"I hereby declare that I have read through this report entitled "Applying Green Building Strategies to a New Commercial Building (Restaurant)" and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (industrial Power)"

Signature : …….

Name : …….

Date : …….

APPLYING GREEN BUILDING STRATEGIES TO A NEW COMMERCIAL BUILDING (RESTAURANT)

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This report is submitted in Partial Fulfillment of Requirements for the Degree of Bachelor of Electrical Engineering (Industrial Power)

Faculty of Electrical Engineering

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2016

I hereby declare that this report entitled "Applying Green Building Strategies to a New Commercial Building (Restaurant)" is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : …….

Name : …….

Date : …….

Dedicated to my beloved parents, siblings

Lecturers and friends

For their love and sacrifices

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ABSTRACT

In this modern era, an enormous amount of energy is being devoured in Malaysia every single day. One of many reasons of the massive amount of energy consumed is due to the vast developing cities with growing number of building constructions. Most of the construction of buildings in Malaysia does not obey the green building strategies which in a long term, will contribute to pollution and hence the global warming. The main purpose of this report is to expose an overview of an installation of electrical equipment based on the Green Building Index (GBI) for a restaurant construction. Other than that, one of the main points is to compare the conventional and GBI building construction in terms of cost and efficiency. The cost of construction covers two major parts, they are the capital and savings. On the other hand, the efficiency of a building covers on the carbon dioxide emission, building energy index (BEI), and energy efficiency index (EEI). This report includes the development and design of a new green building construction (restaurant) by focusing on the green building strategies in term of energy efficiency. The design is lodged mainly to better the development of green building in order to improve the lifestyle of modern living. This project analyses the lighting system and the total electrical load by using DIALux software. Other than that, the HVAC system, SSO design, and even protective devices and cable selection will be done in this project in order to apply maximum effort towards the GBI standards. In brief, this is a project that further explains the basic study of indoor lighting performance in a restaurant.

ABSTRAK

Dalam era serba moden ini, sangat banyak tenaga digunakan di Malaysia pada setiap hari. Salah satu daripada sebab jumlah besar tenaga yang digunakan adalah kerana bandar-bandar sedang pesat membangun dan juga projek pembinaan bangunan yang semakin banyak. Kebanyakan pembinaan bangunan di Malaysia tidak mematuhi strategi bangunan hijau yang akan menyumbang kepada pencemaran dan pemanasan global dalam jangka masa panjang. Tujuan utama laporan ini adalah untuk mendedahkan gambaran keseluruhan pemasangan peralatan elektrik berdasarkan Indeks Bangunan Hijau (GBI) untuk pembinaan restoran. Selain daripada itu, salah satu perkara utama adalah untuk membandingkan pembinaan konvensional dan bangunan GBI dari segi kos dan kecekapan. Kos pembinaan meliputi dua bahagian utama iaitu modal dan simpanan. Selain itu, kecekapan bangunan meliputi pelepasan karbon dioksida, indeks tenaga bangunan (BEI), dan indeks kecekapan tenaga (EEI). Laporan ini juga mengandungi pembangunan dan reka bentuk pembinaan bangunan hijau (restoran) baru dengan memberi tumpuan kepada strategi bangunan hijau dari segi kecekapan tenaga. Reka bentuk yang dibuat bertujuan memperbaiki pembangunan bangunan hijau dalam usaha untuk meningkatkan gaya hidup kehidupan moden. projek ini menganalisis sistem pencahayaan dan jumlah beban elektrik dengan menggunakan perisian DIALux. Selain daripada itu, sistem HVAC, reka bentuk SSO, peranti perlindungan, dan pemilihan kabel akan dilakukan dalam projek ini untuk berusaha sepenuhnya ke arah piawaian GBI. Pendek kata, ini adalah satu projek yang akan menjelaskan kajian asas prestasi pencahayaan dalaman di sebuah restoran.

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GBI	-	Green Building Index
MS	-	Malaysian Standard
LED	-	Light Emitting Diode
HVAC	-	Heating, Ventilating, and Air-Conditioning
SSO	-	Switch Socket Outlet
VRV	-	Variable Refrigerated Volume
JKR	-	Jabatan Kerja Raya
EE	-	Energy Efficiency
LLF	-	Light Loss Factor
BF	-	Ballast Factor
RSDD	-	Room Surface Dirt Depreciation
LLD	-	Lamp Lumen Depreciation
LDD	-	Lamp Dirt Depreciation
PAM	-	Pertubuhan Arkitek Malaysia
ACEM	-	Association of Consulting Engineers Malaysia
IES	-	Illuminating Engineering Society

CHAPTER 1

INTRODUCTION

1.1 Project Background

The global warming which is the raise in Earth's average temperature which caused by the thinning of the ozone layers has been increasing from time to time is a worldwide problem based on reference [1]. In order to resolve this crucial complication, solutions are required to at least decrease the global warming. One of the solutions available is to apply green building strategies in the construction field. On 2014, construction sector consumed 50% of the global energy which is the largest compared to transportation sector and industrial sector which consumed 20% respectively and 10% for the other sectors [2].

