SUSTAINABLE CONSTRUCTION SUPPLY CHAIN FOR GREEN BUILDING：
A CASE OF THE SIEM REAP AIRPORT TERMINAL

By
Mr. Zheng GUAN

A Thesis Submitted in Partial Fulfillment of the Requirements
for Master of Engineering ENGINEERING MANAGEMENT
Department of INDUSTRIAL ENGINEERING AND MANAGEMENT
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โดย
Mr.Zheng GUAN

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรวิศวกรรมศาสตรมหาบัณฑิต
สาขาวิชาการจัดการงานวิศวกรรม แผน ก แบบ ก 2 ปริญญามหาบัณฑิต
ภาควิชาวิศวกรรมอุตสาหการและการจัดการ
มหาวิทยาลัยศิลปากร
ปีการศึกษา 2566
ลิขสิทธิ์ของมหาวิทยาลัยศิลปากร

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Title	Sustainable Construction Supply Chain for Green Building : A Case of the Siem Reap Airport Terminal
By	Mr. Zheng GUAN
Field of Study	ENGINEERING MANAGEMENT
Advisor	Associate Professor Dr. Choosak Pornsing

Faculty of Engineering and Industrial Technology, Silpakorn University in Partial Fulfillment of the Requirements for the Master of Engineering

.... Dean of Faculty of Engineering and Industrial Technology
(Assistant Professor Dr. Arunsri Leejeerajumnian)

Approved by

.... Chair person
(Lecturer Dr. Noppakun Sangkhiew)

.... Advisor
(Associate Professor Dr. Choosak Pornsing)

.... External Examiner
(Lecturer Dr. Thanongsak Thepsonthi)

มหาวิทยาลัยศิลปากร

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Green buildings are buildings that are harmless to the environment, capable of making full use of the natural resources of the environment, and built under conditions that do not destroy the basic ecological balance (Kats, 2003). The green building supply chain needs to be based on the design, production, use, recycling and reuse of environmentally friendly materials. Purchasing decisions directly affect the efficiency and cost of the supply chain, which must be balanced by both customers and industry. The new Siem Reap International Airport in Cambodia is one of the largest public buildings under construction in Cambodia, and the vision of practicing green architecture as a model for both China and Cambodia has been determined from the planning of the project, which is the best choice for this case study as green building supply chain.

In order to maintain the vision of sustainability, the building process must be conducted according to sustainable practices. The purpose of this study is to assess the extent to which the Siem Reap new Airport project contractor has implemented green building practices in the field, and to assess the most important parameters or aspects, and to study more scientific and sustainable procurement criteria and options.This study mainly uses questionnaires to interview major subcontractors and suppliers in the project implementation process. Through the feedback of the interviews, we can count the weight factors that most affect the sustainable implementation and procurement of the project. The process aspect describes the activities that affect how different participants interact and examines how participants collaborate at all levels when approving, designing, and constructing buildings. and discusses how to better strengthen inter-regional supply chain cooperation in the future development of green buildings, make full use of the complementary advantages between East Asia and Southeast Asia, and balance the different needs of different countries in the development of green buildings.

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Zheng GUAN

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CHAPTER 1
INTRODUCTION

1.1 Background of the Research

Global climate change is accelerating human attention to sustainable development, protection and restoration of the ecological environment, and improvement of ecosystems. The conservation and maintenance of natural resources is a key concern of sustainable development. In addition, with the development of the world's population and economy, the competition and use of resources are increasing. Infrastructure and buildings consume 60% of the Earth's resources every year (Bribian et al., 2011,MMSD, 2002).The sustainable development proposed by the Chinese government to achieve the Sustainable Development Goals calls for economic growth, peaking emissions by 2030, becoming carbon neutral by 2060,and developing energy conservation and environmental protection industries (Ministry of Foreign Affairs of the PRC, 2021, China's VNR Report on Implementation of the 2030 Agenda for Sustainable Development). The value of construction contributes to economy in many ways, including improving infrastructure, increasing employment, and stimulating consumption through construction purchases. Despite this policy, private expansion projects will cause environmental deterioration, waste of resources, air pollution and noise, and increase greenhouse gas emissions with the current high consumption and low efficiency. According to the "Global Construction Status Report 2020" and construction, about 28% of global CO_2 emissions come from the construction industry. In addition, public health, safety and welfare are poorly managed by construction accidents that result in occupational injury and even death, and many problems of inadequate pay and working conditions must be faced. Construction projects are considered to be a complex chain of supply problems, Therefore, to achieve the Sustainable Development Goals, building industry must move towards green buildings.

Green buildings are buildings that are harmless to the environment, capable of making full use of the natural resources of the environment, and built under conditions that do not destroy the basic ecological balance(Kats, 2003). It can also be called sustainable development building, ecological building, return to nature building, energy saving and environmental protection building. The basic of green building :(1) saving energy, reducing the burden of building on the environment; (2) providing a safe, healthy and human living space; (3) achieving the harmonious coexistence of people, buildings and the environment. Green buildings have a broad application market in Southeast Asia and other developing countries, affected by the tropical monsoon climate, Southeast Asian countries have a high proportion of the demand for refrigeration. At the same time, the renewable energy utilization potential of Southeast Asian countries is huge, but at present, the utilization rate of renewable energy in Southeast Asian countries is only about 15% (Southeast Asia Energy Outlook, 2022). ASEAN member nations are targeting 23% of all primary energy from renewable sources by 2025 (ASEAN Centre for Energy, 2015), and green building technologies are widely used and developed in Southeast Asia in order to adapt to the special needs of local buildings (Li et al.,2022).

The green building supply chain needs to be based on the design, production, use, recycling and reuse of environmentally friendly materials. Purchasing decisions directly affect the efficiency and cost of the supply chain, which must be balanced by both customers and industry. According to estimates, the initial investment of most green buildings is relatively high, and it takes 5-10 years of management and operation to recover the incremental cost due to the application of green technology (Fei et al., 2023). Moreover, green buildings require a more holistic design concept and a longer design and construction cycle. However, with the development of the construction industry in recent years, competitive bidding for contractor selection has been applied to satisfy the high-speed growth construction market with a winning bid most by the lowest price (Lai et al., 2004), The contradiction between the development of green buildings and the existing supply chain system has become increasingly prominent.

The new Siem Reap International Airport in Cambodia is one of the largest public buildings under construction in Cambodia, and the vision of practicing green architecture as a model for both China and Cambodia has been determined from the planning of the project, which is the best choice for this case study,the Siem Reap

International Airport is the first class 4E international civil aviation airport that invested, designed, built and operated by a Chinese company. The project adheres to the Chinese government's concept of sustainable development. The implementation and development process of the project prioritized sustainable development practices from the planning stage to the construction stage. In order to maintain the vision of sustainability, the building process must be conducted according to sustainable practices. The purpose of this study is to assess the extent to which the Siem Reap new Airport project contractor has implemented green building practices in the field, and to assess the most important parameters or aspects, and to study more scientific and sustainable procurement criteria and options. This study mainly uses questionnaires to interview major subcontractors and suppliers in the project implementation process. Through the feedback of the interviews, we can count the weight factors that most affect the sustainable implementation and procurement of the project. We use the results of a case study conducted in the airport project to discuss measures for a more integrated policy process in the green building. We propose that both the environmental dimension, which is the activity that imposes requirements on the procurement process for governance purposes, and the process dimension are important to the outcome. The process aspect describes the activities that affect how different participants interact and examines how participants collaborate at all levels when approving, designing, and constructing buildings. and discusses how to better strengthen inter-regional supply chain cooperation in the future development of green buildings, make full use of the complementary advantages between East Asia and Southeast Asia, and balance the different needs of different countries in the development of green buildings.

1.2 Research Objective

1. To analyze the existing gap between the actual implementation of the new Siem Reap International Airport terminal project and the relevant regional green building standards and real needs of Southeast Asian countries;

2. Identify the common convergence between China and Southeast Asian countries such as Cambodia in terms of green building technology application, material use, and supply chain.

1.3 Research Scope

The new Siem Reap International Airport is located 51km southeast of Siem Reap city centre, 40km from Angkor Heritage Park and 10km from Benmyle. The building structure system of the terminal consists of the main body of the terminal building, the connector, the core area, the northeast, southeast, southwest and three finger corridors. The base area is about 41,565 square meters, and the total construction area is about 82,000 square meters. The main part adopts reinforced concrete frame structure, and the roof and the structure directly supporting the roof are steel structures. The terminal roof is a double-slope roof, with a total projection area of about 47,000 square meters and an expansion area of about 50,000 square meters.Figure1.1 shows the terminal rendering of the new Siem Reap Airport.

Figure 1.1 Siem Reap Airport terminal renderings

According to the interview with Wang X, discipline chief of terminal design of the Siem Reap airport project, the terminal project is located in a low-latitude area with tropical climate. Winter is from November to April of the following year, the northeast monsoon is dry and cool, the precipitation is less, the average temperature is 25℃-32℃, and the summer is from May to October. Due to the influence of the southwest monsoon, the temperature hovers around 33℃, with abundant rainfall, high relative temperature and small temperature difference throughout the year. Due to the special needs of buildings in Southeast Asia, especially the high demand for refrigeration, a large number of energy-saving and heat-insulation-related green building technologies can be adopted. Given that the potential of these technologies varies from region to region, the application performance of such technologies in tropical regions should be studied. Then from the green building envelope structure (including roof, wall, window), air conditioning ventilation, energy saving, renewable energy utilization of four aspects are reviewed, Such a comprehensive review is essential for highlighting the definition, development and assessments tools of green building in Siem Reap Airport Terminal engineering.Therefore, the research scope of this thesis is mainly the practice of green building related standards requirements in the whole process of procurement, transportation and installation of the main special projects of the terminal metal roof, glass curtain wall, air conditioner, power system, water conservation and find out the gaps and improvement goals.

Moreover, the Siem Reap Airport project is still in the final stage of completion and commissioning when this research was ongoing, it has not been formally delivered and put into operation,there is an absence of a systematic and exhaustive analysis in this thesis.

1.4 Research Contribution

1. To provide some reference for China and Chinese builders in cooperation with Southeast Asian countries in the field of green building.

2. A new thinking on strengthening sustainable supply chains for green buildings across regions and countries.

1.5 Definition of Terms

Building envelope thermal performance trade-off：When the building design cannot meet the requirements of the thermal design specifications of the envelope structure, the method of calculating and comparing the annual heating and air conditioning energy consumption of the construction and design buildings to determine whether the overall thermal performance of the envelope structure meets the energy-saving design requirements is referred to as: weighing judgment.

Transparent curtain wall: Visible light can be directly transmitted into the indoor curtain wall.

Reference building: When the thermal performance of the envelope is judged, it is used as a benchmark building to calculate the annual energy consumption of heating and air conditioning that meets the requirements of the standard.

Integrated part load value (IPLV): Based on the performance coefficient value of the unit under partial load, a single value representing the partial load efficiency of the air conditioning chiller is obtained by weighted calculation according to the cumulative load percentage of the unit under various load conditions.

Electricity consumption to transferred heat quantity ratio (EHR-h): With the design conditions, central heating system cycle pump total power (kW) and design the ratio of heat load (kW).Carbon footprint: Parameters used to quantify greenhouse gas emissions from processes, process systems or product systems and to demonstrate their contribution to climate change

CHAPTER 2
LITERATURE REVIEW

Green building has been widely recognized and developed after more and more recognition of the environmental improvement and potential social and economic benefits brought by green building. Maximum energy saving in green buildings is the common purpose of every countries, and the application of advanced technologies and sustainable supply chain are the fundamental keys to ensure the achievement of relevant technologies and goals. This chapter mainly studies the development of green buildings in Southeast Asian countries and China. And the common goals of Southeast Asian countries and China in the development of green buildings and the application of related technologies.

2.1 Sustainable Development and Green Buildings

The green building movement has been fostered by the Global Sustainable Development Goals, which provide a quantifiable measure of sustainability, Sustainability and green building are often used interchangeably (Bribian, 2002). The energy consumption of buildings during construction and use is very huge, and for human beings, the consumption of non-renewable resources will cause irreversible damage to the environment, and if it cannot be effectively changed in time, it will have disastrous consequences for human generations.

In engineering, sustainable design is a conceptual design idea that embraces the sustainable development of human beings and society. Sustainable development can be defined in many ways. Different factors lead to different approaches to sustainability issues, such as sustainability objectives, context, awareness and economic conditions. In terms of resources, sustainable development is about providing opportunities for the next generation. Sustainable construction is a key aspect of sustainable development. Sustainable building practices are based on ecological principles, do not affect the environment, have a closed material cycle, and are fully integrated into the landscape at the end of the structure's useful life (Sinhaet al., 2013).

