DESIGN AND ARCHITECTURE

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A COMPREHENSIVE APPROACH TO PASSIVE DESIGN STRATEGIES FOR PUBLIC HOSPITAL

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Abstract - Passive design is an element utilized from natural sources intended to maintain the comfort of the building's occupants. This source consists of natural lighting and ventilation adapted through openings in buildings. Building orientation is essential for design openings to be optimized more efficiently. However, occupants usually respond to their immediate environment to achieve the comfort and convenience of their space. The literature is reviewed to identify design strategies for passive design in order to enhance energy efficiency. This paper relates on energy efficiency strategies through passive design in which designers have systematic guidelines for the initial stages of public hospital design. Sustainable hospital architecture can be created through criteria derived from the information found in helping pre-process designers design public hospitals more efficiently in terms of energy use.
Keywords - Passive Design, Public Hospital, Energy Efficiency, Strategies.

1 INTRODUCTION

Buildings consume half the daily consumption of energy. Due to the homogeneous environment created by the designers [architect] and standardized engineering solutions, the energy being used in building rise significantly (Buonomano, Calise, Ferruzzi, & Palombo, 2014). Most buildings today tend to waste a lot of energy by failing to respond to the inhabitants ' climatic circumstances and comfort needs. The next step in realizing this agenda in Malaysia is to develop passive design, especially in hospitals to reduce the use of mechanical energy by establishing green building strategies (Rina & Zakaria, 2014). Hospital can be a symbol of pain, illness and distress but it is also a symbol of healing, life, family and hope (Yimin, Wenyu, & Chunyang, 2014) (Marta Pinzone, 2012). Therefore, building a public hospital is very important to the community, especially in design and operation, which has a huge impact on health and safety.

Passive design relates to the design that provides the user with the convenience of using natural components. These components can provide heating and cooling for buildings, such as lighting and ventilation for user's comfort (Butters, 2015) (Liu, Li, Liu, & Fu, 2006). It will reduce the use of mechanical systems in buildings where temperature cooling and lightingon be controlled (Rasiah, Rosnah, Abdullah, & Tumin, 2011). Passive design refer to the architecture design that utilizes minimal energy consumption and decreases the use of active mechanical devices and enhances consumer convenience. Thus, this paper proposes strategies for the role of passive design in the public hospital environment through literature review related to design and theory.

2 RESEARCH METHODS

Literature from various fields has been brought together to identify strategies for energy efficiency through passive design. It is the used to develop a conceptual framework that will enable designers to reference guideline for designing public hospitals at the early stage. Through a paradigm derived from theory and methodology, identifies the conceptual framework for passive design concepts towards energy efficiency (Lim, Barry, Keumala, & Ab, 2017).

The selected literature reviewed are mainly comprised of four main groups, namely 1) Principle of facade design 2) building energy performance 3) Post occupancy evalution of Building and 4) Net Zero Energy Building. The selected study is limited to ward-related spaces in public hospitals and mainly published in electronic journals such as Building Efficiency, Hospital Design and Science Direct. Building energy efficiency parameters are implemented during the process design process and this is what designers need to emphasize in establishing energy allocation in their hospital buildings, in addition to the passive design concept (Mills, Phiri, Erskine, & Price, 2015: (Marta Pinzone, 2012).

The literature also outlines the observations of hospitals that will be field studies that can help to identify strategies that are successful. The field study thru observation the public hospital environment is a very challenging psychological or physical task (Rina & Zakaria, 2014). This research aims to assist researchers to know the medical care routine's (staff) and function. Researchers should also adhere to the rules issued by public hospital management in seeking information by considering the privacy of patients and not interfering with the responsibilities of nurses who carry out their daily routines. (Rasiah et al., 2011). Thus, researchers need to be more creative in collecting data in hospitals to accomplish the objective.

Through literature review, it is also noted that questionnaire of public hospital users, (staff and patients) during field surveys can help to further strengthen the passive design strategy. According to a study by Kothari's discovered that this technique is often used in the built environment and is an efficient instrument in architectural research (Kothari, 2006). This is because it involves socio-cultural, environmental and management interactions as an investigative tool for assessing the efficiency of building use known as Post Occupancy Evaluation (POE). This method can also identify the effect and reaction of the users on their environment. (Alvaro & Wilkinson, 2015).

