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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

LAPORAN PROJEK SARJANA MUDA

DESIGN A NEW CONSTRUCTION FOR RESIDENTIAL BUILDING (HOSTEL) BY FOCUSING THE GREEN BUILDING STRATEGIES

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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June 2015

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DESIGN A NEW CONSTRUCTION FOR RESIDENTIAL BUILDING (HOSTEL) BY FOCUSING THE GREEN BUILDING STRATEGIES

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Faculty of Electrical Engineering
UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2015

"I declare that this report entitle "Design a New Construction for Residential Building (Hostel) By Focusing the Green Building Strategies" 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".

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Date : ....

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Dedicated to my beloved parents, my siblings

Lectures and all my friends

For their love and sacrifice.

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ABSTRACT

Nowadays, people can see a large energy have been consumed in Malaysia. One of the major reasons of this large energy consumed is due to the increasing of building construction. These building constructions are normally does not follow the green building strategies and it increases the environmental problem and global warming in the future. This report was written to deliver an overview of the installation of electrical equipment based on Green Building Index (GBI) for the residential construction of the building (hostel). Therefore, in this report the development and designing of a new green building construction (hostel) by focusing the green building strategies in term of energy efficiency performance is proposed in order to better development of green building to have a great life for environment and human in this world. The result of the project is to analyze the lighting system and calculate the electrical load by using Dialux software. For the conclusion, this project describes the basic study of indoor lighting performance at the hostel for the residential building development. Besides, the use of recycling and green plant for the projects can decrease the impact on the environment.

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ABSTRAK

Pada masa kini, orang ramai dapat melihat tenaga yang besar telah digunakan di Malaysia. Salah satu sebab utama tenaga besar ini digunakan adalah disebabkan oleh peningkatan pembinaan bangunan. Pembinaan bangunan biasanya tidak mengikut strategi bangunan hijau dan ia meningkatkan masalah alam sekitar dan pemanasan global pada masa akan datang. Laporan ini telah ditulis untuk memberikan gambaran keseluruhan pemasangan peralatan elektrik berdasarkan Indeks Bangunan Hijau (GBI) untuk pembinaan kediaman bangunan (asrama). Oleh itu, dalam laporan ini pembangunan dan rekabentuk yang baru dalam pembinaan bangunan hijau (asrama) dengan memberi tumpuan strategi bangunan hijau dari segi prestasi kecekapan tenaga adalah dicadangkan untuk pembangunan yang lebih baik dalam pembinaan bangunan hijau agar memberikan kehidupan yang baik untuk alam sekitar dan manusia di dunia ini. Hasil daripada projek ini adalah untuk menganalisis sistem pencahayaan dan mengira beban elektrik dengan menggunakan perisian Dialux. Kesimpulannya, projek ini menerangkan kajian asas prestasi pencahayaan dalam bilik di asrama untuk pembangunan bangunan kediaman. Selain itu, penggunaan kitar semula dan tumbuhan hijau dalam projek ini boleh mengurangkan impak ke atas alam sekitar.

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CHAPTER 1

INTRODUCTION

1.1 Project Background

Based on [1], the problem that facing the world nowadays is global warming where it is involved over the world where the average temperature of the Earth's atmosphere has increased compared to the 19th century. Thus, the solutions for the global are required in order to face the challenges to planet, particularly on climate change and sustainable economic development. The construction sector, which is consumed about 40% of the world"s energy, 12% of it is water and also gives 40% of the waste directed to landfill is the major part of this global problem.

Reference [2] said, the construction industry is one of the most important industries that have been penetrating the economic development of any country. This is because the nature of construction activities can change the natural landscape. For example, the Japanese construction industry is focused on decreasing environmental impact through extending infrastructure service life by increasing the sturdiness and considering life-cycle cost. Based on [3], although the significance of sustainable building was widely acknowledged, there are some researches that have been conducted in this specific area, specifically in respect to the developing countries like Malaysia.

The main criteria which is Energy Efficiency, Indoor Environment Quality, Sustainable Site Planning and Management, Materials and Resources, Water Efficiency, and Innovation is Malaysia"s overall rating system for assessing the environmental design of Malaysian buildings. This Green Building Index, developed by PAM (Pertubuhan Arkitek Malaysia / Malaysian Institute of Architects) and ACEM (the Association of Consulting Engineers Malaysia).

According to [4], green Building is a structure that is designed, built, renovated, operated, or re-used in an ecological and resource efficient manner. Sustainable development is maintaining a delicate balance between the human need to improve lifestyles and feeling of well-being on one hand, and maintaining natural resources and ecosystems, and future generations depend.

Based on [32], to encourage sustainable building practice, The Malaysian Standard MS 1525:2007, Code of Practice on Energy Efficiency and use of Renewable Energy for Residential Buildings has been introduced. The standard briefly describes the engineering, architectural, landscaping and site planning aspects in designing to optimize the energy efficiency of a building.

