Correlation of The Planning Process with Environmental Responsive and Healthy Buildings

Case studies in Sweden and Malaysia.

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ABSTRACT

Building is a place for living and working where people in Nordic countries spend almost 90% of their time indoor. Construction and operation of a modernised building may induce direct and indirect environmental impacts, which were discussed comprehensively in this thesis. Sick building syndromes that may cause health risks to occupants is now a highlighted issue. Factors that may influence the quality of indoor environment were identified and encompassed as literature background to provide a perception regarding sick building syndromes. Absenteeism, loss of productivity, liability claims, etc, are factors that stimulate the consciousness among building stakeholders about the importance of building a healthy edifice. A causal-loop diagram that represented the correlation of these factors was illustrated and followed by a brief interpretation regarding the logical flow of the diagram.

Building processes and associated activities that engaged at particular stages were summarised and illustrated in a figure to give a general overview regarding the building phases involved in a building project. With reference to the undertaken studies, accumulated experiences in building industry recognised that incorporating ecology and health concerns at earlier stage, which is the planning stage, is more technologically and cost effective in creating a healthy and environmental responsive building. Planning process with such considerations, namely the proactive strategy, was elaborated comprehensively with identifying the considerable environment and health aspects. Collaboration between involved stakeholders is another prevalent factor to make this proactive strategy a success. Therefore, responsibility of particular stakeholders that required for implementing this proactive strategy was defined subsequently.

Cases in Sweden were investigated to verify the identified aspects associated with environment and health concerns in the planning phase. These aspects were analysed from the perspective of their potential adverse effects on the environment and human health. Cases in Malaysia were also investigated to facilitate the subsequent comparison study. The result of comparison study were presented and analysed accordingly. With reference to the analysis, this proactive strategy was concluded as a necessity in creating a healthy and environmental responsive building in both Sweden and Malaysia respectively though the extent of implementation was distinguishable from the comparison study.
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NOTATIONS

- **AS**: Australian Standard
- **ASHRAE**: The American Society of Heating, Refrigerating, and Air-conditioning Engineers
- **BBR-94**: Boverket’s Building Regulations –1994
- **BFR**: Byggforskningrsrådet (Swedish Council for Building Research)
- **BS**: British Standards
- **CFO**: Certificate of Fitness for Occupation
<table>
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<th>Abbreviation</th>
<th>Full Form</th>
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<tr>
<td>CIBSE</td>
<td>The Chartered Institution of Building Services Engineers</td>
</tr>
<tr>
<td>CO₂</td>
<td>Carbon Dioxide</td>
</tr>
<tr>
<td>DOE</td>
<td>Department of Environment</td>
</tr>
<tr>
<td>DOSH</td>
<td>Department of Occupational Safety and Health</td>
</tr>
<tr>
<td>EIA</td>
<td>Environmental Impact Assessment</td>
</tr>
<tr>
<td>EMCP</td>
<td>Environmental Management and Compliance Plan</td>
</tr>
<tr>
<td>HF-ballast</td>
<td>High Frequency ballast</td>
</tr>
<tr>
<td>HVAC</td>
<td>Heat, Ventilation and Air-Conditioning</td>
</tr>
<tr>
<td>IT</td>
<td>Information Technology</td>
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<tr>
<td>JAS</td>
<td>Jabatan Alam Sekitar (Department of Environment, Malaysia)</td>
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<td>JBA</td>
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<td>JKR</td>
<td>Jabatan Kerja Raya Malaysia (Public Works Department, Malaysia)</td>
</tr>
<tr>
<td>JPBD</td>
<td>Jabatan Perancangan Bandar &amp; Desa (Town &amp; Country Planning Malaysia)</td>
</tr>
<tr>
<td>JPP</td>
<td>Jabaran Penilain dan Perkhidmatan Harta (The Valuation and Services Department, Malaysia)</td>
</tr>
<tr>
<td>JPS</td>
<td>Jabatan Pengairan dan Saliran (Department Irrigation &amp; Drainage, Malaysia)</td>
</tr>
<tr>
<td>kWh/m²</td>
<td>kilo-watt-hours per square meter</td>
</tr>
<tr>
<td>NOₓ</td>
<td>Nitrogen Oxides</td>
</tr>
<tr>
<td>PBL</td>
<td>Planning and Building Act (Sweden)</td>
</tr>
<tr>
<td>TNB</td>
<td>Tenaga National (M) Berhad (Electric Power Utility of Malaysia)</td>
</tr>
<tr>
<td>UFFI</td>
<td>Urea-Formaldehyde Foam Insulation</td>
</tr>
<tr>
<td>USGBC</td>
<td>U.S. Green Building Council</td>
</tr>
<tr>
<td>VOC</td>
<td>Volatile Organic Compounds</td>
</tr>
</tbody>
</table>
1.0 INTRODUCTION

1.1 Problem Definition

Building is a place to provide shelter for living and working. It makes life easier for human beings today but its construction and operation impose impact on environment. As tabulated in Table 1, building is contributing to such impacts as deforestation, air and water pollution, and risk of global warming and stratospheric ozone depletion. With reference to (Roodman & Lenssen, 1995), studies in USA indicated that more than 30% of new and renovated buildings suffer from sick building syndromes, which is threatening the occupant health. In view of this unfavourable circumstance, building industry has tried to mitigate the problems cost-effectively in order to eliminate the environmental impacts induced by buildings while preserving the comfort and amenities that occupant expected from them. One of the methods implemented now is by incorporating the ecology and health concerns into the planning process of a building project. This is because once a building is completed, it will be more difficult and less economically to reduce its energy and water use and improve its air quality than it is to design from scratch for efficiency and health. In short, precaution/pro-action is always better than cure/reaction. This method will be denoted as proactive strategy in this thesis.

Table 1: Summary of Environmental Impacts Emanate from Buildings (Roodman & Lenssen, 1995)

<table>
<thead>
<tr>
<th>Problem</th>
<th>Buildings’ Share of Problem</th>
<th>Effects/Impacts</th>
</tr>
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<tbody>
<tr>
<td>Use of Virgin Minerals</td>
<td>40% of raw stone, gravel, and sand; comparable share of other processed materials such as steel</td>
<td>Landscape destruction, toxic runoff from mines and tailings, deforestation, air and water pollution from processing.</td>
</tr>
<tr>
<td>Use of Virgin Wood</td>
<td>25% for construction</td>
<td>Deforestation, flooding, siltation, biological and cultural diversity losses.</td>
</tr>
<tr>
<td>Use of Energy Resources</td>
<td>40% of total energy use</td>
<td>Local air pollution, acid rain, damming of rivers, nuclear waste, risk of global warming.</td>
</tr>
<tr>
<td>Use of Water</td>
<td>16% of total water withdrawals</td>
<td>Water pollution; competes with agriculture and ecosystems for water</td>
</tr>
<tr>
<td>Production of waste</td>
<td>comparable in industrial countries to municipal solid waste generation</td>
<td>Landfill problems, such as leaching of heavy metals and water pollution</td>
</tr>
<tr>
<td>Unhealthy indoor air</td>
<td>Poor air quality in 30% of new and renovated buildings</td>
<td>Higher incidence of sickness-lost productivity in tens billions annually.</td>
</tr>
</tbody>
</table>

(Source: World Watch Institute, 1995)

Multidisciplinary groups of profession will involve in various activities at different stages of a building project. Obviously, every participating single party plays corresponding role in creating a sustainable building that is sound to the environment and occupants. Partnering through close collaboration and co-ordination between actors, such as national governments, local authorities, property owners, project managers, contractors, users, and architects/designers, is one of the important means to achieve this goal. Knowledge acquisition through continual researches is essential to develop the latest and best available technologies that may mitigate the aroused
problems at source rather than those conventional end-pipe solutions. Trans-boundaries knowledge transfer, in terms of technologies and management skills, is prevalent to prevent developing countries that are under rapid construction boom from repeating the problems as identified in Table 1.

1.2 Objective

The main objective is to investigate the contribution of planning process as a proactive strategy in managing the environment and health concerns of a building project in order to create a good indoor environment for improving occupant comfort and productivity while reducing impact to the external environment.

1.3 Scope of works

Identification of environmental and health factors that may induce adverse effects to the environment and human health was firstly undertaken. Investigation of the adverse effects from unhealthy building was therefore essential in assisting to identify the potential factors. In view of the formulated objective, reasons for demonstrating the importance of integrating ecology and health concerns into planning process were analysed based on those identified environment and health factors. Building industry in Sweden has been developed with good reputation in high environmental awareness. Therefore, one of the building projects in Sweden was selected as case study. Practices undertaken in the case study for concerning relevant environmental aspects associated with particular building phase during the planning process were analysed with reference to the general rule of thumb. The current trend of practising the procedures as specified in case study in Sweden was compared with that in Malaysia. Proposal to improve the contribution of building industry in both countries for attaining the goal of building sustainable edifices was given.

1.4 Methodology

The thesis work was started with relevant literature review for collecting necessary information and data. Related codes and regulations, such as Boverket’s Building Regulations, Planning and Building Act in Sweden, Uniform Buildings By-Laws 1984 (Malaysia), Occupational Safety and Health Act and Regulations (Malaysia) were reviewed. Several interviews with representative personnel of building sector in Sweden were conducted for collecting some specific information. Electronic communications were undertaken to gather relevant information from building sector in Malaysia. Information gathered from representative personnel of building industry in Malaysia was then summarised. Collected information and data was rearranged and analysed sequentially.

1.5 Limitations

Most of the information gathered from building sector in Sweden is written in Swedish, which provoked the difficulty of interpretation. This might result in inaccuracy of terminology used. Since there is no apparently identical building projects exists in the world, comparison between building projects in Sweden and Malaysia was merely focusing on the general environmental
practices that undertaken in planning process. Limited accessibility to certain database resulted in slow progress while gathering information. Data with regards to the projection of cost-benefit analysis, which potentially a useful tool for convincing stakeholders to consider environmental practices during planning process is currently not available. Case studies in both Sweden and Malaysia were respectively used as references but not specifically defined for the entire process of thesis writing owing to confidentiality.

2.0 LITERATURE REVIEW

2.1 Impacts of Modern Buildings on Human and the Environment

The provision and use of modern buildings induce a number of environmental impacts to both human health and environmental safety. Environmental impact emanates from sources such as energy used during building construction; energy used for heating, cooling and lighting; and the chemicals present in materials used in building services and components. Parts of these impacts have been identified for years, and were summarised and tabulated in Table 1. Studies are currently undertaken in order to reduce these impacts. For example, particular measures to maximise energy efficiency; further researches on recyclable and less emission building materials, implementation of integrated life cycle design process (Sarja, 1997); tools set-up for environmentally adapted planning, design, construction and management (Tolstoy, 1997); and etc.

2.2 Requirements for Sustainable Buildings

![Figure 1: Requirements for Sustainable Buildings (Sarja, 1997)](https://example.com/figure1)

With reference to (Sarja, 1997), sustainable building can be defined as building technology and practice that meet the multiple requirements of people and the society for the entire life cycle of building. Figure 1 is a self-explanatory model that summarising the multiple requirements for a sustainable building (Sarja, 1997). Aspects involved to achieve sustainability in buildings consist of considerations on ecology, health, economy, functionality, performance, durability and
aesthetics. Moreover, life cycle principle is also a necessity to be implemented for accomplishing
the goal of a sustainable building. In other words, application of life cycle methodology is
encouraged throughout the whole building process that start from planning to demolition. Human
health and ecology are the main considerations to be discussed in the latter sections of this thesis.

2.3 Integration of Ecology and Health concerns into Building Project

Integrating ecology and health concerns into a building project is essential for achieving the goal of
sustainable buildings. Both economical and environmental benefits are the contemporary reasons
for building a sustainable edifice. Building value of a building with improved aesthetics, comfort
and performance will be higher, which may subsequently result in higher initial sales prices and
rents, and lower operating cost as well. Efficiency of both resource and energy used is respectively
the most significant achievement for a well planned, designed, constructed, and maintained
building. According to (Barnett & Browning, 1999) that 50% of reduction in energy use is easy to
be achieved with using energy efficient appliances while 80-90 % of reduction is only feasible with
a good building design. From the environmental perspective, energy conservation is important
because reduction of 80% of the average energy used by housing activities may apparently reduce
its CO₂ emissions by almost 90,000 pounds for a 30-year lifetime (Barnett & Browning, 1999).
However, in view of the economical perspective that operation and maintenance of a sustainable
building will be easier and consequently more costs effective as well. A positive correlation
between affordability of a house by user (or tenant) and the ease of operation was indicated
significantly. Thus, the reduced costs may make ownership possible for people who might be less
eligible for a mortgage.

Global tendency shows that people are now spending almost average 90% of their time indoors
(Boverket & BFR, D1:1994 ; Barnett & Browning, 1999). Cases of allergies and hypersensitivity
indicated an increment tendency in these recent years. These cases are highly susceptible correlated
to indoor pollutants. It is therefore favourable to relate health problems with ecological concerns of
a building for creating a healthy indoor environment. With reference to (Derek, 2000) that apparent
decrease of complaints from employees who were working in green building about work-related
illness, headaches and eyestrains were indicated. In contrast, 6%-15% increment of employee
productivity was evidenced from several recent studies regarding the environmentally responsive
buildings (Barnett & Browning, 1999; Derek, 2000). Therefore, incorporating ecology and health
aspects into the whole spectrum of building process may inevitably result in a cost effective and
environmental responsive building. Additionally, a thorough environmental planning strategy,
which is the main driver to accomplish this ambition, will be discussed comprehensively in sections
hereafter.