3 STRATEGIES FOR ENERGY EFFICIENCY IN PUBLIC HOSPITAL BUILDINGS

A study conducted by the Institutional Building Services Engineer (CIBSE) (Hassan, Zin, Majid, Balubaid, & Hainin, 2014) states that energy efficiency through passive design in Public Hospital buildings is a a low energy consumption to carry out the same or similar work. more. In addition it does not affect the comfort and actual output required to complete the daily work. Therefore, this energy efficiency can be optimized at the initial stage of the design concept as it will affect the interior space of the public hospital building. Through this strategy of efficient use of energy can also increase the life of the equipment in the hospital as well as avoid the waste effect (Aelenei, Aelenei, & Cubi, 2013).

Through Lechner's (Norbert Lechner, 2015) and later modified by Abbakyari & Taki (Abbakyari, M. and Taki, 2017) study in line with the outline produced by CIBSE, he described the energy efficiency strategy in the form of 'Solar Fruit Tree' and this can be seen in Figure1. This solar panel (active system) consisting of photovoltaic (PV), ventilation for preheating ventilation, daylighting from solar panel, active and passive solar is an important element in generating energy sources to supply for buildings. Thus, the use of this solar panel will result in increased energy costs for the building. The implementation of this strategy approach needs to be planned at the initial design stage in order to save money and reduce the cost of building public hospitals (Hassan et al., 2014): (Takashi, Shuichi, Daisuke, Masahiko, & Jun, 2013).

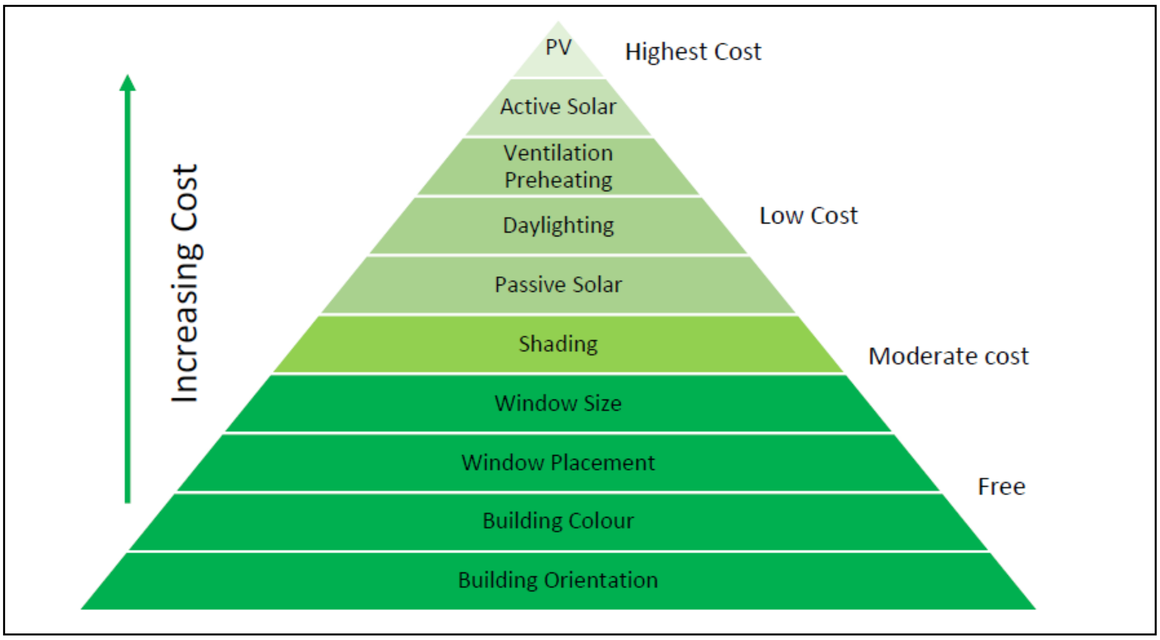

Figure 1. The 'Solar Fruit Tree' showing the costly strategies
(Source: Abbakyari, M. and Taki, 2017 and Norbert Lechner, 2015)

Shading devices and windows (size and placement) are elements that are installed specifically on the building's facade. Shading devices are intended to prevent direct sunlight into the interior of the building which can cause glare or discomfort to the building user. While windows, give an impact on natural lighting and ventilation to the interior of the building. Building color refers to the requirement that the client agree to the building being designed. Whereas the orientation building is guided by the proposed site as well as its potential in providing maximum natural lighting and ventilation which is passive design. These are all designed at the beginning of the design process.