The construction industry is said to be one of the major industries that influence the economic growth of any country, based on reference [3]. The nature of construction movement makes a gigantic change to the natural landscape. Focusing on decreasing the environmental impacts, the Japanese has been extending the infrastructure service life by improving the sturdiness of the design and taking into account the life-cycle cost. There are researches that are still being handled in the construction industry although the significance of sustainable building was already widely acknowledged [4].

In order to achieve the Green Building Index (GBI) in Malaysia, there are several criteria to be considered including the Indoor Environment Quality, Material and Resources Energy Efficiency, Water Efficiency, Sustainable Site Planning and Management and Innovation. Pertubuhan Arkitek Malaysia (PAM) or also known as the Malaysian Institute of Architects and the Association of Consulting Engineers Malaysia (ACEM) are responsible in developing the Green Building Index (GBI).

Cited from reference [5], green building or also known as a sustainable building is defined as a structure that uses environmentally responsible and efficient resources throughout the whole building life-cycle. The life-cycle of a building includes the siting, design, construction, operation, maintenance, renovation and demolition. Green buildings are developed to maintain the balance between human and nature and also in order to improve the lifestyle of the human beings without harming the natural environment, or at least reducing the risk.

The Malaysian Standard [6], MS 1525:2007 which is The Code of Practice on Energy Efficiency and The Use of Renewable Energy for Residential Building has been introduced to promote the sustainable energy practices.

This project focuses on the green building movement in order to reduce pollution and minimize the world energy consumption. A single story restaurant will be designed by applying the green building strategies.

1.2 Problem Statement

At the moment, global warming has been an enormous threat to the human being due to the deforestation, pollution and vast urbanization. As time passes by, people tend to be more creative and intelligent in order to enhance the quality of living. However as the world modernize, people slowly starting to forget and ignore about the environment and the health of nature. Energy demands are peaking because of the rapid construction of buildings either for commercial or residential use. Rate of pollution increase as the rate of energy generation and production increase. Pollution causes the depletion in air quality and results in the increment of carbon dioxide emission. The green building movement is later founded focusing on saving energy in order to at least reduce the pollution by minimizing the usage of non-renewable resources and save construction cost. As a result, to overcome this crucial problem, a restaurant will be built based on the green building index by focusing on energy saving and energy efficiency. This project has an objective that should be achieved to complete the problem statement above.

1.3 Objectives

The major purpose is to design a new construction for a commercial building (restaurant) by focusing on the green building strategies. Yet, there are some other objectives that have to be covered in order to achieve this new construction for commercial building (restaurant) which are:

a) To develop the lighting system by using the DIALux software.
b) To analyze the electrical load before and after applying the GBI standards.
c) To design the layout of the plan such as lighting system, air-conditioning, switch-socket outlet (SSO), protection system and cable selection in the commercial building (restaurant) based on Malaysian's Green Building Index (GBI) using AutoCAD software.

The objective can be achieved by focusing on the scope of work that is needed in this project.

1.4 Scope of Work

This project focuses on the analysis and development according to the assessment of the Green Building Index (GBI) which includes Energy Efficiency, Indoor Environment Quality, Sustainable Site Planning and Management, Water Efficiency, Innovation, Materials and Resources. Apart from that, AutoCAD software will be used to draw the plan for the restaurant while DIALux software will be used to show the brightness of lighting. The commercial building is composed of a single level which includes dining room, corridor, kitchen, chiller and freezer room, outdoor dining, customer switch room, EP room, male toilet, female toilet, male prayer room, female prayer room, hose reel pump room, and overall outdoor area.

All spaces included inside of the plan is designed completely using AutoCAD. After the design plan for this commercial building is completed, the electrical installation will be scheduled. This study focuses on the electrical installation which includes the installation of the lighting system, air-conditioning system, switch socket system (SSO), protection system, and cable selection to examine the energy saving performance.

Electrical installation in context of the sentences above means that every level, every area, and every room shall undergo the electrical installation in order to complete this building before it can be used commercially.