2.4 Factors of Good Indoor Environment

Issues of keeping a good indoor environment are globally getting more attention among public in
these years. In accordance to the knowledge and experience accumulated from years of researches,
there are many pollutants found in the indoor environment. These pollutants may consist of
formaldehyde, wood preservatives, other volatile organic compounds (VOC), living organisms (e.g.
bacteria, moulds, dust mites), particulates and fibres (e.g. artificial mineral fibres, asbestos), radon, combustion products (e.g. oxides of nitrogen), and lead (Prior (ed.), BREEAM, 1993). Influential factors of the quality of indoor environment may comprise all those aspects of a building design that may impose impacts on occupant health, comfort and safety, for instance, the quality of air, use of hazardous material, and etc. Description of these factors will be elaborated hereafter in the following paragraphs.


   It is necessary to minimise the threat of Legionnaires’ Disease that arose from domestic hot water systems of non-domestic buildings. Domestic water systems may be designed to minimise the threat of this disease by following the CIBSE (The Chartered Institution of Building Services Engineers) guidelines, i.e. TM13.

2. **Ventilation, passive smoking and humidity (IAQ)\(^1\)**

   Good ventilation is necessary for minimising the concentration of chemical substances in indoor air. Good ventilation in household may also help to remove moisture that will result in mould and bacterial growth. Therefore, ventilation functions as the primary line of defence of indoor air pollution. There is a controversy between building air-tightness and ventilation, which is obviously detectable between older and newer buildings. With respect to this controversy, heat exchanger or heat recovery ventilator may be an alternative to provide sufficient ventilation without conflicting with the energy conservation strategy. In addition, there are some basic rules applicable to the ventilation system used in a building. For example, air supply and exhaust outlet must respectively be attributed to each combustion appliance that used indoor, air intakes should be located carefully to prevent extracting exhaust air from own building, other buildings or passing automobiles. Insulation or other fibrous materials are guarded from entering the duct system in order to avoid those materials from being combined with indoor air. Regular cleaning and maintenance is required for ventilation system in order to prevent the dirt and other substances such as pollen, mites, spores, etc., from building up and clogging the duct system and filters. Clogged filters and duct system may result in decrease of air flow rate and increase of indoor pollutants. Therefore, the performance of each ventilation system must be regularly checked as prescribed in “Functional inspection of ventilation system” (Boverket & BFR, D1: 1994). Meanwhile, air flow and leakage measurements should be undertaken as prescribed in publication which namely “Methods for measurement of air flows in ventilation systems” (Boverket & BFR, D1: 1994).

3. **Hazardous materials**

   Well-known hazardous materials that are generally recognised for the prevention of occupants health hazard comprise the formaldehyde emissions, asbestos, lead in paint, and wood preservatives. Besides, Volatile Organic Compounds (VOC) that emitted from building materials is now also recognised as source of unhealthy indoor air. Floorings, vinyl floorings, floor topping compounds, linoleum floorings, acrylic paint (outdoor paint which has been applied indoor), odorous building sealant, moisture repellent for walls, mineral wool, damp-proof membrane, and etc. are potential emission sources (Gustafsson, SP Rapport 1994:64). Rational recommendations were given by (Gustafsson, SP Rapport 1994:64) in terms of material selection, substitution and handling in order to reduce the

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\(^1\) IAQ denoted as Indoor Air Quality. The influential factors of IAQ consist of human activities, moisture and building techniques, building materials and emission, ventilation, and building design (Boverket & BFR, D1: 1994).
probability of indoor VOC emissions. Testing and investigations are undertaken continuously by various institutions to identify more building materials with fewer VOC emissions (Johnsson & Gestaffson, SP Rapport 1994:64).

Formaldehyde exists ubiquitously in buildings. It is released from building materials such as chipboards, adhesives and urea-formaldehyde foam insulation (UFFI). In accordance to Agency for Research on Cancer (IARC), formaldehyde has the possibility to cause cancer in human beings though the evidence available is yet sufficient to estimate the risk of cancer. It is therefore important to limit the concentration of formaldehyde inhaled by the occupants. This can be achieved by estimating the emission rate of formaldehyde while simultaneously controlling the ventilation rate of supplied fresh air. Various criteria have been established to caution the usage of formaldehyde contained material either for the purpose of insulation or furnishing, for example, German E1 Standards, BS 8208:Part 1, BS 5618:1985, BS 5617:1985, and etc.

Asbestos is a proven human carcinogen. Exposure to high levels of airborne white asbestos fibres in work place may cause lung cancer (Prior (ed.), BREEM, 1993). Though the risk of lung cancer from the exposure to the very low levels of airborne fibres that normally found in building is considerably low, alternative non-asbestos-fibre should be considered as substitution for the environmental concerned buildings. Caution for choosing substitution materials is necessary for some durable fibres may also be harmful.

Lead is utilised in roofing, windows and paints. The European Directive on Marketing and Use of Dangerous Substances (EC 76/769):8th Amendment has been in effect to prohibit the use of lead paints in new buildings (Prior (ed.), BREEM, 1993).

Wood preservatives are necessary for keeping the long-term integrity of wooden components for buildings and other constructions. Various criteria and codes of practice, for example BS5589, BS5268:Part 5 (Prior (ed.), BREEM, 1993), have been established to give guidance on building components where preservative treatment is essential. Continuous researches and testing are undertaken to update the lists of permissible wood preservatives.

4. Radon (Boverket & BFR, D1:1994; Venolia, 1999)
Radon is gas form indoor pollutant, which is colourless and odourless. It is the by-product of decaying uranium in rocks and soil. It is believed that the combination effect of radon and other indoor air pollutant may significantly increase health hazards. The possible long-term health effect of radon exposure is lung cancer in non-smokers. However, short-term effects of radon exposure have not yet been identified.

The possible source of radon is ground/soil, building materials, and tap water. However, high indoor radon progeny contents may be resulted by radon from ground.

Methods to reduce radon from ground may consist of reducing the transportation of radon from ground, and increasing the air change rate. The protective measures against radon from ground for new buildings may comprise proper site selection, careful material selection and ventilation design. For existing buildings, the most common remedial measures range from applying sealant to foundation, interior masonry, open holes and cracks in the slab, and
may also applying a lower pressure level below the slab with sub-slab depressurisation system. In Sweden, radon testing has to be carried out before the development of a piece of new land.

5. Lighting
Lighting plays an important role to provide a good indoor environment for either office or residential buildings. Interested parameters are illuminance, glare, colour and veiling reflections. Current disputable issues are the effective and optimal use of daylighting, decrease use of artificial lighting in order to conserve energy consumption, and the provision of occupant comfort associated with respective illuminance at different working/living conditions. Use of fluorescent lights that equipped with high frequency ballast at working places has resulted in significant reduction of complaints about headaches and eyestrain (Prior (ed.), BREEAM, 1993; Derek, 2000). Relevant institutions such as CIBSE (The Chartered institution of building services engineering) and British Standard, have recommended the various range of comfortable illuminance for particular working conditions (Prior (ed.), BREEAM, 1993).

6. Thermal comfort and overheating
Thermal comfort is defined as the condition of mind which express satisfaction with the thermal environment (Prior (ed.), BREEAM, 1993). According to the general rule resulted from years of research, surroundings with optimal thermal comfort may provoke the best conditions for performance and well being. Contrary to thermal comfort, overheating is an issue to be avoided in the design of a building. With reference to (Prior (ed.), BREEAM, 1993), overheating can increase the number of sick building syndrome (SBS) type symptoms, such as headaches, lethargy, irritated eyes, itchy skin, and dissatisfaction with indoor air quality. Positive correlation between overheating and the number of accidents at work place has been indicated apparently in some research studies (Prior (ed.), BREEAM, 1993). Appropriate standards (Prior (ed.), BREEAM, 1993) have recommended specification that needed to achieve an optimal condition of thermal comfort while preventing the condition of overheating.

7. Indoor noise
Noise is source of distraction and annoyance in both office and residential buildings respectively. Comfortable noise climate should therefore be achieved. Outside traffic and building services are sources that will induce indoor noise. Proper design in sound insulation and noise reduction can be accomplished by referring to particular criteria/codes of practice that specifically formulated for this purpose. BS 8233:1987 is one of the criteria that can be referred by design team in making such calculation (Prior (ed.), BREEAM, 1993).

8. Personal control on the indoor environment
Individual control of microclimate at working place, such as adjusting level of temperature and luminance, is now a disputable issue in creating a good indoor environment. The common problem of a working place is the inhomogeneous individual demands for comfort level. When 80% of the individuals are satisfied with their work place, it will then be accepted as a good indoor environment. However, the remaining 20% are expected to endure the conditions which may adversely affect their work, comfort and health (Wyon, 2000). In view of this shortcoming, such parameters as acoustic environment associates with
auditory information, indoor air quality in relation to ventilation, heating and air conditioning, and lighting arrangement are therefore investigated to be individual controllable for creating a good indoor environment for every individual in the building. (Derek & Kaluarachchin, 2000)

3.0 PLANNING PROCESS, ENVIRONMENTAL WORKS & HEALTH CONCERNS

3.1 General Description of Building Process

The general building process consists of four main stages, i.e. specification stage, design stage, construction stage, and real-estate management stage. Different occupational groups or stakeholders are involved in the various stages, and the various sections of each stage. Figure 6 illustrated a schematic diagram that indicates the process flow of these stages and various activities engaged in respective stage as well. Meanwhile, some other important stages may exist between and within these four main stages, for example, tender/bid stage, liaison with local authorities stage, and the delivery stage (Boverket & BFR, D1:1994). Insufficient partnering between stakeholders at various sections of particular stage, and/or at various stages, is a conventional tragedy of a building project. This conventional shortcoming may induce conflicts between engaged groups, which may further lead to higher maintenance cost, dissatisfaction among users, less environmental adaptation activities, problem/unhealthy buildings, and etc. Initial stages of a building process play an important role in addition to the collaboration among relevant occupational groups. As indicated in Figure 6 that these initial stages can be categorised and summarised as planning process that comprises activities such as physical planning, design, and procurement and construction planning. With reference to Table 2, it is indicated that every process contributes a portion of responsibility to improve the environmental and health concerns in building projects. A more thorough discussion regarding aspects involved in activities that categorised in planning process would be given in the subsequent section, i.e. Section 3.2.

Table 2: Building processes in 2-D: Technical Interrelationships and Process Interrelationships
(Source : BFR, D20:1991)

<table>
<thead>
<tr>
<th>Processes</th>
<th>Physical planning</th>
<th>Ordering, procurement</th>
<th>Planning</th>
<th>Construction</th>
<th>Handing over</th>
<th>Management</th>
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3.2 The Role of Planning Process/Phase

Unhealthy buildings may be resulted from a variety of factors that occurred throughout the whole building process. All parties engaged in building process, from the fundamental to the ending stage, are responsible for the occurrence of these problematic causes. Beside of unhealthiness, these problematic factors may induce quality defects to the corresponding buildings as well. In accordance to a Swedish-language study of quality defects (Boverket & BFR, D1:1994), undetermined demands of clients/users which lead to additional work, improper design, faulty co-ordination, faulty preparation, incomplete planning, disruption in personal planning, and delays, contributed to the largest portion, i.e. 57%, of the total studied quality defects costs. All these factors can mainly be categorised into the planning process/phase of a building project. Figure 2 illustrated the share of responsibility of factors that will influence the quality defects costs.

Figure 2 : Share of Qualify Defects Costs for a particular building project
(Source: Boverket & BFR, D1: 1994)

With reference to (Boverket & BFR, D1: 1994) that indoor environment is one the elements of quality assurance in building process. Therefore, the vital role of planning process in achieving a good quality building implies the alike function for fulfilling the goal of sustainable building. As a rule of thumb, the building process nowadays is a single direction development, which means earlier stages give instructions, rules and regulations to enable subsequent stages in handling the corresponding technique. Certain processes that takes place simultaneously without systematic coordination at neither earlier stage nor along the whole process may increase the complication of a building project. The most significant example is the improper planned building services that caused by insufficient co-ordination between several respective contractors. High specialisation, short-sighted economic thinking and unrealistic time schedules for planning are the common shortcomings in building industry. These shortcomings resulted in less concerns are devoted to earlier stages which define many properties and qualities of a building. Alterations, compromises and interpretations are unavoidable throughout the entire building process. With regard to this, project without detail planning phase may therefore be deteriorated easily from its original idea. As illustrated in Figure 3 that the further the building process proceeds, the more costly to correct the identified deterioration and less opportunities for the respective corrections as well.
With reference to the particulars explained above, it is obviously that planning phase should be the precedence of building process in view of the potential benefits obtained from different perspectives.

3.3 **Collaboration Between Stakeholders**

Stakeholders engaged in a building project are generally categorised into a few groups, i.e. owner (or sometimes named as proprietor, builder, and client), project designer, local building committee (may be named as local authorities), contractors, material suppliers, property manager, and users (or named as customers). Owner, project designer and contractors are largely the main parties in a building project among these mentioned stakeholders. The roles of these parties were described briefly in the following paragraphs.

