Incorporation of innovative passive architectural features in office building design towards achieving operational cost saving-the move to enhance sustainable development.

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Generally, office buildings developers/tenants/occupiers are not felt to be interested in the savings from increased energy efficiency. This factor is not a major factor of consideration considering the other factors that are preferred by them which include good location. However, sustainability can be related to cost savings by incorporating green building practices such as innovative passive architecture that will enhance the building image, the workplace infrastructure as well as occupants comfort. Thus, in order to promote sustainable buildings, this paper discusses how innovative building features through passive architecture may be incorporated in the building design to achieve operation cost saving buildings. A few local case studies will be highlighted in the move to promote sustainable development.

Keywords:
Green buildings, office buildings, passive architecture, sustainable development

Introduction

Sustainable development is the framework though which sustainability is delivered and driven within the development context. The most acceptable definition of sustainability comes from the 1987 Bruntland Report which defines sustainable development as 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs' (WCED, 1987). Sustainability is achieved through attaining a balance between inter-dependant social, environmental and economic factors. In 2003, the Organization for Economic Co-operation and Development had stated that, the building sector has major impacts not only on economic and social life, but also on the natural and built environment. Various building activities, such as the design, construction, use, refurbishment and demolition of buildings, directly and indirectly affect the environmental performance of the sector.

Against this background, the concept of "sustainable building" – reducing the harmful effect on the environment of buildings and construction activities – has been attracting the attention of stakeholders in OECD countries. This can range from using recycled materials carried by low-polluting forms of transport in construction to maximize energy efficiency in a finished building, for example through improved insulation and solar-powered energy.

For a development to be considered as sustainable, management and operations practices must be financially viable, detrimental environmental impacts must be minimized or eliminated and social issues and stakeholder engagement must be enhanced. The range of stakeholders groups involved in the planning, design, development, construction, ownership, financing, management and occupation of commercial development may be large (OECD publication Environmentally Sustainable Buildings: Challenges and Policies (2003).

Internationally developed countries like USA, UK and Australia have placed emphasized on sustainable buildings through investors who are diversifying their portfolio to include ethical or socially responsible funds.

Objective of the paper

This paper seeks to explore the promotion of sustainable buildings through the green building features. It also seeks to discuss how innovative building features through passive architecture may be incorporated in commercial buildings in the drive to achieve operation cost saving buildings. The literature on sustainable development, sustainable commercial buildings and innovative buildings features through passive architecture shall be explored. Lastly, it attempts to highlight a few case studies of how the innovative green building features have been incorporated in Malaysia.

Green Buildings

A green building is an environmentally sustainable building, designed, constructed and operated to minimize the total environmental impacts. In a study carried out by Oxford Brookes University in the year 2000, green buildings were defined as: buildings which by an integrated and holistic approach to location, siting, design, specification and use of energy and resources, seek to minimize their environmental impact. Green buildings typically have the following features:

- More natural ventilation or, at least, a mixture of natural ventilation and air conditioning, and/or increased fresh air via the mechanical ventilation system.
- Narrow plan forms, often within the 15m limits of natural ventilation and daylight access, the corollary of which is less 'deep' space in the middle, which users dislike.
- Better utilization of daylight.
- More user controls for windows, blinds, lights and ventilators. This can mean that needs (like thermal comfort) are met more quickly even though the conditions may only be 'good enough'. Users preferred rapid response when things go wrong or need changing, and will tolerate conditions which are reasonable.
- Higher floor to ceiling heights, which helps, e.g., with daylight penetration.
- More open plan workspaces (usually desks) close to or next to windows,
- More care taken in design of achieving comfortable conditions, especially in summertime.

Experiences show that green buildings can:

- be more complex, with technologies which are difficult to manage or understand adequately. This follows trends in the 1980s and 1990s when buildings became harder to manage. Complexity encouraged the growth of facilities management.
- include experimental features which may not be robust or tried-and-tested (although this can also be catch-22 because it is part of the much needed development and learning cycle which enables learning from experience).
- incorporate token gestures, with not enough attention given to the basics of good design and construction, usability, manageability and ease of maintenance.
- place too much emphasis on good intentions at the design stage, rather than the practical reality of their management and use.