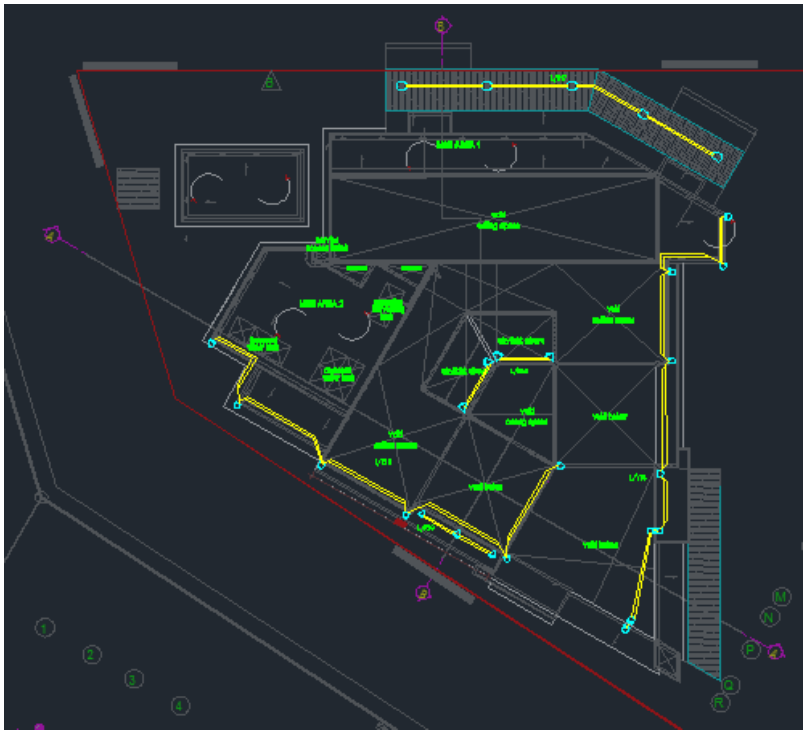

Figure 1.1: Restaurant Floor Layout

Figure 1.1 shows the layout of the first floor of the restaurant. It consists of dining room, corridor, kitchen, chiller and freezer room, outdoor dining, customer switch room, EP room, male toilet, female toilet, male prayer room, female prayer room, hose reel pump room, and overall outdoor area.

In order to build this restaurant, the rules of electrical installation must be followed as set by the IEEE regulation, JKR electrical standard and Electricity Supply Application Handbook of Tenaga Nasional Berhad (ESAH TNB). The electrical installation of a new construction building must follow the rule based on the regulation terms and conditions even though Green Building Index (GBI) is applied in the implementation of the new construction commercial building (restaurant). As for the constructability, the design of the restaurant was developed to be constructible. The design of this restaurant was developed by using AutoCAD, energy and cost data. The data is not limited to one particular state or town in order to provide a wide range of location for the restaurant to be built. The use of common and accessible construction materials, and a repetitive design makes the restaurant simple and easy to construct.

CHAPTER 2

LITERATURE REVIEW

In this chapter, the theory and basic principles in developing this system will be further discussed. Apart from that, there will be a case study where the review of previous works that is related and identical with this project and finally a summary and discussion of the review.

2.1 Theory and Basic Principles

2.1.1 Green Building Index (Commercial)

According to [7], a green building is an environmentally responsible structure and process that covers the building life cycle which includes the sitting, designing, constructing, maintaining, operating, modifying, and even deconstructing. Additionally, to discover the balance between the construction of the building and sustaining the environment is another requirement in designing a green building. In order to achieve that, a close collaboration is required among the design team, architects, engineers, and the clients in every stages of the project. In other name, green building is also well-known as a high performance and sustainable building.

Based on [8], the Green Building practices includes and applies the classic building design that takes into account on the economy, utility, durability and comfort. Table 2.1 differentiates the performance of green buildings and non-green buildings.

Table 2.1: Performance comparison between Green Buildings and Non-Green Buildings [8]

Building Type	**Green Building**	**Non-Green Building**
Building Material	Environmental Friendly	Not Environmental Friendly
Indoor Environmental Quality	Excellent	Good
Project Practices	Sophisticated	Normal
Waste Management	Extremely Efficient	Efficient
Total Energy Consumption	Low	High
Emission	Low	High
Feasibility	>5% Than Threshold	Threshold

According to [9], the type of building plays a crucial part in ensuring that the building achieve the green building standards. Table 2.2 and Table 2.3 display the assessment criteria and green building index (GBI) classification for a new green building construction.