**Owner**

Owner is the party who initiate the building processes. The owner can be an individual, a company, an organisation or a government agency which constructs a building or has it constructed for its own purpose (Boverket & BFR, D4: 1994). The owner is responsible to formulate a functional specification for designated activities and occupant load before starting to design a building. Meanwhile, it is also the responsibility for the owner to formulate his/her own fundamental requirements in sense of building quality, indoor environment, cost savings, and etc. Time scheduling and cost planning, emphasis on long term perspective and entire life cycle of the premises, are also roles that monitored by the owner. It is also necessary for the owner to formulate policies, such as environmental and quality policies, respectively, to facilitate subsequent works for attaining a construction project that can meet personal and community's requirements while conforming to relevant building regulations. The owner may also demand the appointment of consultants and architects is based on their credibility, quality orientation and problem-solving ability, but not merely on costs. Consultants and the architects are parties who provide owner the professional assistance in establishing building specification, technical specification and architectural specification based on his/her desirable requirements. Inspector or work supervisor will be appointed by owner to carry out in-house functional inspection for ensuring if the desirable requirements have been fulfilled.
**Project Designer**

Project designer may sometimes be named as project leader or project manager. Close collaboration between project designer and the owner is prevalent especially in choosing consultants that can suit the desirable quality standard. With reference to the specification formulated by owner, project designer may for example establish quality plans for corresponding work on building; determine and design solution for the performance and characteristics of structures and installations of designated building when necessary; specify essential construction standard, material handling, and relevant activities that are basis for quality plan and subsequent construction plan; and etc. The established quality plans should also serve as a tool for transferring knowledge from project designer to contractors. The quality plans may therefore constitute a program that includes an inspection plan with such critical points as material handling and etc, and a personal review for transferring knowledge to other relevant stakeholders.

**Contractor**

Contractor may serve as pure constructor or a combination role as designer and constructor. This is mainly dependent on types of construction contract desired by the owner. General constructor normally employs a numerous number of subcontractors who are responsible for corresponding building services such as plumbing, mechanical and electrical system, and etc. Close interaction between material suppliers, sub-contractors, and main contractors is necessary to attain the requirements of owner.

The collaboration of stakeholders from multidisciplinary professions was illustrated extensively in Figure 4. Most stakeholders illustrated in Figure 4 will devote directly to activities categorized in the planning phase while those that illustrated with dotted lines may contribute themselves indirectly in certain relevant activities.

![Diagram](source: USGBC, 1996)

Figure 4: Multidisciplinary Stakeholders Team (Source: USGBC, 1996)
3.4 Why incorporating ecology and health concerns into planning process is important? - Causal-Loop explanation

The necessity of integrating environmental parameters and occupant health into planning process was comprehensively reflected in Figure 5. The main idea flow of the causal loop diagram was to symbolise the causes and effects of implementing the proactive strategy. The initial point of the diagram was the implementation of the mentioned strategy in a building project. The consequential effects of this strategy will be explained extensively in the following paragraphs. Briefly, the implementation of this strategy may result in less environmental impact, better indoor environment, less complaints of sick building syndrome, which will subsequently lead to a better reputation and improved economical impact to engaged stakeholders (e.g. building owner, project designer, and relevant contractors). After the main stakeholders, such as the owner, local authorities, project designer and contractors realised the effectiveness of this strategy, continual verification and rectification of the existing or newly established relevant guidelines would be carried out to stimulate the implementation. This would finally close the loop of this logical thinking.

The terminology used for some factors in the diagram will be described briefly in this paragraph. Partnering denoted as collaboration between stakeholders, mainly between owner, project designer, consultants, contractors, and users (if possible). A comprehensive discussion under this topic was given in Section 3.3. Sickness and absenteeism refer to problems imposed by unhealthy indoor environment on either residents or workers of the corresponding buildings. Liability claims here denoted as compensation claims paid by building owners, relevant contractors, and sometimes employers to employees, residents, or occupants that suffer from the unhealthy building. Alteration denoted as changes, corrections, and amendments that made during or after the construction process.
upon the requests of particular stakeholders, such as building owner, users, contractors of building services, and etc. Guidelines here referred to knowledge source, policy instrument, and references that can be used as guidance for decision making in sense of ecology and health concerns. Awareness among stakeholders denoted as realisation of relevant stakeholders about the seriousness of liability claims made by occupants, the effectiveness of collaboration to mitigate problem, and the necessity to be compliant with relevant guidelines.

Considering environmental parameters and occupant health at earlier stages is implied as a proactive “environment and health” strategy for a building project. Environmental impact such as inefficiency of energy consumption may be reduced with the implementation of this strategy. Meanwhile, the quality of indoor environment may be improved by concerning aspects that specified in Section 2.4. Increase of environmental impact will deteriorate indoor environment quality. For instance, selection of environmental sound and less emission building material will inevitably create less impact to both the environment and occupant health respectively. In short, quality of indoor as well as outdoor environment is positively correlated with a reinforcing effect. Environmental degradation and unsatisfactory indoor environment are the factors that stimulate the implementation of this proactive strategy.

As described in Section 2.4 that indoor environment is strongly correlated with occupant productivity. Problem building may result in high absenteeism due to sickness, which will subsequently lead to loss of productivity (Derek, 2000). Unhealthy living/working condition, sick building syndromes, high absenteeism, and loss of productivity are causes of increased insurance and liability claims (USGBC, 1996). These legal actions can be initiated by occupants against associated stakeholders in building industry, and further lead to initial economic impact. Economic impact may also be caused by the increment of total building costs that are mainly dependent on the cost of operation and maintenance, number of alterations made on buildings, and time delayed for the whole project. In accordance to (Ferry, Brandon & Ferry, 1999), operation and maintenance cost constitutes a large portion of the total building costs, which is highly dependable on building type and particular circumstances, but may approximately range from 20% to 50%. The more liability claims and complaints from occupants, the more alterations or corrections on relevant building are required. Improvement of indoor environment is expected after correction, which may consequently reduce liability claims in the future.

On the other hand, associated stakeholders will be aware of the seriousness of problem when liability claims are increased. Awareness will therefore encourage the formulation of respective guidelines that will be used as problem prevention tools. Compliance with the established guidelines is necessary in order to mitigate the problematic circumstances. Formulation and conformance of guidelines play a reinforcing effect on partnering and awareness among associated stakeholders. Awareness of stakeholders will lead to the necessity of partnering among themselves in order to avoid the occurrence of problematic circumstances such as sick building syndromes, liability claims, and etc. Continual rectification and verification of existing guidelines is expected to encourage the implementation of this proactive ecology and health strategy. Application of this strategy is not only expected to prevent the forthcoming environmental and health problems but also upgrade the reputation of relevant stakeholders such as the building owner, contractors, consultants, architects, and the project designers.
**Planning Process**
- Conception
- Specify activities that the building is to accommodate
- Develop building program (incl. defining intended functions to be performed in the premises, demanded indoor climate, and etc.)
- Set-up budget
- Establish project team
- establish project schedule
- review laws, codes & standards
- conduct research/investigation
- physical land-use planning

**Schematic Design**
- Sketch design outlines
- confirm design criteria
- check cost
- liaison with local authorities for planning permission

**Design Development**
- Refine schematic design with analysing requirements for building
- interpret requirements into technical performance specification of structures
- create alternative structural solutions
- preliminary optimisation of detailed design of the selected structural system
- detailed design with consideration of system technology, building physics and biology, and service life
- check cost

**Bid/Tender**
- detailed measurement of all elements in proposed building
- review of building materials used
- review of construction plan/schedule
- build project
- commission the systems
  - testing
  - Prepare operations & maintenance manuals
  - training

**Construction**
- sign contract
- review of construction plan/schedule
- build project
- commission the systems

**Real-Estate Management**
- re-commission the systems
- Occupancy
- perform maintenance
- conduct post-occupancy evaluation

**Figure 6: Schematic Diagram of Building Process**

**Legenda**
- Feedback from the latter process to improve or alter the previous process
4.0 CONTRIBUTION OF PLANNING PROCESS THAT INCORPORATED WITH ENVIRONMENTAL PRACTICES AND HEALTH CONCERNS.

4.1 Identification of Committed Aspects

With reference to Table 2, ecology and health concerns that should be incorporated into planning process were classified into two categories, i.e. concerns associated with building process and those associated with technical issues. Apparent considerations that should be noticed during planning process will be discussed in separate sub-topics hereafter.

Environmental profile is a preliminary document that can be used as fundamental reference for planning the project specific environmental program and subsequently the environmental plan which is detailed with a number of checklists. All environment and health related concerns are listed in the environmental profile comprehensively. However, it is still less reasonable to conform all items listed owing to some constraints, such as limited financial abilities of the owner/contractors, insufficient technologies, unrealistic time scheduling, favourable in short term benefit return, and etc. As a rule of thumb, the payback period of an environmental responsive building is relatively longer than the conventional ones. Therefore, environmental considerations and payback period are two controversial factors that may influence the relevant stakeholders in making a decision regarding new building project. Assessments from various perspectives have to be carried out to determine if environmental compatibility is more convincing than short payback period, or vice versa (Interviews).

4.2 Elements Associated with Building Process

4.2.1 Physical Land-Use Planning

Integrating environment and health concerns into physical planning, which is the initial stage, is important in assisting the subsequent stages for attaining the sustainable building ambition. As traditionally, site analysis and assessment have to be carried out. With the rapid IT development, it is encouraged to have analysis and computer simulation of the local climatic conditions, which can facilitate decision making on localisation and configuration of building and its building services. While performing site analysis, geographical latitude and microclimate factors (e.g. wind loads), topography and adjacent landforms, are substantial characteristic to be aware of for a healthy and environmental-sound building. These characteristics may affect building layout, including solar orientation and location of entrances and windows, building proportions, drainage strategies, and others factors that anticipate a green building. Beside of inspecting the ground adaptation in terms of soil texture and its load-bearing capacity, as conventionally, evaluation of site ecosystem for existence of wetlands and endangered species should also be carried out. This will enable the owner to develop and implement appropriate protective measures before and during construction activities. Instead of exploring a new land, the owner may consider to develop previously disturbed sites such as unused urban lots and commercial sites (USGBC, 1996). This is due to redevelopment will need relatively minimal disturbance of natural systems when comparing to new-development. Proper landscaping and utilisation of natural resources is an ideal concept to provide protection for occupants of building and native wildlife. Considering the adaptation of a building to existing
water sources is also a way to promote environmental consciousness. The reason is water sources and landforms can be used as winter heat sinks in cold climates, and temperature differentials for cooling air movement in hot climates (USGBC, 1996). Installation of greenhouse on rooftop is probable for building with good orientation to take advantage of solar conditions (Miljöprofil, NCC AB). Installation of greenhouse has been realised as a good idea in the community of multifamily buildings (BFR, D3: 1994). Beside of turning greenhouse allotments into food cellars, this idea has also increased communication opportunities among the involved community.

Watershed protection is another decisive factors while making sustainability compliance plan. Human activities at a building site may induce impacts to the watershed. Inevitably, such impacts as sediment from soil disturbance, polluted streams by fertilisers and oil leaks, flooding and erosion due to excessive runoff, and etc, will deteriorate the natural eco-system of the corresponding area. Excessive use of herbicides, pesticides, and fertilisers may probably cause further problem to future occupant who is allergic and hypersensitive to such substances. Thus, parties involved in planning process should include such awareness while preparing relevant documentation such as environmental profiles, programme, and plan, respectively.

4.2.2 Water supply and Drainage

In order to prevent water pollution, improve water efficiency and conservation, local governments have established corresponding regulations and criteria for reference and compliance perusal. These regulations and criteria are baseline requirements for building project to be compliant with for attaining its environmental goals. In spite of that, the requirements regarding environment and health concerns are only stated in a limited extent in such regulations (BBR –94). For example, the concerning issues for water supply is about the impermissible use of material, which is hazardous to environment and health, as parts of the water supply installations. Standard flow-rates at water outlets are another parameter stated in such regulations for water conservation purposes. The same circumstance is applicable and true for the requirements of drainage. Due to the limited guidance stated in regulations, some stakeholders, such as building owner, contractors and project leader, are more ambitious to improve their dedication in this area by preparing related documents to a higher extent during the planning process. The higher order in the environmental profile is finding the feasibility to install local wastewater and sewage treatment plant, which can function in a closed cycle. The local wastewater and sewage plant functions in diverting and reusing wastewater before it enters the centralised municipal’s wastewater treatment plant. The diverted graywater can then be reused for toilet flushing or irrigation. When it is applicable, diverted blackwater can be treated with on-site system, such as sand filters and aerobic tank treatment, composting toilet.

4.2.3 Solid Waste / Residual Products

During planning process, environmental opportunities that can be planned for handling solid waste may rank from pre-separation, composting of organic waste, use of existing structures and recycled building materials, opportunity of energy extraction from residual products, and finally to the implementation of a closed solid waste handling system. Pre-separation should be planned for handling residual products during both construction and utilisation phases respectively. During construction phase, pre-separation of all surplus building materials may facilitate material suppliers to collect for further re-use. Refuse storage rooms should be planned with sufficient space for pre-
separated residual products. Composting of organic waste may be considered on site during construction phase, and in patio building\(^2\) during utilisation phase. On the other hand, opportunity for using re-useable, recyclable, and recycled materials should be seek. Biogas-digestion plant is a place to extract energy in the form of heat and electricity, but with zero emission. If there is possibility to implement this method efficiently, a closed eco-cyclic waste handling system may be accomplished. Numerous case studies of Green Building Challenge '98 (BFR, G8: 1998) revealed that some buildings in Sweden have planned and implemented some of the above mentioned residual products handling methods with satisfactory extent, respectively.

