

Appendix I

Occupant Comfort & Satisfaction Survey

Questionnaire: As employees working in a LEED certified building your experiences and opinions are valuable. The following questionnaire is intended to aid in the examination of the performance of LEED certified buildings within Thailand. Current environmental concerns, such as climate change, deforestation and biodiversity loss have indicated that we must find environmentally friendly alternatives. By examining the performance of green buildings we can determine if they are living up to their predicted performance standards. As employees who work in a certified building your participation is crucial and is greatly appreciated.

Directions: Please place an "x" in the box that best represents your answer to each question.

	Not at all Satisfied ไม่เห็นด้วยเลย	Slightly Satisfied เห็นด้วยเล็กน้อย	Satisfied พึงพอใจในระดับพอ	Very Satisfied พึงพอใจมาก	Extremely Satisfied เห็นด้วยอย่างยิ่ง
1. Overall physical environment? สัมผัสโดยรวมของอาคาร					
2. Conditions in your work space? สภาพต่าง ๆ ในพื้นที่ในการทำงานของคุณ					
3. Overall air quality? คุณภาพอากาศโดยรวม					
4. Air freshness? ความบริสุทธิ์ของอากาศ					
5. Amount of air circulation? จำนวนการไหลเวียนของอากาศ					
6. Ability to adjust ventilation ความสามารถในการปรับอากาศ					
7. Overall temperature comfort? ความสะดวกสบายของคุณโดยรวม					
8. Temperature comfort in your area? ความสะดวกสบายของคุณในพื้นที่ของคุณ					
9. Ability to control temperature? ความสามารถในการควบคุมอุณหภูมิ					
10. Overall noise level? ระดับเสียงโดยทั่วไป					
11. Background noise level? ระดับเสียงรบกวน					
12. Noise level from surrounding areas and hallways? (ระดับเสียงในพื้นที่ ๆ มีเสียงดังเช่นในห้อง)					
13. Noise level from the ventilation system? ระดับเสียงจากระบบปรับอากาศ					
14. Noise level from Outside? ระดับเสียงจากภายนอก					
15. Overall lighting comfort? ความสะดวกสบายของแสง					
16. Amount of light? จำนวนแสง					
17. How bright it gets? ระดับความสว่างที่ได้รับ					
18. Glare from lights? แสงจ้าจากแสงไฟ					
19. Ability to adjust electric lights? ความสามารถในการปรับแสงไฟ					
20. Amount of daylight? จำนวนของแสงสว่างในเวลากลางวัน					
21. Glare from windows? แสงจ้าจากหน้าต่าง					
22. Visual Privacy? ความเป็นส่วนตัวในการมองเห็น					
23. Conversation Privacy? ความเป็นส่วนตัวในการสนทนา					

23. How many sick days have you taken in the past 9 months? ท่านได้ลาป่วยไปแล้วกี่วันในระยะเวลา 9 เดือน
24. What is the one thing you would like to see improved about the building? สิ่งหนึ่งที่ท่านอยากให้อาคารเปลี่ยนแปลงคืออะไร
25. What is the one thing you like the most about the building? สิ่งหนึ่งที่ท่านชอบที่สุดเกี่ยวกับอาคารคืออะไร
26. I am more productive at work when my physical surroundings are comfortable? ฉันทำงานได้คุณภาพมากขึ้นเมื่อสภาพแวดล้อมทางกายภาพรอบตัวฉันมีความสะดวกสบาย
- | | | | | |
|----------------------|----------------------|-------------|-------------------|-------------------|
| 1 | 2 | 3 | 4 | 5 |
| (Strongly) | (Disagree) | (Undecided) | (Agree) | (Strongly) |
| Disagree | ไม่เห็นด้วยอย่างยิ่ง | ไม่เห็นด้วย | ไม่เห็นด้วย | เห็นด้วยอย่างยิ่ง |
| ไม่เห็นด้วยอย่างยิ่ง | | | ไม่เห็นด้วย | |
| | | | ไม่เห็นด้วย | |
| | | | ไม่เห็นด้วย | |
| | | | เห็นด้วย | |
| | | | เห็นด้วย | |
| | | | เห็นด้วยอย่างยิ่ง | |

