hub of scientific and medical knowledge which is also served as the important place for observations on the relationship between the man and the built environment.

The Charter for Health Promotion (Ottawa, 1986), specifies the need to "Create Supportive Environments", i.e. recognizing the inextricable link between man and built environment. The process of humanization involves a holistic vision of people, spaces and activities. Recognizing the interactive processes that occur between the man and the environment, building the concept of humanization means design environments and

spatial distributions in which the needs of the patient (sense of acceptance and familiarity, respect for privacy, space and sensory comfort, ease of orientation) are fulfilled destroying at the same time the factors of stress. The article provide ways through which one can implement a project of humanization such as through the distribution and composition of spaces, the shape of the exterior volume of the building, the presence of views to outside, green (gardens) and worship spaces, furnishings, materials, finishes, colours, signage, light (both natural and artificial), elements of visual reference (for example, art installations). Research also defines features on the supporting areas to health activities that are often overlooked such as entrance hall, corridors, waiting areas, common areas, and rooms of hospitalization. Each of these areas there are specific psychological and emotional needs of the users. The humanization is more important than in others hospital spaces and the issue of architectural quality is most obvious and sensitive. The hospital building, as repeatedly mentioned is just a functional centre of knowledge and therapeutic technologies, and also the place professional and human relational aspects coexist.

The humanistic approach was also discussed by Burpee, H., (2008), in her article 'History of Healthcare Architecture' from Integrated Design Lab Puget Sound, which informed that Florence Nightingale's[5] passion for creating a better healing environment for patients prompted her to write Notes on Hospitals in 1863 outlining her priorities for designing hospitals. Her approach to creating a healing environment for patients not only looked at the physical surroundings, but also looked at the social welfare of her patients by providing patients with access to natural light, air, landscape, attention to diet, as well as a clean and sanitary environment.

Ziqi Wu (2011) in his summary of findings on sustainability in hospital stated that design goals in the built environment should reflects the hospital's core values which is to achieve a healing and humane environment. He brought emphasis that although it is important that the design need to meet the following requirements i.e.:

- maximizes effective use of resources,
- flexible and scalable to accommodate and adapt evolving changes as a result of technologies (both clinical and technical), and processes, and
- consideration for special energy conservation methods to reduce operational costs,

the hospital should foremost be welcoming to patients, improves their quality of life, promotes well-being and supports families and employees, which are humanistic values.

Summary of a Green Hospital attributes

The case studies stated above, were mostly quoted from hospitals with simple single storey structures and located on a spacious land. The issue is more eminent when the

[5] Florence Nightingale (1820-1910) was a very influential figure in nursing following the Crimean war in 1854. She is lauded for her intuitive, observational approach in healthcare environment. She recognized that cleanliness within the hospital ward correlated to patient survival, a quarter century before Louis Pasteur formally proposed his germ theory of disease. Nightingale is lauded as the mother of modern nursing. Her humanist approach had influenced hospital design far beyond her time (Straus, 2006) (Source: Burpee (2008).

hospital is designed on a tight site which may induce deep planning, stacking of conflicting requirements in satisfying the strict regulatory requirements for safety and health, and other priorities. As accorded by Srazali Aripin in his paper presented at the Conference on Sustainable Building South East Asia, 5-7 November 2007, Malaysia, he reiterated that the call for sustainability or *green building* in the health care facilities or system as a paradoxical situation. He questions whether the Green Requirement, as is, treat sickness or promote the condition of health and whether it is difficult to conceive the link and benefit of sustainability in contributing to the patients' health outcomes. A discussion evolving sustainability in healthcare facilities, according to Srazali Aripin (2007), should embrace the notion of creating a supportive environment in hospital design (i.e. healing environment) that is physically healthy and psychologically appropriate as the aim of designing a hospital. Although it is imperative for the physical aspects to be considered in hospital buildings, these physical aspects (i.e. building orientation, daylighting, window design, thermal conditions, materials use and others) should be cleverly designed to achieve the balance and the principles of economic, social and ecological sustainability without compromising the functionality of hospital building (Linda, 2004). Complexity does arise when the 'pathogenic' areas of the hospital , due to circulation, adjacencies and functions, are required to be adjacent to the 'humanised' or 'salutogenic' areas of patient care and support services in a 'patient centred' concept. Then the need to prioritization in balancing the act applies. No solutions to each of the designs are alike.

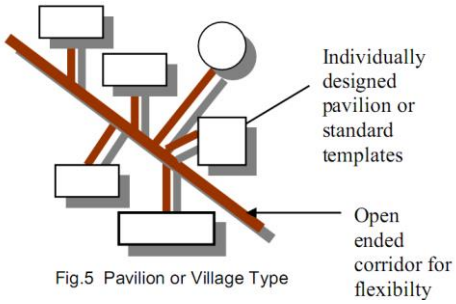


Figure 5 : Pavilion building form
(Source: Norwina Mohd Nawawi & Srazali Aripin (2004)

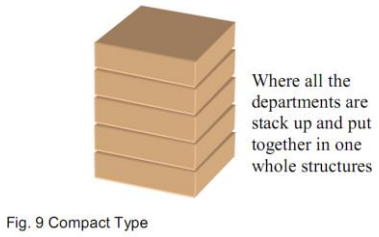


Figure 6 : Compact or Stacked Building Form

Architectural sustainability and clinical functionality, despite the constant dilemma for hospital planners and designers to balance its physical requirements effectively, innovation in approach and outcome should be a constant quest. The sophistication in the architecture with the need for better healthcare through provision of state of the art facilities within reach of the people for their wellbeing has been the goal and objectives of most nations. In the tropics, how can this be realized within the green agenda?

MALAYSIAN HOSPITALS: TOWARDS A GREEN AGENDA

The country Malaysia is located within a tropical equatorial zone with latitude and longitude at 2° 30' N and 112° 30' E respectively (refer Figure 7 and 8).

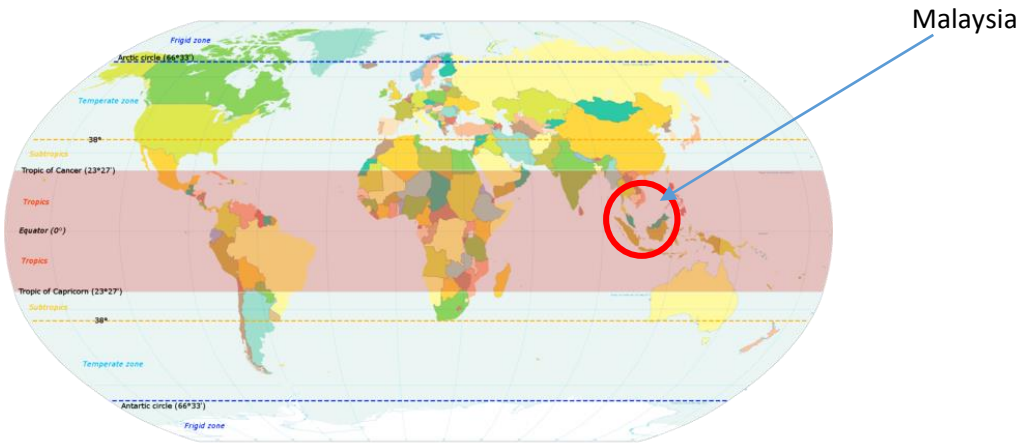


Figure 7: Location of Malaysia in the tropics (Source: Worldmap indicating tropics and subtropics. Retrieved 12 August 2013 at http://en.wikipedia.org/wiki/File:World_map_indicating_tropics_and_subtropics.png.)

Figure 8: Map of Malaysia in the tropics (Source: Malaysia latitude and longitude map. Retrieved 12 August 2013 at http://www.mapsofworld.com/lat_long/malaysia-lat-long.html)

Malaysian general climatic data, retrieved from Malaysian Meteological Department (MMD) 2012 as cited in Norita Johar (2012) thesis is as per Table 2 for temperature and Table 3 for wind direction.

Table 2: Malaysian General Climatic Data (Source: MMD (2012) as cited in Norita Johar (2013) unpublished thesis)

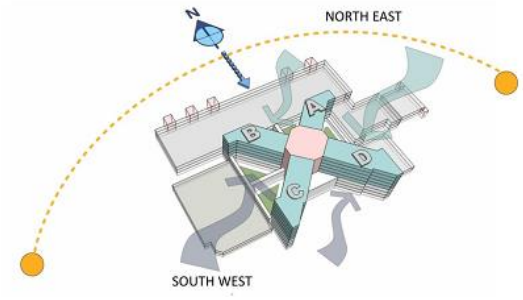
Climatic Data	
Average Minimum Temperature	24ºC or 74ºF
Average Maximum Temperature	33ºC or 90ºF
Average Low Humidity	74%
Average High Humidity	89%
Average Wind Speed	7.7 m/s

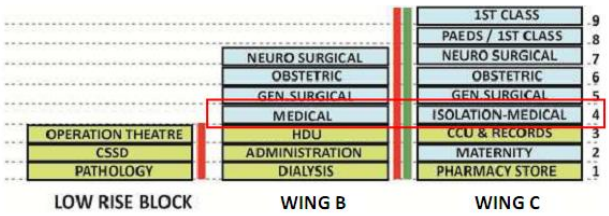
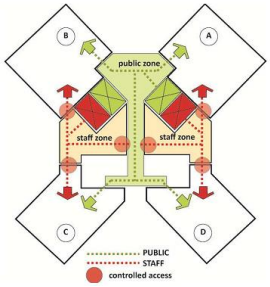
Table 3 : Factors affecting natural ventilation (Source: (NIBS (2011), Ghiaus et al.,(2005), Allard & Santamouris (1998), Jiang et al., (2003) as cited in Norita Johar (2013) unpublished thesis)