2.1.1 Sustainability with respect to building materials.

The goal of sustainable development is to protect and restore ecosystems. The main goals of sustainability are to minimize material consumption and environmental impact, improve human satisfaction, and increase the reuse of materials. One important aspect is to minimize consumption, and another is to either reuse the same materials or recycle them into different or similar building products.

2.1.2 Financial benefits.

Compared with traditional buildings, the economic benefits of green buildings are also increasingly prominent, such as saving water, electricity, gas and other energy, improving indoor environmental quality, reducing employee health costs, and reducing operating costs.

Green buildings save operating and maintenance costs mainly by reducing energy consumption; Improved occupant comfort and productivity. As shown in Figure 1, the total economic benefits of green buildings far exceed the average initial cost of green buildings. Although the data is limited, it is enough to show that green buildings are hugely cost-effective nowadays (Kats, 2003).

Table 2.1 Economic benefits of green buildings

Category	**20-year Net Present Value**
Energy savings	$5.80
Emissions savings	$1.20
Water savings	$0.50
Operations and maintenance savings	$8.50
Productivity and health value	$36.90 to $55.30
Subtotal	$52.90 to $71.30
Average extra cost of building green	(-$3.00 to $5.00)

Source: Capital E Analysis

Life cycle assessment (LCA) is a quantitative method used to evaluate the specific impact of a product on the environment during its entire life cycle. Since the goal of green building is to reduce the impact of a building on the environment, LCA is often used as an objective standard to measure green building. Life Cycle Inventory (LCI) quantifies the environmental inputs and outputs associated with a product over its entire life cycle. Life cycle Energy consumption in all stages from raw material procurement, primary and secondary processing or manufacturing, packaging, transportation, installation, use and maintenance until the end of the life cycle, as shown in Figure 2.1

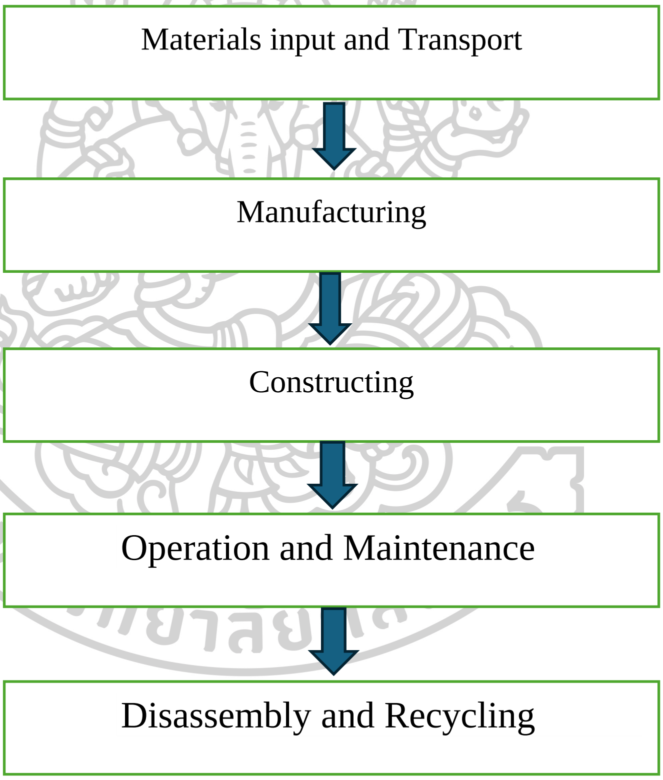

Figure 2.1 Simplified green building presentation of LCA

For green buildings, the life cycle usually begins with the extraction of original resources from the nature or the recycling materials. These original resources are then manufactured into usable products, such as cement, rebar, etc. The product is then transported to the construction site, In site, the products then are assembled into a building. it consumes energy over the life of the building, Finally, the building is demolished and its materials are disassembled as construction waste or recycling reuse. Each steps is accompanied by the consumption of energy and materials and the generation of waste. The purpose of LCA is to quantify the environmental impact of a construction product or system at each stage of its life cycle, including: energy consumption, resource utilization, greenhouse gas production, solid waste generation, and pollution generation.

Green building construction must integrate building professionals to achieve the common goal of sustainable development. This integration must begin at the pre-design stage and continue after operation to optimize building performance. Integrated design is an important means to achieve this goal, so research related to "green" buildings should focus on LCA analysis at all stages of the product from primary processing, use to disposal.

2.2 Green Building Development in Southeast Asia

Clear definition of green building is conducive to the promotion and implementation of green building. However, there has been no uniform standard on what green buildings are or what green buildings should include (Zuo,2014). According to About Green Building n.d Singapore, Green building is resource efficient and environmentally responsible in the life-cycle of a building. In Malaysia, not only consider factors above, but also the overall impact of the surrounding environment, in Cambodia, The Green Building Council is also primarily concerned with the environmental responsibility and resource efficiency of buildings throughout their life cycle. Due to its rapid urbanization in Southeast Asia ,most countries have developed its own green building assessment tools. Table 2.2 summarized the Southeast Asia countries green building assessment tools.

Table 2.2 Southeast Asia countries green building assessment tools

Countries	Release time	Name of assessment tools	Organization
Singapore	2005	Green Mark	BCA
Malaysia	2009	GBI	malaysiaGBC
Indonesia	2008	Greenship	GBCIndonesia
Thailand	2012	TREES	TGBI
Cambodia	2020	CAMEEL	CamGBC
Vietnam	2010	LOTUS	VGBC
Myanmar	2020	JADE	MGBS
Philippines	2009	BERDE	PGBC
Brunei	2016	BAGUS	The Ministry of Development

Source: https://www1.bca.gov.sg

The summary found that all green building assessment tools in Southeast Asia also aim to reduce energy consumption and improve the quality of living. In addition, fiscal policies and incentives have also been introduced in succession, which has greatly promoted the standardized development of green buildings in Southeast Asian countries (Li et al.,2022).

2.3 Green Building Energy-saving Technologies in Southeast Asia Wall

The geographical and climatic characteristics of Southeast Asia challenge the moisture resistance and thermal insulation performance of wall materials. The thermal properties of wall materials affect its ability to resist solar radiation, the insulation layer of materials affects the U-value during transient heat flow instantly (Mohamed et al.,2015). The most common materials of wall are bricks in Southeast Asia. However, the defects of insulation effect of brick wall in hot and humid climate are increasingly apparent (Kubota et al.,2019). The advantages and disadvantages of using external insulation materials in tropical areas should also be fully considered ,Another technology applied in tropical areas is adopting novel composite walls.

Roof

In tropical regions, a number of roof technologies such as roof ventilation, mass and reflective insulation, and cool paint are used to improve cooling efficiency and reduce the need for cold air (Tong,2017). Numerous case studies have shown that roof and wall insulation technology is high effective, but the application rate is very low in tropical regions (Dahim et al.,2022). The roof using insulation technology reduces the heat transfer to the room during the day when the sun is direct, and slows the heat loss to the outside at night. Such as aluminum foil and polyurethane are commonly used roof insulation materials (Sabouri, 2012). Roofing in Southeast Asian buildings often uses angled roofing to improve resistance to wind exposure, while facilitating drainage and reducing the impact of direct sunlight (Sadrzadehrafiei, 2013).

In brief, The main purpose of the roof design in Southeast Asia is to reduce heat transfer, while the insulation reduces temperature fluctuations, combined with natural ventilation, quickly discharge the heat transferred through the roof.

Windows

The transmittance and thermal properties of glass directly affect the transmission efficiency of solar energy and indoor heat gain. (Hien et al.,2005). In Southeast Asia, the use of naturally ventilated double glazing for Windows and facades to improve thermal comfort and reduce energy consumption is very significant, It can yearly save energy of up to 4 % when installed on clear glass and up to 7.5 % when suing tinted glass (Shan et al.,2020).

In the tropics, there is an innovative Sustainable Glazed Water Film (SGWF), which 70 % of 1300–2500 nm shortwave infrared was absorbed. Showed as Figure 2.2.

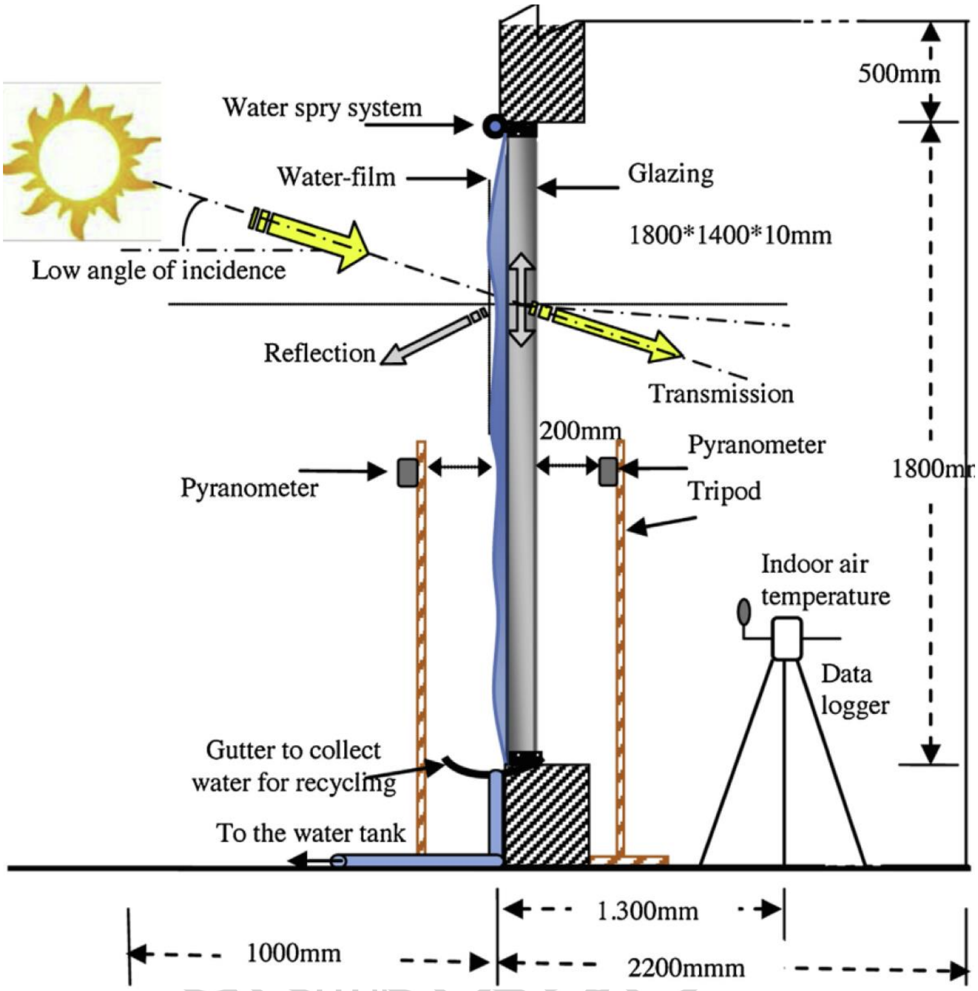

Figure 2.2 Transmittance experiment within the SGWF.

Source: https://doi.org/10.1016/j.enbuild.2014.03.051

Envelope shading

The shading device combined with the right type of glass can greatly regulate the thermal effect of the window to achieve the purpose of saving energy (Gratia et al.,2007). In Southeast Asia, shading has great advantages in reducing indoor temperature and cooling energy consumption. In Southeast Asia, shading can effectively reduce indoor temperature and cooling energy consumption. Studies have shown that the 30 cm deep horizontal sunshade device can reduce the energy cooling load by 2.6-3.2%, when the length reaches 60 cm , the corresponding cooling load can be saved by 5.6-7.0%, when the length is close to 90cm, the corresponding cooling load is reduced by 8.3-10.0% (Wong et al.,2007). Excellent architectural shading design should fully consider indoor lighting, ventilation, line of sight and other factors, effectively adjust the natural light and heat conduction, improve indoor comfort.

Air conditioning

Due to the hot climate, the design of air conditioning systems should have a certain vision, in Southeast Asia, the cooling and heat source equipment should be reasonably selected, especially the chillers' efficiency and energy saving. A good innovation in chiller systems is the centralized production of chilled water, which is then distributed through a network of pipes to nearby buildings for energy efficient use (Mulchand,2013).