Reference [26] said, the use of energy in buildings has increased in recent years because of the growing demand in energy used for heating, ventilating and air conditioning (HVAC) and lighting in buildings. Based on [27], „Green building" methods use design and construction techniques to reduce the energy use and corresponding environmental impact of buildings. Based on [28], energy efficiency is energy intensity, which, in simple terms, refers to the use of less energy to provide the same level of energy service or to do more work with the same unit of energy. Besides, it will bring a lot of benefits for long term application and gives a lot of saving in ROI.

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Every project has a problem statement that should be solved by a clear concise description of the issues that need to be addressed.

1.2 Problem Statements

Nowadays, people mutually recognize that global warming is actually a fact rather just a scientific theory and it has been fuelled up quickly as resulted from rapid urbanization. Rising demand for energy in the developing countries has initiated greater efforts among many organizations to balance between energy generation and energy consumption. With concern about energy saving, global warming and depletion of the planet non-renewable resources has produce the green building movement. In order to overcome this problem, a hostel will be build based on the green buildings index by focusing on energy efficiency.

This project has an objective that should be achieved to complete the problem statement above.

1.3 Objective

The main objective is to design a new construction for residential building (hostel) by focusing the green building strategies. However, there are other objectives must be covered in order to accomplish this new construction for this residential building (hostel) which is:

a) To analyze the lighting system by using DIALux software.
b) To analyze the electrical load after implementing the GBI standards.
c) To design all the layout of the plan such as lighting system, air-condition, switch socket outlet (SSO), protection system and cable selection in the residential building (hostel) based on the Malaysia‟s Green Building Index (GBI) using AutoCAD software.

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

1.4 Scope of Work

This project will focus on the study and development based on assessment of the Green Building index, which is Energy efficiency, Indoor Environment Quality, Sustainable Site Planning and Management, Materials and Resources, Water Efficiency, and Innovation. Besides, the plan of the hostel will be drawn using AutoCAD and the lighting will be shown using Dialux software. This residential building (hostel) consist of 10th level, it typically includes the following space which are office, lobby, discussion room, TV room, prayer room, principle house, toilet, felo house, washing room, corridor, student rooms, activity room, briefing room, quarantine room, M&E room, hose reel pump room and EP room.

All spaces included inside the plan that is design using AutoCAD. After the design plan for this residential building is done, the electrical installation will be set up. This study will focus on the electrical installation including the lighting system, air-condition, switch socket outlet (SSO), protection system and cable selection to evaluate the energy saving performance.

Electrical installation in context of the sentences above will bring a meaning, every block, every room will doing the electrical installation to complete this building before all people can used it.

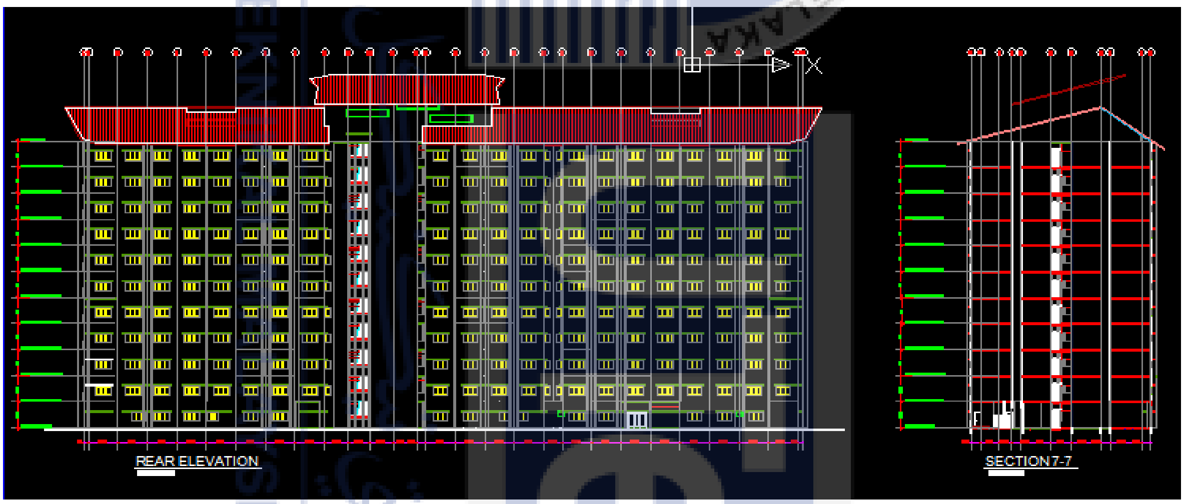

Figure 1.1: Layout Elevation

Figure 1.1 shows the layout elevation of the hostel that will be used in this project. This building consists of 10^{th} floor with the area 12182.90 sq.m for the whole block.