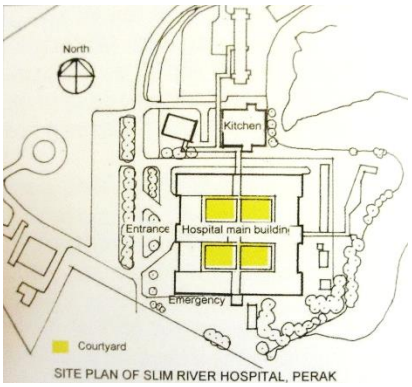
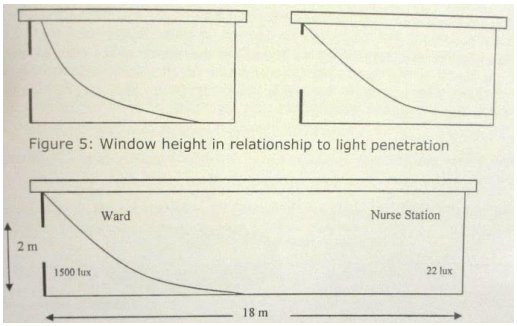
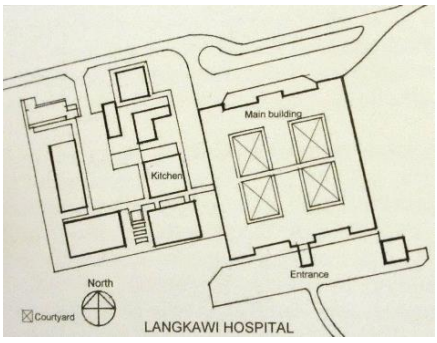
Factors	Descriptions
Wind direction	Northeast & Southwest
Outdoor wind speed	As measured
Building orientation	Facing wind direction
Building	Shape, depth, size, volume
Openings	Size, location

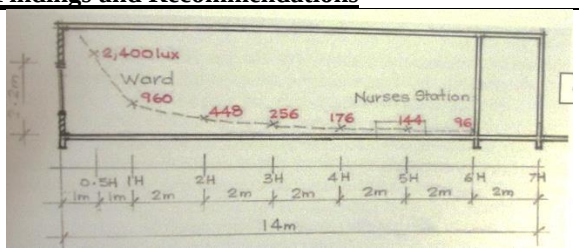
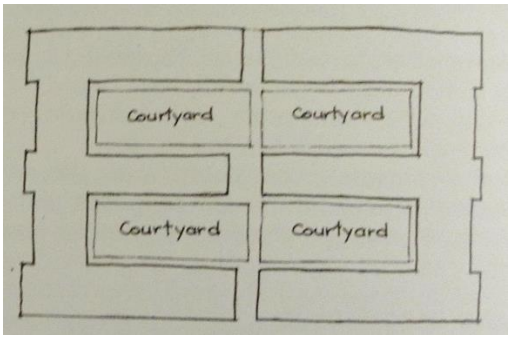
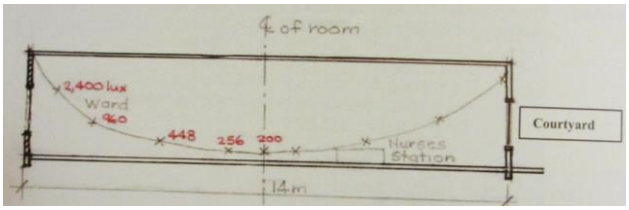
On the disease patterns of the tropics, Malaysia in particular, being hot and humid, is also a haven for vector borne diseases brought about, among others, mosquitoes that causes malaria and dengue fever. Hence, towards a green agenda, Malaysian researchers, while busy defining and refining the parameters for a green hospital, should also note of the conflicting implications the recommendation would make in combating some of the diseases. Table 4 below are the list of researchers' findings and recommendation on physical hospital building designs in Malaysia.

Table 4: List of Researchers, focus area and their findings on Malaysian Hospital Buildings

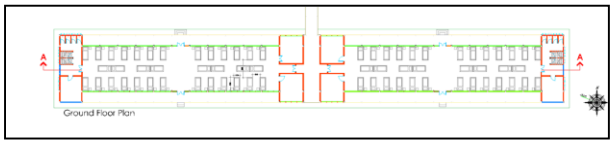
Researcher	Year	Focus area	Findings and Recommendations
Norita Johar	2013	Infectious Disease	 Figure 9 : Physical Orientation of the Case Study Hospital in Selangor, Malaysia with respect to Sun direction and Prevailing Wind (Source: Norita Johar (2013))

Researcher	Year	Focus area	Findings and Recommendations
			 Figure 10: The vertical configuration of the case study hospital and location of the wards that affects natural ventilation and infection. (Source: Norita Johar (2013)  Figure 11: Illustrate the floor plan of the tower block indicating ward configuration, the staff and visitors/public circulation at the vertical circulation core that may incur cross infection. "…upon spatial observation of the case study wards in the selected hospital with infectious disease ward, is that there is no definite "yes" or "no" on the feasibility of open wards for Airborne Infection Isolation (AII) use. However, it is not totally feasible for certain planning and design variables because of contradiction between orientation and circulation as compared to functionality or decision to use the wards for future pandemic. She recourse the study to take note of the ward vertical location in the whole building set up in relation to other buildings nearby, as well as the visiting traffic that seems to complicate chances of the cross infection
Sh. Ahmad et al,	2007	Daylighting in General Wards	Excerpts of their findings were as follows: • The shape of wards as in 'E', 'H', 'F' is suitable for daylighting. • Case study 1- Slim River Hospital had a square plan with 4 courtyards, which are appropriate for both daylighting and natural ventilation of the interiors, but preferable that the plan be elongated East and West ward to get maximum daylighting and ventilation from North and South without the West radiation and heat. Ideal width of natural daylit wards is 14 m. Case study hospital had a width of 18m, hence interior area had to be supplemented

Researcher	Year	Focus area	Findings and Recommendations
			with the artificial lighting.  SITE PLAN OF SLIM RIVER HOSPITAL, PERAK  Figure 12 Slim River Hospital Layout and Ward Cross Section (Source: Sh.Ahmad et al (2007) • Case study 2- Langkawi Hospital, is similar to Slim River hospital in its square plan and 4 courtyards, but its width is kept to 14.4m which is about ideal for natural daylight penetration of the interiors. However in ward study, the location of nurse's station at the far end with full wall towards the corridor, hinders the flow of daylight into the space. 

Researcher	Year	Focus area	Findings and Recommendations
			 Figure 13. Langkawi Hospital Site Layout and Cross Section of Maternity Ward studied (Source: Sh. Ahmad et al (2007)) An ideal orientation and cross section of courtyard hospitals was suggested as in Figure 14 and Figure 15.  Figure 14. Recommendation for building orientation for courtyard hospitals to be elongated towards East and West to get the most of daylight orientation (Source. Sh. Ahmad et al (2007))  Figure 15. Recommendation for Cross Section of A Ward to be not more than 14m for Daylighting from Courtyard..Other detail requirements to refer to original text. (Source. Sh. Ahmad et al (2007)) For this research, other discussions and measurements were made on window design, glazings and other considerations in determining the final outcome and recommendation for corrections that includes building orientation, choice of illumination, efficient lamps and proper control. Those detail requirements, though not highlighted in this text should be referred for contextual decision
Sh. Ahmad et al	2007	Thermal Comfort in Naturally Ventilated Wards of	Findings were as follows: • The indoor condition of the naturally ventilated wards in Slim River and Langkawi Hospital are thermally uncomfortable with indoor temperature between 25.9 - 31.8 C; recorded velocity of

Researcher	Year	Focus area	Findings and Recommendations
		Langkawi and Slim River Hospital'	0.4m/s and Relative Humidity between 49-83%. • In the same wards, rainy days command a cooler temperature but higher than 80% humidity level. Increased cross ventilation, shading and integrating mature trees in the courtyard for shade and coolness may decrease heat gain. Similar to recommendation made in daylighting studies of the same hospitals, recommendations made for thermal comfort are listed as follows: 1. Orientation to North and South with elongated boundaries towards North and South should be explored; 2. The positioning of openings on both East and West orientation to be expansively shaded or protected with overhangs during the day but flexible to put aside at night to provide night cooling. It is recommended that where possible, windows should be open at night to let out hot air and allow for cool air in. In this condition, adjustable lourvres with flexibility of opening and closing the windows is recommended. Suggested best practice MS 1525 with balance of daylighting, view and thermal & glare control; 3. Ceiling height should not be less than 3m with proportionately height increase to depth of space (3:14); 4. Roof should be insulated and ventilated. Flat roof to be avoided as it is directly exposed to the sun throughout the day and heat deflected to indoor space within. 5. Pitch roof should not be less than 25" to allow for shading and self cleansing during raining as well as creating cooler roof space; 6. Insulated wall facing East and West such as the use of aerated concrete blocks with low heat and thermal transfers; 7. Cross ventilation with maximum width of 14 m, encourage air movement at bed height levels for wards to approximately 1 m high, and partition where possible, not to be full height; 8. Humidity to be reduce through installation of mechanically ventilation i.e. exhaust fans especially in bathrooms and toilets.