Ventilation

Natural ventilation is the most needed to be adopted in green buildings, mechanical ventilation is usually only as a means to assist natural ventilation, natural ventilation does not consume energy, and does not require complex design and installation, It is usually achieved in the overall scale of the entire building, as well as considering the influence on surroundings (Song et al.,2019). Due to the climate characteristics of Southeast Asia, another type of wind ventilation is mainly adopted for air flow design. The local natural dominant wind direction and lightweight building structure are used to form different air pressure on the lee side and the windward side, so as to accelerate the air circulation and achieve the effect of ventilation.

Solar energy

The most common ways to use solar energy are photothermal and photoelectric, Solar energy is abundant in Southeast Asia as shown in Figure 2.3.

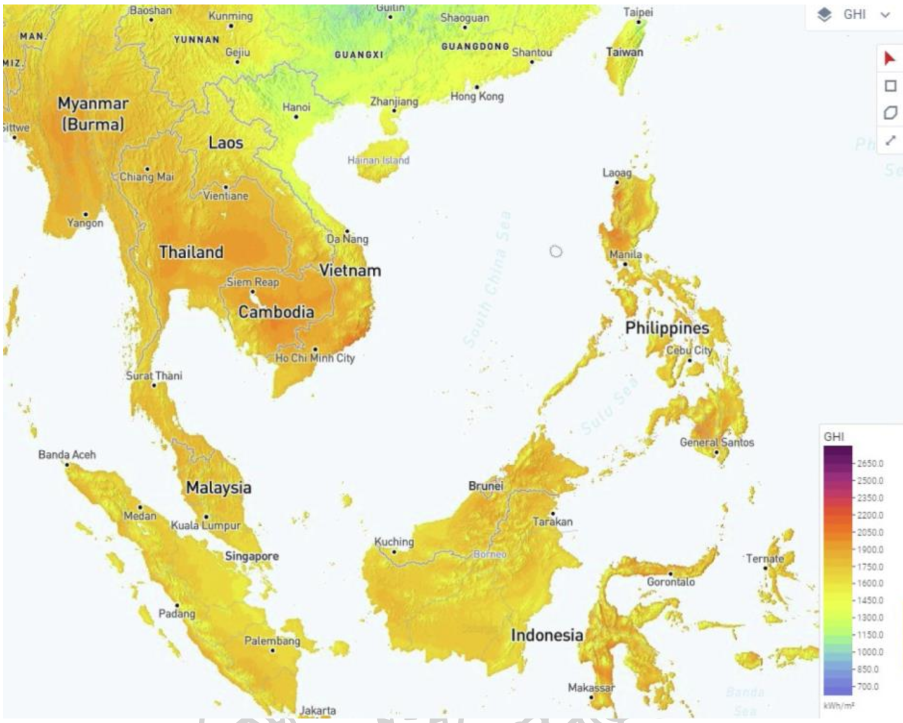

Figure 2.3 Solar energy resource in Southeast Asia

At present, solar water heating systems are mainly used in residential buildings in Southeast Asian countries, and building integrated photovoltaic technology (BIPV) has made rapid progress in recent years, which can reduce the operational carbon emissions of buildings by more than 50% (Hsieh et al., 2019). At the same time, the cost of BIPV is also gradually reducing, but module degradation and conversion efficiency still need to be addressed.

Water-saving appliances

Despite abundant rainfall in Southeast Asia during the rainy season, freshwater resources are still in short supply in some countries, and water conservation measures are equally important, At present, the widely used effective water-saving technologies are mainly the use of pressurization technology to prove stable water flow, intelligent control to reduce water waste, and the use of anti-corrosion materials to reduce the generation of scale.

2.4 Green Building Development in China

The concept of green buildings came later in China than in Western developed countries, and energy problems related to urbanization have gradually emerged.

From the initial basic energy saving concept to strengthening the transformation and development of wall materials, promoting household energy saving, land saving, water saving and material saving, the concept of "four provinces and one environmental protection" has been generated, and now green buildings have been widely recognized and developed in China, For example, even in Yunnan Province, which is economically less developed in China， has already reached 84.3 % green buildings in new urban buildings by 2022, and the provincial government is now aiming for 100 % green buildings by 2025（General Office of Yunnan Provincial Government， 2023）.

2.5 Green Building Energy-saving Technologies in China

China's building energy saving technology is mainly concentrated in two aspects of the building, envelope structure and equipment system, including doors, Windows, roofs, floors and walls, the main form of Windows for high thermal insulation performance of steel Windows, aluminum Windows, aluminum wood Windows and so on. Window glass includes single-layer glass, double-layer insulating glass, hollow glass ,Low-E glass, etc (Wang, 2007).

Similar to Southeast Asian countries, in China, the roof insulation material must be lightweight and efficient and can be used for long-term stable performance as a thermal insulation layer. (Wang, 2009). Energy-saving technologies related to air conditioning systems, including ice storage technology, heat pump technology, solar adsorption air conditioning, etc., have been rapidly developed and applied to the market. Central heating in cold areas in northern China has also been proved to greatly increase energy efficiency and reduce energy consumption in winter in northern China (Zhao et al.,2015). In terms of energy-saving technology for building equipment, green lighting, passive energy-saving technology and natural ventilation, natural lighting, shading, etc., have been popularized, and continuous exploration and innovation are also being made in making full use of renewable energy sources, including solar energy, wind energy, biomass energy, etc (Wu,2011).

However, the sustainable procurement of green construction and the application of advanced technologies are mainly achieved in developed countries, like the European Union. China and Southeast Asian countries have many common needs in terms of the development level and goals of green buildings, In order to practice the concept of green building, for example，the terminal Design of Siem Reap Airport was referred to the thermal performance limits of mild areas in the Design standard for energy efficiency of public buildings P GB50189 --2015 of the People's Republic of China as showed in Table 2.3，Because it has nearly similar climatic and thermal performance technical requirements to Southeast Asian countries.

Table 2.2 Thermal performance limits for envelope structures of Class A public buildings in mild areas

<table>
<tr><th colspan="2">Structural part of the building envelope system</th><th>Heat transfer coefficient [W/(m2 ·K)]</th><th>solar heat gain coefficient SHGC (East, South, West/North)</th></tr>
<tr><td rowspan="2">roofing</td><td>Thermal inertia index D≤2.5</td><td>≤0.50</td><td rowspan="2">——</td></tr>
<tr><td>Thermal inertia index D＞2.5</td><td>≤0.80</td></tr>
<tr><td rowspan="2">External walls (including non-transparent curtain walls)</td><td>Thermal inertia index D≤2.5</td><td>≤0.80</td><td rowspan="2">——</td></tr>
<tr><td>Thermal inertia index D＞2.5</td><td>≤1.5</td></tr>
</table>

Table 2.2 Thermal performance limits for envelope structures of Class A public buildings in mild areas (continued)

<table>
<tr><th colspan="2">Structural part of the building envelope system</th><th>Heat transfer coefficient [W/(m2 ·K)]</th><th>solar heat gain coefficient SHGC (East, South, West/North)</th></tr>
<tr><td rowspan="8">Single elevation exterior window (including transparent curtain wall)</td><td>Window wall area ratio ≤0.20</td><td>≤5.2</td><td>——</td></tr>
<tr><td>0.20 < window wall area ratio ≤0.30</td><td>≤4.0</td><td>≤0.44/0.48</td></tr>
<tr><td>0.30 < window wall area ratio ≤0.40</td><td>≤3.0</td><td>≤0.40/0.44</td></tr>
<tr><td>0.40 < window wall area ratio ≤0.50</td><td>≤2.7</td><td>≤0.35/0.40</td></tr>
<tr><td>0.50 < window wall area ratio ≤0.60</td><td>≤2.5</td><td>≤0.35/0.40</td></tr>
<tr><td>0.60 < window wall area ratio ≤0.70</td><td>≤2.5</td><td>≤0.30/0.35</td></tr>
<tr><td>0.70 < window wall area ratio ≤0.80</td><td>≤2.5</td><td>≤0.26/0.35</td></tr>
<tr><td>Window wall area ratio > 0.80</td><td>≤2.0</td><td>≤0.24/0.30</td></tr>
<tr><td colspan="2">Transparent part of the roof (transparent part of the roof area ≤20%)</td><td>≤3.0</td><td>≤3.0</td></tr>
</table>

Source: Design standard of the People's Republic of China

2.6 Cross-regional Challenge

Challenges and problems exist in the realistic scenario of the sustainable procurement supply chain between China and Southeast Asia and other countries. Although each country has almost the same goal direction for green buildings, the methods, regulations, policies and application technologies of each country are different. "Mankind is living in the same global village, in the same time and space where history and reality meet. We are increasingly becoming a community with a shared future." A comprehensive consideration of the green building supply chain from the perspective of a wider geographical region will also be more conducive to the saving of resource consumption by all mankind and the practice of the concept of green building. Therefore, this thesis aims to propose a feasible analysis and method to fill the gap in this respect. The possibility and direction of establishing a more sustainable green building supply chain across countries and regions through the implementation case study of the Siem Reap Airport Terminal project.

CHAPTER 3
RESEARCH METHODOLOGY

The common goal of green building research is to verify that the project reduces the overall impact of the building on the natural environment and human health. Because each project has a different design and concept, there is no one-size-fits-all approach that can be adapted to all projects, and appropriate research methods need to be developed for individual project characteristics.

In this chapter, a systematic and consistent research method is applied in the whole process.

3.1 Research Method

Qualitative methods are used in this study by conducting a green building assessment of the Siem Reap Airport Terminal project. In the discussion, the approaches used in this study are case studies and comparative. There is no standard method for using comparative research, but comparability analysis investigates two or more items, products, data sets, or other forms of collection. This study compares the results of target plans and actual site performance by investigation in order to evaluate performance achievements in the form of a desired value that provides information on the gap between actual field performance and the maximum target value.

Siem Reap is the capital of Cambodia's Siem Reap province, 311 km from Phnom Penh and only 152 km from the Thai border, with a population of about 140,000. In recent years, Siem Reap's tourism has grown rapidly, thanks to the fact that it is the gateway to Angkor, one of the four wonders of the East. As the current Siem Reap Airport is only about 5 km away from Angkor Wat, and the takeoff and landing routes are located above Angkor Wat, the vibration caused by aircraft noise effect will destroy the stability of the masonry structure. According to the regulations of UNESCO (United Nations Educational, Scientific, and Cultural Organization) on the protection of World Historical sites, the current Siem Reap Airport should not take off or land more than 200 flights, and cannot take off or land from the direction of Angkor. In order to avoid the impact of aircraft noise on the ancient complex, the

Siem Reap government decided to build a new Siem Reap airport elsewhere as showed in Figure3.1.

Figure 3.1 The existing runway to the Angkor Wat monument

Due to flight route restrictions, the aircraft had to land northeast of Runway 05 and take off southwest of runway 23. This mode of operation lengthens the time between arrivals and departures and results in planes sometimes operating downwind, with their load limited by downwind winds as showed in Figure 3.2.

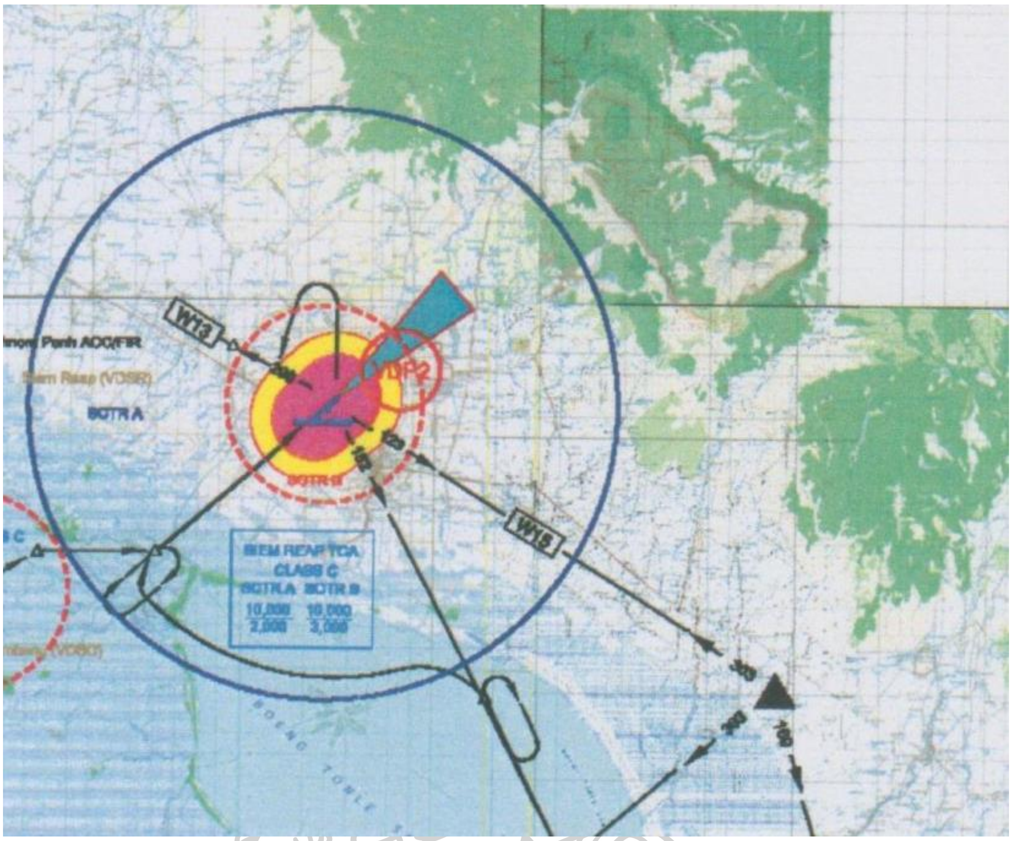

Figure 3.2 current airport flight program map

The new Siem Reap International Airport is located 51 km southeast of Siem Reap city centre, 40km from Angkor Heritage Park and 10 km from Benmyle. As the new airport is located far from the historic sites of Siem Reap, the landing route will not affect the historic buildings as showed in Figure 3.3.