4.2.4 Design and Construction

Building configuration, shape of the rooms and their locations in the building will influence air ventilation and circulation. Good layout may provide building with protection against noise, good lighting conditions, room acoustics, and etc. Sufficient and readily accessible spaces for building services and maintenance are also important aspects that needed for a building layout. All these demanding and explicit targets are necessary to be specified in the planning phase to facilitate the design work of architects and design engineers.

A dry and clean construction site is important for moisture protection for constructing a building with good structural safety. Pre-separating and consistent clearing residual materials are means to create a good moisture condition at construction site while facilitating material suppliers to collect those residual materials for further re-use. Prefabricating building products may be effective to minimise residual building material on site. Reduction of energy consumption for transportation and other means, such as construction machinery, may decrease the total energy consumption for the entire building’s life cycle. Formulating these strategies is necessary during the planning process so that they can be followed in the subsequent construction phase.

4.2.5 Delivery

Delivery is a transition section in between the construction and the management & administration phase, which is an important element throughout the building process. In many buildings, design features and installed building services, such as mechanical and electrical systems, plumbing, security, and etc., have normally not performed as expected. Building commissioning\(^3\) was developed in response to this problem in order to help to integrate and organise the design, construction, operations, and maintenance of a building’s systems. Commissioning involves examining and approving building systems to verify aspects of the building design, ensure that the building is constructed according to the contract documents, and verify that the building and its systems function as intended (USGBC, 1996). Commissioning normally will be conducted pre- and post- occupancy. Re-commissioning on an annual basis may also be considered since it is useful for ensuring the proper functioning and maintenance of building systems throughout their useful

\(^2\) Allotments provided for composting of food scraps and garden refuse respectively (BFR, G8: 1998).

\(^3\) Building commissioning is a process to ensure the building is constructed in accordance with the contract documents, and verify that the building and its systems function as intended (USGBC, 1996). This process is commonly performed when building systems are constructed or installed and preferably once again 12 months during post-occupancy. In accordance to building regulations in some countries, e.g. Malaysia, this process will be carried out before the delivery of a building to users is allowed.
lives. In fact, good commissioning process may start during the design phase with agreement on how the design criteria will be verified and documented during the post-construction and post-occupancy assessment (USGBC, 1996). It is therefore necessary to specify the following aspects in planning process so that they can be followed afterwards
1. Prepare and develop forms/documents for delivery and commissioning.
2. Prepare systematic building documentation with readily perceivable and instructive operating and maintenance instructions.

4.2.6 Building administration and management

The necessary planning for this process may include prior investigation for operating costs of different technical systems. The result of this investigation can then be used as reference for the subsequent premises management process. Cleaning and tidying methods without adverse effects on the environment and health can be prescribed in planning process to facilitate the following administration and management works. Methods of continual monitoring the indoor conditions and reactions of users may be proposed in the planning process so that installation of such systems will be considered when necessary.

4.2.7 Operation and Maintenance

Continual evaluation is necessary during the utilisation phase though environment and health requirements are formulated in prior. It is necessary to plan some methods for measurement and evaluation of indoor climate experience, such as comfort classification, acceptance limits, risks limits, influence on behaviour, etc. Meanwhile, it is also essential to investigate the special needs of sensitive group, such as allergic groups, asthmatics, disabled groups, etc. The result of the investigation may help the particular designers to design a more comfortable living/working place for fulfilling the demand of these special groups.

4.3 Elements Associated with Technical Issues

The function of the whole technical system and its subsystem will not be attained and maintained unless the choices and decisions made at various phases of the building process have been assessed. This circumstance is true and applicable to the building configuration, for instance. Therefore, knowledge of the relevant techniques and their application should be well distributed among the parties engaged in building process. These issues will be discussed briefly as below.

4.3.1 Material Selection

Material selection in a building project is closely related to resource efficiency and material-related health issues. In addition to code/regulation approvals; performance; aesthetics; costs; and availability, minimisation natural resource use and creation of a healthy, comfortable, non-hazardous space for building occupants are now the influential elements for attaining a sustainable building. Not only in the phases of construction and maintenance, building material may also be hazardous to the environment in the demolition phase as well. Some criteria may be established
during planning process as guidance for material selection. Optimal use of products rather than excessive procurement is a way for achieving the cost-effective resource conservation strategy. Use of reused material whenever it is applicable, for example, reuse of building components, equipment, and furnishings. Renewable material with sustainable management practices may be another alternative (USGBC, 1996). Prioritise the use of local materials so that energy consumption in transportation can be reduced. Durability is one of the determinants while selecting material. Therefore, materials with higher initial purchase cost may be considered since this higher initial cost can be offset by a lower maintenance cost in the subsequent administration phase. Moreover, priority should be given to the recyclable materials. Beside of requesting material specification from manufacturers, planning the schedule to review emission levels at the respective stages of installation, occupancy, maintenance and removal is necessary.

Material specification is a statement of material contents in respect of climatic stability and emission of chemical substances (Boverket & BFR, D4: 1994). Meanwhile, material with well-defined moisture criteria in different environments will be a requisite for attaining a healthy building. However, the combination effect of different substances emitted from various building materials is still an unknown. Request for documentation with combination effect of materials is therefore necessary to be listed as one of the requisite in the environmental plan. Continual survey on materials that could be hazardous from the environment and health perspective should be undertaken to update the material database. For some contractors and building owners, private-owned material database is available for evaluating and verifying the chemical characteristics of building materials. A phase-out list of certain hazardous substances was prepared as reference while selecting building materials (NCCs phase out list of hazardous substances, 1999). A satisfactory result has been achieved in a pilot project in Sweden that made use of eco-specified building materials. Users of this project were given an eco-specification in a special housing file that specified all constituent materials while moving in (BFR, G8: 1998). Thorough planning was one of the prerequisites of this case study.

4.3.2 Structures of Building

Environmental safe structures are the basis of a healthy building. Carefully choose materials with well-defined statement of contents and low emission for the building structures, fixtures and fittings. It is favourable to deploy foundation that can eliminate undesirable moisture migration, infiltration of radon and chemical pollutants from the ground. Consistent structural testing should be undertaken from the perspective of building physics (e.g. moisture dimensioning) and long-term durability (BFR, D20: 1991). Understandable instructions about the care and maintenance of structural materials/products is necessary to be requested from suppliers in order to justify the materials are appropriate to be exposed under the particular climate condition. All these strategies are essential to be defined in the planning process to facilitate the subsequent processes, such as procurement, design and construction.

4.3.3 Building Configuration

Formulating building configuration is a vital role for the subsequent design phase. This is because building configuration perform as a guidance for architects and relevant engineers to design the architectures, functions, structures, and building services that can meet the formulated functional
requirements. Configurations that should be focused on while formulating such requirements are indicated as below:

1. Optimal use of daylight and solar energy
2. Interactions between shape, light and colour.
3. The room proportions and volumes that will influence the indoor environment and room acoustics as well
4. The mass and hygroscopic properties of the building envelope, which are important for indoor environment
5. Measures used to prevent noise disturbance from traffic, neighbours and building services.
6. Utilisation of structures and materials that are health and environmental responsive.

4.3.4 Indoor Environment

Despite the true extent of health problems induced by indoor environment is still an uncertainty, the general sources may arise from site selection, construction materials, equipment installed, building contents, human activities, light, noise, furnishings, and HVAC systems. The requirements of indoor air quality, ventilation, light, thermal environment, moisture and acoustics control, and building services (in terms of construction materials used, air tightness, air velocity, and humidification), were stated in Swedish Building Regulation (BBR -94) and PBL (Boverket, PBL 1993). These criteria may serve as fundamental references while planning to build a healthy building. Several entities have carried out considerable efforts to improve the existing knowledge in this area, such as the Swedish National Board of Housing, Building and Planning; Swedish Council for Building Research; Occupational Safety & Health Administration in Sweden, and etc. Some construction and real-estate companies have also contributed in acquiring new knowledge and experiences for promoting the quality of indoor environment. Proper ventilation control is needed to prevent parts of the ventilation system from becoming sources of biological contamination, which is one of the sources of indoor air contamination. It is therefore necessary to formulate strategies for ventilation control during planning process. For example, prioritise the maintainability and cleanability of the HVAC system, plan to implement a building-commissioning program that is useful for ensuring the installed ventilation system can provide good indoor air with high energy efficiency, and etc.

Thermal discomfort in a working place may result in rheumatic troubles, which might further lead to clumsiness and thus increasing the risk of accidents (BFR, D3: 1991). Distraction, headaches and fatigue are also effects that will result in absenteeism subsequently. In view of this, thermal comfort is one of the aspects to be included in the planning phase since it is one of the decisive parameters for attaining a healthy building. As described in Section 2.4 that although relevant criteria have been established by respective entities, such as ASHRAE, Swedish National Board of Health and Welfare, and etc., it is impossible to meet the demand of every individual in a building such as an office building. Various heating and cooling system have been developed and being improved to meet the intended requirements of occupants. Possibility to install a system with individual control ability may be considered in the planning process. Additionally, system with occupancy sensing facility may be another methods to provide intended comfort to occupant while conserving energy consumption, which is beneficial to the owners or real-estate companies.

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4 HVAC denoted as heat, ventilation and air-conditioning system
In view of parameters specified in Section 2.4, improvement from a holistic perspective will be the best practice for achieving a good indoor environment. Installation of control and alarm system for continual monitoring of emissions and electromagnetic radiation in a building might be necessary in the near future. All these measures can only be applied to reach optimal performance after going through a thorough planning process prior to designing.

4.3.5 HVAC Systems

HVAC system is often identified as the problem source that deteriorates the occupant health and comfort (USGBC, 1996; BFR, D4: 1994). Approximately 40%-60% of the overall energy consumption in a building is attributed to this system. In view of these circumstances, designing a HVAC system that can meet occupant needs through the most efficient and environmentally friendly methods at the lowest initial and life-cycle cost has been a prevailing issue. The performance of heating is strongly correlated with the building systems and characteristics, such as solar accessibility, building envelope, lighting and other heating loads. An integrated approach that will review all these interrelated factors is a requisite. Proper planning is needed because decisions made in this phase will result in a reduction of energy consumption and simultaneously lower the HVAC systems costs. In the planning phase, development of a computer simulation model that illustrates the projected energy use and sources is feasible. This simulation model can be used as baseline study for comparison of system options (USGBC, 1996). Meanwhile, it will be useful to analyse the model with various approaches for evaluating the impact caused by other possible parametric changes. Interested parameters may range from building envelope, passive solar availability, glazing selection, building locations and etc. Systems and components for ease of maintenance should also be considered. The interaction between daylighting and artificial lighting is another factor to be considered since benefit resulted from HVAC and lighting energy savings have been indicated substantially. The use of architectural elements such as blinds, shades, and louvers should be considered to reduce undesirable direct solar radiation. Feasibility to improve control systems and sensors should be considered so that building systems can be operated in accordance with the occupancy pattern. Preference of a flexible controllable HVAC system is now a disputable topic regarding the correlation of indoor environment and productivity (Derek ed.), 2000). Accurate and realistic pricing should be developed in the planning phase by reviewing all possible up-front and annual operating costs respectively. In addition to conventional heating source, i.e. district heating, alternate and local heating sources should be considered. As mentioned in the previous paragraph that it will be feasible to look for the opportunity of utilisation of biogas plant. Biogas plant is a closed system that can use organic waste from activities to produce energy for heating, hot water and sometimes electricity. A successful example has been shown in a school situated in Östersund, Sweden (Mitthögskolan) (BFR, G8: 1998).

4.3.6 Energy Use

Approximately 40% of total energy consumption in Sweden is attributed to the built environment, which therefore resulted in the focus of nation energy policies has been put on this area since the middle of 1970s (BFR, G8: 1998). The energy conservation standards introduced thereafter and the Swedish Building Regulations (BBR 94) were previously focusing on improving the efficient use of

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5 Selection of glass windows or walls with considering appropriate R value. R value is a measure of the resistance to heat flow across a wall or window assembly (with higher values representing a lower energy loss) (USGBC, 1996).
thermal energy (i.e. for building heating), while less attention on efficient electricity consumption. However, the holistic energy conservation approach should be relatively more effective since energy use in Sweden is attributed respectively to heating, hot water supply, and electricity. Comparative energy use per year was indicated significantly between Swedish office buildings that built before and after 1980. The total specific energy use per year for office buildings that built before 1980 was 240 kWh/m² (electricity used 125 kWh/m² and heating used 115 kWh/m²), while for those that built thereafter was 140 kWh/m² (electricity used 95 kWh/m² and heating used 45 kWh/m²) (BFR, T10:1997). In view of this, improving the efficiency of energy use and implementation of more renewable energy forms are therefore necessary.

Energy conservation in building is not just a benefit for the environment but also for various parties such as building owner, users, energy supplier, and the community. A building with higher energy conservation may benefit the owners when the tenants were satisfied, the operation costs were low, simpler maintenance was needed, which would further lead to the reduction of overall costs. The users/tenants would be satisfied with better indoor environment (better HVAC, air quality, and lighting), decrease of sickness and absenteeism, and consequently reduction of rent and energy bills.