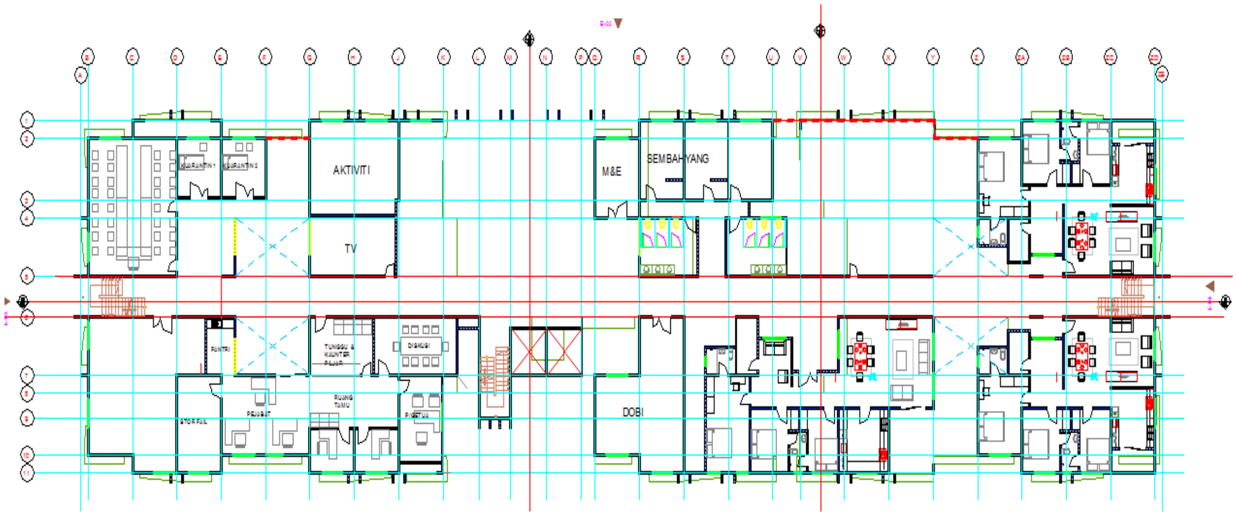

Figure 1.2: Layout Ground Floor

Figure 1.2 shows the layout for ground floor at the hostel, this level has a Felo house, Principle house, Office area, Student house, prayer room, washing room, activity room, TV room, lobby, and briefing room.

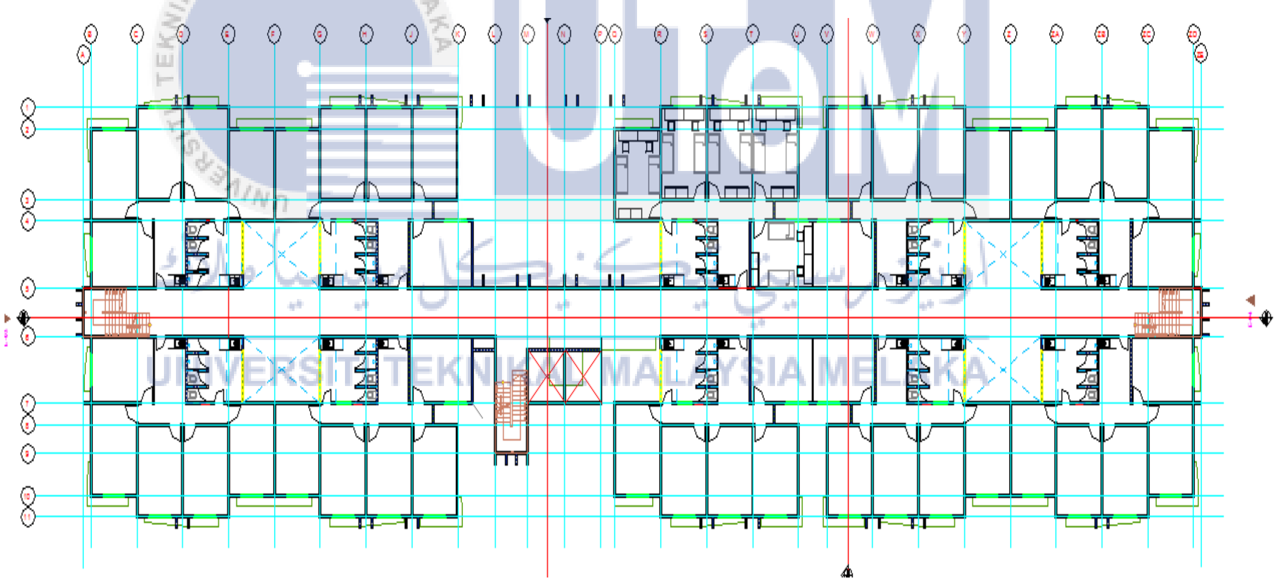

Figure 1.3: Layout First Floor – 10th Floor

Figure 1.3 shows the layout for first floor until 10th floor which has lobby and lift. It also has 11 Student House which consist of bedroom, pantry, toilet and other spaces.

To build this hostel, the rule of electrical installation must be follow as set by IEEE regulation, JKR electrical standard and Electricity Supply Application Handbook of Tenaga Nasional Berhad (ESAH TNB). The electrical installation of new construction building must follow the rule that based on regulation term and condition even though the

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GBI is used in the implementation of the new construction residential building (hostel). For the constructability, the design of the hostel was developed to be constructible. The design of hostel is designed 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 locations for the hostel to be built. The use of common, accessible construction materials and a repetitive design make the hostel simple and easy to manufacture.