The main strategies to achieve a green building include: reduced energy consumption, water conservation, recycling waste. Well designed green buildings will save money, increase comfort and create healthier environments for people to live and work, using improved indoor air quality, natural daylight, and thermal comfort (OECD publication Environmentally Sustainable Buildings: Challenges and Policies (2003). Environmental issues have the potential to give impact on virtually all aspects of property investment, development and management. D E Shiers, 2000 has noted the benefits that commercial property can offer to building owners and occupiers which include the acknowledgement that green buildings can offer a lower level of environmental risk providing more healthy buildings, getting positive responses among occupants and employees toward the organization which can be perceived as more socially responsible and progressive, having the potential to offer cost advantages particularly in terms of running costs. It was also stated that occupiers of speculative offices may not be willing to pay higher rents for green benefits, if comparable accommodation is available in the same location,

In Australia, commercial buildings produce 8.8% of the national greenhouse emissions and have a major part to play in meeting Australia's international greenhouse obligations. A commercial building sector baseline study found that office buildings and hospitals were the two largest emitters by building type, causing around 40% of total sectoral emissions (Environmentally Sustainable Buildings: Challenges and Policies' - a report by the OECD, 2003, 'Australia State of the Environment' Report, Commonwealth Department of Environment & Heritage, 2001).

Sustainable Planning

Both urban and rural planning can benefit from including sustainability as a central criterion when laying out roads, streets, buildings and other components of the built environment. Conventional planning practice often ignores or discounts the natural configuration of the land during the planning stages, potentially causing ecological damage such as the stagnation of streams as well as ignoring the site element between the neighboring buildings. Ignorance towards the right to the space, light and ventilation may deprive the current development within the particular area. Cohousing is an approach to planning based on the idea of intentional communities. Such projects often prioritize common space over private space resulting in grouped structures that preserve more of the surrounding environment.

Sustainable Commercial Building

From an investor's perspective, sustainability in the commercial building sector is important because firstly, it is significant in determining the intangible and future value of the business and secondly, it impacts on material risks and opportunities of the business. Both of these factors are essential for making better informed investment decisions. The UN principles for responsible investment (PRI) were signed by over 190 leading financial institutions with greater than USD 8 trillion assets under management. The PRI was formed in 2006 by the UNEP Finance Initiative and the UN Global Compact, along with key financial stakeholders. Signatories commit to acting in the best long-term interests of their beneficiaries, and acknowledge, in their fiduciary role, that environmental, social, and corporate governance (ESG) issues can affect the performance of investment portfolios. The rapidly growing list of major investors and fiduciaries indicates that companies will increasingly be assessed by their ESG performance, and that investors will be active owners in the ESG space.

Sustainable commercial buildings have been described to have the following building elements: Site which optimize the building orientation, the natural lighting, shading and ventilation it can capture. Secondly, the building fabric and material uses low embodied energy materials, use of recycled materials and the use of high performance material. Thirdly the building is likely to have efficient operational and maintenance cost. Fourthly, the building is efficient with the use of energy and water which could be operated through a Building Management System and manage to generate it electricity for example by the use of photovoltaic array on its roof or façade, rainwater tanks can be used to collect and store rainwater.

Commercial buildings developers in the US has identified real financial benefits that can be derived from sustainable building which include lower operating costs for energy, water and waste, increased rental rates, marketing advantage due to point of differences, an after lease-up period, higher tenant retention rates due to increased comfort and productivity, lower liability and risk leading to lower insurance rate, higher loan value and lower equity requirements, higher building value upon sale and appraisal and overall greater return on investment (Kat, 2003). A survey of 10 major property investors' thinking and attitudes towards green building found the following:

- most agreed that sustainable building credentials were well regarded
- most rated and benchmarked their buildings for energy efficiency
- most expected energy costs to increase beyond the rate of inflation
- all did not fully understand the differing rating schemes for sustainable building
- all believed that tenant requirements for sustainable building credentials would be a contributing factor for building obsolescence
- all had empathy for the cause of sustainable building
- most believed they could afford to pay extra for sustainable buildings unless there was a direct and compensating financial return
- all agreed that tenant demand for sustainable buildings would be a principal driver for investment in green buildings

While cost for the development of sustainable building would be an issue, it has been reported by the New Zealand Government that costs for them internationally shows a relatively marginal cost increase for sustainable building. Davis Langdon had stated that significant environmental measure can be incorporated leading to long term recurrent cost reduction, potential increased asset valuation and a more attractive home for tenants for as little as 2-4% additional capital cost (Davis Langdon Australia, 2004). In another literature on costs of sustainable or green building, an early 2003 article in the New York Times entitled "Not Building Green Is Called a Matter of Economics." summaries the context of determining the cost of building green compared to conventional design. Several dozen building representatives and architects were contacted to secure the cost of 33 green buildings from across the United States compared to conventional designs for those same buildings. The average premium for these green buildings is slightly less than 2%, or US$3-5/$ft^2$, substantially lower than is commonly perceived. The majority of this cost is due to the increased architectural and engineering (A&E) design time, modeling costs and time necessary to integrate sustainable building practices into projects. As a rule of thumb, the earlier green building features are incorporated into the design process, the lower the cost is.

In general, the process of driving sustainability in construction in Southeast Asia region is slow. Studies (Shafii et al 2005) showed that there are barriers in sustainable development which include:

(a) Lack of awareness on sustainable building
(b) Lack of training and education in sustainable design and construction
(c) The higher cost of sustainable building option
(d) Procurement issues
(e) Regulatory barriers
(f) Lack of professional/designers capabilities
(g) Disincentive factors over local material production
(h) Lack of demonstration examples

Passive Architecture Features for Sustainable Building

Passive design sustainable architecture features are elements that are permanently attached to or part of the building design such as building orientation, double skin envelope, sun-shading device, large overhang etc.

The active design sustainable architecture features are elements that bring in different results and actively react to the surrounding such as the solar panel, photovoltaic, rainwater harvesting, roof spray, landscape etc.

Some of the features illustrated in a few literatures include those on the passive cooling, lighting and ventilation.

Cooling of Buildings – Some of the passive techniques based on thermal protection of the building envelope and on the dissipation of buildings thermal load to a lower temperature heat sink, have been proved to be very effective. Passive technique as alternative to air conditioning can bring important energy, environment, financial, operational and qualitative benefits. A useful framework for considering passive and hybrid cooling in the context of environmental design can be summarized as follows: prevention of heat gain, modulation of heat gain & dissipation of heat. Protection from heat gain may include landscaping & the use of outdoor and semi outdoor spaces, building form, layout and external finishing, solar control & shading building surfaces, thermal insulation and control of internal heat gain. The designers of early skyscrapers tempered the heat from the sun by setting windows deep into the façade where they were sun shaded and helped shield the most exposed portion of the building. The application of the concepts within the framework may include the use of air movement through open spaces, external and internal shading, appropriate arrangement of immediate surrounding space vegetation, open pools & ponds and use of proper building materials. Large opening of the building allow for ample cross air movement which can have a significant cooling effect. The use of vegetation for necessary shading will absorb large amount of incident solar radiation and maintaining lower air temperature which is further reduced by evaporation from the trees. Another approach is considering the building orientation in the design stage. In Malaysia, the east and west facing windows received direct sunlight and if not treated properly the heat gain inside the building can easily increased the building energy consumption by 20%. Good site planning involves proper building shape and orientation by taking advantage of natural site features such as topography, sunlight, shade and wind to promote energy efficiency.

Ventilation – Natural or forced ventilation is paving way of reducing the cooling load in building. Natural ventilation is caused by pressure difference in the inlets and outlets of a building envelope, as a result of wind velocity and stack effects.