Researcher	Year	Focus area	Findings and Recommendations
Yau, Y.H. and Chew, B.T.	2009	Thermal Comfort of Hospital Workers	The research had revealed that only 44% of the examined locations met the comfort criteria specified in ASHRAE Standard 55. Their survey had also examined the predicted percentage of dissatisfied persons in the hospitals and showed results that 49% of the occupants were satisfied with the thermal environments in the hospitals. Their field survey analysis also revealed that the neutral temperature for Malaysian hospitals was 26.4 degrees C with comfort temperature that satisfied 90% of the occupants in the space was in the range of 25.3-28.2 degrees C. Generally the results from the field study suggested that a higher comfort temperature was required for Malaysians in hospital environments compared with the temperature criteria specified in ASHRAE Standard (2003).
Noor Hanita Abdul Majid	2008	Thermal Comfort of 1930s-1970s tuberculosis ward	Studies conducted in the 4 zones of the tuberculosis/ isolation ward as shown in Figure 16 continuously from 19th June 2008 until 25th June 2008, and data was collected from 7am to 7pm with interval 30 minutes time. The findings confirmed the relationship of the temperature, air velocity and relative humidity to thermal comfort of the users in the design of colonial hospital architecture in peninsular Malaysia. The location where the instruments were placed is a wind catch area. It is noted in the study that natural ventilation is indeed use to circulate the air in the wards that helps the users stay comfortable. The study noted that then, in 1930s, the hospital is located in a green lung of the city with perhaps better air flow. However with development surrounding the hospital, the current reading is affected.  Figure 16: The configuration of the Tuberculosis Ward to the general layout of the hospital

The Malaysian authorities, towards the green agenda of the nation had worked on many aspects of implementation through regulation, best practices and contractual obligations. Table 5 listed selected guidelines as a move towards making healthcare buildings green in Malaysia.

Table 5: Malaysian Green Design Guidelines

Organisation	**Source**	**Focus**	**Guidelines**
Public Works Department Malaysia or *Jabatan Kerja Raya Malaysia*	Source: Statement of Needs Energy Efficiency in IIUM Teaching Hospital RFP Vol.9/9 (2010):	'Green' requirements to hospital projects	**General Conditions** The building shall be designed according to: a) MS 1525:2007 "Standard for Energy Efficiency and Use of Renewable Energy in Non-Domestic Buildings". b) Garis Panduan dan Peraturan Bagi Perancangan Bangunan oleh Jawatankuasa Kecil Piawaian dan Kos bagi JPPN Jabatan Perdana Menteri, edisi tahun 2008, Bab 4. c) Rancangan Malaysia Ke 9, 'Bab 19 – Pembangunan Tenaga Mapan, Bil 19.19, 19.22, 19.49 and 19.50'. d) Malaysia Green Building Index, minimum Silver rating scores with assumption that advance energy efficiency performance will achieve 10 points due to specification provided below for energy efficiency in a hospital.
			To increase efficiency according to E.E., additional design criteria imposed were addressed by discipline: • Architectural: covering window design, day-lighting, roof performance, internal space planning, air tight building and any other spaces deemed energy consumed such as car parking area; • Mechanical : covering chill water piping system, zoning of AHU and air distribution System, heat recovery from fresh air intake, occupancy dependent fresh air intake, cooling system and any other mechanical installations such as lifts; • Electrical: covering high efficiency motors, zoning of lighting system, lighting control system, efficient lighting fittings, VSD and VAV standard, power factor and harmonic distortion, electrical power distribution system, low losses transformer and any other electrical associated installations ; • Energy Management System : covering Building Management System (BMS), Monitoring, trending and displaying of energy system,
Occupational Health Unit of the Ministry of Health of Malaysia (MoH),	'Guidelines On Prevention and Management of Tuberculosis for Health Workers in Ministry of Health	Identify high risk areas that require special environmental controls	Spaces identified by MoH Malaysia to be equipped with special environmental control to prevent the spread as well as reduce the concentration of infectious droplet in the air are as follows: . □ Isolation rooms □ Treatment rooms □ HIV care facilities □ Immunocompromised patient care areas □ TB wards & clinics □ Intensive Care Unit where TB patients may receive treatment □ Sputum Induction Room □ Bronchoscopy Suites □ Operating Rooms □ Accident & Emergency □ Outpatient department □ Laboratories □ Radiology department

Organisation	Source	Focus	Guidelines
	Malaysia' 2012,		The MoH (2012) provided the following suggestions for the above strategy including illustrations as in Figure 17-20 as design guidelines: *"A variety of simple to complex EC can be used to reduce the number of aerosolized infectious droplet nuclei in the work environment:* • *The simplest and least expensive technique is by maximizing natural ventilation through open windows;* • *More complex and costly methods involves the use of mechanical ventilation i.e. local exhaust ventilation (LEV) and negative pressure rooms which may include HEPA filtration to remove infectious particles and the use of ultraviolet germicidal irradiation (UVGI) to sterilize the air. "*

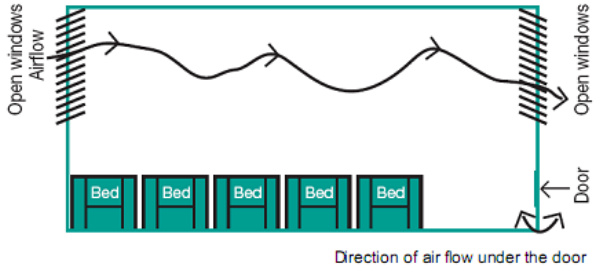


Figure 17: Cross section conceptual spatial requirement for natural ventilation with free flow of ambient air in and out through open windows (Source: MoH (2012) Diagram 3.1, pp 10)

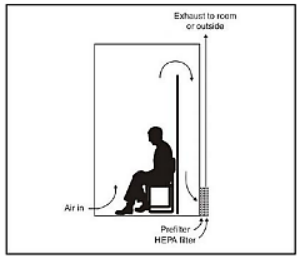


Figure 18: Showing an individual space control of ventilation on infectious patients (Source : MoH(2012). Diagram 3.2. 'An enclosing booth designed to sweep air past a patient with tuberculosis disease and collect the infectious droplet nuclei on a high efficiency particular air (HEPA) filter., pp12 (Source: Guidelines for Preventing the Transmission of *Mycobacterium tuberculosis* In Health-Care Settings, 2005. MMWR

Organisation	Source	Focus	Guidelines
			Recommendations and Report. CDC, 30th December 2005 / 54(RR17);1-141))

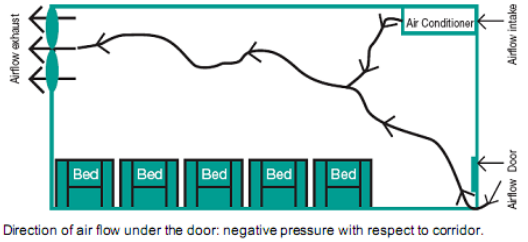


Figure 19: Illustrate the required ventilation system for a complex spatial condition. (Source: MoH (2012). Diagram 3.3 Negative pressure rooms; diagram illustrating airflow from outside a room, across patients' beds and exhausted out the far side of the room, pp 13)

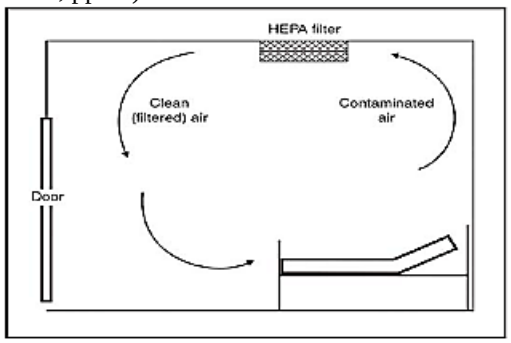


Figure 20: Illustrate the direction of air required in the cross section spatial configuration of a room for infectious patient. (Source: MoH (2012). Diagram 3.4. Example of a fixed ceiling-mounted room-air recirculation system using a high efficiency particulate air (HEPA) filter for a room,pp 14(Source: Guidelines for Preventing the Transmission of *Mycobacterium tuberculosis* In Health-Care Settings, 2005. MMWR Recommendations and Report. CDC, 30th December 2005 / 54(RR17); 1-141)

From the brief and fragmented research on different hospital buildings above, we have an idea what preferred environmental conditions of a hospital design should physically and conceptually 'look' like for similar conditions. In the guidelines, however, the subject of climatic condition are not spelt out. Hence detail studies, not only for each hospital building area of the whole complex but for each locality in Malaysia is also required. For this brief study the following case studies were selected to represent the period on whence it was built to give insights what belies the tendencies of the architects as designers of the time, the respect and consideration of the various factors in time and place, in designing a truly complex building in the tropics that succumbs its existence till today**.**

CASE STUDIES OF SELECTED MALAYSIAN HOSPITAL DESIGNS THROUGH THE AGES

Selected hospitals that represent the period identified as Colonial/pre independence Period; Post-Colonial / Independence 1960s and 1970s; Towards nation building & Health for All 1980s-1990s; and Towards a developed nation 2000s to present; were analysed through qualitative method based on the criteria listed below:

1. Site location (on orientation/organization/topography)
2. Building configuration and layout (planning layout compact or sprawl, shape of building- deep or thin)
3. Built form , Material Use and Construction Detail (low rise, high rise; the make)
4. Internal planning strategy (clinical, humanistic)
5. Cultural and Humanistic Values

The findings of the above analysis is tabulated in Table 7.