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CHAPTER 2

LITERATURE REVIEW

In this chapter, there will be detail about theory and basic principle in developing this system. Besides, there will be a case study where review of previous related works that similar with this project and do the summary and discussion of the review.

2.1 Theory and basic principles

2.1.1 Green Building Index (Residential)

Based on [6], green building is the structure and process that is environmentally responsible throughout a building life cycle from sitting to design, construction, maintenance, operation, modification, and deconstruction. Furthermore, green building design involves finding the balance between construction of building and sustaining environment. This requires close collaboration of the design team, the architects, the engineers, and the client at all project stages. Green building is also known as a high performance and sustainable building.

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According to [7], the Green Building practice expands and complements the classical building design concerns of economy, utility, durability, and comfort. Table 2.1 shows the comparison between green buildings and non-green buildings of the development.

Table 2.1: Comparison between "Green Building" and "Non-Green Buildings" [7]

Building Type	Green Buildings	Non-Green Buildings
Energy consumption	Low	High
Indoor Environment Quality	Very good	Good
Emission	Low	High
Waste Management	Highly Efficient	Efficient
Building Material	Environmentally Friendly	Not Environmentally Friendly
Project Practices	Sophisticated	Normal
Feasibility	>5% than Threshold	Threshold

As shown in Table 2.1, based on [8], building types play an important rule to ensure the criteria of the buildings reached the specification of green buildings.

Table 2.2 and Table 2.3 below shows the assessment criteria and green building index (GBI) classification for residential new construction:

Table 2.2: Assessment Criteria for Overall Points Score [8]

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

The points that gained in these criteria will mean that the building will likely to be more environment-friendly. Points will also be awarded under the GBI assessment framework, for achieving and incorporating environment-friendly features which are above present in industry practice. Buildings will award Platinum, Gold, Silver or certified ratings depending on the total score achieved (see Table 2.3).

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Table 2.3: Green Building Index Classification [8]

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

According to [9], there have some models or buildings built than there are well referred as case studies today, such as the ST Diamond Building and also the GEO Green Energy Office. Since 2006 onwards, the occurrence of building energy performance awareness in Malaysia can be observed. As far as there are private small scale properties who took up the initiative to have a more energy efficient building premises for the good CSR Corporate Social Responsibility effort, there is certainly a need of a mechanism to put the benchmark for the building industry to move forward.

Based on [29], daylight is an important contribution to the lighting of an interior and provides supplementary illumination for substantial periods in some buildings. The major factors that affecting the daylighting entering the building are depend on the depth of the room, the size and location of windows and rooflights, the glazing system and any other external obstructions. According to [30], high performance green building requires close integration of building systems with a special focus on energy, daylighting, and material analysis during their design process.

To achieve the GBI ratings, one of the processes is using DIALux software. The lighting strategies will be divided by seven zones of lighting. Each of the zones will have the control circuit to enhance the energy saving consumption.

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2.1.2 DIALux

Figure 2.1: Logo DIALux

DIALux is available to users all over the world and used globally in light planning, in the continuous development of the programmer consideration has to be given to different styles of planning. People will be able to plan the lighting that will use in a room, scene or building by using this DIALux. It also able to calculate and visualize the daylight, as well as letting plan of the lighting vision, plan the color and intensity of the lights that will be used, position on the project the emergency lighting, with the right legal number of luminaires, and many more.

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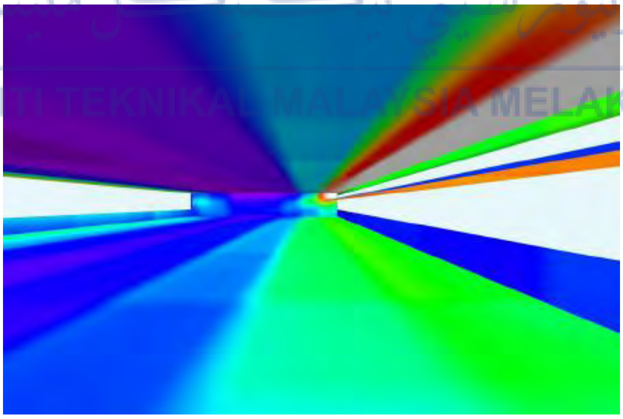

Figure 2.2: DIALux False Color Rendering of Building Interior [12]

Figure 2.2 is an example of a False Color rendering. According to [12], it shows a 3D perspective view of the building interior with different colors assigned to present illuminance values (Lux).

Based on [12], with DIALux people can prepare the realistic visualizations of the planning. For a better realism, the program can use different textures and furniture, and it uses an integrated ray-tracing module. It can also save the result in .PDF format file, or export to .DWG and .DXF files. Besides, it can even import files in those formats to apply the lighting with DIALux.