Several efforts have been developed for improving the efficiency of energy use. Generally, potential applications in domestic or office buildings that can be improved the energy efficiency comprise the HVAC installations, lighting, other electrical appliances, windows and other parts of the building envelope, and the control systems and strategies. A case study in Sweden demonstrated a significant drop of total energy use and power demand of an office building after applying an energy retrofit program (BFR, T10: 1997). In this retrofit program, energy efficient measures that have been undertaken were: improving the control systems to a higher occupancy sensing ability, improving lighting performance with using energy efficient appliances, use of high R value double-pane windows, and etc. This implies that a better achievement from economical perspective may be obtained if such considerations were planned during planning process for eliminating the high retrofit costs.

Substitution of the other forms of renewable energy, such as solar and wind power may be considered during the planning phase. Incorporating the features of passive solar heating, cooling, and thermal storage into building design may reduce energy loads for corresponding building services while increasing occupant comfort. Active solar systems may become another alternative which can provide energy for domestic water heating, ventilation air preheat as well as space heating. Prior planning is necessary for determining which alternative is more financially feasible.

Electricity use in both residential and office buildings respectively shows an increasing tendency in Sweden (BFR, T10: 1997) though the total energy use indicates a decreasing trend (BFR, G8: 1998). This circumstance implies previous measures for efficient energy improvement were merely focusing on reducing energy dependency on oil. Various efforts that implemented for reducing heat demand, such as installation of heat pumps and heat recovery systems, have resulted in significant increment of electricity consumption. Moreover, utilisation of electric powered appliances, either household appliances or office equipment, has dramatically increased nowadays. It is therefore necessary to seek opportunity for having green electricity supply in addition to choosing energy efficient electric appliances. Photovoltaics (PV) and wind power technologies are alternatives that probably can be implemented into the electricity supplied network. Thorough consideration is therefore necessary while planning a building project for investigating the feasibility of practising such alternatives.
4.4 Case Study in Sweden (Akademiska Hus, Miljöprogram, 2000)

Ecology and health concerns have been integrated into planning process of some building projects in Sweden. A building project that with holistic and detailed planning for environmental works throughout the building’s life cycle was chosen as case study for this thesis. In order to demonstrate the commitment to environmental works, the owner of this project has contributed some efforts in preparing relevant documentation that will be discussed hereafter.

General environmental prerequisites have firstly been formulated based on the company owned environmental goals and policies while referring to the environmental demands of municipality and future users. Three fundamental principles were used as baseline guidance for the environmental control works throughout the planning process, i.e. prioritisation, precautionary principle, and the substitution principle. Adaptation of environmental works to these principles is essential as designated in the Miljöanpassad Projektering (Arkitekt & Ingenjörskorpsetagen, 1997) while its positive effects were also discussed extensively in Section 3.2. Prioritisation will be focused on the following five steps, which started from resource conservation, sequentially followed by re-use as a whole entity, material recovery, energy extraction through incineration, and special treatment on hazardous waste. With reference to the Miljöanpassad Projektering (Arkitekt & Ingenjörskorpsetagen, 1997), utilisation of materials which contents and chemical characteristics are unknown should be avoided in order to be compliant with the precautionary principle. In accordance to the substitution principle, building materials or products that are suspected to emit higher emission or chemical substances should be substituted with other functional equivalent materials/products.

The company owned environmental policies and general environmental goals served as guidance for formulating project specific environmental program. Project specific environmental factors and conceivable requirements could only be identified after prior investigation associated with issues such as energy supply and demand, daily water supply, etc. External consultation was important since those professional opinions were useful in identifying environmental and health factors. Project specific goals that were determined and documented in the environmental program of this case study were mainly focusing on such items as energy, emission, field, and residual products. Consistent verification and rectification of these goals with reference to the best and latest available technologies, relevant codes and regulations were necessary throughout the planning process.

Control of material and product selection, such as plastic utilisation, was one of the most impressive environmental goals established in this case study. This goal indicated that ecology and health concerns have now been integrated and incorporated explicitly in the planning process. Provision of environmental value declarations for all building materials and products to future users was one of the ambitions determined by the owner. The other goals gave a general overview regarding the concerns of owner on the fragile environment and the health of future users. Careful scheduling for the delivery plan of building materials was also an intended goal, which could influence the energy consumption for transportation in construction phase and reduce excessive protection applied for moisture sensitive materials/products. The requirement of natural daylights implied that the owner has realised the benefits arise from the integrated building design approach, which involves multidisciplinary expertise from phases of programming to commissioning, respectively. As discussed in Section 3.2, substantial reduction of energy use and increase of occupant comfort might be the stimulation of this consciousness. As for regular building projects, energy consumption was also the main consideration of this case study. Therefore, declaration regarding
the rate of energy used during both the construction and utilisation phases was determined as one of the environmental goals.

Detailed environmental plan could be established based on the environmental program, which gave an overview of all applicable and relevant environmental aspects. The environmental plan would be formulated for specific building processes, from programming, sequentially followed by system handling, construction, contract/bid, and administration (operation and maintenance). However, there was no specific environmental plan established for the demolition phase. This might be due to the elaboration of aspects associated with demolition phase was correlated implicitly with activities of other building phases. The respective environmental requirements of both local municipality and users would be reviewed and counter-checked based on the established environmental goals to prevent the occurrence of conflicts of requirements/ideas. The environmental plan included a time schedule with items that related to those in construction planning. With this time schedule, project leader may contribute in closely monitoring the environmental works associated with activities of particular building phase. Meanwhile, contribution from other relevant parties at different building stage could also be estimated accordingly with using this time schedule. Thus, the environmental goals could be achieved by following the formulated environmental plans orderly.

Commitments that should be contributed in particular building phase in order to reduce environmental impact and health hazard were elaborated thoroughly in environmental plan. As mentioned previously, feasibility in reducing energy and water consumption, and using local solar or windpower plants was also specified in environmental plan. Realisation of good building configuration, such as appropriate orientation, good building envelope, proper design of physical layout, good thermal insulation and air-tightness were the influential factors of energy conservation strategy, was also demonstrated in the environmental plan of this case study.

Prohibition of PVC contained plastic floorings was clearly stated. Meanwhile, restrictions that to be followed while selecting floorings, paints, wallpapers, adhesives, and etc, were proposed. This implied the real ambition of the owner and other related parties in constructing a healthy building. The importance of users participation in decision making uran the selection of indoor furnishings was realised and stated in the environmental plan. This is true with reference to Figure 3 that post occupancy’s alterations are definitely more costly.

Inductance of the electromagnetic field should be considered while determining the appropriate locations for installing electric facilities. Proper installation to provide electric safety in future usage was also one of the stated commitments of the owner. Collaboration between owner and users was emphasised for the installation of electric equipment in order to meet the diverse demands of different users. Reputation of the owner and relevant stakeholders, such as the designers, architects and contractors could be promoted by the increment of comfort level and satisfaction among stakeholders. This circumstance was true and applicable to the lighting system in the building. Though installation of fluorescent lights was recommended owing to the efficiency of energy consumption, high frequency ballast was needed to regulate the modulating light that may cause complaints of headache.

Despite the energy efficient ventilation system was discussed extensively in Section 3.2, proper maintenance and regular cleaning was more on emphasis in this case study. This is because proper installation, cleaning and maintenance of ventilation system are important to prevent dirt such as
dust from circulating back into the building. As described in Chapter 2 that high concentration of
dust, chemical substances, and emission is one of the potential sources of sick building syndrome.

Careful arrangement of delivery schedule for building materials and products during construction
phase was emphasised in the environmental plan. Just in time delivery was favourable in order to
reduce excessive storage space and care for moisture protection. Protection against moisture is
important to prevent the quality of product/material from deteriorated and ensure it is sufficiently
good for the occupant health after installation. Prioritised local available building material/product
if its environmental adaptation characteristic is equivalently sound as others. This might avoid
excessive transportation, which is one of the vital energy consumption in the construction phase.

As stated in the environmental plan of this case study, it was the responsibility of project leader to
establish a waste management plan for both construction and administration phases, respectively.
The most effective waste handling method is minimising the quantity of waste at source. It was
therefore the responsibility of project leader and relevant professionals to find the latest available
technology for fulfilling this stated intention. Anyhow, waste generation is unavoidable from
activities occurred throughout the building process as well as from daily lives. It is therefore
necessary to handle generated waste in a proper way to reduce its impact on environment and
human health. Pre-separation or pre-sorting of waste at construction site was suggested for this
would facilitate the collection work of reusable material/product that would be carried out by
relevant material suppliers. The five basic sorting categories suggested in this case study were
combustible material such as wood; metal; mass with mineral contents; corrugated cardboard and
paperboard, and hazardous waste and waste that will induce environmental impact. The additional
waste classification was encouraged when necessary while an ordinance for handling hazardous
waste was proposed to project leaders and relevant parties as reference. Closed cycle waste
treatment which heat can be acquired from was not emphasised in this case study though sorting
combustible materials may imply the utilisation of this technology. Ignorance of planning the
handling of waste for demolition phase implicated a minor flaw of this environmental plan.

Prior planning of operation, management and maintenance work from the earliest stage was
proposed. Installation of building system and facility that is simple to be installed, operated and
maintained was also proposed in this environmental plan. Meanwhile, consideration of keeping the
energy used for installing, operating and maintaining particular building system to minimal was also
specified in this case study. This is important because approximately 85% of total energy used
throughout the building life cycle is attributed to the operation and maintenance phase where energy
is used mostly for operating and maintaining particular building services/systems. Project leader
was proposed to prepare a routine checklist for particular maintenance works. It is consequently the
commitment of project leader to carry out a routine inspection with reference to the prepared
checklist.

4.4.1 Subsequent Procedures After Environmental Plan (Akademiska Hus, Miljöprogram,
2000)

Formulated environmental goals could only be accomplished with consistent follow-ups associated
with those activities suggested in environmental plan. External experts from multidisciplinary areas
would be necessary to provide professional consultation through common meetings with related
stakeholders, such as the owner, users, project leader and contractors. Environmental consequence reports or sometimes namely the environmental impact assessment reports would be prepared after carrying out some particular investigations. These reports are useful references for preparing general environmental checklists that would cover all subsequent stages in order to report the status of particular building stage. Checklists that have been verified and adjusted to suit with the activities of every phase of the building process would then be prepared. These final checklists were useful for project leaders to closely monitor those environmental works associated with particular building processes in order to achieve the environmental requirements formulated by the owner, users, and the local municipality. Consistent inspection and revision of checklists with the assistance of internal and external consultants in order to update the relevant stakeholders regarding the respective environmental contributions was also another specified responsibility for the project leader.

Generally, the awareness of integrating ecology and health concerns into planning process has been indicated in this case study. The environmental plan demonstrated the concerns and commitments of participated stakeholders to the issue regarding the future occupant comfort and health, and the environment. However, those committed activities are less ambition from the technological perspective. Intelligent building that equipped with various sensing instruments and flexible control system may be one of the effective ways to reduce the probability of unhealthy building while conserving energy consumption. Environmental planning for the design phase, which is the most important phase for determining the building configuration and characteristics, was however not established in this case study.

4.4.2 The Importance of Partnering

From the prepared documentation for planning process, property owner and project leader were evidently played a vital role in managing environmental practices for a building project. This circumstance is true as described in Section 3.3 that the most influential stakeholders for practising environmental planning process are respectively the building owner, project designer, and contractors. Project leader normally will serve as an environmental co-ordinator if one is assigned. Co-ordination with other related stakeholders at particular building phase is necessary for a project leader to fulfil the requirements of property owner. This implication is indicated via the established time schedule and checklists in the environmental plan, which have been discussed in previous paragraphs. Observation from such documents implies that different party plays a different role in committing environmental practices to building project. The involved parties may vary from the architect, construction contractor, consultants of various building services, to interior designers. However, such commitments are conventionally dedicated to building phases that aside from planning process. This conventional approach may cause misunderstanding and conflicts between project leader and the involved professional groups, and among themselves as well. Participation of these professional groups into planning process is therefore suggested to prevent the occurrence of such incidence. Advice with respect to the newest knowledge that associated with corresponding professions is prevalence in decision making during both the programming and design stages respectively. Close collaboration between these professional groups at programming stage may facilitate the subsequent design and construction phase, which may result in fewer post-constructions' alterations. Alterations that made before construction phase are significantly easier and less costly because the opportunities for making changes are far more flexible. This logic is truly indicated in Figure 3 that illustrated in Chapter 3.
User demands are going to be one of the influential parameters in decision making regarding the floor plan and choices of material and standard within the groups of architects and the designers of building services and interior furnishings. This implication was indicated in this case study through the encouragement of collaboration between the owner and users regarding the issues of lighting and flooring. The architect was also suggested to carry out demand survey on users, especially on those groups of people who need intensive care, i.e. disabled people and people who are hypersensitive and allergic to chemical substances and emissions. Such investigation is essential to be undertaken during the planning phase of a building project before initiating the design works. This practice may probably result in fewer complaints of sickness and discomfort because prior agreement and satisfaction have been acquired from the occupants. The success of this practice was apparently demonstrated in another building project in Sweden, which considered occupant comfort during the programming phase (BFR, G8: 1998).