Day lighting - Daylight is very important for people inside buildings physiologically and psychologically. The natural light can be capitalized by the use of windows, light shade, atria etc. The design should avoid direct sunlight penetration into the building instead sun light is diffused from strategically placed louvers that are painted eggshell white to achieve colorless, soft cool lighting. Glare is avoided by placing all such diffusing surfaces and glazing well above eye level. The color, shape and material of the luminaires will affect distribution of light. Highly reflective wall coverings indirectly make the space feel lighter. What the interior need is ambient daylight without the radiant heat and glare which is called cool daylight / diffuse daylight. When daylight enters a room through windows, the illumination near the windows will be high and it reduces quickly as it gets further into the depth of the room. Designers should always try to create a better uniformed daylight distribution into a space. The simplest and most often used strategy to improve the daylight penetration to the back of the room is by having high level windows or clerestory window, where the lower window is for vision and the higher level window is purely for daylight. A light shelf between the upper and lower window would help to distribute daylight deeper into the room by bouncing lights of the shelves to bring illumination deeper into the room.

It is important to use appropriate control fittings for dimming or switching off lights at the area where artificial light is not required. The choice of glazing and window shading devices will determine the amount of heat gain and solar radiation entering the room and increase the cooling load inside the room. The type of glazing chose should provide good visible light transmission but low solar heat transmission. Double glazing is better option than single glazing in terms of energy efficiency. However the initial cost to install the double glazing maybe hard to justify the savings from running cost and annual savings on cooling load. It is most common to use tinted glazing to reduce solar heat gain through openings. Dark tinted glass will reduce the availability of the natural light penetration into the room and require the artificial lights to be switched on all the time. It would be desirable to choose glazing that would provide good visible light transmission but low solar heat transmission. Studies done by Danida has shown that in Malaysia the price of green tinted glazing is 40% less than double glazing with low E film, however the energy savings is only 6% more than the light tinted glass.

Glazing recommendation:

1. Lighting system layout and control must allow artificial lighting near the façade to be turned off when not needed.
2. Glazing selected should provide good visible transmittance (50%) and low solar transmittance (50%)(or low shading coefficient(60%)).
3. Be aware of high surface temperature form single glazing with high solar absorption (>30%)
4. Heavily tinted glazing does not provide a clear view of outdoor and eliminate the possibilities of daylight harvesting.

Solar design-Solar energy can be used directly or indirectly in buildings. In solar passive design the orientation of the building, mass of the building and the materials selected for the façade all contribute towards reducing energy consumption very significantly. By using the façade as the climate moderator, in addition to being a transmitter of solar energy, means that there is also a reduction in the need for building services components which have a much shorter lifetime than the building fabric, thus reducing maintenance costs. For a good penetration of daylight into building the width of the building should not exceed about 15m.

Solar energy - To take advantage of the solar radiation, the form, fabric and orientation of the building need to be considered. External blinds are more efficient than internal blinds. The rules of thumb for solar design (source: Rawlings 1999) are as follows:

Form orientation	Create sun spaces, lighting ducts, light shelves Main glazing to face 30 either side of due south Reducing the north glazing Minimize tree overshadowing In housing estate build a density of <40 properties/ha Design atriums/roof lighting in accordance with position of the sun
Fabric	Fabric transmission losses may be reduced by improving insulation or by reducing the mean inside air temperature