To realize this passive design, Huang and Anderson have introduced two strategies for energy efficiency of Net Zero Energy Buildings (NZEB) (Huang, Huang, & Sun, 2018): (Anderson & Robinson, 2016) . The first strategy is more than a passive approach to planning that focuses on reducing energy demand. The second strategy for designing is the use of energy efficiency systems. Then this approach can offset the energy consumption of hospital building hospitals. Combining these two design methods can be successful in achieving the energy efficiency required through NZEB targeting. Therefore, the first passive design method is defined in subsection 4.1 and the second design approach is defined in subsection 4.2.

4 STRATEGIES APPROACH FOR PASSIVE DESIGN

4.1 First Strategy: Passive Design Approach

To achieve this NZEB, the design of this public hospital building began with an understanding of the building's use, its internal comfort needs and the study of natural and environmental resources at the proposal site (Aelenei et al., 2013). Choosing the best orientation for a building is key to thermal comfort and energy efficient design (Abdellah, Nasid Masrom, Chen, Moham, & Omar, 2017). The orientation of the building needs to be determined in terms of the angle of the solar and the direction of the wind. The design of rectangular buildings extending north and south is best intended for direct sunlight and ventilation to the openings. Whereas for buildings facing east and west are not good because natural lighting and ventilation are not directly proportional to the openings on the facade building (Hyde, Rajapaksha, Rajapaksha, Riain, & Silva, 2012).

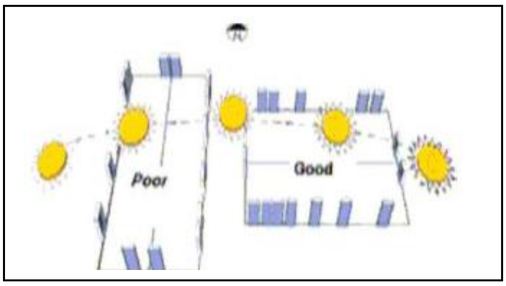

Figure 2 Building orientation in tropical climate
(Source: Abdellah, Nasid Masrom, Chen, Moham, & Omar, 2017)

The shape of the building, form and massing have a direct impact on energy efficiency. Architects [designers] are the main designers in determing the building shape aspect of the passive design to achieve NZEB (Habash et al., 2014). Building shape differs from heat resistance to elements such as windows, walls and roofs that have a significant impact on the total energy consumption of public hospital buildings (Abdellah et al., 2017). In the form of high-rise public hospital buildings, it has a large surface area that results in significant heat loss. Notwithstanding the impact of different shape factors for buildings with different thermal properties and different positioning of the proposed site (Brambilla & Capolongo, 2019)(Omrany & Marsono, 2016).

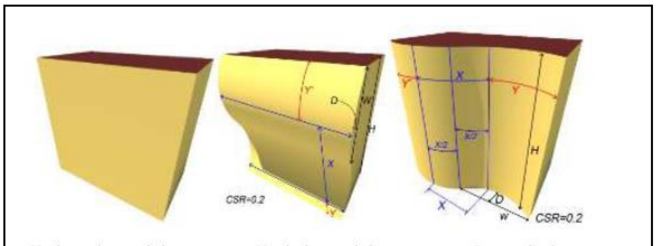

Figure 3 Shape of the building
(Source: Habash et al., 2014)

Buffer spaces and double skin facades are tools on the external facade that provide adjustable sun protection such as curtains or sun shading devices installed in the interiors to protect the interior from high heating loads caused by radiation (Aelenei et al., 2013). Energy savings can minimize solar load on building perimeter and low U value. The optimum width for buffer spaxpo,.ces is between 200mm to 2000mm. Natural ventilation can be carried out through cross ventilation on the double facade, where the wind blows directly at the openings in the building (Thalfeldt, Pikas, Kurnitski, & Voll, 2013).