The main contractor who is mainly responsible for construction activities and building services installation is necessary to participate into planning process and conceive the environmental requirements that formulated in the process. With this perception, main contractor may then select the relevant sub-contractors based on the project specific environmental goals that determined during planning phase. Selection of sub-contractors is also based on the company owned business and environmental policies respectively (Interviews with NCC AB & JM AB). Meanwhile, in the project-planning phase, contractor may use IT based project model that can co-ordinate the phases of planning, construction and operation. This model will enable building costs and future operating costs to be calculated. Therefore, users will be able to know how the various selections of designs and technology may affect the overall economy, energy consumption and potential environmental impacts. Close co-ordination and collaboration with users and other sub-contractors may be a key to success for contractors in achieving a good business performance while complying with the environmental requirements formulated by local municipality and the owners.

4.4.3 Implication of the Effectiveness of the Proactive Strategy

The effectiveness of implementing environmental practices into building project has been quantified by some big construction companies in Sweden, such as NCC AB and JM AB (Interviews). These quantitative parameters have become prevalent since the other stakeholders in the building industry would like to use such parameters as evaluation tools for the contributed environmental efforts. The quantitative parameters, or named as key environmental ratios, that commonly presented are energy efficiency, material efficiency, share of waste deposited, projected energy consumption, emissions of CO₂ and NOₓ, and environmentally adapted subcontractors. Construction companies that have contributed environmental practices and health concern into various building stages including the planning process demonstrated significant improvement on the performance of such key environmental ratios. Evidence of such improvements was apparently indicated in environmental reports that prepared by such construction companies (NCC, Imagine, 2000; JM AB Miljöredovisning 1999). These improvements of performance imply that environmental awareness and realisation of the importance of collaboration have been raised among stakeholders in Swedish building industry. Only stakeholders with environmental consciousness are willing to contribute their efforts into environmental practices, and only with satisfactory collaboration, the significant improvement can be demonstrated. Construction companies are commonly good at profit making. Thus, the improvement of key environmental ratios may also
imply the realisation of such companies regarding more investments in proactive strategy are less costly and may bring more revenues. Anyhow, these positive effects may stimulate the awareness and subsequently commitments of other relevant stakeholders to practice environmental works in order to create more sustainable buildings.

5.0 COMPARISON OF PLANNING PROCESS IN SWEDEN & MALAYSIA

5.1 Brief Description of the Comparison Study

Ecology and health aspects that would be considered during the planning process were identified and presented in Section 5.2. Scope of environmental practices that were planned in both countries in order to mitigate the potential problems arise from those specified aspects were compared. The result of comparison was tabulated in Section 5.2, while the implication of the comparison would be discussed comprehensively in the subsequent section.

The comparison was merely based on the general study but not the specific case study of the planning procedures of building projects in both Sweden and Malaysia respectively. Meanwhile, the comparison was carried out based on the available information, which might be insufficient to demonstrate the real circumstance and practices. For instance, for case in Malaysia, mitigating measures that planned for construction activities were demonstrated explicitly in the available EMCP (Environmental Management and Compliance Plan) while environmental practices for other building phases could only be extracted from the common practices. Thus, the environmental practices associated with particular building phases other than construction phase would probably be demonstrated in a limited extent. References used for investigation cases in Malaysia encompassed EMCP (UEC Sdn. Bhd.) and Environmental Impact Statement (UEM HDU, 2000) that prepared by two well-known main-contractors for particular building projects that are under progress. In addition, report of the Environmental monitoring and Audit Programmes for a finished building project (KLIAB, 1997) was referred. Relevant seminar papers (Fong, 2000), Occupational Safety and Health Act and Regulations–1994 (DOSH, 1997), Uniform Buildings By-Laws 1984 (Legal Research Board, 1999), Environmental Impact Assessment Guidelines (DOE Malaysia, 1995), and comments that given by representative personnel of building industry in Malaysia were also reviewed.
5.2 Comparison of Building Related Ecology and Health Elements in Planning Process in Sweden & Malaysia

Table 3: Comparison of Building Related Ecology and Health Elements in Planning Process in Sweden & Malaysia

<table>
<thead>
<tr>
<th>Items</th>
<th>Related Building Phase</th>
<th>Practices in Malaysia</th>
<th>Practices in Sweden</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health influenced</td>
<td>Common new buildings</td>
<td>Ambitious new buildings</td>
<td>Common new buildings</td>
</tr>
<tr>
<td>Environmental Factors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air quality</td>
<td>Occupancy</td>
<td>- Well configure and design of building envelope and air tightness.</td>
<td>- deliberate site selection</td>
</tr>
<tr>
<td>- VOC emission</td>
<td></td>
<td>- installation of energy efficient HVAC system</td>
<td>- well configure and design of building envelope and air tightness</td>
</tr>
<tr>
<td>- chemical substance</td>
<td></td>
<td>- reduction of building chemicals and emissions with the use of environmentally compatible products, materials, and adhesives.</td>
<td>- installation of energy efficient HVAC system</td>
</tr>
<tr>
<td>- micro-biological</td>
<td></td>
<td>- Intelligent building with high sensing ability and flexible occupant controllability</td>
<td>- Regular maintenance for HVAC system in the post-occupancy stage.</td>
</tr>
<tr>
<td>growths</td>
<td></td>
<td></td>
<td>- Reduction of building chemicals and emissions with the use of environmentally compatible products, materials, and adhesives.</td>
</tr>
<tr>
<td>- air velocity</td>
<td></td>
<td></td>
<td>- Measures for moisture protection.</td>
</tr>
<tr>
<td>- air temperature</td>
<td></td>
<td></td>
<td>- Surveys on people need intensive care (e.g. disabled, hypersensitive &amp; allergic).</td>
</tr>
<tr>
<td>- etc.</td>
<td></td>
<td></td>
<td>- Intelligent building with high sensing ability and flexible occupant controllability.</td>
</tr>
<tr>
<td>Radon</td>
<td>Occupancy</td>
<td>- less information is available</td>
<td>- Radon testing is a requisite during site investigation.</td>
</tr>
<tr>
<td>Lighting</td>
<td>Occupancy</td>
<td>- Fluorescent lights with HF ballast</td>
<td>- Select building materials and design ventilation deliberately.</td>
</tr>
<tr>
<td>- Consideration of efficient energy use and occupant comfort (time control, occupation sensing, etc.)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Positioning of luminaires and layout of workplaces.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sun- or Day-light</td>
<td>Occupancy</td>
<td>- Building orientation to access to daylight.</td>
<td>- Building orientation to take advantage of solar access, shading and natural lighting.</td>
</tr>
<tr>
<td>Tap water (Potable water)</td>
<td>Occupancy</td>
<td>- Forbiddance of pipes and relevant fixtures, such as connectors and joints, which may contain PVC, lead, nickel and other suspected harmful substances.</td>
<td>- Forbiddance of pipes and relevant fixtures, such as connectors and joints, which may contain PVC, lead, nickel and other suspected harmful substances.</td>
</tr>
<tr>
<td>Items</td>
<td>Related Building Phase</td>
<td>Practices in Malaysia</td>
<td>Practices in Sweden</td>
</tr>
<tr>
<td>------------------------</td>
<td>------------------------</td>
<td>--------------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Legionellosis</td>
<td>Occupancy</td>
<td>- Regular inspection on the hygienic of cooling towers</td>
<td>- Attention in warm water temperature for preventing the breeding of legionella bacteria.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Use of air conditioning system with the most advanced technology.</td>
<td></td>
</tr>
<tr>
<td>Noise Control</td>
<td>Occupancy</td>
<td>- Proper design and arrangement of rooms proportions and layout</td>
<td>- Proper design and arrangement of rooms proportions and layout</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Use of sound insulation materials.</td>
<td>- Use of sound insulation materials.</td>
</tr>
<tr>
<td></td>
<td>Construction</td>
<td>- Implementation of noise control measures for mitigating noise annoyance to occupants in adjacent areas.</td>
<td>- Implementation of noise control measures for mitigating noise annoyance to occupants in adjacent areas.</td>
</tr>
<tr>
<td>Electromagnetic Field</td>
<td>Occupancy</td>
<td>- less information is available</td>
<td>- Arrange proper places for the installation of electric facilities and equipment.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Meeting with users to acquires relevant opinions and demands.</td>
</tr>
<tr>
<td>Moisture</td>
<td>Management</td>
<td>- less information is available</td>
<td>- Regular re-commissioning, maintenance and cleaning program to maintain the performance of ventilation system.</td>
</tr>
<tr>
<td></td>
<td>Construction</td>
<td>- less information is available</td>
<td>- Good housekeeping is planned to provide a dry and clean construction site.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Proper arrangement of the delivery schedule for building materials that need moisture protection care.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Environmental Parameters</th>
<th>Site Selection / Localisation</th>
<th>Practices in Malaysia</th>
<th>Practices in Sweden</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Physical Land-Use Planning</td>
<td>- IT based site analysis and assessment</td>
<td>- IT based site analysis and assessment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Dependence on decisions of the municipalities.</td>
<td>- Contact with prospective users and neighbours to broadening the localisation decisions.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Minimisation of disturbance to natural ecological cycles.</td>
<td>- Minimisation of disturbance to natural ecological cycles.</td>
</tr>
<tr>
<td></td>
<td>Watershed areas</td>
<td>Physical planning</td>
<td>Physical planning</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Minimisation of disturbance to watershed</td>
<td>- Minimisation of disturbance to watershed</td>
</tr>
<tr>
<td>Items</td>
<td>Related Building Phase</td>
<td>Practices in Malaysia</td>
<td>Practices in Sweden</td>
</tr>
<tr>
<td>-----------------</td>
<td>------------------------</td>
<td>---------------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Construction</td>
<td>-</td>
<td>- Implementation of watershed management system for the avoidance of soil erosion.</td>
<td>- Implementation of watershed management system for the avoidance of soil erosion.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Use of integrated pest management to minimise the use of herbicide, pesticide, etc</td>
<td>- Use of integrated pest management to minimise the use of herbicide, pesticide, etc</td>
</tr>
<tr>
<td>Water and Drainage</td>
<td>Construction</td>
<td>- Proper design and construction of culverts</td>
<td>- Harvest and reuse of rain water.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Separation of waste oil and grease from ordinary drainage.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Occupancy</td>
<td>- Proper design and construction of culverts</td>
<td>- Consideration of water conservation in building operation.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Regular design and construction of culverts</td>
<td>- Reuse of grey-water.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Regular maintenance of the drains</td>
<td>- <em>Harvest and reuse of rain water.</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Compliance with relevant national legislation.</td>
<td>- <em>Consider implementing the effective local-ecocycles approach.</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- <em>Harvest and reuse of rain water.</em></td>
<td></td>
</tr>
<tr>
<td>Sewage</td>
<td>Occupancy</td>
<td>- Properly operation and maintenance of the Sewage Treatment Plant (STP).</td>
<td>- Installation of local and meticulously monitored sewage system that is able to guarantee the sludge quality.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Proper record of the plant operation in a daily basis.</td>
<td>- Reuse of good quality sludge as fertiliser.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Regular removal of scum, grease &amp; sewage sludge from the STP.</td>
<td>- <em>Separation of urine and faeces</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Regular treatment on drying beds and disposal at an approve site.</td>
<td></td>
</tr>
<tr>
<td>Solid waste</td>
<td>Construction</td>
<td>- Prohibition of open burning</td>
<td>- Pre-sorting of waste generated at construction site.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Provision of sufficient waste containers</td>
<td>- Composting of solid organic waste.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Separation of domestic, construction and vegetation waste.</td>
<td>- Reuse and recycling of solid waste.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Domestic will be regularly collected and removed to an approved sanitary landfill site.</td>
<td>- Optimal use of materials to reduce waste generation.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Construction waste will be removed and disposed of at a dumping site approved by the local authority.</td>
<td>- Energy recovery from solid waste.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Vegetation waste will be removed to designated dumping site.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Prohibition of dumping solid waste in or near watercourses.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- <em>Minimising waste discharge.</em></td>
<td></td>
</tr>
<tr>
<td>Operation/</td>
<td>- Provision of proper bins for solid waste disposal.</td>
<td>- Pre-sorting of domestic waste</td>
<td></td>
</tr>
<tr>
<td>Occupancy</td>
<td></td>
<td>- Collection of bins by the council in a regular basis.</td>
<td>- Patio building for composting of solid organic</td>
</tr>
<tr>
<td>Items</td>
<td>Related Building Phase</td>
<td>Practices in Malaysia</td>
<td>Practices in Sweden</td>
</tr>
<tr>
<td>--------------</td>
<td>-------------------------</td>
<td>--------------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Building Materials</td>
<td>Design &amp; construction</td>
<td>- Encourage recycling of solid waste</td>
<td>- Reuse and recycling of solid waste.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Service and clean dumpsters in a regular basis.</td>
<td>- Optimal use of materials to reduce waste generation.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Use of indigenous building materials.</td>
<td>- Local eco-cycles approach for energy recovery from waste.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Use of materials/products that type approved by authorised councils and agencies.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Prohibit the use of poisonous and hazardous materials.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Encourage the use of recycled and reused materials/products.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Encourage the use of materials with low emissions.</td>
<td></td>
</tr>
<tr>
<td>Administration</td>
<td></td>
<td>- Less information is available</td>
<td>- Request for moisture dimensioning, and moisture specification of building materials from manufacturers or related suppliers.</td>
</tr>
<tr>
<td>Demolition</td>
<td></td>
<td>- Encourage the use of recyclable and reusable materials.</td>
<td>- Select environmentally evaluated materials with reference to Swedish Building Centre’s environmental material database.</td>
</tr>
<tr>
<td>HVAC system</td>
<td>Design &amp; Construction</td>
<td>- Properly sized and efficient HVAC system</td>
<td>- Use of recycled and reused materials/products.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Use of environmentally adaptable refrigerant</td>
<td>- Use products with recycled material contents</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Select materials with environmental declaration of combination effect of material.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Use materials with low emissions.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Consideration of energy use to produce building materials (e.g. asphalt).</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Survey on potential users regarding the sensitivity level to chemical substances emitted from building materials.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Prepare an eco-specification that specifies all constituent materials of the building.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Be aware of chemical content and volatility of maintenance and cleaning materials.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Use of recyclable and reusable materials.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Properly sized and efficient HVAC system</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Installation of heating system with alternative energy source.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Use of waste energy powered heating system, e.g. biogas plant.</td>
</tr>
<tr>
<td>Items</td>
<td>Related Building Phase</td>
<td>Practices in Malaysia</td>
<td>Practices in Sweden</td>
</tr>
<tr>
<td>--------------</td>
<td>------------------------</td>
<td>---------------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------</td>
</tr>
<tr>
<td>Maintenance</td>
<td>-</td>
<td>Inspection, cleaning and maintenance of HVAC system in a regular basis.</td>
<td>- Inspection, cleaning and maintenance of HVAC system in a regular basis.</td>
</tr>
<tr>
<td>Occupancy</td>
<td>-</td>
<td>Preferable system with high sensing ability and flexible controllability.</td>
<td>- Preferable system with high sensing ability and flexible controllability.</td>
</tr>
<tr>
<td>Energy</td>
<td>Physical Planning</td>
<td>Building orientation to facilitate the accessibility of solar power.</td>
<td>- Building orientation to take advantage of solar access.</td>
</tr>
<tr>
<td></td>
<td>Design</td>
<td>- Thermal efficiency of building envelope and airtightness.</td>
<td>- Alternative energy sources</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- <em>Encourage considering alternative energy sources, i.e. solar and renewable energy.</em></td>
<td>- Thermal efficiency of building envelope and airtightness.</td>
</tr>
<tr>
<td></td>
<td>Maintenance</td>
<td>- less information is available</td>
<td>- Inspection and maintenance of particular installations and systems in a regular basis.</td>
</tr>
<tr>
<td></td>
<td>Occupancy</td>
<td>- Minimisation of electric load from energy efficient electric appliances.</td>
<td>- Minimisation of electric load from energy efficient electric appliances.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Partnering</th>
<th>User participation</th>
<th>Post occupancy</th>
<th>During planning process</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Material suppliers</td>
<td>Provision of information to authorised councils and agencies at earlier stages before construction.</td>
<td>Provision of the most updated information to project leader, contractors and owner throughout all building phases.</td>
</tr>
<tr>
<td>Items</td>
<td>Related Building Phase</td>
<td>Practices in Malaysia</td>
<td>Practices in Sweden</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>------------------------</td>
<td>---------------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Owner participation</td>
<td>Full dependent on authorised architect and contractors. Employ third party consultant to carry out EIA in compliance with the requirement of DOE. Provision of EIA report to contractors.</td>
<td>Formulate own environmental requirements, goals and sometimes policies.</td>
<td></td>
</tr>
<tr>
<td>Contractor participation</td>
<td>Formulate environmental management compliance report (EMCP) based on EIA report that provided by owner. The EMCP will be established in compliance with the requirements of DOE.</td>
<td>Contractors are committed into environmental works with own environmental strategies, objectives and policies. Possession of own environmental products/materials database. Emphases on selecting sub-contractors whom possess environmental awareness.</td>
<td></td>
</tr>
<tr>
<td>Participation of Project leader/project manager</td>
<td>Environmental co-ordinator will normally be assigned for most the projects.</td>
<td>Committed as an environmental co-ordinator.</td>
<td></td>
</tr>
<tr>
<td>Documentation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental goals</td>
<td>Applicable to all stages</td>
<td>Formulated implicitly while conforming requirements of carrying out EIA.</td>
<td>Formulated with the collaboration of owner, local authorities, users, project leader and contractors.</td>
</tr>
<tr>
<td>Environmental Program</td>
<td>Planning</td>
<td>Implicitly incorporated in land-use plan, landscape, and infrastructure plan.</td>
<td>Established and elaborated with detailed checklists.</td>
</tr>
<tr>
<td></td>
<td>Design</td>
<td>Implicitly incorporated in architectures plan and building plan.</td>
<td>Established and elaborated with detailed checklists.</td>
</tr>
<tr>
<td></td>
<td>Construction</td>
<td>Environmental Management Compliance Plan</td>
<td>Established and elaborated with detailed checklists.</td>
</tr>
<tr>
<td></td>
<td>Operation &amp; maintenance</td>
<td>Probably incorporated implicitly in building plan.</td>
<td>Established and elaborated with detailed checklists.</td>
</tr>
<tr>
<td></td>
<td>Demolition</td>
<td>Less information is available</td>
<td>Implicitly incorporated in environmental plan for planning, design and construction phases, respectively. It is a legal requirement that all new buildings in Sweden must have a demolition plan for future use.</td>
</tr>
<tr>
<td>Environmental Reporting</td>
<td>Environmental Impact Assessment Report</td>
<td></td>
<td>Environmental Consequences Report</td>
</tr>
</tbody>
</table>