Appendix II

ISB LEED Credits



International School of Bangkok: LEED Certification Credits Achieved

	Environmental Site Assessment	Earned	0 ✓
SS Credit 1	Site Selection	Earned	1 ✓
SS Credit 2	Development Density & Community Connectivity	Earned	1 ✓
SS Credit 3	Brownfield Redevelopment	Not Attempted	1
SS Credit 4.1	Alternative Transportation: Public Transportation Access	Earned	1 ✓
SS Credit 4.2	Alternative Transportation: Bicycle Storage	Earned	1 ✓
SS Credit 4.3	Alternative Transportation: Low Emitting & Fuel Efficient Vehicles	Denied	1
SS Credit 4.4	Alternative Transportation: Parking Capacity	Earned	1 ✓
SS Credit 5.1	Site Development: Protect & Restore Habitat	Earned	1 ✓
SS Credit 5.2	Site Development: Maximize Open Space	Earned	1 ✓
SS Credit 6.1	Stormwater Management: Quantity Control	Denied	1
SS Credit 6.2	Stormwater Management: Quality Control	Earned	1 ✓
SS Credit 7.1	Heat Island Effect: Non-Roof	Earned	1 ✓
SS Credit 7.2	Heat Island Effect: Roof	Earned	1 ✓
SS Credit 8	Light Pollution Reduction	Earned	1 ✓
SS Credit 9	Site Master Plan	Earned	1 ✓
SS Credit 10	Joint use Facilities	Earned	1 ✓
Total SS Credits Achieved			13
Water Efficiency			
WE Credit 1.1-1.2	Water Efficient Landscaping	Earned	2 ✓
WE Credit 2	Innovative Wastewater Technologies	Earned	1 ✓
WE Credit 3.1-3.2	Water Use Reduction	Earned	3 ✓
WE Credit 4	Process Water Use Reduction	Not Attempted	1
Total WE Credits Achieved			
Energy & Atmosphere			
EA Prerequisite 1	Commissioning of the Building Energy Systems	Earned	0 ✓
EA Prerequisite 2	Minimum Energy Performance	Earned	0 ✓
EA Prerequisite 3	Fundamental Refrigerant Management	Earned	0 ✓
EA Credit 1	Optimize Energy Performance	Earned (2 of 6)	10 ✓
EA Credit 2	On-Site Renewable Energy	Not Attempted	3
EA Credit 3	Enhanced Commissioning	Earned	1 ✓
EA Credit 4	Enhanced Refrigerant Management	Earned	1 ✓
EA Credit 5	Measurement & Verification	Earned	1 ✓
EA Credit 6	Green Power	Not Attempted	1
Total EA Credits Achieved			5
Materials & Resources			
MR Prerequisite 1	Storage & Collection Recyclables	Earned	0 ✓
MR Credit 1.1-1.2	Building Reuse	Not Attempted	2
MR Credit 1.3	Building Reuse, Non-Structural	Not Attempted	1
MR Credit 2	Construction Waste Management	Earned	2 ✓
MR Credit 3	Resource Reuse	Not Attempted	2
MR Credit 4	Recycled Content	Earned	2 ✓
MR Credit 5	Regional Materials	Earned	2 ✓
MR Credit 6	Rapidly Renewable Resources	Not Attempted	1
MR Credit 7	Certified Wood	Not Attempted	1
Total MR Credits Achieved			6
Indoor Environmental Quality			
EQ Prerequisite 1	Minimum IAQ Performance	Earned	0 ✓
EQ Prerequisite 2	Environmental Tobacco Smoke (ETS) Control	Earned	0 ✓
EQ Prerequisite 3	Minimum Acoustical Performance	Earned	0 ✓
EQ Credit 1	Outdoor Air Delivery Monitoring	Earned	1 ✓
EQ Credit 2	Increased Ventilation	Earned	1 ✓
EQ Credit 3.1	Construction IAQ Management Plan: During Construction	Earned	1 ✓
EQ Credit 3.2	Construction IAQ Management Plan: Before Occupancy	Earned	1 ✓
EQ Credit 4	Low Emitting Materials	Earned	1 ✓
EQ Credit 5	Indoor Chemical & Pollutant Source Control	Not Attempted	1
EQ Credit 6.1	Lighting System Design & Controllability	Earned	1 ✓
EQ Credit 6.2	Thermal Comfort: Controllability	Not Attempted	1
EQ Credit 7.1	Thermal Comfort: Design	Earned	1 ✓
EQ Credit 7.2	Thermal Comfort: Verification	Earned	1 ✓
EQ Credit 8.1	Daylighting & Views: Daylighting	Not Attempted	4
EQ Credit 8.2	Daylighting & Views: Views for 90% of Spaces	Not Attempted	1
EQ Credit 9	Enhanced Acoustical Performance	Not Attempted	2
EQ Credit 10	Mold Prevention	Not Attempted	1
Total EQ Credits Achieved			10
Innovation & Design Process			
ID Credit 1.1	Innovation in Design	Earned	1 ✓
ID Credit 1.2	Innovation in Design	Earned	1 ✓
ID Credit 1.3	Innovation in Design	Earned	1 ✓
ID Credit 1.4	Innovation in Design	Earned	1 ✓
ID Credit 2	LEED Accredited Professional	Earned	1 ✓
ID Credit 3	School as a Teaching Tool	Denied	1
Total ID Credits Achieved			5