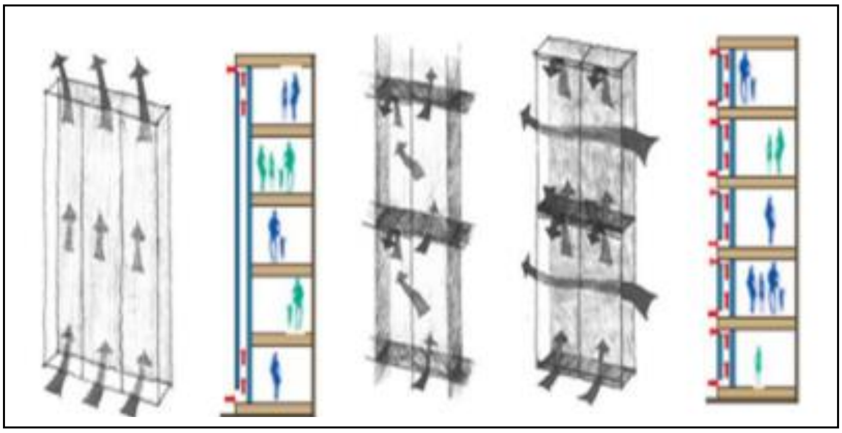

Figure 4 Double skin facade
(Source: Aelenei et al., 2013)

Through effective space planning or space layout will provide the advantage of energy efficiency to work more efficiently and NZEB will be achieved. Spaces such as wards, isolation rooms, operating theaters and labrotories in public hospitals require more serious attention during the early design stage (Kamaluddin, Imran, & Yang, 2016). These spaces have standard requirements that have been issued by the relevant parties for ventilation and natural lighting and should be followed without any compromise (Ahmed, Abel-rahman, Ali, & Suzuki, 2016). Through the planning of this space indirectly it affected the opening of the building's facade which allowed natural ventilation and lighting to enter the space. Users will enjoy comfort, natural healing and also the use of mechanical systems (air conditioning) will be reduced. The size and position of the openings of this building will affect the facade of the building (Kamaluddin et al., 2016)(Wang, Li, Liao, & Fang, 2016). Through the openings of the facade, the flow of natural ventilation and sunlight will be proportional to the interior of the building and the layout of the space.

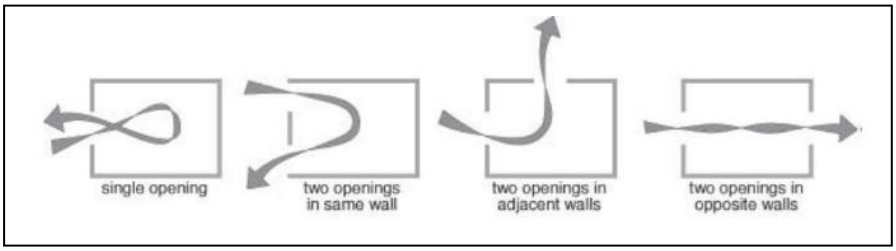

Figure 5 Single and cross ventilation methods
(Source: (Kamaluddin et al., 2016)

This indicates that it is very important to consider passive design approaches such as orientation, building shape, buffer spaces, double skin facade, space planning and facade openings building when designing NZEB. this is because it enables energy efficiency to be used optimally and benefits the building of public hospitals.

4.2 Second Strategy: Energy Efficiency System

Energy efficiency plays an important role in implementing the passive design strategy to achieve NZEB and provide optimum comfort to users (Wang et al., 2016: Sartori et al., 2016). Therefore, the main purpose of this energy efficiency is to protecting relatively limited energy sources and to minimize the cost of waste (Cullen & Allwood, 2010). In addition it can reduce the release of carbon dioxide (CO^2) which affects climate change.

This passive design strategy also improves energy efficiency, including with the air tension being prevented from infiltration through mechanical ventilation systems. Through this system heat recovery provided by efficient air conditioning as well as internal air quality (IAQ) will be ensured and heat dissipation can be avoided (Barbolini, Cappellacci, & Guardigli, 2017). Therefore, the selection of high-efficiency technologies is essential to enhance energy efficiency in buildings. For example, the use of low-power lamps (lighting) should be changed into LED lamps to decrease electricity consumption by 75 percent and energy-efficient electrical equipment in the indoor space is aimed at designing an energy balance that is not too excessive (Musall, Sc, & Voss, 2012).