6 EIA is denoted as Environmental Impact Assessment. According to the Environmental Quality Order, 1987, EIA is required for construction project more than 10 hectares (DOE Malaysia, 1994)
5.3 Implication of the Comparison Study

With reference to section 5.2, comparison between environmental practices that would be planned during planning process in both countries Malaysia and Sweden was presented respectively. Obviously, building industry in both countries have contributed some effort into environmental works in order to mitigate building related environmental and health risks. However, comparative differences that associated with the extent of implementation were indicated. Implication arises from such comparative differences would be discussed in the following paragraphs. The discussion would somehow focus on the main aspects such as indoor environment, sewage and solid waste disposal, energy use, partnering, documentation, etc.

Indoor Environment

Apparently, design and configuration of a building are responsible to provide good indoor environment. This practice seems a fundamental consideration that would be planned in prior by the relevant groups of profession such as the architects and design engineers, either in Sweden or in Malaysia. With reference to the result of comparison, it was recognised that the considerable aspects during planning process in order to create a good indoor environment were generally identical in both countries. However, in view of the planned mitigating measures, the extent of implementation was somehow remarkably distinguishable.

Efforts planned for building in Sweden were relatively more thorough and comprehensive. The planned efforts may vary from the initial stage, i.e. site selection, to the occupancy and maintenance stage, i.e. maintenance of the installed systems in a regular basis. Integrated mitigating measures with broader extent would be more effective and preferable in eliminating potential problem at its source. This integrated approach would be planned from a holistic perspective by relevant stakeholders during the planning process. Implementation of such integrated planning approach implicated the existence of awareness that associated with the adverse health effects arises from unhealthy indoor environment. Such awareness might arise from the increasing complaints of sick building syndromes. Seriousness of sick building syndromes can be evidenced from the result of surveys that conducted by WHO\(^7\) and SIB\(^8\). According to (Boverket & BFR, D4: 1994), WHO estimates that 10 - 30% of new and modernised houses in the industrialised world may be afflicted with problems. With reference to SIB that approximately 10% of the Swedish population lives in buildings that cause health problems. This is the obvious reason why considering the creation of good indoor environment is a highlighted issue in Sweden. In this regard, selection of building materials would be undertaken more deliberately as stated in Section 5.2 because emission from building material is one of the sources that will cause unhealthy indoor air.

With respect to the planned environmental practices in Malaysia as stated in Section 5.2, awareness associated with adverse health effects that arise from unsound indoor environment is insufficient. Correlation of occupant productivity and indoor environment is still an ignorant dispute in Malaysia’s building industry. Insufficiency of knowledge among stakeholders regarding the correlation of building materials and indoor air quality is another shortcoming. Participation of users at earlier stage to convey personal demand, especially the special groups who need intensive

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\(^7\) WHO denoted as World Health Organisation. It is an autonomous, international health organisation approved by the United Nations Conference on International Organisation in San Francisco in the year of 1945.

\(^8\) SIB denoted as National Swedish Institute for Building Research, which is abbreviated as BFR in Swedish.
care, is yet an uncommon practice. These shortcomings have therefore confined the planning of mitigating measures in a conservative manner. However, new buildings that are situated in the conceptualised sustainable city, namely PutraJaya (Web-sites), will be required to be planned with an integrated and holistic approach. Intelligent buildings will be one of the ambitions that enable the occupant to control the indoor environment effectively while conserving the energy consumption efficiently.

**Water and Drainage**

With reference to the comparison result, proper water and drainage handling in construction and occupancy stages is planned at earlier stage by relevant stakeholders of building industry in both countries respectively. However, the extent of environmental practices in water and drainage handling is remarkably distinguishable between these two countries.

In Sweden, approximately 1000 million-ton of water per year are supplied for buildings in operation stage. The high water consumption rate has stimulated the awareness of water conservation. With reference to section 5.2, harvesting and reuse of rainwater, and reuse of grey-water are environmental efforts that planned to be implemented. Feasibility of the local ecocycles approach will also be considered. With respect to these commitments, it is obviously that the conventional legislation and supplementary standards, such as ISO 14001, are insufficient to provide necessary guidance. Moreover, the supplementary standard, ISO 14000, can never be the quality guidance. The only guidance provided is that all companies that are certified in accordance with ISO 14001 at the minimum must comply with existing national legislation. Formulation of company-specific regulations and policies has therefore been initiated in a voluntary basis in order to achieve the established goals.

Approaches that planned based on the requirements stated in relevant legislation in Malaysia were relatively conservative while comparing to those in Sweden. This is true because legislation only provides minimum standards of environment, health and safety in most cases, which is sometimes insufficient to tackle the potential building related environmental and health problems. However, substantial improvement of environmental awareness can be noticed from the ambitious plan for new buildings in the city of PutraJaya, Malaysia (Web-sites).

**Sewage**

Improper handling of sewage discharge may result in adverse effect to both environment and human health. Raw sewage can pollute the environment while the sludge itself and the effluent may pose a danger to public health. Therefore, planning the proper way in handling sewage discharge to mitigate the potential environmental and health risks has been considered at earlier stage in both countries respectively. The extent of practices was somehow different as presented in section 5.2.

Reuse of sludge has been a disputable issue for almost a decade in Sweden. Therefore, it is feasible to plan a proper approach in handling sludge for future perusal while reducing the threat from sludge disposal in landfill areas. Installation of facility that used for separating urine and faeces would therefore be planned in order to facilitate subsequent procedures in handling the sewage discharge.
Sewage treatment plant with advanced technology has been introduced to Malaysia. Since landfill is not prohibited, treated sewage sludge will therefore commonly be disposed of in approved landfill areas. These factors result in fully dependency on centralised sewage treatment plant. Thus, close-loop sewage disposal method that can produce feasible sludge, which is reusable as fertiliser, was not considered as a mitigating measure at the planning stage.

**Solid Waste**

Solid waste management is an important aspect at both construction and occupancy stages respectively. This fact can be realised from the comparison result as demonstrated in section 5.2. Differences in sense of the scope of environmental efforts can however be recognised.

According to a statistical study that building industry in Sweden has utilised approximately 40% of natural resources in Sweden while generating 6-8 million tonne of waste per year. In view of this, waste reduction as well as proper handling of generated waste at construction site are highlighted issues in Swedish building industry. Beside of conventional means, energy recovery from combustible solid waste via advanced technological incineration was planned as one of the mitigating measures. Pre-sorting of solid waste was therefore planned in order to facilitate the subsequent waste-collection procedure. Besides, providing waste sorting facilities can also increase the environmental awareness among public. Public with high environmental awareness may dedicate to environmental works with reducing waste generation during occupancy period. Energy recovery from generated waste is also another planned environmental practices in order to mitigate problems that arise from solid waste in a closed-loop manner.

Relatively, environmental practices that planned by Malaysia building industry were generally conservative for mitigating problems arise from solid waste. Lack of environmental awareness among public may be the main cause of such conservative mitigating measures. Illegal open burning can still be tackled from time to time regardless of at construction site or residential areas. Dumping illegally is still a favourable manner in some of the residential areas. Mitigating measures are therefore planned with focus on promoting environmental consciousness among public. Waste minimisation will be emphasised on building projects that are planned for the conceptualised sustainable city, i.e. the city of PutraJaya (Web-sites).