Appendix III

General Building Information Survey

International School of Bangkok: General Information Survey

Cultural Center	
1. Building Size	9,816 m ²
2. Date of Full Occupancy	August 2010
3. Number of Occupants	470-730
4. Primary Building Activity	Performing Arts, Theater, Classroom
5. Location	Thailand
6. LEED Certification Level	Gold
7. Project Team	Woods Bagot
LEED Design General Information	
1. LEED Credits Achieved	45
2. Estimate Electricity Consumption (annually)	751,713.7 kWh
3. Estimated Water Consumption (annually)	522,310 liters

Appendix IV

EKC Methodology

RESEARCH DESIGN

The EKC analysis defines GDP as the independent variable with SO₂, NO₂, PM₁₀ and CO as the dependant variables. A descriptive research approach was used. Although key variables have been established, the causality of this relationship has only been theorized and not definitively tested. A longitudinal design has been designated as the EKC analysis is a trend study in order to establish the trend between the independent and dependant variables. The EKC analysis uses quantitative research derived from secondary data and has been modeled after preceding studies.

RESEARCH POPULATION & SAMPLE

The population consists of all elements that are included in the government database, which have documented historical key air quality metrics. A criterion sample was used as only facilities which met the criteria were utilized.

RESEARCH METHOD

The EKC analysis uses a quantitative method in which secondary data was gathered through a government database. The EKC is analyzed in order to establish a correlated trend between air quality and GDP. The Thai Meteorological Department, Bangna and the Thonburi Power Substation were utilized as they provided the most complete data sets spanning from 1996 to 2010. Although many facilities have kept records of air quality metrics in recent years, very few kept records dating back to 1996 in which the earliest set of records are available within Thailand. Both facilities were chosen due to their ability to provide the most complete data sets. Additionally, using data sets from single, consistent sources minimizes inconsistencies in variables and measurement techniques.

DATA COLLECTION

The EKC analysis utilized secondary data obtained through formal letters of request. Air quality metrics were provided by the Pollution Control Department: Air Quality and Noise Management Bureau's database, and was supplied as raw data from the Thai Meteorological Department, Bangna and the Thonburi Power Substation's historical, monthly records.