ANALYSES AND FINDINGS

Summary of Analyses

Healthcare facilities that include hospitals are not a traditional building typology in old Malaya or present Malaysia. Traditionally all illnesses were traditionally treated at home. These facilities were brought by the colonial masters as early as the 15th century by the Portuguese, subsequently by the Dutch and most recently by the British through its East Indian Company and North Borneo Company. The British deploy similar designs from India and Africa[6] to Malaysia. Hence the analysis were made on hospital buildings from the colonial period onwards and tabulated the observations made on each of the criteria set forth.

Colonial period witness pavilion and climate friendly building typology as illustrated in Figure 21, brought over by the British from other parts of the colony of similar climatic experience and adjusted on site by British soldiers. Table 6 demonstrate the standards exercised throughout the British Empire.

[6] Interview with Dr. Peter Low, a retired Medical doctor and planner of Planning and Development Division Ministry of Health Malaysia and former Kedah State Health Director at his home in 8th September 2013, 230pm-4.00pm

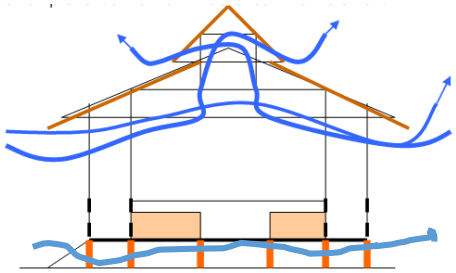


Figure 21: Typical Cross Section of a Single Storey Colonial hospital ward pavilion. (Source: Norwina Mohd Nawawi and Srazali Aripin (2004)

Table 6: Statistical table on hospital accommodation in Pinang (Penang) (Source: The Commissioners, The Report of the RCSSAI, Vol. 2, 1863 cited in FIGURE 2.12, Genealogy of Tropical Architecture: Singapore in the British (Post)Colonial Networks of Nature, Technoscience and Governmentality, 1830s to 1960s,pp154)

Table of Hospital Accommodation.

The date of the construction of the native artillery and European hospital is not known.
The native infantry hospital was erected in 1860.
Total number of wards, 5.
Total regulation number of beds, 46.

Wards. No.	Regulation Number of Sick in each Ward.	Dimensions of Wards.				Cubic Feet per Bed.	Superficial Area in Fee per Bed.	Height of Patient's Bed above the Floor.	Windows.		
		Length.	Breadth.	Height.	Cubic Contents.				Number.	Height.	Width.
		Ft.	Ft.	Ft.				Ft. In.		Ft. In.	Ft. In.
Native Infantry Hospital, 3 - -	14	80	18	19	49,590	1,771	93	2 6	27	2 6	5 0
	7	39	15	19					12	7 0	5 0
	7	39	15	18							ventrs.
European Artillery, 1	10	38	19	10	7,220	722	72½	2 6	5	5 0	3 6
Golundauze, 1 -	8	27	18	10	4,860	607½	27	2 6	4	5 0	3 6

Upon independence in 1957, towards nation building and meeting WHO's 'Health For All' agenda by 2000, Malaysia embarked in hospital buildings as replacement of old hospitals as well as constructing new ones at new hospitals sites with 'standard' and 'type' drawing plans. Designs such as Jerteh plan (Figure 28) and Kuala Brang Plan (Figure 30) were revised from lessons learned through post occupancy evaluations. However, as the standard plans fall short of its green requirements in so many aspects to current requirements and demands, passive design considerations were subsequently written in the design and project briefs as part of design requirement bounded in the contract documents for consultants to interpret and implemented. Orientation of the building is one of the initial consideration to prevent heat load, then the adjacencies of the functional departments with direct access, the grouping of 24 hours human occupancies and equipment temperature maintenance for energy.

Late 80s and 90s , with the advent of Information and Communication Technology (ICT), the mechanical means of transportation of goods and information, the medical discovery and the change in medical practices, the adjacencies of functional departments that were critical to be side by side is no longer critical and may be placed elsewhere. Similar to the requirements of the passive design, with the advent of medical

breakthrough on the welfare of patients and the importance of natural daylight and view in care. Apart from wards, intensive care units, laboratory and even operating theatre suites became imperative to have access to these requirements. Passive design considerations in this case takes a slightly different meaning than just mere natural daylight or saving energy but that provides a healing environment as well as orientation to hours of the day to recovering patients and tired staffs.

The 2000 year series of hospital designs witness the sprouting of more one-off designs on even smaller hospitals including health care centres. With more rural areas becoming urban due to extensive development and opening of new areas, architectural structures of the district level which were simple then, had evolved into more sophisticated structures using more mechanical means. As care is the priority, introduction of outreach facilities, such as haemodialysis and intensive care areas, which itself needs indoor controlled environment, at the doorstep of the people, this add on to the energy requirement to the former low energy hospitals.

With urban centres becoming heat islands, it became imperative to sustain human comfort in almost all public facilities with air conditioning to cool. Culture had it that to have air-conditioned spaces in clinics and hospitals is a mark of progress as it signify comfort to the patients and accompanying relatives. Hence the introduction of air conditioning to hospitals and clinics in all waiting areas were made. Hospitals built at this period due to the environment located within cities and clashing of requirements within hospital functional departments itself, produce many problems among which are problems of condensation. This lead to growth of moulds in many hospitals. Government had address the problem technologically on site for existing problems and provide guidelines to new ones including the need for a simulation of design for new projects.

Today, towards a develop nation, project briefs of new projects has been integrated with green requirements under the green brief. The green brief are separately prepared from the medical requirement brief, architectural brief as well as the mechanical and the electrical brief. All public hospitals are expected to adhere to these requirements with a certain weightage given for design evaluation. In the public sector, clinical functionality takes priority in design decision over all else after bottom line are set. However, implementation and monitoring remain difficult due to priority of needs when the project commences, lack of experienced human resource to monitor and make decision and most of all the will to make it happen by the builders under certain procurement method. Hospitals designed at this period try their best to avoid deep plans; have wider corridors and patient areas with access to natural daylight; avoid flat roofs and have more space for respite. Being in a tropical climate, Ministry of Health Malaysia calls for ‘mosquito free’ hospitals. Water and lush plants brought into gardens create a humid environment and a haven for mosquitoes. So does designs that retains water element to a certain degree.

Recently more private sector healthcare providers answers to Malaysia’s call for integration of services and health tourism in complementing the public sector healthcare provisions. Latest project, the ‘healing hands’, was introduce as a concept by Nightingale Associates, in association with Malaysian practice M&R Architects. The project promise of a green agenda with state of the art technology, material and the concept of care enveloped in finger like forms. The project won an international design competition held by leading private healthcare provider, KPJ Healthcare Berhad.

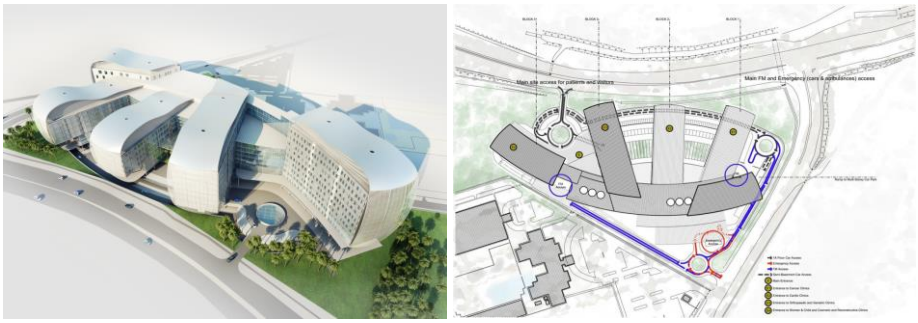


Figure 22. The Healing Hand Hospital, Kumpulan Perubatan Johor.
(Source: Nick Varey at Aug 3rd 2011 on Habitables,**Johor Bahru Hospital, Malaysia – Nightingale Associates** at http://www.habitables.co.uk/feature-2/johur-bahru-hospital-malaysia-nightingale-associates. Retrieved 30Apr2012

On public hospitals development, the so called 'Green' hospitals are yet to complete and tested. So what makes the newer hospitals greener than the previous hospitals built throughout the century in Malaysia?

Summary of Findings

Generally each period hospital design is itself an improvement and had met their physical objectives and needs of the time i.e. simple structures to combat simple communicable diseases of the British period, through economic and human resource compatibility of hospital building in the immediate post independent period of standardization and types to reaching the people on basic ailments; and current sophisticated requirement of specialist and non-specialist hospital facilities to address the new communicable disease and life style disease of a progressive nation. Retrospect of the colonial period to present, the demand of physical facilities, environment and medical development has evolved tremendously over time. The culture of 'new' hospital building should be a better building is relative. Location, level of care, population, size of site, planning decisions, project priority and moment in time are among other criteria that defined whether the hospital is green and sustainable.