DIALux determines the energy of light solution based on the supports in complying with the respective national and international regulations [13]. Table 2.4 will show the visual evaluation of lighting systems 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 Colour	Is the light colours experienced as warm or cold?	Warm – cold
Colour	How are the colours and objects viewed?	Distorted – natural
Glare	Does unpleasant glare occur?	Troublesome – not noticeable
Shadow	Whether they are hard or soft?	hard – soft
Reflections	Whether they are instance or diffuse?	Intense - diffuse

From the Software DIALux, "By planners for planners," DIALux determines the energy of light solution based on the supports in complying with the respective national and international regulations. To create lighting, AutoCAD plan is very useful to facilitate the work.

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2.1.3 AutoCAD

Figure 2.3: Logo for AutoCAD

Based on [10], AutoCAD is a commercial software application for 2D and 3D computer-aided design (CAD) and drafting available since 1982 as a desktop application and since 2010 as a mobile web and cloud-based app marketed as AutoCAD 360. AutoCAD was used across a wide range of industries, by the professionals. It is supported by 750 training centers worldwide as of 1994.

As Autodesk's flagship product, by March 1986 AutoCAD had become the most popular CAD program worldwide. According to [11], AutoCAD is in its twenty-ninth generation, and collectively with all its deviation, continues to be the most used CAD program throughout the entire world. Mike Riddle built CAD products for over 29 years now, starting with Interact for the Marinchip 9900 released back in 1979, one of the first PC-based CAD programs available. Interact went on to become the architectural basic for the first versions of AutoCAD.

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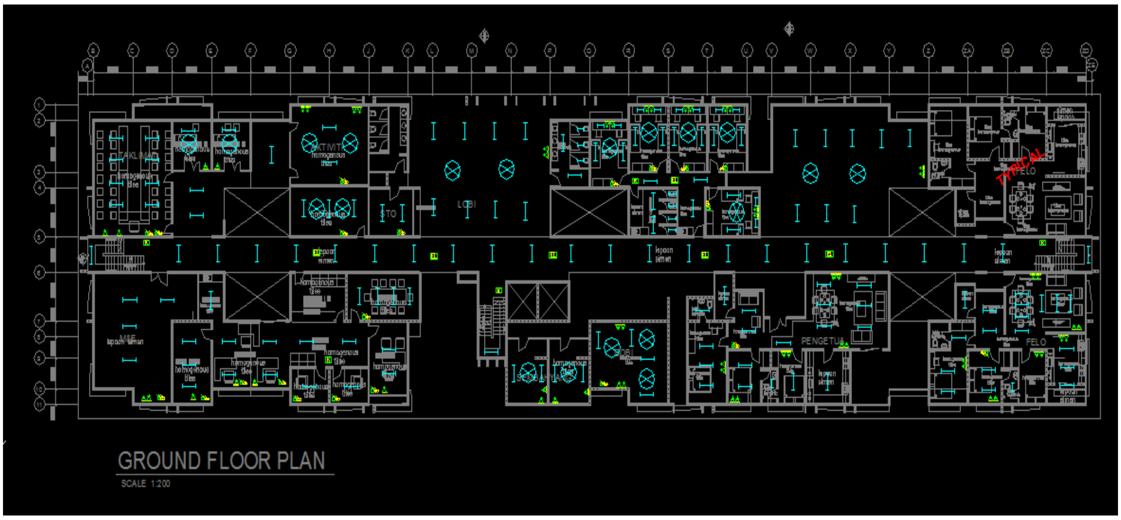

Figure 2.4: Design Layout with Electrical Installation

Figure 2.4 is the design layout for the electrical installation using AutoCAD. This design will be inserting to the DIALux software to make lighting for every rooms and places at the buildings. These sustainable designs can be integrated with communities to build upon the communities cultural assets and work with those communities to implement sustainable actions while also preserving community cultural values. Green building design is a newly emerging movement that is working mutually with communities to not only benefit the building itself, but also the community that uses it.

2.1.4 Lighting

Reference [14] said, lighting design is considered to be simply the chosen of the lighting equipment for a system. The most cost-effective and energy-efficient products is important, because it is are tools to achieve the design. True lighting design involves the assessing and meeting the needs of the people who use the space and balancing function and the aesthetic impact supplied by the lighting system. Lighting was an art such as a science. This implies that there are no difficult and fast rules for lighting design nor will there be one ideal or optimum solution to a lighting problem.

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Daylight controls the natural weather, effects the mood and built a sense of wellbeing. But daylight alone is not suitable in most rooms, artificial light is also needed to produce the right light levels. Inadequate lighting will affects student wellbeing and can also result in eye strain, fatigue and poor performance, particularly in roles involving problem solving and concentration.

Lighting is an essential service in all the industries. The power consumption by the industrial lighting varies between 2 to 10% of the total power depending on the type of industry. Innovation and continuous improvement in the field of lighting, has given rose to bigger energy saving opportunities in this area. Lighting is an area, which provides a major scope to achieve energy efficiency at the design stage, by incorporation of modern energy efficient lamps, luminaires and gears, apart from good operational practices.