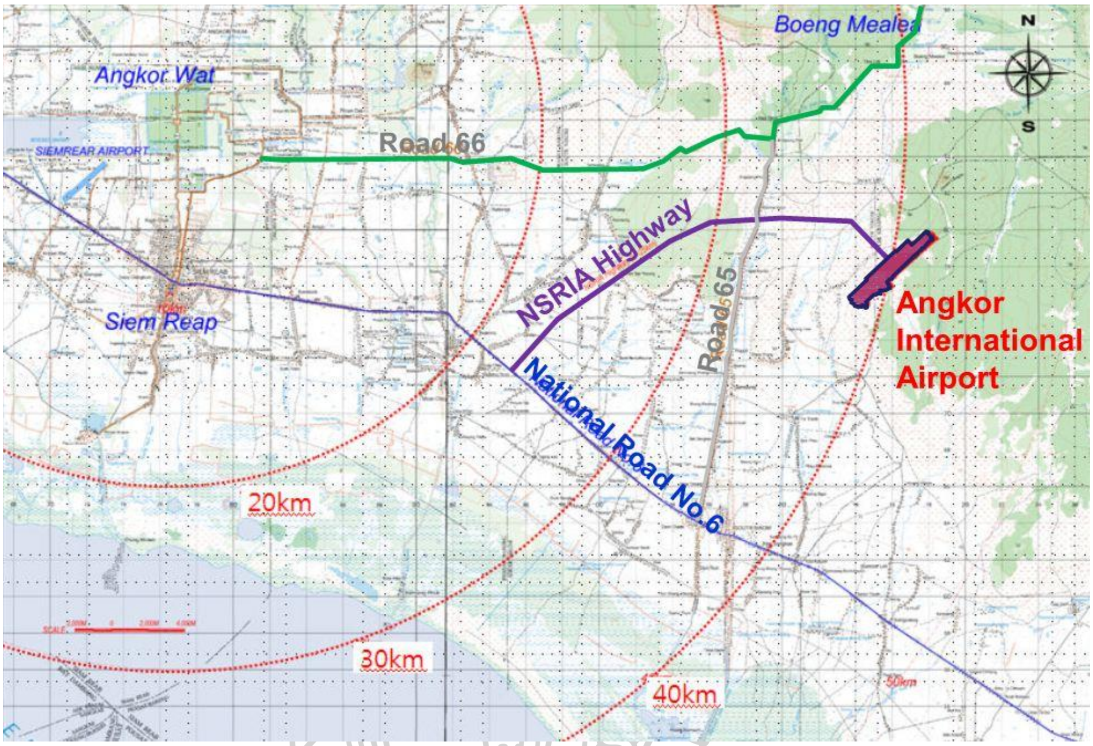

Figure 3.3 Siem Reap new airport location map

By making a special interview form and interviewing Mr. Feng Li, general contracting project manager of Siem Reap Airport, Mr. Shan, President of glass curtain wall Subcontractor Group, Mr. Yan Jian, Vice president of metal roofing subcontractor, and Mr. Li Lun, civil structure engineer, A lot of real detailed information and data about the application of green building technology at Siem Reap Airport was obtained.

For example,

1) Under the guidance of the long-term planning principles of the airport, the total plane design of the terminal area of the airport in the current period should be as compact as possible, and buildings with similar functions should be built together as much as possible, which is conducive to the effective use of the land, so as to achieve the requirements of occupying less land and saving land resources.

2) Arrange the power facilities such as cooling, water supply and power supply in the terminal area as close to the load center as possible, and rationally select

the route path to reduce the pipe network length and energy consumption, and facilitate operation and management.

3) The outer protective structure of the building is all made of external heat insulation structure, and the thermal insulation performance (heat transfer coefficient K) of the outer protective structure meets the specified limit.

4) Natural ventilation, natural lighting, heat insulation and shading. The roof of the terminal is partially equipped with skylights to introduce natural light to the center of the terminal to ensure the soft and comfortable natural lighting. Under normal daylight conditions, the interior of the terminal can rely on natural lighting to operate normally.

5) Reasonable design of lighting control mode, intelligent lighting control system, centralized monitoring of lighting fixtures in public areas of the terminal, and set up energy consumption monitoring system, information collection, analysis and processing of energy equipment and systems.

6) water speed pumps should be adopted, the use of variable frequency speed control pump running state, reduce the power consumption of water supply system, pressure, flow rate of pipeline network to automatically adjust according to the needs of users, through the optimization of water supply network, improve the use efficiency of water supply network.

In order to carry out this case study, it is necessary to collect primary and secondary data of the project extensively for more objective data analysis. The primary data is obtained through site observations at the construction site, such as project feasibility studies, planning documents, design drawings, design specifications, construction plans, construction progress reports, quality inspection reports, as well as Questionnaires and Interviews with site project managers, contractors, site supervisors, subcontractors, suppliers and other participants are also very important sources of data, especially for contractors and site supervisors to carefully design appropriate questionnaires and carefully recorded.

While the secondary data data is collected from the database, and a large number of relevant literature and research results and practical applications such as "green building", "green building technology", "green building assessment", "green building in China", "Southeast Asia", "ASEAN" and the name of each country are consulted and useful data are collected.

3.2 Research Procedure

Since the main purpose of the data analysis was to analyze Siem Reap Airport's green building performance in Southeast Asia, the research was divided into the following procedures ;

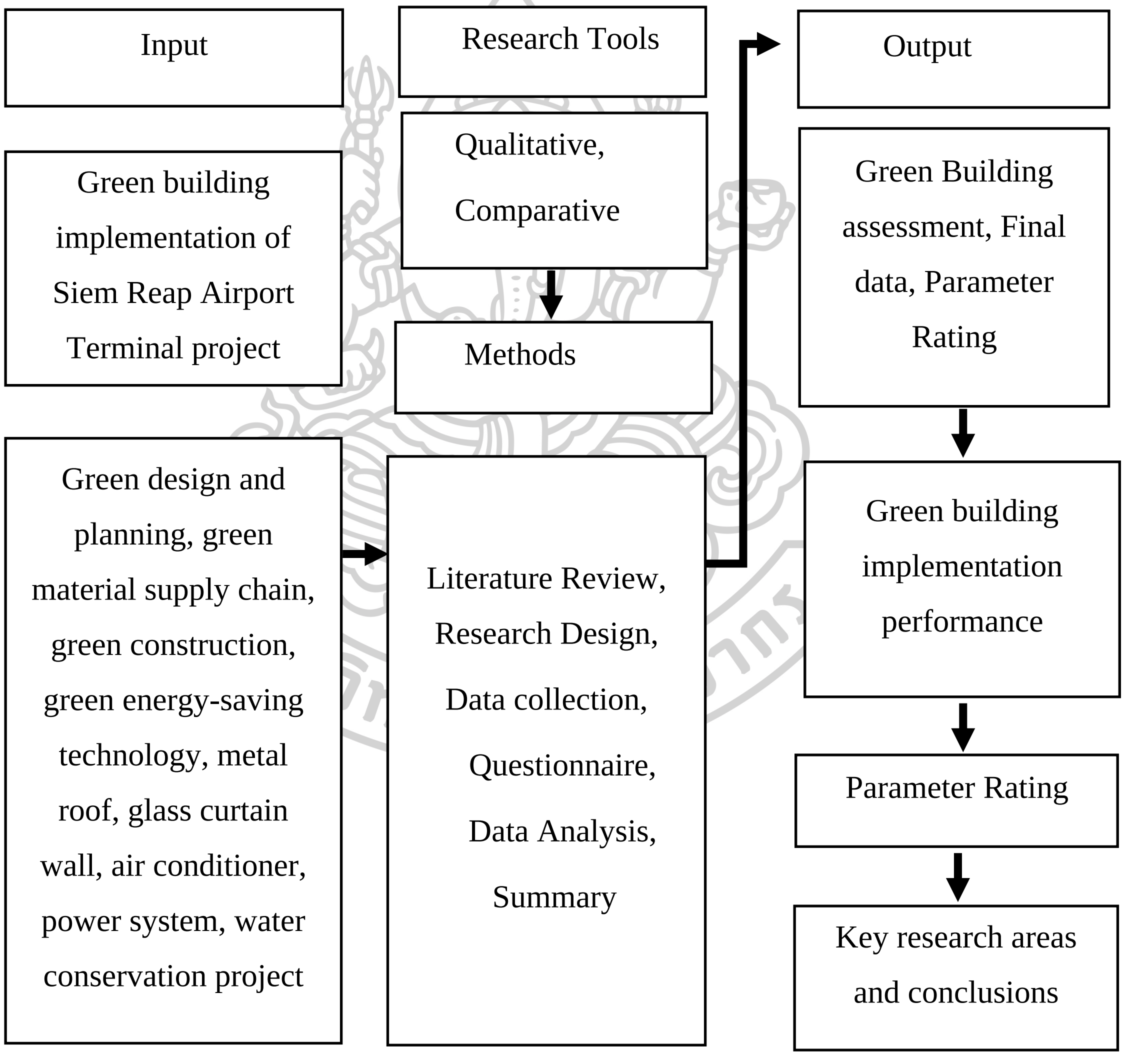

Figure 3.4 Research conceptual framework

Step1, systematically summarizes the collected literature, compares the main scope and standards of green building evaluation in Southeast Asian countries, and makes a questionnaire form based on the actual situation of Siem Reap International Airport to collect data.

Table 3.1 Major green building assessment in Southeast Asian countries

Category	Singapore	Thailand	Malaysia	Cambodia
tool	Green Mark	TREES	GBI	CAMEEL
objectives	1. Improve energy efficiency 2. Reduce carbon emissions to mitigate the effects of climate change a 3. Achieve sustainable development	1. Reduce pollution and environmental impact 2. Increase quality life of building occupants	Promote the building industry in its march towards sustainable development	1. Transform how buildings are designed 2.built and operated to improve 3.the quality of life
categories	1. Energy Efficiency 2. Intelligence 3. Health & Wellbeing 4. Whole Life Carbon 5. Maintainability 6. Resilience	1. Building Management 2.Site and Landscape 3.Water Conservation 4. Energy and Atmosphere 5.Materials and Resources 6. Indoor Environmental Quality 7. Environmental Protection 8. Green Innovations	1.Energy Efficiency 2. Indoor Environmental Quality 3. Sustainable Site Planning & Management 4.Materials & Resources 5. Water Efficiency 6.Innovation	1.Water Efficiency 2.Indoor Environmental Quality 3. Sustainable Site 4. Material & Resources 5. Energy & Atmosphere 6.Innovation & Design
Character	Mandatory	Voluntary	Voluntary	Voluntary

Step 2, Make Siem Reap Airport Green Building assessment form based on the summary and research of relevant data.

Table 3.2 Siem Reap Airport Green Building assessment form

Category	Rating			
	Roof	**Curtain Wall**	**Air conditioning**	**Water and electricity engineering**
green designed				
Material &Resources				
Energy-saving				
Sustainable Site Planning &Management (SM)				
Indoor Environmental Quality				

Step3, The data collected in the questionnaire survey were screened and classified, and the data that had nothing to do with the research topic and repeated studies were initially excluded. Only data consistent with the objectives of the study is retained.