Energy usage in public hospitals can be reduced through different building levels as well as space throughout the hospital building (Maassen, 2017). This can be accomplished by controlling the heating and cooling in a room or thermal zone (adapting the use of sensors that control the radiator valve) and adjusting the temperature to the room temperature for mechanical air conditioning. In addition, the efficient use of HVAC (Heating Ventilation Air-conditioning) system as well as the use of high performance glass materials SHGC (Solar Heat Gain Coefficient on building facades especially window material) can absorb the heat needed through sensors and set points for indoor temperatures (Marshall, Steinberger, Dupont, & Foxon, 2016). The application of strategies to mechanical systems of energy as well as electrical systems in public hospital buildings is crucial to NZEB as energy efficiency and controllable savings.

Achieving energy efficiency strategies for passive design is therefore essential to attaining NZEBs. It aims at decreasing active energy usage and saving energy consumption in public hospitals as well as improving consumer health care. The combination of energy efficiency and passive design can assist to decrease demand for energy consumption in hospital building.

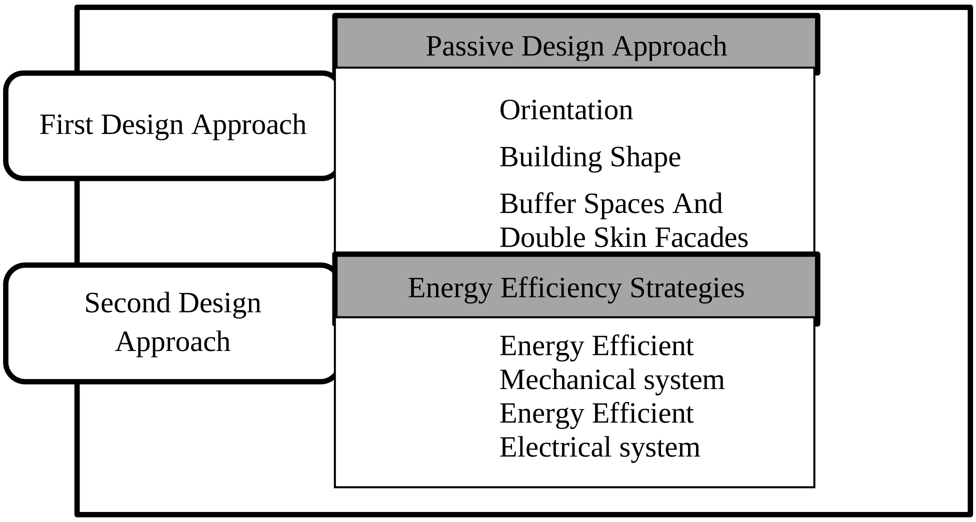

Figure 6. The strategies approach for Passive Design in hospital buildings.

5 FINDINGS

The advantages of applying this passive design through the strategies used for viable technolg y will benefit the users as well as the environment.

1. In building energy use (lighting and ventilation) and thermal comfort, it depends on the temperature of the set point and the behavior of the user.
2. The best control strategy for the sun shading system is only 70% during the afternoon (daytime) east and west. This indicates low wall heating and lighting especially for the northern and southern hospitals, due to the direct irradiation of the sun..
3. Pre-ventilation in the morning is best as it improves the indoor air quality but also helps to heat these indoor spaces and thus improves energy efficiency at the same time.
4. Cross-natural ventilation (passive cooling) rather than active cooling can reduce indoor temperatures during the day and in line with consumer convenience as well as extend the life of health equipment.
5. For high efficiency HVAC applications, good lighting, applications and equipment and control systems are effective strategies for reducing energy consumption. However, energy savings can be achieved through an optimal design design process, while minimizing the heating and cooling loads through innovative HVAC solutions.

6 CONCLUSIONS

Public hospital buildings are complex and involve several service areas to accommodate different work environments. In addition, aspects of low energy as well as environmental control should be the focus. This is important to ensure that the passive design of the public hospital building principle will be achieved for the use of clean zero energy (NZEB). This focus on NZEB is very important for public hospital buildings especially in developing countries. It is possible to conclude that two principles of strategy should be used to identify possibilities for achievement of NZEB requirements in public hospitals. The principles of this strategy consist of a passive design approach and energy efficiency combine together. Therefore, it is in this context that the NZEB concept has the potential to be used in public hospital buildings to ensure energy efficiency and to achieve maximum energy efficiency. Adaptation to the characteristics of a passive design strategy is crucial to keep the building more environmentally friendly and achieve sustainable development.

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