In architectural design, simulate the natural daylight and the artificial light is a complex subject, involving many parameters. But it is an important element which cannot be ignored in the architectural design, especially in the major requirements for energy efficiency and comfortable or ecological building design. The technology of lighting design software is much more effected and accuracy after 20 years of development. Such software is usually used by lighting designers and other related professionals in and abroad.

Table 2.5: Details of Lumen Methods [14]

Symbol	Terms	Units
N	Number of luminaries required	
A	Floor area to illuminate	m^2
E	Required lux	lux
F	Initial lamp lumen	lm
N	Lamp per luminary	
MF	Maintenance factory	
UF	Utilization factor	
L	Room‟s length	m
W	Room‟s width	m
H	Room‟s height	m

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In this project, the development situation and the trend are the most important features of the lighting design software, based on the advantages and disadvantages of the same type of lighting design software. These can be reference for practitioners and researchers in the choice of lighting design software or in the similar studies.

Lighting is the main element to be consists in electrical system design installation. Lighting can be decorated to make the property stylish. In this project, the type of lamp that has been used is LED lamp and fluorescent light (1 x 36, 2 x 36, 2 x 18, downlight). All of these types of lamp installed in the outdoor lighting, office, corridors, toilets, meeting room, rest room, pantry, living room, prayer room, bed room, washing room, and store . Generally, the average luminance level used range from 100 to 500 lux. The lamp types by standard qualifications are divided by five. For example, incandescent lamps, fluorescent lamps, HID lamps, low pressure sodium lamps, and LED sources. The basic types of fluorescent lamp are preheating lamps, instants start lamps, and rapid start lamps.

There are several things must be considered before the lamps are chosen and implementing in the projects which is lux, lumen, room index, and mounting height. Every type of lamps, have different ballast that must be consider. For example, fluorescent light (2 x 36W) the ballast that will use should be four which mean the power of light must be add with value of ballast, therefore the actual power is 42W.

Table 2.6: Luminous Performance Characteristics of Commonly Used Luminaries [14]

Type Of Lamp	**Lumens**	**/Watt**	**Color Rendering Index**	**Typical Application**	**Typical Life (Hours)**
	Range	Avg			
Incandescent	8 - 18	14	Excellent	Homes, restaurants, general lighting, emergency lighting	1000
Fluorescent Lamps	46 - 60	50	Good w.r.t coating	Offices, shops, hospitals, homes	5000
Compact fluorescent lamps (CFL)	40 – 70	60	Very good	Hotels, shops, homes, offices	8000 – 10000
High pressure mercury (HPMV)	44 – 57	50	Fair	General lighting in factories, garages, car parking, flood lighting	5000
Halogen lamps	18 – 24	20	Excellent	Display, flood lighting, stadium exhibition grounds, construction areas	2000 – 4000
High pressure sodium (HPSV) SON	67 – 121	90	Fair	General lighting in factories, ware houses, street lighting	6000 – 12000
Low pressure sodium (LPSV) SOX	101 -175	150	Poor	Roadways, tunnels, canals, street lighting	6000 – 12000

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2.1.5 Electrical System Design Purposes

The main purpose that electrical system design would contribute to consumers is safety. Safety is the most important element besides being main factor to do the electrical design. Besides that, safety is one of the ways to keep people saves and the project will be last.

Within installation electrical design, second factor that will consider after safety is to determine the minimum requirement for installation besides the minimum cost for equipment installation too. There are several solutions to produce the service that can increase the performance consistently. For example, supplying multiple utility power sources or services, supplying multiple connection paths to the loads served, using short-time rated power circuit breakers, using the best installation methods, and selecting the highest quality electrical equipment and conductors.

Electrical system designs will able to vary the ways of electrical installations due to the design contribute benefits to surrounding. It also helps in space saving and also easy to troubleshoot when any fault was occurred. In electrical system design, designer should think any possible faults or the thing that will adds on installation, for example, amplify the number of circuit or add a „spare". This is because, if any troubleshoot happened, it has a precaution.

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Without dropping essential loads, the system should be designed with an alternate power circuit to take electrical equipment (requiring periodic maintenance) out of service. The breakers and combination starters can also minimize maintenance cost and out of service time.

a) Protection

Based on [16], the main requirements for the protection device that will be used on this project are Residual Current Circuit Breaker (RCCB), Miniature Circuit Breaker (MCB), Molded Case Circuit Breaker (MCCB), and Air Circuit Breaker (ACB). The protection can be categorized into three, which is protection against electric shock, protection against thermal effects, and protection against overcurrent. There are a few protective devices used in this project. All the protective devices used to keep circuits and equipment form damage of overcurrent and fault current. This clearly shows that protective device become the most important in the installation design process.

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Figure 2.5: Residual Current Circuit Breaker (RCCB)

Residual current circuit breaker (RCCB) is an electrical wiring device that provides a better protection against the risk of electric shock and provides an excellent protection against the possibility of fire resulting from earth faults current. However, a molded case circuit breaker (MCCB) is an automatically electrical switch designed that to protect an electrical circuit from damage caused by overload or short circuit. Its basic function is to detect a fault condition and, by interrupting continuity, to immediately discontinue electrical flow. Unlike a fuse, which operates once and then must be replaced, a circuit breaker can be reset to resume normal operation. Main standards for MCCB are MS IEC 60947-1&2: 2010.