Step4, Through the comparative study of the data of roof, curtain wall, air conditioning system and other items, the conformity analysis is obtained. The values of each parameter are compared and added to the total value and final data as a reference for prioritizing the sustainable supply chain of green buildings in Southeast Asia.

Table 3.3 Percentage of the results of the green building performance assessment of the Siem Reap International Airport

No.	Condition	Claim	Percentage
1	Conformity of the performance of the green building assessment table	79.11	28%
2	Green construction process	86.92	16%
3	Green supply chain	69.66	34%
4	Practice green behavior	79.39	22%
Total All Parameter Rating		77.2	100%

Overall, the Siem Reap Airport Terminal project received a high score of 77.2 out of 100 in the green building assessment, indicating that most components of the project in the design, supply chain and construction process are highly implementing the green building concept. As the project has not yet been officially put into operation, the implementation data of some green buildings cannot be verified.

Among all the research data, green supply chain obtained the largest weight percentage of 34%,This indicates that green supply chain is a significant parameter successfully applied by contractors during the construction of Siem Reap Airport, and that green supply chain parameters and their required standards can be given more attention and developed in future green building research.

3.3 Questionnaire

This questionnaire consists of 3 sections of questions as follows:

Part 1: Demography.

Part 2: Information on the implementation of the Siem Reap Airport project, especially from the aspects of green design, Material &Resources, Energy-saving, Sustainable Site Planning &Management (SM), Indoor Environmental Quality , to describe the implementation of the Siem Reap Airport project and conduct score evaluation as the basis for data analysis.

Part 3: Suggestion

CHAPTER 4
RESULT AND ANALYSIS

This chapter mainly reports the results and analysis of this study. The data analysis are mainly based on the assessment of the implementation practice of Siem Reap International New Airport and the survey feedback of the main direct participants.

4.1 Populations and Samples

In Populations, there are about 90 companies or groups from investors, designers, builders, operators, subcontractors, suppliers, etc. These respondents are direct or indirect participants in the Siem Reap Airport project. They are familiar with the project situation and can participate in the questionnaire survey in a targeted way. The study included 304 participants, mainly Cambodian state departments, officials, project designers, general contract managers, engineers, technicians, subcontractors, suppliers, etc., who completed 287 questionnaires returned via online social network channels, accounting for 94.41% of the sample size.

Table 4.1 Basic information of the respondents

Position	Work Scope	Number	Percentage
Owner/Investor	Overall implementation and operation	26	9.06%
Official	Official management and direction	15	5.23%
General contractor	General contract construction management	101	35.19%
Subcontractor	Trade subcontracting implementation	49	17.07%
Designer / Technicist	Design optimization and technical management of general and special projects	33	11.50%

Table 4.1 Basic information of the respondents (continued)

Position	Work Scope	Number	Percentage
Counselor or Supervisor	Supervision, inspection and guidance	17	5.92%
Supplier	Supplies of materials	39	13.59%
Transporter	Delivery of goods and materials	7	2.44%

4.2 Research Objectives

4.2.1 To analyze the existing gap between the actual implementation of the new Siem Reap International Airport terminal project and the relevant regional green building standards and real needs of Southeast Asian countries.

4.2.2 Identify the common convergence between China and Southeast Asian countries such as Cambodia in terms of green building technology application, material use, and supply chain.

Through sorting and statistics of all questionnaire data, the green building implementation score of each trade project is obtained, and the score can directly show the actual implementation level of green building from each trade projects of roof, curtain wall, air conditioning and. The option with a high score indicates that the actual implementation level of green building of the trade project is high, while the one with a low score indicates that there is a gap between the green building implementation of the project and the actual local requirements. There is still room for improvement in the implementation of the local similar projects in the future.

Table 4.2 Green building assessment score for the actual implementation

Category	Trade project			
	Roof	**Curtain Wall**	**Air conditioning**	**Water and electricity engineering**
Green designed	4.73	4.23	4.12	3.89
Material &Resources	4.32	4.17	3.97	3.97
Energy-saving	4.67	4.81	4.33	4.09
Sustainable Site Planning &Management (SM)	4.07	3.97	4.01	3.77
Indoor Environmental Quality	4.77	4.73	4.36	3.89
Total score	4.51	4.38	4.16	3.92

4.3 Green Designed

Through interviews with the designers, owners and operators of Siem Reap Airport, as well as comprehensive analysis of respondents' replies and other data, the following main conclusions are drawn about green design.

For civil airports, the terminal is the most important, most prominent and most representative building. For the city, the terminal is an important window, a symbol of the city's modernization. The passenger terminal is a functional transportation building directly serving passengers, a land and air connection and transfer system for passengers and luggage, the main building of the terminal area and the central building of the entire airport. Therefore, the design of the terminal is coordinated with the entire terminal area and practice the local green development and green building concept, The design of the terminal follows the following principles: green and convenient, energy saving and environmental protection, combining the existing resources and conditions of the airport, integrating the effect of Cambodian architecture, landscape and space, highlighting the iconic role, comply with the client's technical requirements and meet the functional requirements of the terminal, strive to make all kinds of streamline simple and smooth without crossing, convenient for passengers to use and owners to manage.

Terminal building design scheme and principles apply modern building materials, structural forms, construction methods and ecological technologies. The design idea of the terminal fully interprets the characteristics of the contemporary Cambodian national gateway architecture. The perfect unity of architectural form and structural design, architectural modeling for structural components, structural components have a strong expression, the design idea of structural aesthetics in line with the oldest design standards - solid, beautiful. The unity of architectural design and ecological design. The design mode integrated with nature is proposed, and various conditions such as local monsoon, rain, sunshine and temperature are taken as the design basis to jointly determine the shape, lighting, shading and ventilation of the building, thus truly realizing the green design from ecological technology measures to the overall building.

The plane configuration of the terminal is in the shape of a long bar, and the layout of two layers is half. The first layer is the arrival layer, the middle layer is the arrival mezzanine to solve the problem of inbound and outbound passengers, and the second layer is the departure layer. In the application of specific green building technology, a large number of green energy-saving optimization practices have been carried out, such as: terminal air conditioning and ventilation scheme design of air conditioning and ventilation system mainly include: air conditioning and ventilation air system and smoke control system. The baggage claim ticket hall, lounge area adopts full air system, air conditioning unit combination for fresh air, coarse filter section, mixed, tables, cold period of blower paragraphs. The air flow organization form is as follows: there is a ceiling space on the first floor, and the diffuser or strip tuyere is used to send it down according to the ceiling form, and the single-layer louver return air is set centrally. A spherical nozzle is used in the two-storey large space, and single-layer louver return air is set centrally. The office area adopts fan coil and fresh air air conditioning system, the fresh air unit adopts heat recovery type fresh air unit, and the combination of fresh air unit is: fresh air section, coarse efficiency filter section, heat recovery section, surface cooling section and fan supply section. The command center needs 24 hours uninterrupted operation area adopts variable refrigerant flow air conditioning system, and sets the fresh air system, and the fresh air unit adopts heat recovery unit. Weak current room, UPS room, etc., use air-cooled room dedicated constant temperature and humidity air conditioning units, and set up fresh air system, in order to maximize the purpose of saving energy consumption. Terminal distribution, the design principle of lighting solution to meet architectural modeling, and use the function of the process, reduce the power distribution system series, achieve the effect of energy saving, For especially important loads such as fire alarm and fire control system, all weak current systems and electronic facilities, emergency lighting (including evacuation lighting, safety lighting and 10% normal working lighting), UPS and EPS are set up as backup power supplies at the same time, two 22 kV power supplies are standby for each other, and any 22 kV power supply fails. The other 22 kV power supply can bear all one and two loads.

Lighting system: illuminance standard lounge: 200 lux corridor: roads 200 lux passenger: 300 lux VIP rooms: 200 lux business district: 300 lux elv room: 300 lux office space: 300 lux equipment room: 200 lux lamps and lanterns and light source selection ceiling forms according to the building public area and office area take the form of lighting is given priority to with compact energy-saving lamps and lanterns, lounge space using metal halide light tube light, substation, etc without condole top office room with derrick energy-saving fluorescent lamps, choose high quality grille lamp and the point light source of lamps and lanterns, The combination of flood lighting and local lighting is used in large space areas, and all fluorescent lamps, energy-saving lamps and gold halide lamps have their own power factor compensation capacitors, power factor compensation to 0.9. Emergency lighting within the current terminal emergency lighting adopts centralized emergency lighting power distribution unit (EPS), the emergency lighting distribution box distribution to emergency lighting lamps and lanterns. The emergency lighting fixture is usually involved in lighting, and is used as emergency lighting in the case of accidents. The evacuation indicating fixture is equipped with a battery. Lighting control within this period the public areas in the terminal building lighting set up public area lighting control system. The system provides communication interfaces with fire fighting and building control systems. In the building sewage and rainwater drainage system design in the shunt system. Domestic sewage is discharged into the airport sewage pipe through the community sewage network, and finally into the airport sewage treatment plant. The sewage water is mainly discharged to the outdoor sewage network by gravity flow, and then uniformly discharged to the airport sewage treatment plant through the outdoor sewage network. The rainwater adopts the underlying green space and the rainwater collection and reuse system. In addition, the center set up in front of the terminal landscape, mainly USES the low shrubs, grass and trees landscape green plant. On both sides of the viaduct, set up a green isolation belt between the work area, reduce the interference to the work area, and can also play a role in microclimate regulation. The greening of the work area adopts street trees and scattered greening.

4.4 Material &Resources

In terms of the use of green materials in Siem Reap Airport, the respondents have received sufficient positive feedback. Investors, owners, general contractors, subcontractors and material suppliers have all reported that Siem Reap Airport strictly follows various inspection standards in the actual use of materials, uses a large number of international advanced green materials, and makes innovative use based on the actual local climate conditions, The general contractor and subcontractor of the project conducted a large number of practical experiments to innovate the original technology and applied for a number of patents.

In the envelope system of Siem Reap new airport, a large number of new green materials and green processes are used, and a large number of new green building technology inventions have applied for patents, such as new materials - honeycomb aluminum plate instead of the traditional curtain wall material of aluminum veneer, aluminum honeycomb plate is the application of aviation and aerospace materials in the field of civil construction, not only good strength, and pollution-free, recyclable. The aluminum honeycomb core separates the inner and outer layers of the plate. Compared with the aluminum veneer, it has a good thermal insulation effect. The practice of Siem Reap Airport shows that it is a very successful environmental protection and energy saving product.

The facade of Siem Reap Airport terminal uses nearly 10,000 ㎡ of honeycomb aluminum plate. The panel is mainly made of high-quality 3003 alloy aluminum plate as the base material. The thickness of the panel is 0.8~1.5 mm fluorocarbon roller coated plate, the thickness of the bottom plate is 0.6~1.0 mm, the total thickness is 20 mm, and the core material is hexagonal 3003 aluminum honeycomb core. Aluminum foil thickness 0.04~0.06 mm, side length 5~6 mm, using roll forming technology to complete the forming of the positive and back skin, automatic machine equipment folding, positive and back skin in the installation side tightly bite. The whole processing process is completed in the modern factory, using hot pressing technology, because of the high heat conduction value between the aluminum skin and the honeycomb, the thermal expansion and contraction of the aluminum skin, There are small holes on the honeycomb aluminum skin, so that the gas in the plate can flow freely, The inner layer is a special hexagonal aluminum honeycomb, made of aluminum alloy with a hardness of H19, which acts as a core plate adhering to the sandwich structure and is subjected to pressure at the cut side. The total thickness of the aluminum honeycomb panel is 15 mm, and the aluminum honeycomb panel with a thickness of 1.0mm and the bottom plate is only 6 kg/㎡. The honeycomb plate with the same stiffness weighs only 1/5 of the aluminum veneer, 1/10 of the steel plate, and the interconnected aluminum honeycomb core is like countless I-beams, the core layer is distributed and fixed in the entire plate surface, making the plate more stable, and its wind pressure resistance is much higher than that of the aluminum plate and aluminum veneer, and it is not easy to deform, and the flatness is good, even if the cellular plate size is very large. It can also achieve extremely high flatness, The center is an aluminum hexagonal honeycomb, with a small density (about 3 to 7 kilograms per square meter), which is 1/5 of the weight of the wood with the same thickness and area, 1/6 of the glass and 1/7 of the aluminum, greatly reducing the building load and cost, because the middle sandwich contains a lot of air, Sound insulation (air insulation up to 30 dB), heat insulation (thermal resistance up to 0.02 ㎡·K/W), no combustible material, fire rating up to B1 level, waterproof, moisture-proof, no harmful gas release, the specific strength per unit mass is large, the specific stiffness is high (structural stiffness is 1.7 times of the rib-type), not easy to deform, It completely overcomes the defects of deformation and middle collapse of other decorative panels when the area of a single piece is large. Aluminum honeycomb plate front aluminum plate using the PVDF fluorocarbon paint surface in line with E.C.C.A. quality standards also has excellent weather resistance. Because the honeycomb core in the honeycomb composite panel is divided into many closed chambers, it prevents the air flow, so that the heat and sound waves are greatly hindered, and therefore, it has the effect of heat insulation, heat insulation and sound insulation. For 100-3200 HZ sound source bath can reach 20~30 dB, the thermal conductivity is 0.104-0.130 w/m.k, so the energy absorption capacity of aluminum honeycomb panel is 150-3500 KJ/M&sup2.