Table 2.2: Overall Points for Assessment Criteria [9]

Part	Item	Maximum Point
1.	Energy Efficiency	23
2.	Indoor Environment Quality	11
3.	Sustainable Site Planning And Management	39
4.	Material And Resources	9
5.	Water Efficiency	12
6.	Innovation	6
	Total Score	**100**

From Table 2.2, it is clear that as the number of points increases, it means that the building is more environment-friendly and more likely to achieve the status of a green building. When a building achieve and apply environment- friendly features, it will be awarded with points under the GBI assessment framework. There are four level of awards that might be given to a building depending on the total GBI score achieved. Table 2.3 shows the required points in order to achieve the awards.

Table 2.3: Green Building Index Points Classification [9]

Points	**GBI Rating**
86 to 100 points	Platinum
76 to 85 points	Gold
66 to 75 points	Silver
50 to 65	Certified

As referred to [10], there are some buildings in Malaysia that has been awarded as green buildings such as Suruhanjaya Tenaga Diamond Building and GEO Green Energy Office. The public awareness among Malaysians on the importance of high efficiency buildings started to rise in 2006. The energy efficient building trend started growing among premises in this starting from small and private scale properties to huge residential or commercial construction project. The green building rating should really be set as a benchmark in the construction sector in order for it to excel forward brilliantly.

According to [11], natural light or more widely-known as sunlight is an important factor in lighting up the interior and provide free light energy in buildings. There are certain factors that will vary the results of lighting and illumination level of a room. The factors are the depth of the room, the size and location of windows, the glazing system and any other external obstructions. Based on [30], in order to achieve the state of a high efficiency green building, a close integration of building of building systems with a detailed focus on energy, day-lighting, and material analysis during the design process.

In order to attain the GBI ratings, DIALux software has to be used so that the simulation of lighting design can be done. There are seven zones of lighting divided in the lighting strategies. A control circuit is placed in each zone so that the consumption of energy can be minimized.

2.1.2 DIALux

Figure 2.1: DIALux Logo

As a free software, DIALux is widely used by designers, architects and even engineers in order to plan the interior and outdoor lighting of a building to achieve different desires and designs that satisfy the client's expectations. The highlight of this software is the ability to visualize, estimate and calculate the amount of natural light (sunlight). Other than that, DIALux software is able to plan lighting vision, design the color and intensity of lights which are going to be applied. Not forgetting, it may also arrange the position of emergency lighting with the acceptable level of luminaires and many more potentials.

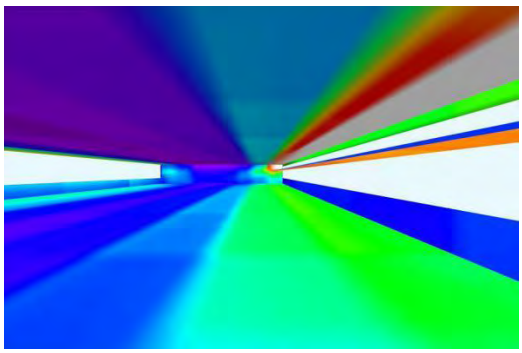

Figure 2.2: False Color Rendering of Building Interior by DIALux [12]

Figure 2.2 is an example of false color rendering. Based on [12], the image viewed from a 3D perspective of a building interior where different colors are assigned in order to differ the illuminance value measured in lux.

Based on [13], DIALux enables users to prepare a realistic visualization of the lighting plan. As an addition, the software uses different textures and even furniture. Not forgetting to mention that it applies an integrated ray-tracing module. While DIALux is able to save the file in .PDF format, it can also export the drawings made into .DWG and .DXF files. Other than that, it can even import files in those formats to apply the lighting plan with DIALux. DIALux regulates the intensity of light energy based on the support complying with the respective national and international regulations. Table 2.4 will show the visual evaluation of lighting system in work areas.

Table 2.4: Visual evaluation of lighting systems in workplace [13]

Concept	**Description**	**Evaluation**
Light level	Whether it is dark or light in the room or at the workplace?	Dark - Light
Light Distribution	How is the light distributed in the room or at the workplace?	Varied - Equally
Light Color	Is the light color experienced as warm or cold?	Warm - Cold
Color	How are the colors and objects viewed?	Distorted - Natural
Glare	Does unpleasant glare occurs?	Troublesome - Not Noticeable
Shadow	Whether they are hard or soft?	Hard- Soft
Reflection	Whether they are instance or diffuse?	Intense - Diffuse