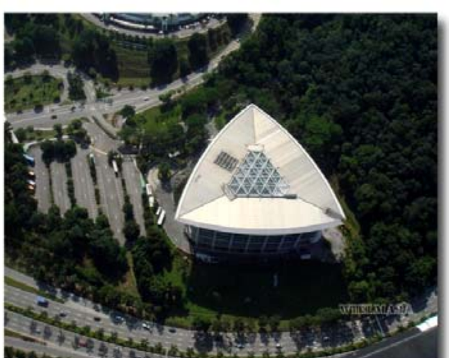
Building fabric - Building envelope components has three important characteristics that affect their performance: their U-value or thermal resistance R-value; their thermal mass or ability to store heat (heat capacity) and their exterior surface finish (for example, light surface color reflects heat and dark surface absorb solar heat). Typical building in Malaysia is constructed with 115 mm thick brick wall with 15 mm thick cement plaster on both sides. Innovative materials such as aerated concrete block with 15mm thick plaster on both sides have the U-value of 0.32 W/m^{2}K for 400mm thickness up to 1.05 W/m^{2}K for 100mm thick block. The U-value of the typical brickwork is 2.43 W/m^{2}K which is almost half of the U-value of the aerated block of the same thickness. The lower the U-value means the less heat absorbent the material is, the less cooling load required to cool down the interior required and less thermal mass release at night. The amount of heat absorbed during the day will be released towards the evening when the outdoor temperature gets cooler however the wall internal surfaces remain cool even in the late afternoon. Being an office building it will be unoccupied at night, therefore the indoor temperature amount of heat release to the indoor is negligible.

Roof and Insulation - The roof received the most direct heat gain from solar radiation. Studies have been carried out to search for the effectiveness of the type of insulation available locally. The results shows that for typical concrete roof of 100mm thick with polystyrene foam provides better insulation then other type of insulation with the same thickness. The peak cooling loads affects the size of the HVAC equipment to be selected. High peak cooling load will cost more on HVAC equipments as ductworks, chiller, and cooling tower to be larger. The peak cooling load drops approximately 30% with the use of at least 50mm thick insulation on the roof. The economic feasibility study shows that providing an insulation of 50mm thick the payback period will be approximately 8 to 9 years.

While there is no simple list that covers the requirement for sustainable building, there are a number of heating systems used to evaluate sustainable architecture in general such as LEED (Leadership in Energy and Environmental Design), BREEM (Building research Establishment Environmental Assessment Method). Both rate buildings according to their environmental impact. The systems define environmental progressive architecture as an architecture that uses renewable sources, generate energy that uses passive techniques for ventilation as illumination, that incorporates and maintains and recycle greenery, water and waste that advances the use of environmentally conscious construction techniques and that foster a viable visible urbanism.

Case Examples of Sustainable Buildings in Malaysia

Designing with climate results in the reduction of overall energy consumption of the building by the use of passive structural devices, instead of mechanical equipment, which require much energy (Yeang 1996). Cost savings in the operational costs means less use of electrical energy resources, usually derived from burning of non-renewable fossil fuels. The lowering of energy consumption would further reduce the overall emission of waste heat thereby lowering the overall heat-island effect on the locality. In Malaysia the sustainable commercial building awareness started in the year 1992 when the Mesiniaga Tower was completed. Other corporate building owners start to include sustainable design features in their new building.



Security Commission Building in Malaysia

The building concept based on a premier intelligent office was developed as energy efficient and a flexible office workspace environment. The basic characteristics of this intelligent building is to create a holistic design incorporating the following features : effective building shell, environmentally responsiveness, energy efficient of design both in passive and active concepts, a flexible work space, provide a healthy working environment, environmentally friendly with minimum cost of operation. Passive design concepts involve factors like the orientation and building design. The design was optimized to fit the existing valley topography, minimizing earth removal for construction of basement car parks and facilities that do not require natural daylight hence, the auditorium, lecture theatre and squash court were placed in the basement. A 12 meter wide moat runs around the building to bring natural daylight into the spaces below ground that require natural daylight.

UMNO Tower, Penang, Malaysia

The 21 storey tower sees the architect vision to turn wind load by having different cladding on the leeward and windward sides of the tower to offset the different weathering conditions on each side. Large fin or wing wind wall are angled to create an artificial pressure zone and pull wind in through and out of each office floor providing an estimated 30 air changes per hour. This natural ventilation reduced 30% of the air-conditioning cooling load. The building core is located on one side of the building to make use of the open planning and natural ventilation.