In the process of implementation, Siem Reap Airport has also carried out a number of patented technical inventions related to green buildings according to the local climate conditions, such as: the new type provided by the transverse frame support structure shading system, the utility model has the beneficial effects of the transverse frame support structure shading system: The sunshade system of the transverse frame support structure is connected and installed through the vertical steel frame upper ear plate to form the curtain wall frame system, and the sunshade unit system assumes the role of the transverse frame support structure. The horizontal setting of the sunshade system of the horizontal frame support structure can effectively shield direct sunlight, reduce glare, maximize the reasonable use of natural light, and meet the needs of building energy saving and daily life. Reasonable setting sun system, effectively cover direct sunlight, reduce glare, reasonable use of natural light to the greatest extent, meet the needs of building energy efficiency and daily life. mullion details node sunshade curtain wall system as showed in Figure 4.1.

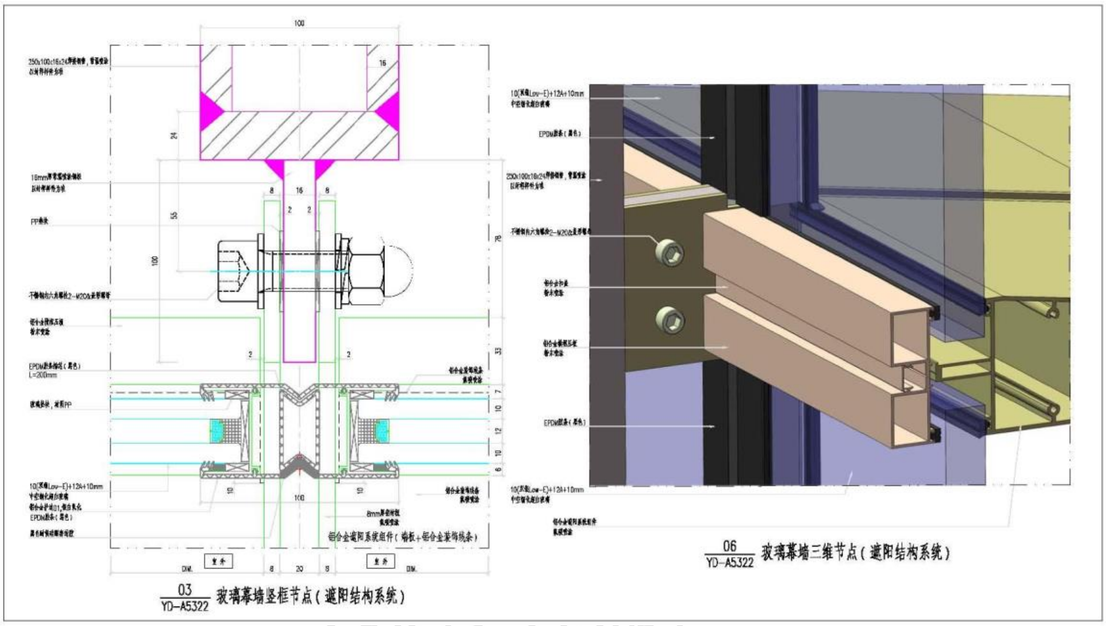

Figure 4.1 Mullion details node sunshade curtain wall system

Indoor air conditioning system adopts formaldehyde-free environment-friendly silencer air duct. The relevant parameters are: thickness of 25 mm, density of 96 kg/m3 or more, thermal conductivity of 0.033 w /m.k at 20 ℃, combustion grade of class A non-combustible material, average fiber diameter: 3~7 mm. The white coating on the inner wall of the formaldehyde-free duct can inhibit the generation of mold and bacteria, and has no water absorption. Ventilation duct is made of galvanized steel plate making, all the galvanized metal parts, the surface rust removal and brush anti-rust primer twice, The surface of non-insulated pipe fittings needs to be painted twice, and the smoke exhaust pipe laid in the suspended ceiling needs to be insulated. The insulation material is made of ultra-fine centrifugal glass surface with a thickness of 100 mm. As shown in Figure 4.2.

Figure 4.2 the insulation material

Pipe and insulation pipe USES the carbon steel pipe, all nominal diameter DN< For 100 mm, use thickened welded steel pipe (GB3092-82); DN≥100 mm, the application of seamless steel pipe (GB8163-87); DN≥250 mm, use spiral welded steel pipe. All cold water, hot water pipe insulation. Insulation material is centrifugal glass wool, nominal diameter DN≤40 insulation thickness is 35 mm, nominal diameter DN > 50 mm, DN < 100mm insulation thickness is 40 mm, DN≥125 mm, DN≤250 insulation thickness is 45 mm, DN≥300 mm insulation thickness is 50 mm, condensate pipe insulation thickness is 25 mm. Use PVC plastic pipe condensate pipes. Pipe connection: nominal diameter DN 32 mm or less, the threaded connection; Nominal diameter DN≥40 mm, welded connection; Valves are connected with flanges. Configuration is 3/4 "peak water piping system, automatic vent valve; In the system low, configuration DN25 drain valve of air conditioning water system heat preservation material thickness.

Table 4.3 Air conditioning water pipe insulation materia

Type of pipeline	**DN**	**Thermal insulation material**	**Insulation thickness（mm）**
Air conditioning cold water piping system and valve	DN≤25	Rubber and plastic insulation pipe	25
	32≤DN≤50	Rubber and plastic insulation pipe	28
	70≤DN≤100	Rubber and plastic insulation pipe	32
	125≤DN≤150	Rubber and plastic insulation sheet	32
	DN≥200	Rubber and plastic insulation sheet	36
Condensate pipe	-----	Rubber and plastic insulation pipe	9
		Rubber and plastic insulation pipe	13

4.5 Energy-saving

Through the collection and statistics of feedback on energy-saving of Siem Reap Airport, most respondents replied that energy-saving of Siem Reap Airport is crucial, which is not only the practical need to practice green buildings, but also a key factor related to the operating costs of the airport, under the guidance of the long-term planning principles of Siem Reap Airport, the total plane design of the terminal area of the airport at this period should be as compact as possible, and buildings with similar functions should be built together as much as possible, which is conducive to the effective use of land, so as to achieve the requirements of occupying less land and saving land resources. The power facilities such as cooling, water supply and power supply in the terminal area should be arranged as close to the load center as possible, and the route path should be reasonably selected to reduce the pipe network length and energy consumption, and facilitate operation and management. The traffic route design in the terminal area is simple and smooth, convenient for operation and management, saving ground transportation distance and time, and saving fuel energy. The energy-saving structure of building is mainly designed from two aspects: building wall and building roof. As for the energy-saving structure design of the building wall, according to the local climate characteristics, the external wall insulation system is designed to adapt to it, so as to reduce the building energy consumption, And adopt the corresponding window wall ratio to ensure the full use of natural lighting while maintaining the low energy consumption of the building, The building adopts natural passive ventilation system design to ensure the ventilation effect and reduce the building ventilation energy consumption. For the energy-saving structure design of the building roof, according to the local climate characteristics, considering that the local climate is tropical monsoon climate and the rainy season is long, the double slope roof design is adopted, On the one hand, it is convenient for rainwater discharge; On the other hand, ensure the ventilation and heat insulation of the building, thereby reducing energy consumption.

In strict accordance with the requirements of the energy-saving design standards for public buildings, the outer protective structure of the building is all made of external heat insulation structure, and the thermal insulation performance (heat transfer coefficient K) of the outer protective structure meets the specified limit. Natural ventilation and natural lighting is an effective measure to reduce the energy consumption of building use. The roof of the terminal is partially equipped with skylights, which introduce natural light to the center of the terminal and ensure the soft and comfortable natural lighting. Under normal daylight conditions, the interior of the terminal can rely on natural lighting to operate normally. In the transition season, natural ventilation can be relied on to meet the indoor environment temperature and humidity requirements. Inside the building, the divided work area is arranged against the external wall, through the opening of the glass window for ventilation and lighting, which is energy saving and environmental protection, and can improve the indoor air quality. Control the skylight area of the roof, and set electric sunshade components in the room to shield the direct sun light in summer. In order to meet the requirements of energy saving standard, reasonable control is put forward for shading coefficient of external wall glass.

Power supply engineering energy-saving measures: use low loss energy-saving transformer, The low voltage side is equipped with reactive power compensation capacitor to improve power factor and reduce line loss,Reasonable selection of power supply line section to reduce line loss, Adopt efficient and energy-saving gas discharge lamps and energy-saving distribution and transformation products to reduce power los, In strict accordance with the energy consumption indicators stipulated in the "Architectural Lighting Design Standard" (GB50034-2013), reasonable selection of lighting fixtures and light sources to reduce energy consumption, Reasonable design of lighting control mode, intelligent lighting control system is adopted to centrally monitor the lighting in the public area of the terminal. Set up the energy consumption monitoring system, collect, analyze and process the information of the energy using equipment and system. Cooling engineering energy saving measures: according to characteristics of the local energy, refrigeration station and supporting facilities choose energy-saving, environmental protection and efficient equipment, refrigeration efficiency efficiency should be consistent with the provisions of the "public building energy efficiency design standard". The design load of the refrigeration system is implemented with reference to the "Energy-Saving design Standards for Public Buildings" : the indoor refrigeration design is divided into reasonable systems according to the orientation, use function and use time, and is measured and adjusted according to the specific conditions of each system. The air conditioning system adopts variable air volume and variable flow system. The air conditioner adopts the fan tray and fresh air system, which can be opened according to the load change to achieve the purpose of energy saving, The operation state of the system is adjusted through the integration of mechanical and electrical to make the system run in high efficiency and low energy consumption. The insulation material of the cooling pipe should choose high quality products, In the transition season, strive to make full use of fresh air to reduce the time of equipment operation. At the same time, in order to prevent the loss of building energy consumption, an air curtain is set at the main entrance and exit.

Energy saving measures for water supply and drainage projects include: water supply should adopt speed regulating pump, use frequency conversion governor to control the running state of the pump, reduce the power consumption of the water supply system, so that the pressure and flow in the pipe network can be automatically adjusted according to the needs of users. Through the optimization of water supply network scheme, the efficiency of water supply network is improved. The use of high-quality pipes, improve the construction quality of the water supply network, the use of tight performance of better valves, reduce the pipe network may leak hidden dangers. Indoor sanitary appliances shall adopt water-saving products recommended by the state.

4.6 Sustainable Site Planning &Management (SM)

Through the statistics and analysis of the questionnaire feedback of general contractors, supervisors and subcontractors of Siem Reap Airport, it is shown that Siem Reap Airport has formulated strict rules and regulations on sustainable site management in the implementation of the project, and strictly implemented the relevant rules in the construction process, with good implementation effect, and fully guaranteed the green management of Siem Reap Airport in the implementation process.

The existing Siem Reap International Airport is only about 5 km away from the historical site of Angkor Wat, and the runway direction is northeast-southwest (05/23). The takeoff and landing routes have to pass over Angkor Wat, and the vibration caused by aircraft noise will destroy the stability of the masonry structure of Angkor Wat. According to the provisions of UNESCO on the protection of World historical sites, in order to prevent the damage of the historical sites caused by the noise and vibration of flights, eliminate the adverse impact of airport operation on the scenic area of Angkor Wat, and not only consider the construction project of the new airport, but also leave room for long-term development, To provide technical support for the healthy and sustainable development of the airport, re-select a new site to build Siem Reap New Airport through relocation, and the decision to build Siem Reap Angkor Airport itself is the best practice of green building concept. After the completion of the new airport can allow space for the development of the city, improve the rationality of the layout of the whole city. Old airport and surrounding land can better planning and business development, promoting the value of land use, increase the employment of new international airport in Siem Reap, Cambodia, feasibility study and based on the principle of sustainable development, planning and design for a large number of the main factors that impact on the environment of prophase techno-enabled, compare more solutions for key problems, Strive for optimal solutions and take preventive measures in advance, such as ecological impact, the construction of the airport will occupy a large amount of land, and construction activities such as the levelling of the construction site will destroy the surface vegetation, affect the habitat of local animals and plants, and affect the local ecosystem. Noise impact: Large mechanical equipment used in the construction process, such as bulldozers, road rollers, loaders, graders, excavators, pavers, generators (groups), mixers, etc., have high noise, which will have an impact on the surrounding acoustic environment. Influence of exhaust gas, in the period of construction, when the surface excavation, the bare soil losing the surface vegetation will generate dust in the wind under the construction disturbance, and the construction personnel will produce oil smoke and exhaust gas when they enter the food. During the transportation and handling of materials, a large amount of dust is scattered into the surrounding atmosphere. At the same time, the exhaust emissions of large construction machinery will also cause some pollution to the air.