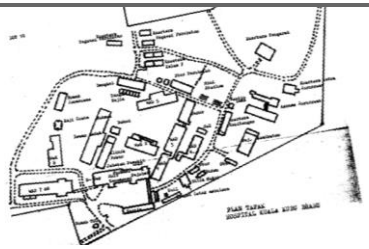
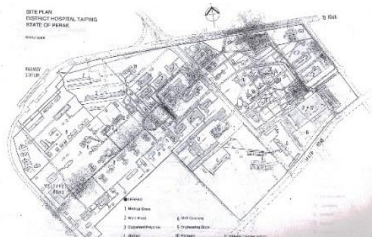
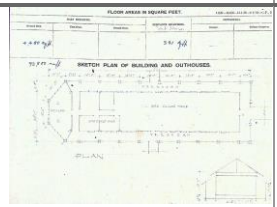
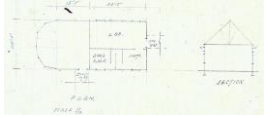
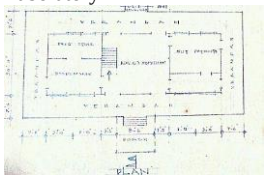
Physically the analysis of location, building layout and configuration as well as building form contribute to the decision in acquiring the green solution. Each hospital scrutinised has its reasons why it is built the way it is built due to many conditions from site orientation or site conditions, despite the north and south facing norms for the Malaysian climate conditions. In the design of the modular block for colonial and post independent hospitals, due to the functional requirements of certain building that requires daylight, ventilation and view, the positioning has to compromise its orientation as the best option of the time. Similar situation hits new development especially in cities as an island site with minimal space for best orientation option with respect to evening sun. While newer hospitals have to opt for compact designs, older hospitals can sprawl with the luxury of the site and location on either hillocks site or at the coast. Similar findings to layout and built form, apart from the standard plan or nucleus hospital, that pointed out to site as one of those main factors to shape its layout.

Older facilities provide simple and effective solutions to protection from rain, heat and glare through passive and intuitive designs. Separate pavilions were designed for alienated control conditions as centralised. Newer facilities, due to conflicting

requirements require more technological solutions. With patient and human centred care in newer hospitals, duplication of certain service areas for both patients' and staff convenience is evident and expected.

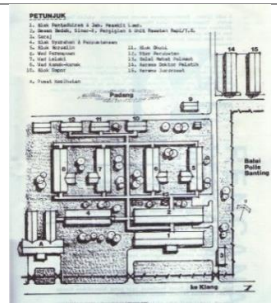
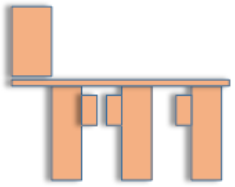
Material use are always the most robust at the period of time to the wear and tear of a hospital, infection control containment, noise abatement and colours symbolic to the place of care i.e. from cement render, through tiles and terrazzo. Humanistic values demonstrated through the culture of use and indirect provision of healing environment through orientation, space for respite, relatives wait, staff rest and simple provision on spaces for prayers and meditations, with a view, daylight and access to the gardens and therapy spaces.

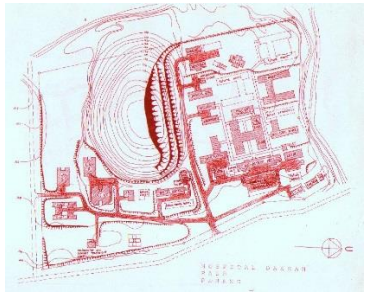
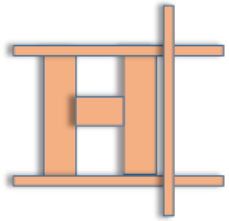
Table 7: Summary of Analyses and Findings from the Physical and Observational Criteria on Selected Case Studies of Selected hospitals from colonial to current through the ages

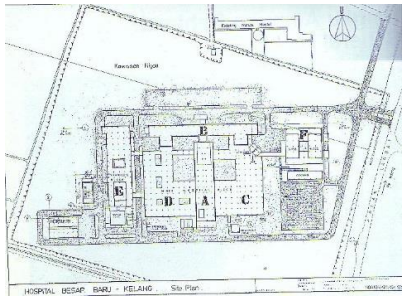
Hospitals	Site Location	Building configuration and layout	Built form, material use and construction detail	Internal planning strategy or space quality	Cultural or Humanistic Evidences
Colonial/ pre independence Period	**On hillsides, by the coast, open, accessible for public** Most colonial hospitals at this period of time, command good location for the hospital site, either at the hillsides or sea-sides with good view, through natural ventilation and natural daylight. European hospitals in the Far East were based on their home built form with innovation to suit the climate and the different hierarchy of spaces of master and servants. In Malaysia, the early hospitals initiated by the British colonial government were different for the European community and the people. For the European community there were European hospitals and for	 Kuala Kubu Bharu Hospital on a hillock  Taiping Hospital on a flat land Figure 23: Typical sprawling Layout of Colonial Hospital in small towns following the ground terrain with each building having natural ventilation, daylight and access (Source: Norwina Mohd Nawawi & Srazali Aripin (2004), Norwina Mohd Nawawi (2000)).	 Kuala Kubu Bharu Hospital ward block, Selangor  Taiping Hospital Ward, Perak  Sg.Petani Hospital, Kedah Figure 24: Colonial hospital built form in small towns (Source: Norwina Mohd Nawawi & Srazali Aripin (2004)	 Tuberculosis Ward  Laboratory  Operating Theatre Figure 26. Colonial Kota Bharu Hospital, Building sketches for PWD Maintenance (Courtesy of JKR Kota Bharu) Old sketches (refer Figure 26) for maintenance retrieved from the Public Works Depart of Kota Bharu	Site friendly i.e. building platform follow the natural terrain Blend with local context from the overall scale of architecture, small pavilion With access to views, gardens, natural ventilation and daylight In groups by gender, age and whether infectious or non-infectious. Privacy is address by portable curtains to bedside, separate bathroom, and wards Relatives are able

Hospitals	Site Location	Building configuration and layout	Built form, material use and construction detail	Internal planning strategy or space quality	Cultural or Humanistic Evidences
	ordinary people there were Pauper's hospital. Hospitals then were built in the outskirt of the town as the towns itself were small and unpopulated. Migrants from China brought the practice of medicine that can be obtained from *Sing - Seh* or Chinese medicine shop which forms part of the rows of two storey shop houses in the urban setting. Chinese hospitals, patronised by the rich Chinese Kapitan or *towkay* initially started with a maternity hospital and later to include other treatment in selected urban areas. Similarly to the then Indian migrant health treatment until the British provide them with estate hospitals of simple pavilion structures in the plantations.	Colonial small town hospitals were built on sprawling configuration similar to the pavilion concept found in Britain and Europe. Pavilion form of hospitals were based on modular design, i.e. from modules of the same function as well as those with specialized functions linked by covered corridors. Shape and sizes of pavilion type of design allows for expansion without disturbing the existing structures.	Outskirt colonial hospitals are made of hardwood timber horizontal panelling on masonry or concrete raised pillars. The colonial hospital built form is kept quite standard throughout the country with local variation on the make and building function. Findings at the national archive on Kota Bharu Hospital buildings blocks were hollow bricks designed for insulation. Kuala Krai Hospital still retain the Chengal or Teak timber column of its current ward blocks.  Figure 25a: Penang General Hospital in 1882 local/native ward block with raised ground floor, high ceiling, verandah all round and attap roof. (Courtesy of Penang Hospital)	on Kota Bharu hospitals revealed the pavilion and type plan the British had utilised for ease of implementation.  Figure 27. Balik Pulau Hospital (Source: Balik Pulau Hospital website) As illustrated in the built form, the internal planning strategy is clinical, ease of supervision and ease of maintenance. Details to their design in their awareness of the climatic factor, the colonial British, had successfully executed open-able wall cum door panels, louvred doors and windows, low eaves, washable	to access the patient anytime from five foot way corridor even after visiting hours. In low-rise or sprawling hospitals, the five foot path or verandah around the block is a social space by day and relative wait by night. Both highrise and lowrise patient areas are nightingale type wards for ease of supervision, orientation, company and service delivery Both highrise and medium rise hospitals, patient areas, except for first class ward,

Hospitals	Site Location	Building configuration and layout	Built form, material use and construction detail	Internal planning strategy or space quality	Cultural or Humanistic Evidences
			 Figure 25b: Lady Templar Hospital, Cheras for Tuberculosis with apron overhang at every floor for sunshading (now demolished)  Figure 25c: Melaka Hospital (1936) located on the hill. Multistorey buildings with high ceiling, multi-louvered timber windows and concrete overhang Figure 25 Colonial Hospital buildings built in big towns and cities. Big town hospitals as shown in Figure 25 were of bricks/ masonry with internal partitions of either wood or bricks. Some hospitals used	floors of durable material, hot air ventilated pitch roofing system with wide overhang, high ceiling, perimeter drainage system, open and airy connected corridors and the choice of building material to breathe with nature. Manually operated bamboo blinds for prevention of rain was a common element added to the structure. The built form for European hospitals to pauper hospital differs slightly depending on location and venue. In smaller towns, both are on built on stilt or raised platform, of pavilion shape and form, naturally ventilated and the used of bamboo/rattan blinds as shades, apart from the wide overhang roofs and external perimeter corridors for added coolness. Table	are all naturally ventilated