Telekom Tower, Kuala Lumpur

The building was constructed in 1996. At 310 meter high, it has 75 storey with a floor area of 1.2 million ft^2. The curvy shape is a major breakthrough of tall building architecture. The Tower has slabs at every 5 floors which accommodate gardens like a mini park. Beyond its functional attributes, Telekom Tower is more than just an intelligent building. It offers residents a work environment that enhances their well-being in an intelligent, efficient building with state-of-the-art facilities. It also has the Sky gardens which help to 'green' the Tower thus making the architecture environmentally sensitive. Varying in size and landscaping at different levels, these Sky gardens provide natural shade on the eastern and western facades and also serve as spaces for relaxation and informal meetings. Offices are designed within a central core and make the best use of natural lighting while keeping out the heat. The narrow eastern and western frontages minimize solar penetration, reducing air conditioning loads while allowing for high amount of indirect lighting.

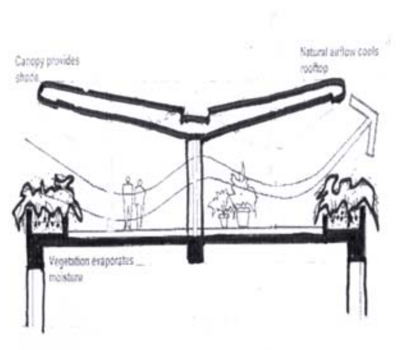
LEO Building, Putra Jaya

Another good example of a sustainable building is the low energy office (LEO) building built by the Government of Malaysia with the technical input from DANIDA (Danida International Development Assistance) where it now houses the new Ministry of Energy, Water and Communications (MEWC) headquarters. The building design and energy systems at LEO Building were optimized for minimum energy consumption using a computerized design tool. A saving of 50 % was targeted on the energy consumption compared to the performance of additional office buildings in Malaysia.

Low Energy Office building is a 2 blocks of 6 storey high building with 2 basements located in Parcel E of Putrajaya. Its floor area is approximately 19,237 M^2 of air-conditioned area. It is the government intention for the building to be an energy efficient showcase. The base building cost was RM50 million and additional 10% was added to equipped the building with its sustainable features. The building was completed in September 2004.

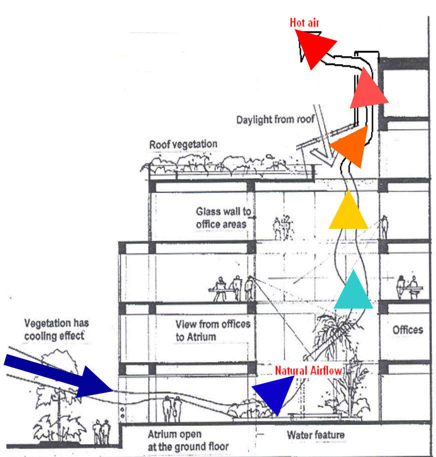

South facade

The passive sustainable features of LEO building are:
Orientation - the building maximize the land use however to capitalized on the orientation, the west and east side of the building have less openings for windows therefore reduced the heat gain into the building.
Internal planning - The work space was planned with the active spaces located along the external wall and facing the internal atrium while passive spaces such as seminar rooms, stores and toilets are placed in the inner side of the building. This allows the staff to utilize the cool daylight while working and therefore saves the electricity consumption from artificial lighting.
Building materials - Wall: For space efficiency and acceptable low value, the external wall of LEO building is constructed of 200mm thick aerated concrete block with 15mm plaster on both sides.



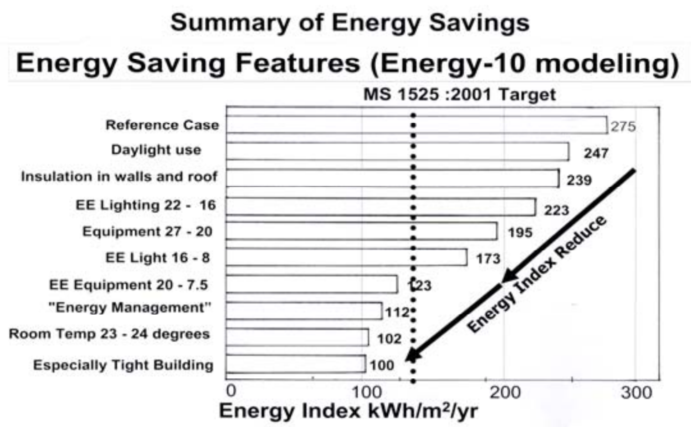
Roof insulation - The flat roof is constructed of 100mm thick reinforced concrete with 50mm thick polystyrene insulation. A secondary roof was provided to further shade part of the insulated roof and this provides spaces at the rooftop for the office activities. The roof is surrounded by planter box which also acts as the safety railing. Rainwater form the secondary roof is harvested for watering the plants. By not having a green roof at the top the designer has reduced the maintenance cost.