Wastewater impact, construction machinery running, running, dripping, leakage of dirty oil and outdoor machinery washed by rain, resulting in a certain amount of oily sewage, construction materials washed by rain on the surrounding water pollution, construction workers produced domestic sewage, etc., will cause some pollution to the surrounding surface water and groundwater. Solid waste during the construction period: the domestic waste generated by the construction side and construction personnel will have an impact on the surrounding environment.

Noise control measures during construction period mainly from the following requirements: the use of reasonable arrangement of construction machinery and equipment to reduce noise using time, strengthen the maintenance of all kinds of construction machinery, reduce construction machinery noise emissions, strictly prohibited piling machinery used in the night. During the construction process, the main high-noise equipment should be placed in an appropriate position or sound insulation and noise reduction measures should be taken. In the structural construction stage, the concrete pump and concrete tank truck can be built a simple enclosure to reduce noise, and strengthen the maintenance of the concrete pump, strengthen the training and responsibility education of the construction personnel, to ensure the smooth operation of the vehicle.

Construction dust control measures mainly include: during the period of construction is timely on site storage of earthwork sprinkler, in accordance with the relevant construction standards for retinal coverage, at the same time should be to keep its surface moist, or take cover way, to reduce the discharge of dust. It is forbidden to stack building materials in the open air, and fine granular bulk materials should be stored in the warehouse and handled gently to prevent the rupture of the packaging bag. Restricted access transport vehicle speed, but also for transportation, lime, cement, earthmoving and construction garbage easily generate dust vehicles to cover tightly, avoid scattered along the way. Vehicles entering and leaving the site should build a washing tank at the site gate in accordance with the relevant construction regulations to clean or sweep the wheels to avoid bringing dirt into the city road. The construction site should be equipped with enclosures or partial enclosures to reduce the diffusion range of construction dust and reduce the pollution of dust to surrounding units.

Water pollution prevention and control measures of construction period:the airport during the construction of water pollution is mainly manifested in the rain will wash and engineering construction site in sludge oil into the natural water and groundwater. Therefore, in the construction process, it is necessary to do the hardening of the construction road and the daily maintenance of the construction machinery. In this way, water pollution problems during construction can be avoided. For construction workers and emissions of water need to establish a unified deployment of management system. The domestic sewage should be collected and treated in a unified manner. Avoid domestic sewage pollution of the surrounding environment. Solid waste treatment in the airport construction project during the construction period will produce large amounts of construction waste and daily life garbage workers, in order not to affect the surrounding environment, during the period of construction of the construction waste will strictly abide by the relevant laws and regulations of the construction waste emissions and at the same time, the maximum to avoid the development area of grass and destruction and pollution of surface waters. Do a good job of closed transfer of engineering waste. At the same time, the domestic waste generated by workers should be collected and transported in a unified manner.

4.7 Indoor Environmental Quality

Siem Reap Airport plans to receive more than 5 million passengers every year, and indoor environment is crucial to the success of the project. According to the screening and classification statistics, the respondents' responses received a high evaluation of indoor environment, and most respondents replied that Siem Reap Airport has made a large number of feasible measures to improve indoor environment. It has a tropical monsoon climate, with a rainy season from May to October and a dry season from November to April. The average daily temperature in summer is close to 30℃, and the average daily temperature in winter is more than 25℃. The hottest month is April, with an average daily temperature of 29.8 ° C and the hottest month with a maximum daily average temperature of 37.8 ° C. The weather is hot and humid rainy season, the weather is mild in December to February less rainfall, noon sun is very strong, siem reap, airport air for best practice concept of green building, the largest indoor environment could be improved, set up strict interior design parameters such as show in table.

Table 4.4 Interior design of Siem Reap terminal

Area	Dry-bulb temperature (℃)	Relative humidity (%)	Personnel density (㎡ /P)	Fresh air volume (m3/h.P)	Permitted noise level in room (dB)
Ticket office, baggage claim, departure	≤26	≤60	5	25	≤45
Office or ancillary premises	≤26	≤60	10	30~35	≤40
VIP room	≤24	≤55	10	50	≤45

Through a series of the application of the green building technology to ensure the indoor environment to meet the design parameters, such as: the ventilation and smoke exhaust system some toilet, smoking room and equipment houses were set mechanical ventilation system, air blower set in a layer of the fan inside the room. The substation design and mechanical exhaust, machinery repair air ventilation system. The ventilation amount is calculated according to the heat of the process equipment to eliminate the residual heat and humidity in the room. A layer of baggage claim hall, indoor length of more than 20 meters within the corridor and the rooms are set to smoke mechanical exhaust system. Large space on the second floor set the power sunroof natural smoke exhaust. The indoor smoke-proof stairwell is equipped with a mechanical pressure air supply system. Duct, indoor air-conditioning duct insulation and paint with hcho-free environmental sound duct. The relevant parameters are: thickness of 25 mm, density of 96 kg/m³ or more, thermal conductivity of 0.033 w /m.k at 20 ℃, combustion grade of class A non-combustible material, average fiber diameter: 3~7 mm. The white coating on the inner wall of the formaldehyde-free duct can inhibit the generation of mold and bacteria, and has no water absorption. Ventilation system of the duct is made of galvanized steel plate making. All non-galvanized metal parts, the outer surface should be removed rust and brush anti-rust primer twice, The surface of non-insulated pipe fittings needs to be painted twice. The smoke exhaust duct laid in the ceiling shall be insulated. The insulation material shall be ultra-fine centrifugal glass surface with a thickness of 100 mm.

Aircraft noise pollution prevention and control measures to aircraft noise pollution is a major pollution, airport and airport planning is very important. According to the analysis of the influence curve of airport noise of the same type and level, the 70 dB contour of aircraft noise in this airport includes roughly 5000 m at both ends of the runway and 800m at both sides of the runway. Under normal circumstances, residents whose noise is greater than 85 dB should be relocated, and buildings should be sound-proofed between 75 and 80 dB of noise. The airport aircraft noise larger influence on terminal. The insulating glass used in the exterior window of the building has the function of eliminating aircraft noise. From past experience, it is not necessary to completely reduce aircraft noise in the terminal, because the terminal is a public transport facility with a large number of people, and a certain amount of noise is acceptable as long as the noise does not reduce the clarity of the public address system. Terminal operating noise pollution prevention and control measures in use in the project of the ventilation and air conditioning system of the noise of the fan at run time to produce large, most of the more than 80 db. In order to reduce the impact of noise on the environment, high efficiency and low noise equipment are preferred in design, and shock absorption devices are set up. The air conditioning unit is provided with a silencer on the supply and return air pipes, and a silencer on the inlet and outlet of the fan (except the smoke exhaust machine), The connection between the equipment and the air duct shall be connected with non-combustible soft joint, Air conditioning units, water chillers and water pump supply and return pipes are equipped with vibration isolation pipes to eliminate mechanical vibration and noise.

Airport sewage is mainly domestic sewage, in addition to a small amount of production wastewater, including oil tank cleaning water, boiler room regular drainage, car wash water, road flushing water. Sewage treatment plant construction area of 100 m^2, sewage treatment facilities, covers an area of about 1200 m^2, buried form for the whole, all processing unit under the green space construction, does not affect the ground landscape. Terminal, the oil-water separator, office buildings and so on sewage pretreatment of oil depot oily waste water, the oil separation treatment of oily sewage, all kinds of sewage and wastewater after pretreatment to the sewage treatment station, After treatment, the qualified sewage is discharged into the reuse pool in the airport, which is used as the airport greening irrigation water. The water quality of the reclaimed water shall meet the local water quality standards for urban greening.

A landscape center is set up in front of the terminal building, which is mainly landscaped with low shrubs, grass and street trees. On both sides of the viaduct, set up a green isolation belt between the work area, reduce the interference to the work area, and can also play a role in microclimate regulation. The workspace the planting trees and sporadic greening.

Determining the airfield terrain design on the basis of the principle is: On the basis of meeting the technical standards for the flight area of civil aviation airports, taking into full consideration the relationship between short-term projects and long-term development according to the layout of the general plane of the airport, combined with the actual situation of the site, while meeting the safety and stability of aircraft operation, conducive to the construction of supporting facilities and ancillary facilities, and meeting the drainage requirements of the flight area, fully combining the existing terrain conditions, Strive to reduce the amount of earthwork, save investment. The terrain design is closely combined with the drainage design, and the layout of the drainage line enables it to quickly collect and remove surface rainwater in the flight area, reflecting the principle of technical rationality and economic saving, and taking into account the elevation connection with the terminal area. On the place to prevent the slope surface slope rainfall infiltration and flowing directly scour, vegetation was carried out on the slope surface processing, and can meet the requirements of soil and water conservation.

Air conditioning wind system terminal check-in hall, at the scene of the joint inspection, baggage claim hall and the terminal such as large space adopts modular air conditioning units, VIP \ CIP, commercial retail, office and other small space by two control fan coil plus fresh air system, The dining area adopts exhaust + supplementary air (fresh air unit) DC system (kitchen area), two-pipe fan coil (dining area), PCR\DCR\SCR and other strong and weak current room adopts variable refrigerant flow multi-link system (precision air conditioning +VRV). Air conditioning units and fresh air units on the supply air duct of muffler and muffler elbow, air valve, return air valve adopts adjustable air valve and chain with each other. The CO2 sensor is set in the main return air duct of the air conditioner to control the minimum fresh air volume under the minimum fresh air condition and the minimum fresh air volume under the low frequency operation of the air supply unit of the air conditioner to ensure the minimum fresh air volume requirement under the low frequency operation of the system. Fire water pump room ventilation system supply air directly by the outdoor fresh air after fresh air unit treatment add, Mixed flow fan is used for air exhaust in the bathroom, and the air supply mode is negative pressure inhalation, The induction fan system is set in the baggage handling room for auxiliary ventilation. The air supply mode is negative pressure inhalation. The exhaust system automatically controls the fan operation according to the internal temperature of the equipment room. Gas fire protection zone in gas disaster at the back of the wind system and ventilation system share or separate setting at ordinary times, send, air exhaust duct path are set and gas fire extinguishing control chain of electric valve, to ensure that the gas out the protection zone ventilation pipe to shut down in front of the gas release. The air supply and exhaust units are respectively equipped with electrical switches in indoor and outdoor locations that are convenient for operation. Kitchen ventilation using dc system. The replenishment air volume is 80% of the total exhaust air volume. The kitchen replenishment air is directly replenished by the outdoor fresh air treated by the fresh air unit. After the local exhaust air is treated by the oil fume purification device, it meets the "Comprehensive Emission Standard of Air Pollutants" GB16297-1996 standard and is discharged centrally. The exhaust unit of the kitchen stove adopts the centrifugal fan outside the motor, and the supplementary air unit is interlocking with the corresponding exhaust unit.

Air conditioning water system of this project only summer cooling air conditioning system, the winter without heating demand. The air conditioning cold source of the terminal is provided by the planned energy center in the terminal area.