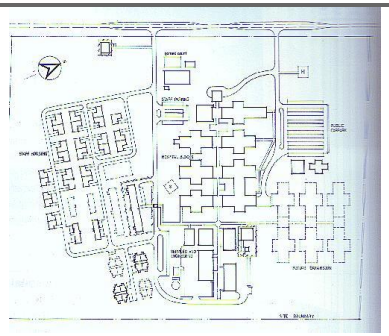
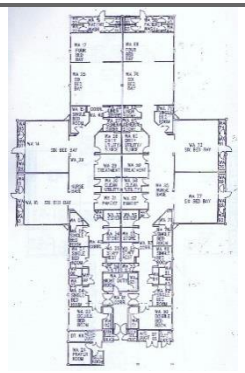
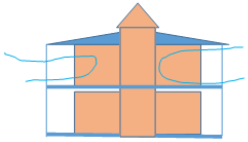
Hospitals	Site Location	Building configuration and layout	Built form, material use and construction detail	Internal planning strategy or space quality	Cultural or Humanistic Evidences
			mix of cast iron, wood and cement. Roofs were initially of 'attap' or nipah/thatched but subsequently replaced with asbestos cement and later clay roof tiles. Both the structure and material had stood the test of time and remain relevant and in used till today.	6 provide an insight on detail standard requirement of the colonial wards. Figure 21 shows a cross section of a typical colonial patient ward that can still be found all over Malaysia.	
Post-Colonial / Independence 1960s and 1970s	Post-independence witness added hospital sites to the existing ones. Only when the old hospital building or site cannot accommodate the new requirements, it will be replaced along-side existing ones or to a new location. The old hospital is then changed to take another healthcare facilities function as a health clinic or other as the land still belongs to Ministry of Health (MoH) Malaysia land bank. The issue is on siting a hospital in either new of existing towns.	 Figure 28: Layout plan of a typical district hospital for <100 beds. Eg. Banting Hospital, Selangor -pavilion type. (Source: Norwina Mohd Nawawi et al (2004) The immediate post-independent basic hospital building configuration layout in Malaysia followed the WHO international standards for developing nation and	 Figure 29: Jertih Type (Sik Hospital, Kedah) *(Nawawi(2001))* Low rise finger like pavilion hospitals. Buildings designed for different service function but linked by covered corridors. Structure-frame structure, bricks and asbestos free/ concrete tile roof.	 Figure 31 Jertih Type Plan The immediate post independent designs for Jertih type plan were straight forward pavilion design using 'I' and 'T' shaped slim wards for natural ventilation; and a thicker 'I' for diagnostic and treatment areas. Figure	Smaller/ non-specialist hospitals are located near home. Both specialist and non-specialist hospitals patient areas have access to view, natural ventilation and daylighting. There are no ceiling height partition in the wards. Visual privacy when lying down is

Hospitals	Site Location	Building configuration and layout	Built form, material use and construction detail	Internal planning strategy or space quality	Cultural or Humanistic Evidences
	Although the MoH had provided guidelines, acquiring appropriate site in location and is acreage is not an easy task. New hospitals in new towns are located in the institutional zone.	implement standard and type plans right to its land form for fast construction. The type plan is called 'the Jertih' and 'Kuala Brang' respectively (refer Figure 29 and 30). Dissimilar to the colonial building configuration that relates to natural land form and terrain, the newly independent supposedly 'tropical' layout implement the basic requirements of North-South orientation to West-East orientation with regard to thermal comfort and taxing energy on air-conditioned areas were considered. The prevailing wind direction for good natural ventilation, passing through or emitting from is important especially in location of the naturally ventilated area of the wards.  Figure 32: Kuala Brang Plan (Baling Hospital, Kedah) *(Nawawi(2001))*	 Figure 30: Kuala Brang Plan (Baling Hospital, Kedah) *(Nawawi(2001))* Standard district hospitals designs for 50-150 beds hospitals were of single to two stories template forms. Other standard plans developed to replace in piecemeal as add-ons of single function standard plans to existing hospitals. The completely new hospital designs were also based on pavilion type architecture and layout where each block of building represents different disciplines, departments or functions for ease of design. Each of this building was designed with pitch roof, flat ceilings and on raised platforms cement floor. With exception of Operating Department and other clinical areas that require a controlled indoor environment, other spaces were naturally	indicate the cross section of the respective blocks showing absence of the double roof present in the colonial ward with a flat ceiling. The windows are glass louvres above 0.9m throughout the building. All wards were naturally ventilated with mechanical fans. Air conditioned areas were confined to Operating Theatres (OT)s, Sterile Department (CSSD), Imaging Units and , administration office.  Figure 33 Kuala Brang Type Plan Kuala Brang type plan	ascertained. Apart from paediatric ward and rehabilitation unit, there are no direct access to gardens. There is controlled access to relatives /visitors to wards. There are no relative wait at the ward except at main foyer for medium rise hospital. In smaller and low rise hospital, relatives wait at the small pavilions or '*wakaf*' before visiting hours. For smaller hospitals the blocks are linked

Hospitals	Site Location	Building configuration and layout	Built form, material use and construction detail	Internal planning strategy or space quality	Cultural or Humanistic Evidences
		 Figure 34: Layout plan of typical tower & podium type state hospital . Eg. Klang Hospital, Selangor (Courtesy of JKR Malaysia). This design was built at 6 sites where each sites varies its content according to locality  Figure 35: Kuala Lumpur Hospital Not many new general or tertiary hospitals were designed at	ventilated using horizontal louvred glass windows with some mechanical fans. For shades, curtains were provided. Similar to the colonial buildings, all these buildings were connected with shaded open corridors through gardens and landscapes. The designs as shown in the Jertih, and Kuala Brang Type Plans. were suited to small district level hospitals of 50-150 beds. Cement render, terrazzo, ceramic and quarry tiles were the floors of the day. Typical state general hospital design came about in late 70s as replacement for old general hospitals. The design as shown in Figure 36 were designed by Public Works Department or Jabatan Kerja Raya (JKR), which were constructed in 6 states with Seremban Hospital of 700 beds as the first prototype. The design based on tower and podium configuration provide roof lights and courtyard gardens for the	as shown in Figure 30 and 33 intend to improve the thicker 'I' shapes of Jertih Plan with 'H' shape with shared facilities. 'H' shape create sense of space with courtyard. Similar to Jertih Plan, this design maintain the width and length of the block to allow daylight and ventilation for naturally ventilated areas. The typical tower and podium hospital of general hospitals had clearly alienated areas that are naturally ventilated and those of control environment by the thickness of the width of the building. Wards with cubicle beds command the view and natural ventilation from bedside.	by covered corridors. The corridor aslo act as a social place.

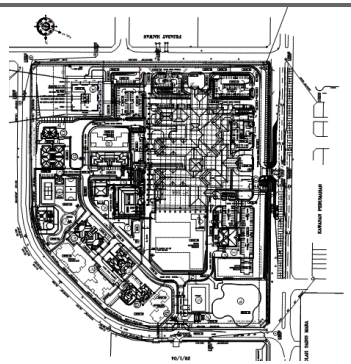
Hospitals	Site Location	Building configuration and layout	Built form, material use and construction detail	Internal planning strategy or space quality	Cultural or Humanistic Evidences
		immediate post independent period with exception of a few replacement hospitals using the standard type plan 'Klang Plan' based on tower and podium within a limited acreage of land. One-off hospital designs at this period was the Kuala Lumpur Hospital as a national referral hospital and the University Hospital or University Malaya Medical Centre as the first teaching hospital in the country (refer Figure 35 and 37 respectively). Both hospitals were designed in a thin linear tower block for its wards and deep planning with courtyards for its diagnostic and treatment area, as internationally recommended.  Figure 37: University Malaya Medical Centre (UMMC)	podium level of clinics and laboratories; deep with inpatients areas raised higher above ground to 10-11 stories for the natural cross ventilation.  Figure 36a: Seremban Hospital  Figure 36b: Kuantan Hospital Figure 36: Typical State General Hospital Design Hospital) *(Nawawi(2001))*	Diagnostic and treatment facilities are centralized	

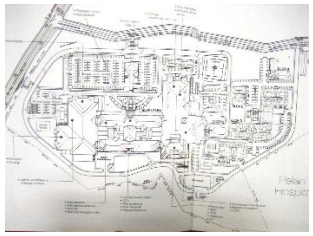
Hospitals	Site Location	Building configuration and layout	Built form, material use and construction detail	Internal planning strategy or space quality	Cultural or Humanistic Evidences
			 Figure 38. Sun shading fenestration at Kuala Lumpur Hospital Facades of hospitals at this period had permanent sun-shading through concrete fins, corridors cum set back, longer eaves at roof tops as the norms of the day. Flooring material was terrazzo for major areas with tiles at wet or expose to weather areas.		

Hospitals	Site Location	Building configuration and layout	Built form, material use and construction detail	Internal planning strategy or space quality	Cultural or Humanistic Evidences
Towards nation building & Health for All 1980s-1990s	Continue and redevelopment of existing site	 Figure 39: Layout Plan of a Malaysianised Nucleus Hospital for 90 (Non Specialist) - 300 (Specialist) beds hospitals (Courtesy of Ministry of Health Malaysia) built at 12 sites. In the late 80s, through a pact with the British Government, the Malaysian government procured through a turnkey system, 12 hospital projects using the Nucleus Hospitals template concept of the UK as illustrated in Figure 39 above. Nucleus hospital building configuration and layout is based on standard building template and linked by covered corridors. The template is designed with the same perimeter layout but have different internal layout for different use All template came with perimeter	 Figure 40: Malaysian Nucleus Hospital (Courtesy of Ministry of Health Malaysia) The Nucleus Hospital design as shown in Figure 40, were Malaysianised or rather tropicalized model from their British design within the constraints of the budget. Thus, 12 Malaysian Nucleus Hospitals which were converted from the temperate country to tropical country were constructed with additional perimeter corridors, additional overhangs, covered and shaded skylights and added mechanised ventilation systems (fans and exhaust fans) in the interiors. Depending on the locational health services requirements, these hospitals were built on single stories for the 90-108 beds with two stories for 300 beds. Both types remain sprawling or pavilion based design layout with connected	 Figure 40: Malaysianised Nuclues Ward Template (MoH) The template is kept on the ground floor with additional toilet located at the end wall thus hampered the ventilation and view.  Figure 42: Cross Section of Template for 300 bed 'Nucleus' hospital There is no pass through ventilation for	Presence of long and wide corridors to accommodate the visitors during visiting hours. Additional porch area with retail and waiting area. Presence of visitor's hall for short stay Limited access to gardens, views, daylight from ward by full access from corridors Spaces within, if not air-conditioned, are rather warm for the naturally or mechanically fan ventilated areas.