Glazing - To balance between the initial cost and running cost, LEO building uses 12 mm thick light green tinted glass for both the skylight and windows. Window shading device adopted in Leo building is the deep set window design with 600 mm setback for the north and south façade and 800 mm setback for the east façade. The windows are split into two with light shelves that reflect the solar light up to 2 – 2.5 times of the opening height deeper into the room. The internal surface opposite the window is further applied with light colors to reflect the bounced light back into the room. The skylight is made of 12mm thick tinted glass and to prevent excessive direct heat gain to the atrium floor, series of movable white canvas will cover part of the glass in the afternoon.



Natural ventilation - It is trendy to have the reception lobby of office building a huge open space with high ceiling level. The atrium lobby of the LEO building is five storeys high with skylight. The space is naturally ventilated. To promote the air to surge upwards thermal flue is introduced at the fourth and fifth storey wall by painting the wall black. This increased the air heat and promotes it to surge upwards and outwards faster which creates a negative air pressure at the chimney and indirectly induced the air in the lower floor of the atrium to rise up and escape through openable glass louvres at the top of the thermal flue chimney. The air movement inside the lobby is 6 to 8 air changes per hour. When the outside air gets warmer rows of water mist will be automatically released along the line of the first floor beam to cool down the air that enters the lobby. A three storey water wall inside the atrium provides evaporative cooling to the indoor temperature which remains stable at 24º C throughout the day.

The active sustainable features in LEO building are the photocell sensor, occupancy sensor, built in photocell occupancy sensor and light controller; high frequency electronic ballast lighting, high efficiency chilled water system for air-conditioned, energy efficient office equipment, water harvesting system for watering the plants and photovoltaic cell to generate energy for the water wall in the atrium. The Ministry of Energy, Water and Telecommunication managed the energy consumption of LEO building closely by analyzing the energy consumption on monthly basis. In the year 2006 report done by the Ministry it was found that LEO building has the energy index of 110 compared to a typical building of the same floor area which is 275, a savings of RM0.6 million per year. LEO building is expected to achieve the payback of the construction cost in 8 years period with the savings made from less electricity consumption.



Conclusion

It is noted that the building sector has major impacts not only on economic and social life, but also on the natural and built environment. Various development activities, such as the design, construction, use, refurbishment and demolition of buildings, directly and indirectly affect the environmental performance of the sector. In order for a development to be considered sustainable, management and operations practices must be financially viable, detrimental environmental impacts must be minimized or eliminated and social issues and stakeholder engagement must be enhanced. The range of stakeholders groups involved in the planning, design, development, construction, ownership, financing, management and occupation of commercial development may be large but each one has to realize the role that has to be played taken to make it a sustainable development. At the design stage of the sustainable buildings, the incorporation of passive architecture is an important consideration which may enhance the future operations for energy efficiency and lowering operational costs.

The green features of commercial sustainable buildings portray benefits that could enhance the efficiency performance as well as reduce operating costs. Some literatures have proven that the sustainable commercial building do reduce operations cost. Cost savings in the operational costs means less use of electrical energy resources. The use of passive architecture intends to promote the sustainable development towards the move to reduce costs especially energy costs. These features have been incorporated in a few buildings in Malaysia which include Menara Telekom, Security Commission Building and LEO Building. Thus, greater awareness is encouraged towards the development of sustainable buildings in Malaysia.

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