Figure 2.6: Air Circuit Breaker (ACB)

For the air circuit breaker (ACB) is normally applied to large breakers that will protect the incoming circuit fed. Air is the medium of electrical insulation between electrically live parts and grounded (earthed) metal parts. The Air Circuit Breakers (ACB) is characterized by their sturdy construction, ample electrical clearances, availability in high current-carrying, interrupting and making ratings. The ACB applications are at main switchboard is to protect the incoming circuit either fed by local generator or LV side of transformer from utility. The ACBs are constructed for longer life than other types of LV circuit breaker (MCB or MCCB) and suitable for more operations. ACB need regular inspection and maintenance [16].

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Figure 2.7: Moulded Case Circuit Breaker (MCCB)

2. Switch Socket Outlet (S.S.O)

According to [16], socket is the part of main element in the electrical installation design. Generally the plug is the movable connector attached to an electrically operated device mains cable and also has male contacts, and the socket is fixed on equipment or a building structure and has female contacts. Plug and socket systems can incorporate safety features to reduce the risk of electric shock. These may include socket design intended to accept only compatible plugs inserted in the correct orientation. Sockets are designed to prevent exposure of bare live contacts. The exposed contacts present in some sockets are used exclusively for earthing or the other word grounding.

In this project, the type of socket that used are 13pin 13A (BS 1363) and industrial socket (BS EN 60309-2 32A). For this kind of socket, there are two types that usually used for this project, that are single phase and three phase. All of this socket that used are depends on the project plan that is suitable to used it. For this project only two type of socket that will be used.

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Figure 2.8 Three phase industrial socket

Figure 2.9 Single phase industrial socket

Figure 2.8 and Figure 2.9 shows the three phase and single phase industrial socket, this socket provide a connection to the electrical mains rated at higher voltages and current than household plugs and socket.

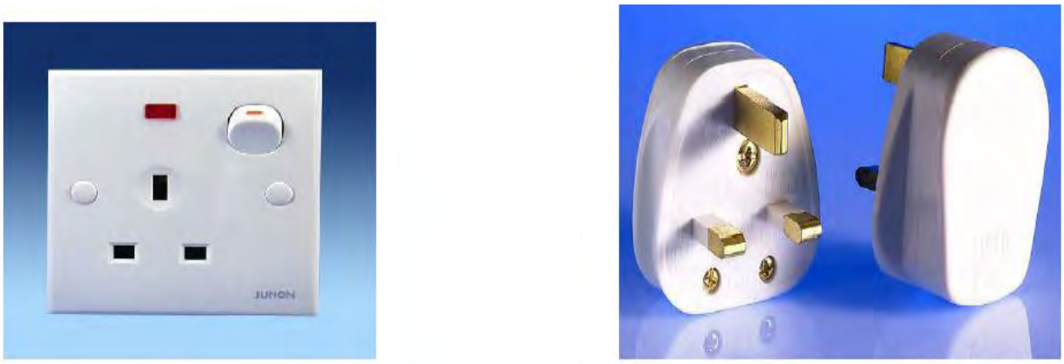

Figure 2.10: (3 pin 13A) (BS 1363)

Figure 2.10 shows the 3 pin 13A socket and plug that will be used in this project. This socket is to reduce the risk of users accidentally touching energized conductors and thereby experiencing electric shock. Plug and socket systems often incorporate safety features in addition to the recessed contacts of the energized socket.

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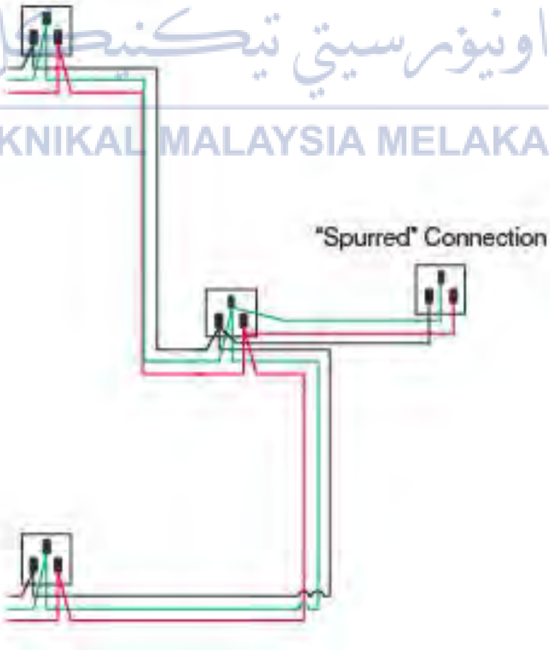