Hospitals	Site Location	Building configuration and layout	Built form, material use and construction detail	Internal planning strategy or space quality	Cultural or Humanistic Evidences
		windows where required. For Malaysian used which differ from the British origin, the template is not join at the wings to allow ventilation and fire escape. Public Works Department within the same period design many standard blocks based on function to upgrade or replace existing hospitals with ward, OT, Xray, laboratory blocks as and when required. Thus the layout plan of hospitals that was in harmony then witnessed a mixture of architecture of varied performances and used.	corridors and pockets of garden. Through ventilation, with exception of the open corridor, remain questionable as the original design of the UK was for energy efficiency of the temperate kind. The extensive use of vinyl as flooring was introduce at this time.  Figure 41: Courtyard hospital (Slim River) Other one-off hospital designs came about in the early 90s for large district level hospitals, replacement of state general hospitals, special hospitals or institutions and second general hospitals. Apart from the large district hospital of over 300 beds – 500 beds, most of the current hospital designs were	wards or other spaces. Patients are placed in 2-6 beds curtain cubicles with visual privacy but ease of staff supervision.	Skylight provide some indirect light to the ward. Staff rest areas, day room for patients are introduce

Hospitals	Site Location	Building configuration and layout	Built form, material use and construction detail	Internal planning strategy or space quality	Cultural or Humanistic Evidences
			either based on hi-tech outlook, fully air-conditioned environment following the private sector hospitals with immaculate corporate image or the resort and vernacular stand. In line with ecological, sustainable or environment friendly echoes of the current society, these mega structures claims that new technology subscribed in their architectural development succumbed to these calls. Material use was reinforced concrete frame structures, with infill clay or cement brick walls. Roof material was initially asbestos cement but was eventually changed to either clay tiles or concrete tiles due to its effect on health.		

Hospitals	Site Location	Building configuration and layout	Built form, material use and construction detail	Internal planning strategy or space quality	Cultural or Humanistic Evidences
Towards a developed nation 2000s to present	Continue, part of Educational facilities, within the urban framework to meet urban densities in decongesting older facilities at new satellite township. Site is compact in new urban outskirt .	 Figure 43: Jempol Hospital layout plan Located in new township, this non-specialist hospital is planned into a compact sloppy site and thus require stacking up of facilities of finger type layout development.  Figure. 44: Ampang Hospital, Selangor. Urban hospital such as Ampang Hospital (Figure 43) have no space	 Figure 45 : Jempol Hospital, Negeri Sembilan Gentle cascading roof and human scale built form greets the people of the new town of Jempol with care. 2 - 3 stories building with wards on the above and clinics below.  Figure 46: View of Ampang Hospital, Selangor from the main road. Wards are place on medium rise tower blocks that shapes as 'H'. Pitch roof is a mandatory requirement.	The compact 2-3 stories for the podium part of the hospital building is generally aligned with clear hospital street that has access to courtyards and exits. While diagnostic block has its necessary internal deep spaces due to control environment requirement, the wards on the elevated levels had access to natural ventilation and view. This period improves the full height partition wall to all the bed cubicle areas and rooms to isolation and 2nd class wards.	Daylight is access through courtyards for the inner departments. Many spaces of respite is placed at strategic areas for both patients and visitors.

Hospitals	Site Location	Building configuration and layout	Built form, material use and construction detail	Internal planning strategy or space quality	Cultural or Humanistic Evidences
		to place the 500 beds in a sprawl onto the site. Priority has to be made on accessibility to the important department first, before view, ventilation or daylight requirement. Human spaces are played by the receiving main foyer with smaller courtyards as landmark that engaged on wind stack effect to induce natural ventilation at assigned areas.  Figure 47 : Temerloh Hospital, Pahang Located at the outskirt of a new town ,the linear layout of Temerloh hospital planned according to site configuration provide a compact but well space suburban hospital on a hill. Facing north-south is ideal for patient spaces.	 Figure 48: Main entrance of Temerloh Hospital, Pahang Wide porte coche/entrance at Temerloh, typical at most hospitals of this period provide protection from rain and shine for drop offs and pick-ups for patients and visitors. Passive design facades going back to the colonial days were employed in the deep fenestration and fins. Newness in high tech material is evident. Consciousness of green building material is introduce at this period.		

CONCLUSION

This study initiates with the purpose of defining 'Green' and the concept of 'Sustainability' in designing tropical climate hospitals for Malaysia with the objective of contributing qualitative attributes in the formation of Malaysian Green Building Index for hospital buildings. The study defines sustainability of a hospital which defer from the general physical definition due its clinical requirements and the nature of its conflicting spatial requirements with human as the central user and healing environment as the supportive aim.

As accorded by Verderber, S.(2010) , Yeang, K.(2012), ZiQu Wu (2011), Srazali Aripin (2007), Pellitteri, G., and Belvedere, F., (n.d.) and Burpe, H (2008), the sustainability that embraces the green requirements in healthcare facilities should also embrace the notion of creating a supportive environment (i.e. healing environment) that is physically healthy and psychologically appropriate. The hospital is designed as a place for the sick to recover. Apart from the clinical needs, it is imperative for the physical aspects to be considered in hospital buildings. The physical aspects (i.e. building orientation, daylighting, window design, thermal conditions, materials use and others should be cleverly designed to achieve the balance and the principles of economic, social and ecological sustainability without compromising the functionality of hospital building (Burnet, L. 2004). Thus achieving sustainable hospital design through appropriate physical aspects is not an impossible task. The growing research evidence made by the local researchers and the case studies presented above in the Malaysian public hospitals provide unequivocal direction to suggest that the physical aspects have a significant role in creating a healing environment. It is important to note that in the context of hospital buildings, the measurable patients' health outcomes in a healing environment are indirectly the result of appropriate design of physical aspects. Taking daylighting as an example, a well-designed daylighting will obviate the need for artificial lighting. The effort to reduce dependency on artificial lighting would directly contribute to the energy consumption of hospital buildings, subsequently assisting sustainability.

Unlike temperate countries, professionals engaged in the healthcare projects and services in Malaysia should be inspired with the availability of natural environment (i.e. wind, year round daylight and natural view) in the Malaysian climate without sacrificing clinical functionality and design visions. One must accept the fact that the design of a hospital to create a supportive and healing environment as well as physically healthy and psychologically appropriate is a multidisciplinary effort that can contribute to a sustainable design. Hence healthcare designers ought to consider issues beyond the project brief and requirement. The step towards '*one-off*' design for public hospitals in Malaysia through improved procurement system is a commendable starting point as each location requires customized design to overcome contextual issues. However, stringent requirements on the physical aspects to meet environmental issues should be explicitly stated in the design briefs for any hospital developments and for the designer to comply with. These requirements must be validated by healthcare designers and approved by the healthcare providers.

This short study is not an end in itself but aims to open more inroads into looking at the Green requirements for hospitals in tropical climate like Malaysia holistically. In conclusion, the findings made by respective researchers and from the case studies on existing hospitals towards the green agenda for hospital design in the tropical climate of

Malaysia, found respective period provides peculiar and interesting physical solutions derived from the details construction of walls, floors, ceiling as well as structures whether technically or mandatorily through the implementation of standards and UBBL. Humanistic requirements are derived from the scale, proximity and caring requirement intuitively woven as part of the design. These findings could significantly be integrated as a document to reinforce the project briefs provided by the healthcare provider (Ministry of Health Malaysia) as well as the general green guideline for hospitals for Malaysia for healthy population.

Bibliography

Burnet, L. (2004), Healing Environment, Contract Vol.46, Issue 9;Career and Technical Education, Pg.60.

Burpee, H. (2008), 'History of Healthcare Architecture', Integrated Design Lab Puget Sound, p.1. Retrieved on 12 June 2013 at http://www.mahlum.com/pdf/HistoryofHealthcareArchBurpee.pdf

Chin, M.Y. (2009). 'Health check for Malaysian architecture' in Livestyle, MyStar Online. Retrieved 16April2012 at http://thestar.com.my/lifestyle/story.asp?file=/2009/1/4/lifeliving/2926441&sec=lifeliving

Cook, G.C. (2002). 'Henry Currey FRIBA(1820-1900): Leading Victorian hospital architect, and early exponent of the "pavilion principle"', in Postgraduate Medical Journal, Postgrad Med J 2002.78:352-359 doi:10.1136/pmj.78.920.352. Retrieved 01May 2012 at http:/pmj.bmj.com/content/78/920/352.full

Department of Energy. (2003). Table C3: Consumption and gross energy intensity for sum of major fuels for non-mall buildings. Retrieved 17 Mar 2011 from 2003 CBECS Detailed Table:at http://www.eia.gov/emeu/cbecs/cbecs2003/detailed_tables_2003/2003set9/2003pdf/c3.pdf

Fatimah Lateef. (2009). 'Hospital design for better infection control' in Journal of Emergencies, Trauma and Shock, J Emerg Trauma Shock 2009 Sep-Dec; 293):175-179. Retrieved 01May 2012 at http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2776365/?report+p...