The total cooling load of the terminal in summer is about 14000 kW, and the air conditioning cold source adopts electric compression refrigeration equipment. Air conditioning water system consists of two control systems, the summer is supply and return water temperature 7 ℃ ~ 12 ℃. Air handling units, fresh air units chilled water return pipe is set on the dynamic balance of electric control valve, air handling unit by controlling the water valve opening size, which can realize the control of indoor temperature (return air temperature), The fresh air unit can control the fresh air supply temperature by controlling the opening degree of the water valve. Each layer water supply branch main fan coil set manual balance valve, the water branch main set self-reliance type differential pressure control valve, fan coil terminal set electric two-way valve. When the indoor cooling load changes, the temperature controller with the fan three-speed switch in the room controls the electric two-way valve (turn on and off) on the refrigerated return pipe of the fan coil to run the water flow or select the fan coil at low, medium and high speed to maintain the indoor temperature. Terminal system pipe ends differential pressure control secondary pump running frequency (speed), the energy centre, the main secondary pump system in traffic signal control secondary pump running number. Chilled water air conditioning water system pipe set ion exchange water softener and automatic filter device, the cooling water system set up automatic dosing drainage device. The lowest point of the water system is equipped with a water discharge valve, the discharge pipe is connected to the nearest sump or trench, and the highest point and end are equipped with an automatic exhaust valve. Terminal PCR set inside computer room precision air conditioning system, refrigerant R410a, power distribution, humidifier, other room use VRF air conditioning system. Fire control center, the control center building, luggage monitoring center (including reading room) and part of substation room set variable refrigerant flow systems (VRV) compressor adopts frequency conversion control technology, refrigerant R410a.

4.8 Green building supply chain .

Through the collection of responses from general contractors, subcontractors, suppliers, and logistics carriers, Siem Reap Airport's supply chain has undergone the most stringent test during the implementation process, although the project has experienced unprecedented obstacles in customs clearance and logistics transportation due to the impact of the COVID-19 pandemic during the implementation phase.

Figure 4.3 Logistics transportation

The governments of China and Cambodia, as well as the owners and general contractors, have ensured a reasonable and smooth supply chain through adequate efforts, which also shows that it is completely feasible for China and Southeast Asia countries like Cambodia to jointly build and share a sustainable supply chain for green buildings.

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1	3209909090	钢结构防火涂料 1|0|聚磷酸铵45%.季戊四醇25%.三聚氰胺10%.苯丙乳液10% 水10%|适用于钢结构	60000千克 60000千克	1.6879 101274.00 美元	中国 (CHN)	柬埔寨 (KHM)	(13019)石家庄其他	照章征税 (1)
2	3209909090	钢结构防火涂料 1|0|聚磷酸铵45%.季戊四醇25%.三聚氰胺10%.苯丙乳液10% 水10%|适用于钢结构	40800千克 40800千克	1.6879 68866.32 美元	中国 (CHN)	柬埔寨 (KHM)	(13019)石家庄其他	照章征税 (1)
3	8424899990	多功能喷涂机 1|0|防火涂料施工喷射出料|巨森|防火涂料|4KW卧式喷涂机	2台 550千克 2台	759.4350 1518.87 美元	中国 (CHN)	柬埔寨 (KHM)	(13019)石家庄其他	照章征税 (1)
4	3926909090	胶套 1|0|防火涂料施工|塑料|巨森|D8-2	1.5千克 25个	32.5472 813.68 美元	中国 (CHN)	柬埔寨 (KHM)	(13019)石家庄其他	照章征税 (1)
5	8503009090	螺杆 1|0|电机零件|巨森|无型号	4千克 10个	36.1640 361.64 美元	中国 (CHN)	柬埔寨 (KHM)	(13019)石家庄其他	照章征税 (1)
6	8424200000	喷枪 1|0|防火涂料施工喷射材料|巨森|防火涂料|D160	2个 10千克	37.7350 75.47 美元	中国 (CHN)	柬埔寨 (KHM)	(13019)石家庄其他	照章征税 (1)

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Figure 4.4 Customs declaration form

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CHAPTER 5
CONCLUSION

The last chapter is the summary of this study, and tries to put forward some suggestions and thoughts for future research.

5.1 The Results of Research Objective 1

To analyze the existing gap between the actual implementation of the new Siem Reap International Airport terminal project and the relevant regional green building standards and real needs of Southeast Asian countries. Through a detailed study on the classification of major trade projects such as roof, curtain wall, air conditioning, water and electricity engineering, this study draws the following conclusions through comprehensive analysis:

5.1.1 The four trade projects of comprehensive roof, curtain wall, air conditioning, water and electricity engineering scored a weighted average total score, Siem Reap Airport scored 4.24 points out of 5 points in green building implementation, indicating that Siem Reap Airport has achieved great success in green building implementation, Siem Reap Airport Terminal Project has made a lot of excellent practices in the field of green building. It has deeply practiced the concept of green building from the beginning of planning and design, extensively applied green technology in the implementation of the project, and innovated the use of green building technology and materials from China in combination with local climate characteristics. It also ensured the sustainability of the entire project supply chain during the COVID-19 pandemic, making it a good example of green public buildings in the international construction market.

5.1.2 The water and electricity engineering trade project only got 3.9 out of 5 points in all trade projects, which is the only one lower than 4 points in all trade projects, indicating that the green building implementation of Siem Reap Airport is not perfect in terms of water and electricity engineering projects, and there is still much room for improvement in the later stage. According to the follow-up survey of the general contractor and subcontractors, due to the impact of the COVID-19 epidemic, Siem Reap Airport purchased a certain proportion of water and electricity engineering materials from the local authorities in order to save time and complete the project navigation task on time. Although the standards for the use of relevant green building materials were strictly followed, it still had an impact on the overall project implementation. At the same time, there was no other building development around the airport. Investors and owners canceled the original planned rainwater recycling system, which is also an important reason why water and electricity engineering can not get high points for green building implementation.

5.2 The Result of Research Objective 2.

Identify the common convergence between China and Southeast Asian countries such as Cambodia in terms of green building technology application, material use, and supply chain, the results of this objective are as follows:

5.2.1 China's building energy saving technology is mainly concentrated in two aspects of building, envelope structure and equipment system, including doors, Windows, roofs, floors and walls, which is the same as the green energy saving technology in Southeast Asia. China's green building development direction and standards in regions with similar climates at the same latitude are basically the same as those in Southeast Asia. This shows that China and Southeast Asian countries can share materials and technologies in the development of green building technologies. Similar to Southeast Asian countries, in China, the roof insulation material is lightweight and efficient and can be used for long-term stable performance. Energy-saving technologies related to air conditioning systems, including ice storage technology, heat pump technology, solar adsorption air conditioning have been rapidly developed and applied to the Southeast Asian market. In terms of energy-saving technology for building equipment, green lighting, passive energy-saving technology and natural ventilation, natural lighting, shading, have been fully verified in the implementation of Siem Reap Airport, which is suitable for the future development direction of green buildings in Southeast Asian countries, China leads the world in terms of both technology and scale of new energy development, and there is huge room for the development of shared technologies in making full use of solar, wind, biomass and other renewable energy sources.

5.2.2 With the deepening of economic globalization, the links between countries will become closer and closer. By establishing the infrastructure network of many Southeast Asian countries and strengthening the exchanges and cooperation between them, the logistics supply chain between China and Southeast Asian countries will be guaranteed more efficiently. The author of this thesis also has the honor to participate in the construction of the highway from China to Laos. In the future, the road can also connect to other Southeast Asian countries, when the land transportation between China and Southeast Asian countries will be more efficient, even in the past three years during the COVID-19 epidemic between China and Southeast Asian countries have maintained smooth logistics. Therefore, the construction and sharing of sustainable supply chains between China and Southeast Asian countries is completely feasible and inevitable for the development of the world economy.

5.3 Suggestions for Future Study

Challenges and problems exist in the realistic scenario of the sustainable procurement supply chain between China and Southeast Asia and other countries. Although each country has almost the same goal direction for green buildings, the methods, regulations, policies and application technologies of each country are different. "Mankind is living in the same global village, in the same time and space where history and reality meet. We are increasingly becoming a community with a shared future." A comprehensive consideration of the green building supply chain from the perspective of a wider geographical region will also be more conducive to the saving of resource consumption by all mankind and the practice of the concept of green building. Therefore, this thesis aims to propose a feasible analysis and method to fill the gap in this respect. The possibility and direction of establishing a more sustainable green building supply chain across countries and regions through the implementation case study of the Siem Reap Airport Terminal project.

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APPENDIX

Questionnaire

The Analysis of the existing gap between the actual implementation of the new Siem Reap International Airport and the relevant regional green building standards

This questionnaire consists of 3 sections of questions as follows:

Part 1: Basic information about the respondents, the scope of work they are responsible for, and the services they provide.

Part 2: Information on the implementation of the Siem Reap Airport project, especially from the aspects of green design, Material &Resources，Energy-saving, Sustainable Site Planning &Management (SM)，Indoor Environmental Quality，to describe the implementation of the Siem Reap Airport project and conduct score evaluation as the basis for data analysis.

Part 3. Suggestion

The researcher kindly requests your help in answering a questionnaire regarding your opinions. Please prioritize both your importance and experience on all topics. Thank you for your participation. This research will not affect the organization directly, but it will benefit the organization and the wider academic community.

Zheng Guan

Student ID 650920047

Student Program in Engineering Management

Department of Industrial Engineering and Management

Graduate School, Silpakorn University

Instruction: Please provide an explanation and mark it clearly✓ right channel ❒ Please read the provided text and answer one question with as much accuracy as possible.

Part 1

1. Gender 1.❒ Male

2. Age 1.❒ 20- 29 Years

2.❒ 30- 39 Years

3.❒ 40- 49 Years

4.❒ 50- 59 Years

5.❒ 60 years or older

3. Education

1.❒ Under Bachelor's Degree

2.❒ Bachelor's Degree

3.❒ Master's Degree

4.❒ Doctoral Degree

5.❒ Other (please specify)..................

4. Position

1.❒ Owner/Investor

2.❒ Government official

3.❒ General contractor

4.❒ Subcontractor

5.❒Designer / Technicist

6.❒ Counselor or Supervisor

7.❒ Supplier

8.❒ Transporter

5. Period service for the project

1.❒ 3 Months

2.❒ 3-6 Months

3.❒ 6-12 Months

4.❒ more than 12 Months

6. Entire period of actual operation.

1.❒ 3 Years

2.❒ 4-6 Years

3.❒ 7-9 Years

4.❒ 9 Years or more

<u>Part 2</u>

Questions

1. What professional services did you provide for the implementation of Siem Reap Airport? In terms of your services, can you describe what green building materials and technologies you have successfully used in the implementation of Siem Reap Airport?

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2. please describe in detail what innovations and efforts you have made in the implementation of Siem Reap Airport in terms of Green designed, Material &Resources, Energy-saving, Sustainable Site Planning &Management (SM), Indoor Environmental Quality.

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3. Can you describe what efforts you have made to ensure that the green building designs, technologies and materials that you have applied meet the actual needs of the local green building community?

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4. Can you describe the similarities and differences between China's green building technology and materials and the actual needs of Southeast Asian countries?

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5. Can you describe what you think can be improved in the implementation of green building in Siem Reap Airport project?

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6. Can you describe the use of green materials that Southeast Asian countries can share with China and other countries in their supply chains?

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7. On a scale of 1-5,Please give a green building assessment score for the actual implementation of various professional projects of Siem Reap Airport.

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....

The actual implementation of green building assessment scoring	Level of Implementation				
	5 Very High	**4 High**	**3 Moderate**	**2 Low**	**1 Very Low**
1. Roof					
1.1 Green designed					
1.2 Material &Resources					
1.3Energy-saving					
1.4 Sustainable Site Planning &Management (SM)					
1.5 Indoor Environmental Quality					
2. Curtain Wall					
2.1 Green designed					
2.2 Material &Resources					
2.3 Energy-saving					
2.4 Sustainable Site Planning &Management (SM)					
2.5 Indoor Environmental Quality					
3. Air conditioning					
3.1 Green designed					
3.2 Material &Resources					
3.3 Energy-saving					
3.4 Sustainable Site Planning &Management (SM)					
3.5 Indoor Environmental Quality					

The actual implementation of green building assessment scoring	Level of Implementation				
	5 Very High	4 High	3 Moderate	2 Low	1 Very Low
4. Water and electricity engineering					
4.1 Green designed					
4.2 Material &Resources					
4.3 Energy-saving					
4.4 Sustainable Site Planning &Management (SM)					
4.5 Indoor Environmental Quality					

8. On a scale of 1-5, How important do you think the following options are to the successful implementation of green buildings at Siem Reap Airport.

Condition	Level of Important				
	5 Very important	4	3	2	1 not important
Conformity of the performance of the green building assessment table					
Green construction process					
Green supply chain					
Practice green behavior					

Part 3

In your field of expertise, how can China and Southeast Asian countries share and build a sustainable supply chain for green buildings? Please provide your ideas and explanations.

Suggestion……………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………

มหาวิทยาลัยศิลปากร

VITA

NAME	Zheng GUAN
INSTITUTIONS ATTENDED	1. Chengnan College, Changsha University of Science and Technology Bachelor's degree in Economics, 2. Silpakorn University, Master of Engineering, Program in Engineering Management

มหาวิทยาลัยศิลปากร