DATA CRITERIA

Participating facilities must be part of the air quality database provided by the Pollution Control Department: Air Quality and Noise Management Bureau. Further, they must provide consistent data sets spanning from 1996 to 2010.

DATA ANALYSIS

The EKC analysis was designed as a trend study. Quantitative data was used in a quantitative analysis of raw secondary data. Secondary data was taken in monthly measurements and then combined to form a yearly average from 1996 to 2010. A trend analysis of the independent and dependent variables was used to compare GDP to key air quality metrics including SO₂, NO₂, CO and PM₁₀.

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Appendix V

Methodology (method of Estimation)

METHOD OF ESTIMATION TERMOLOGY

Modeled baseline- is a performance estimate of the energy and water consumption for a similar building that does not include green features consistent with ASHRAE 90.1. This figure is generated by the project team and used during the certification process.

Predicted estimate- is performance estimate of energy and water consumption of the designed building. In this case, ISB's Cultural Center's predicted consumption. The predicted estimate was generated by the project team and was used by the project team.

Actual measured- is the actual measured performance generated from billed energy and water consumption. In this case, it is the billed energy and water consumption of ISB's Cultural Center.

National average EUI- is the national average energy use intensity of Thailand's non-certified buildings given in a yearly average.

Sector-based EUI- is the national average energy use intensity of Thailand's non-certified buildings by sector. In this case average EUI of educational facilities given in a yearly average.

Actual measured EUI- is ISB's yearly average EUI generated using actual measured performance.

METHOD OF ESTIMATION

Energy consumption: Data is measured energy use of the whole building included in monthly energy bills. Site energy use was chosen over source energy use, as it is the most useful metric to owners. Site energy is the more easily controlled by owners and therefore deemed the most useful. Furthermore, site energy is the basis for calculating source energy and is the most closely related to utility bill information. Energy consumption data will be used to report emission levels. Data will be provided for the most recent months available. Energy consumption data is further defined as:

Purchased Energy Only: Consistent with ASHRAE 90.1 and energy star, which excludes onsite renewables and is indicated by kilowatt-hours used including meter dates.

Annualized energy: This study requires a minimum of one year of energy consumption data to evaluate performance, however there is no maximum number of months specified and participants were encouraged to provide the longest post-occupancy data set possible. Longer data sets show long-term performance and minimize sporadic changes attributable to short-term problems.

Water consumption: Data was includes meter start/end dates and billed on-site usage.

Financial analysis: Actual measured energy and water consumption was compared to both the modeled baseline and the predicted estimate, i.e., actual energy/water consumption vs. modeled baseline energy/water consumption and actual measured energy/water consumption vs. predicted estimate energy/water consumption. In order to compare actual performance to average, non-certified performance and actual performance to expected performance. Energy consumption is then converted into energy costs using the Metropolitan Electrical Authority's pricing structure for the greater Bangkok area while the cost of water was calculated using the Metropolitan Waterworks Authority's pricing structure. Actual measured costs were then compared to the estimated baseline model costs and the predicted estimate costs.

Environmental analysis: The environmental performance analysis is calculated in the same manner using the site energy consumption to estimate emissions. CO₂ emissions are then estimated for the actual measured, modeled baseline and the predicted estimate using:

0.5057 tCO₂/MWh

or

0.5057 kgCO₂/kWh

ISB's actual measured, estimated emissions are then compared to the modeled baseline and the predicted estimate.

Energy Use Intensity (EUI): Is the most basic performance benchmark and represents both the financial and environmental performance of ISB's Cultural

Center. It is used in comparison with national average EUI and average EUI of buildings within the same sector and of a similar end use. This allows a comparison of the actual measured EUI to the national average and sector-based EUI.

EUI is calculated as follows:

$$\text{EUI} = \frac{\text{kWh/sf}}{n}$$

kWh= Kilowatt hours

sf= square feet

n= period of time

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