Gatermann, H.(2003). Programming, Guidelines and Masterplanning for Hospitals, Contributions to the 23rd International Public Health Seminar in San Francisco 28 July-4 August 2003. Germany.Union of International Architect Workprogramme Public Health.

Infection Control in Health-Care Settings : Tuberculosis. Retrieved 5 May 2012 at http://www.cdc.gov/tb/publications/factsheets/prevention/ichcs.htm.

Jiat-Hwee Chang. (2009). A Genealogy of Tropical Architecture: Singapore in the British (Post) Colonial Networks of Nature, Technoscience and Govemmentality, 1830s to 1960s. Doctor of Philosophy in Architecture Dissertation. University of Berkeley, California.

JKR Design Guidelines: 1)Garispanduan bagi Mencegah Pembentukan Kulat didalam Bangunan, 2) Arahan Teknik untuk mencegah Kulat Dalam Bangunan Kesihatan

Keneally, V. (1997). 'An Introduction To Energy Efficiency In Air-Conditioned Tropical Buildings', in BDP Environment Design Guide August 1997.Gen 14.pp 1-3, Royal Australian Institute of Architects.

King, A. (n.d.) Hospital Planning: Revised Thoughts on the Origin of the Pavilion Principles in England. Retrieved on 12August2013 at http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1033641/pdf/medhist00149-0058.pdf

Khairul Azmi Kamaluddin. (2011). Healthcare Facilities Design and Operational Issues in relation to Mold Problems. Powerpoint presentation at Engineering Services Division Conference 2011 Port Dickson (28 - 30 May 2011). Retrieved 12 August 2013 at http://www.google.ca/url?sa=t&rct=j&q=&esrc=s&source=web&cd=3&ved=0CEQQFjAC&url=http%3A%2F%2Fengineering.moh.gov.my%2Fv3%2Fmodules%2Fwfdownloads%2Fvisit.php%3Fcid%3D13%26lid%3D84&ei=5RxFUseTAcWC2gXEwIGoBA&usg=AFQjCNFPbF8wSDNIDK9SCTSMQjTLbNc_IA&sig2=-kj5z-xqb0HAnvcSofwAug

Kleczkowski, B.M. and Pibouleau,R.(ed.) (1983).Approaches to planning and design of health care facilities in developing areas. Vol. 4.WHO. Retrieved 4 May 2012at http://whqlibdoc.who.int/offset/WHO_OFFSET_72_%28part1%29.pdf.

Kleczkowski, B.M., Montoya-Aguilar, C and Nilsson, N.O.(ed.) (1985).Approaches to planning and design of health care facilities in developing areas. Vol. 5.WHO. WHO OFFSET 91.Retrieved 4 May 2012.

Lian, K.S., Nila Inangda, Ahmad Ramly,(n.d.). Sources Of Indoor Air Quality Problem In A New Hospital In Malaysia . Retrieved 12 August 2013 at http://www.inive.org/members_area/medias/pdf/Inive/IAQVEC2007/Lian.pdf

Mendler,A, Odell,W and Lazarus, M.A. (2006) 2nd Ed. The Guidebook to Sustainable Design. United States of America. John Wiley & Sons, Inc.

Ministry of Health Malaysia. (2012) Guidelines on Prevention and Management of Tuberculosis for Health Care Workers in

Ministry of Health Malaysia. Occupational Health Unit, Disease Control Division, Ministry of Health Malaysia. Retrieved July 2013 at http://www.moh.gov.my/images/gallery/Garispanduan/Guidelines%20On%20Prevention%20And%20Management%20of%20Tuberculosis%20For%20HCWs%20In%20MOH.pdf

Morbidity and Mortality Weekly Report,Vol.54,Guidelines for Preventing the Transmission of *Mycobacterium tuberculosis* in Health-Care Settings, 2005. Retrieved 5th May 2012 at http://www.cdc.gov/mmwr/pdf/rr/rr5417.pdf

Nightingale, F. (2010). Notes on Hospitals By Florence Nightingale. London. Savill and Edwards.

Noor Hanita Abdul Majid et al. (2011). Climate Responsive Strategies versus the Cultural and Religious Dimensions in the Architecture of Malay Traditional Houses, in Norwina Mohd Nawawi (ed.). (2011). Malay Vernacular Architecture-traditional and contemporary expressions. Kuala Lumpur, IIUM Press. Chp.6, pp 59-70.

Noor Hanita Abdul Majid and Ibrahim Udale Hussaini, ' Islam and the Concept of Sustainable Development' in *The Islamic Quarterly*, in the Fourth Quarter

1432/2011, Vol.55,No.4, The Islamic Cultural Centre and Londn Central Mosque, pp 275-291

Norita Johar (2012).The Feasibility of Open Wards For Airborne Infectious Isolation Use During Seasonal Pandemic Crisis: A Case Study of Sungai Buloh Hospital. A thesis presented to the Kulliyyah of Architecture and Environmental Design of International Islamic University Malaysia in Partial Fulfilment of the Requirements for the Degree of Master of Science (Unpublished).

Norwina Mohd Nawawi and Srazali Aripin, (2004).Comparative Study on Passive Design Considerations on Selected Hospital Designs in Malaysia. Paper presented at Seminar in Passive Design Consideration in the Built Environment from the 22st-23nd November 2004 in KAED, IIUM, Malaysia

Norwina Mohd Nawawi, Noor Hanita Abdul Majid, Zaiton Abdul Rahim, Abdul Razak Sapian, and Zuraini Denan (2013) Configuring The Nature Of Colonial Hospital Architecture In Peninsular Malaysia - Serie 1:- Special Studies On The Tuberculosis Ward And Hospital Administration Building Typologies of Kota Bharu Hospital . unpublished study report

Pellitteri, G., and Belvedere, F., (n.d.) Characteristics Of The Hospital Buildings: Changes, Processes And Quality. University of Palermo. Retrieve 12 June 2013 at http://www.aia.org/aiaucmp/groups/aia/documents/pdf/aiab087217.pdf

Private Healthcare Facilities And Services Act And Regulations 2006.

Shah, R.C. and Kesan, J. P. (n.d.). How Architecture Regulates. Retrieved *6 May2012* at www.governingwithcode.org/.../How_Architecture_Regulates.pdf.

Sharifah Fairuz Syed Fadzil and Byrd, H. (2012), Energy and Building Control Systems in the Tropics. Pulau Pinang. Universiti Sains Malaysia

Sh. Ahmad, S., Mat Som, N., Ong, S.H., Harith,Z.Y., and Othman, A.R. in 'Daylighting in Courtyard hospital wards in Malaysia', in PAM Academic Journal, Kuala Lumpur, Yamagata, Vol 1, 1/2007, pp 97-117.

Sirajoon Noor Ghani and Yadav.H. (2008) Health Care in Malaysia. Kuala Lumpur. University of Malaya Press.

Srazali Aripin. (2007). Healing Architecture: Daylight in Hospital Design, Proceeding of Conference On Sustainable Building South East Asia, 5-7 November 2007, Malaysia, pp. 173-181.

Srazali Aripin. (2012). The Role of Daylighting in the Green Built Environment. Proceeding at International Conference on Green in Built Environment (ICGBE) 2012: 'Green' Built Environment: Redefined, Kulliyyah of Architecture and Environmental Design, International Islamic University Malaysia.

Stagno, B. (n.d.).Designing And Building In The Tropics, at www.brunostagno.info/articulos/ENGLISH/Designing. Retrieve on 5th May 2012

Statement of Needs Energy Efficiency in IIUM Teaching Hospital RFP Vol.9/9 (2010) (Unpublished)

Verderber, S. (2010). Innovations in Hospital Architecture. London. Routledge

Van Lengen, J. (2008).The Barefoot Architect. A Handbook for Green Building. USA. Shelter Publication

Wagenaar, C. (ed.). (2006).The Architecture of Hospitals. Belgium. NAI Publishers

WBDG Sustainable Committee (2011). Sustainable at http://www.wbdg.org/design/sustainable.php.retrieved 5th May 2012

Yau, Y. H. and Chew, B. T. (2009), Thermal comfort study of hospital workers in Malaysia. Indoor Air, 19: 500–510. doi: 10.1111/j.1600-0668.2009.00617.x. Retrieved 02Sept13 at http://www.ncbi.nlm.nih.gov/pubmed/19719535

Yeang, K. (2006). Ecodesign, a manual for ecological design. London: Wiley-Academy.

Yeang, K. (2012). Green Design and Planning. Keynote paper for Session 3: International Conference on Green in Built Environment (ICGBE) 2012: 'Green' Built Environment: Redefined, Kulliyyah of Architecture and Environmental Design, International Islamic University Malaysia

Yudelson, J., and Meyer, U. (2013).The World's Greenest Buildings: Promises Versus Performance in Sustainable Design. United Kingdom. Routledge

Zi Qi Wu. (2011). Evaluation of A Sustainable Hospital Design Based On Its Social And Environmental Outcomes. A thesis presented to the Faculty of the Graduate School of Cornell University in Partial Fulfilment of the Requirements for the Degree of Master of Science. Retrieved 12April 2013 at http://iwsp.human.cornell.edu/file_uploads/Ziqi_Wu_THESIS.pdf

Zhang, G., Zheng, C., Yang, W., Zhang, Q., & Moschandreas, D. J. (2007). Thermal comfort investigation of naturally ventilated classrooms in a subtropical region. Indoor and Built Environment, 16(2), 148–158