**Building Materials**

In Sweden, concerns associated with building materials would be considered at different extent for building phases such as design and construction, administration, and demolition, respectively. Use of recycled as well as recyclable building material is emphasised during the design and construction phase in order to reduce the amount of generated waste. Request for various declarations and specifications of materials used is essential for preventing the occurrence of sick building syndromes. Survey on special groups who need intensive care before making decision on building material selection is planned because it is believed that special needs and preferences of customers often provide the most valuable idea. Eco-specification associated with the constituent materials of a building is planned to be prepared in administration phase. This eco-specification is a useful tool to demonstrate the users regarding the environmental efforts contributed by property owner. This is an assessment tool for the users to evaluate the environmental commitments of particular property owner.
In Malaysia, use of indigenous material as well as prohibition of poisonous material are the most common considerations while planning the environmental practices for design and construction phase. However, it is recognisable that less environmental efforts have been contributed to the administration phase. Material selection is mainly dependent on database that established by authorised councils and agencies. This instance is different from that in Sweden where some construction companies possess own material database. The dependency on a single database may delay the progress of updating the nation-wide building industry sector. Competence in updating individual material database may indirectly stimulate the environmental awareness among contractors. Appreciable improvement can therefore be expected from better collaboration between material suppliers/manufacturers and relevant contractors in Malaysia building industry. Alternatively, continual researches regarding the phasing out toxic substances are feasible to promote the environmental contributions among stakeholders.

**Energy**

Prior planning of energy related considerations for various building processes, i.e. from physical planning to occupancy, was carried out in both countries respectively. This implies that reduction of energy consumption for the entire building life cycle is a highlighted issue in building industry of both countries. As for other instances, the extent of implementation of the planned strategy is somehow distinguishable for particular building phase.

Approximately 40% of society’s energy use in Sweden is attributed to building industry (NCC, Imagine, 2000), energy issue is therefore increasingly important in this industry sector recently. Fully taking advantage of solar access is one of the important strategies in physical land-use planning in Sweden, which is a country that can access to least sunlight during long winter. As stated in Section 4.4 that approximately 85% of energy used for the entire life cycle of a building is attributed to the operation phase while heating constitutes the largest portion of total energy use. Therefore, thermal efficiency of building envelope would be considered as a strategy to reduce energy consumption. Regular maintenance is necessary to guarantee the optimal performance can be obtained from particular equipment. Such consideration is therefore supposed to be planned during the planning process to facilitate the subsequent task of project leader or environmental co-ordinator.

The main energy source in Malaysia is electricity, which is mainly generated from hydropower and fossil fuel. Elimination of excessive energy use is a new consideration in Malaysia building industry. Alternative energy source such as solar power and other renewable energy will be planned as a feasible strategy for new buildings in order to achieve the goal of sustainable energy use. Maintenance plan was ignored owing to the misconception about the preparation of such plan should be the responsibility of subcontractors who are responsible for the corresponding building services/systems. Efficient energy use through energy efficient electric appliances is realised among the community in Malaysia and Sweden respectively. Therefore, installation of such appliances in a new building would be planned.

**Partnering**

With reference to Section 5.2, the importance of partnering has been realised inevitably in building industry of both countries respectively. Main stakeholders who involved in building project are
committed environmental efforts in different extents with respect to their corresponding roles in the project.

In Sweden, contribution associated with environmental works from stakeholders other than those specified in Section 5.2 has also been recognised to have influential capability on building market, which is a place to reflect the public response about the popularity of environmental responsive buildings. For example, architects and design engineers, who consider the demands of users before deciding the design plan, may eliminate after-sales complaints. Decrease of after-sales complaints will be one of the indicators for the public to evaluate the performance of so-called environmental responsive buildings. It is obviously indicated that property owner and contractors, especially some large-scale construction and real-estate management companies, have put some efforts in promoting the quality of environmental works. Some construction companies have been identified as environmental leaders within the Swedish building industry sector (NCC, Imagine, 2000; JM AB Miljöredovisning 1999). Those companies conceive that environmental adaptation should be included as natural and integral parts of their normal operations. With reference to section 5.2, property owners in Sweden are committed more investments into environmental efforts at earlier stage in a voluntary basis. This implies that those owners have realised that proactive strategies are relatively more technologically and financially effective than subsequent reactions. Therefore, property owners are preferable to collaborate closely with other relevant stakeholders in conducting a thorough and comprehensive planning with detailed environmental requirements, goals and plans, respectively.

With examining the roles and participation manners of certain stakeholders in Malaysia building industry, it is indicated that partnering exists implicitly and in a limited extent. Lack of environmental awareness and short-term benefit minded might be the probable causes in this case. Commitments of relevant stakeholders, such as the contractors and material suppliers, are statutory requisites that determined by local authorities and relevant department of ministries, such as DOE, DOSH, etc. Participation of users will only initiate after the issuance of CFO (Certificate of fitness for occupation). Most contractors are more interested in short payback period rather than contributing investments into environmental practices that may consequently bring long-term benefit. Ignorance of planning environmental practices in prior might be due to the insufficiency of knowledge among stakeholders, especially property owner, about the potential adverse effects that may arise from building related ecology and health problems. Only building owner with definite environmental requirements is able to stimulate the environmental concerns in this industry sector. Appreciable improvements may be obtained if environmental awareness among public is promoted. This is true because public with environmental awareness will be able to weigh in environmental factors and considerations while making choices in purchasing a property.

Documentation

With reference to Section 5.2, documentation system for planning environmental practices that associated with building processes is remarkably distinguishable between these two countries. Generally, the comparison implicated that the environment and health concerns were incorporated implicitly into planning process of a building project in Malaysia. The documentation system shown was somehow relatively conservative, non-holistic and inadequate transparent compared to that in Sweden. Neither environmental policies nor objectives were formulated by any contractors and other relevant stakeholders in Malaysia building industry until to date. Similarly, project specific environmental goals and plans that would serve as guidance throughout the entire building
project were not formulated in prior as well. These deficiencies resulted in local prescription regulations and particular supplementary standards (i.e. BS, AS, ASHRAE and CIBSE) were used as the only references by architects and consultant engineers while designing particular provisions. However, such regulations and standards only provide minimum and general standards of environment and health, which is insufficient for the target of creating sustainable buildings. The ignorance of formulating company-wise environmental goals and policies implicated that the environmental consciousness of property owners is generally inadequate.

In Malaysia, environmental practices were only planned to mitigate potential problems arising from construction activities. This circumstance was due to the misconception regarding the construction activities were the main cause of building related environmental problems. Meanwhile, building related health problems yet become the highlighted issue in Malaysia building industry. The preparation of EMCP was somehow a good inauguration for Malaysia building industry to recognise the necessity of a systematic documentation system that is useful to guarantee the planned mitigating measures would be undertaken accordingly.

5.4 Constraints of the Proactive Strategy

As a rule of thumb, planning process that incorporating environment and health concerns may result in long-term and implicit benefits. However, the implementation of this proactive strategy is uncommon in countries, Sweden and Malaysia, respectively. This uncommonness may probably due to constraints that will be encountered while planning such strategies.

Limited number of material suppliers who monopoly the market of building materials may cause the inflexibility of the supply value chain of construction industry (Andersson, 2000). This inflexibility may confine the evaluation and selection made by contractors or relevant subcontractors who intend to choose suppliers that can provide high quality products/materials. Therefore, the success of partnering will probably be influenced if less material suppliers are committed their efforts into environmental works. Workers’ attitudes may play an important role in making the implementation of such strategy a success as well. All planned mitigating measures can only be carried out with the co-ordination between relevant stakeholders and respective subordinates/workers. Workers who have inadequate particular working skills probably may influence the effectiveness of planned mitigating measures. The co-operation between workers and relevant stakeholders such as project leaders or environmental co-ordinators, and among workers themselves, is also another appreciable factor.

The procedures defined for deliverance of building project may be another influential factor. These procedures may encourage the application of partnering between relevant stakeholders. Requirements formulated by particular governmental agencies or department of ministries will be necessary to be fulfilled accordingly while following the specified procedures. However, for cases in Malaysia, most of these requirements do not emphasise on integrating health and environmental parameters into planning process. This circumstance probably provides relevant stakeholders a good excuse for not implementing the above-mentioned proactive strategy. Lack of financial ability will be another constraint especially for small- and medium-scale construction companies. Planning process that integrating such environmental considerations requires relatively longer time compared to the conventional ones. This circumstance will lengthen the payback period while
increasing the up-front cost, which is unaffordable by most of the small- and medium-scale companies.

5.5 Suggestions for Promoting the Proactive Strategy

Implementing the proactive strategy may encounter some constraints as discussed above. The following suggestions were therefore given to promote the implementation in view of its consequential benefits.

Generally, it is necessary for building industry in Malaysia to contribute more efforts in improving documentation system that is relatively well established by Swedish building industry. A transparent and systematic documentation system will be a fundamental basis in making this proactive strategy a success. Relevant stakeholders such as contractors and owner should be devoted to formulate company-wise or project specific regulations, such as the environmental policies, so that good indoor environment and occupant comfort can be guaranteed. Take construction company in Sweden as an example, explicit environmental goals and policies were defined as overall guidelines and converted into action plan in its roles as a management tool. Meanwhile, environmental awareness among public in Malaysia should be raised. Only customers, as well as property purchasers and tenants, that with environmental awareness will weigh in environmental factors and considerations in making choices and deciding which property is worthiness. Meanwhile, the real-estate management companies should be encouraged to provide relevant documents such as detailed environmental products declaration regarding the constituent materials of a building. Sales representative may play a role in giving necessary explanation to users who are lack of knowledge about the adverse effects arise from building related environment and health problems.

For cases in Sweden, quantify financial effect of environment-related investments might be an appropriate suggestion to enable the environmental efforts being indicated transparently. With showing positive effects in monetary form, stakeholders will be convinced by potential benefits, such as long-term benefits, that can be obtained from commencing environmental works at planning stage. Prior planning of appropriate environmental practices may result in the reduction of environmental risks while increasing the socio-economic benefits, such as high productivity, reduction of health risks, reduction of liability claims, enhancement of production efficiency and etc. In this regard, environmental efforts will then become one of the evaluation parameters for investors in determining an investment decision. This instance will probably provoke competition between stakeholders to increase their respective environmental commitments.

Provision of economy incentives to small- and medium-scale construction companies that have limited financial affordability in implementing such proactive strategy may be necessary. According to (Roodman & Lessen, 1995) that Sweden’s largest housing bank has announced that it plans to lend money only for “green” buildings. This idea is probably applicable to promote the implementation of this proactive strategy either in Sweden or in Malaysia. With economy incentives, prior planning of environmental practices will probably be carried out in a voluntary basis by either big or small scaled construction companies. Meanwhile, continual training for workers may be necessary to be provided for enhancing the effectiveness of this proactive strategy. Only workers with sufficient skills are capable in carrying out the planned mitigating measures
effectively. Workers’ working experiences should also be taken as an invaluable feedback while making environmental plan for respective activities associated with particular building process.

6.0 CONCLUSION

With reference to previous paragraphs, it is obviously that adverse environment and health effects may arise from modernised buildings that provide us shelter for living and working. However, this is still an ignorant issue in most of the countries in the world where building stocks are increasing rapidly in these decades.

A holistic and integrated planning process that perform as a proactive environmental strategy is a necessity for building industry that are committed to protecting the environment while meeting the occupant comfort. This proactive strategy, which integrates environment and health aspects into the planning phase of a building project, is still an uncommon practice. Thus, improvement from various aspects is required. The most effective approach is by promoting partnering and environmental consciousness among relevant stakeholders. Provision of economy incentives to small- and medium-scale construction companies that have limited financial affordability in implementing such proactive strategy could be another effective method as well.

A systematic and transparent documentation system is an apparent example that indicates that Swedish building industry has contributed some efforts in practising this proactive strategy. Although instances in Malaysia indicated that Malaysia building industry is now at the initial stage in practising this proactive strategy, an improving tendency is intimated from the planning of new buildings for the mentioned conceptualised city. As a conclusion, investigation of case studies revealed that health and environmental parameters are now tending to be the decisive factors that should be incorporated simultaneously with other factors, such as the socio-economic benefits, into the planning process for making a building project the success.
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WEB-SITES


APPENDICES

Building Project Development Approval Process in Malaysia (Fong, 2000)

The general building delivery process in Malaysia was illustrated in the following flow chart.

Figure A-1: Flow Chart of Building Delivery in Malaysia

Process of Planning Permission Approval

The planning permission is regulated under the Town and Country Planning Act 1976 (Act 172). Among the key requirements is that of Development proposal report (LCP) under section 21 of TCPA. The process is as shown in the diagram below. The approval process start with checking the submission against the development plan and seeking comments from the technical agencies.
The Procedures of Building Plan Approval

The building plan is principally regulated by the Streets, Drainage and Building Act 1974 (Act 133) and the subsidiary Bylaws like Uniform Building Bylaw 1984, Earthworks Bylaw and so on. The procedures was summarised and illustrated in the following diagram.
Party involved

Submitting person

Application

Local Authority

- Register and issue file No.
- Payment based on architect/engineer calculation
- Specify technical agencies required to be referred to

Action

Check list A

Technical agencies

- Comments by technical agencies (internal and external) to be compiled by submitting person.

A) External Technical Agencies
   1) JKR
   2) JPS
   3) JPP
   4) JBA
   5) JBP
   6) TNB
   7) Telecommunication provider

B) Internal Technical Agencies
   1) Planning Department
   2) Park and Recreation Department
   3) Engineering Department
   4) Town Services Department
   5) Building Department

Site visit to check for commencement of works without approval and fine

Continue
Continue

Local Authority

- Checking for compliance

Local authority

- Recommendation by Planning and Building Plan Committee

Local Authority

- Approval by Local Authority Full Council

Local Authority

- Plans signed by Local Authority
- Submitting person informed

Figure A-3: Flow chart of Building Plan Submission Process