Figure 2.11: Radial Connection

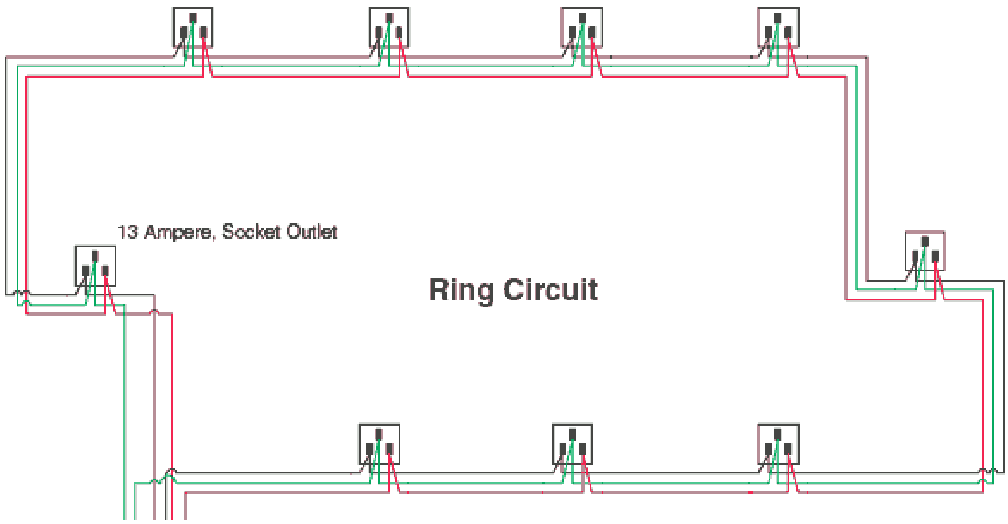

Figure 2.12: Ring Connection

Figure 2.11 and Figure 2.12 show the radial connection and ring connection of the circuit that will be used. The selection of this socket was based on amount if socket on the circuit. Those sockets installed using the radial method, where consist of a few number of socket in the circuit. However, for socket that more than six, ring type is more applicable because it save cost and if any socket breakdown, other sockets still can be used.

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2.1.6 Heating, Ventilating, and Air Conditioning (HVAC)

According to [17], about 40% of the energy used for heating, ventilating, and air-conditioning (HVAC) systems account in commercial buildings in the United States. By improving the control of HVAC operations and improving the efficiency of the system uses, many business or government agency has the potential to realize significant savings. Based on [44], most of energy use in buildings is for the provision of HVAC, which takes about 50% of building energy consumption on an average. High-level performance of HVAC systems in the whole building lifecycle is critical to building sustainability. Therefore, many professionals in the building industry have been aware of this problem and work hard to improve lifecycle performance of HVAC systems, such as selecting energy efficient materials.

An integrated and efficient building envelope with suitable window and glazing design not only reduce the energy and operating costs of a facility, but also can reduce the size and cost of the HVAC system needed to maintain air pressure in the building, good indoor air quality and a comfortable thermal environment for building occupants. The integrated design process can provide the way to facilitate early consideration of wind loading, vibration, blast and seismic considerations related to rooftop HVAC equipment.

Reference [17] said, HVAC systems should provide comfort as efficiently as possible. While existing buildings might not be as efficient as newly constructed facilities initially, green building retrofits can help to improve the energy efficiency of these structures. These improvements can provide many environmental and economic benefits by reducing the energy requirements of these buildings.

Figure 2.13: International Terminal Building in Istanbul"s Ataturk Airport uses laminated glass for safety and security

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2.1.7 Lift

2.1.7.1 Firefighting or fireman's lift

According to [31], the building construction, smoke detection, alarm systems, fire extinguishing installation, hydrants etc. are subject to National Building Regulations. Generally, the Fire Service meaning of the term „high rise" applies to those buildings with floors above the reach of the Fire Service Equipment. Fires in high rise buildings are not new problems nowadays.

Based on [31], possibly the first recorded fire happened in 1908 when the 12 storey „Parker‟ building in New York was involved in fire on all floors. In 1911, 148 people were killed by fire at the 10 floor „Shirt Waister‟ factory. In 1916, as a result of these and other similar fires, New York City Council revised its building codes to provide such features as protected staircases, fire mains, lifts and sprinklers.

The increasing development of the high rise era has presented architects and fire services with two well defined issues, the first being to design buildings which will resist fire and smokes spread and provide a high degree of safety for the occupants. Firefighters lifts is one of the lift where the number of which and their location within the building is determined by national Regulations are an important tool for fire attack, transporting firefighters and equipment and for evacuation under control of the firefighters.

The firefighters lift shall be applied under the direct control of the fire service, in the event of fire. A firefighter‟s lift shall serve every floor of the building. A firefighter‟s lift, unlike a normal lift, it designed to operate as long as is practicable when there is a fire in parts of the building. The lift may be used as a passenger lift when there is no fire. To reduce the risk of an unobstructed entrance when the lift is required to operate the fire service, its use for moving refuse or goods should be restricted. Below are the specific provisions that include:

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a) Break-glass key switch (at G/F to control the lift)
b) Min. duty load, say 630 kg (for firefighting equipment)
c) Min. internal dimensions (m), 1.1(W) x 1.4(D) x 2.0(H)
d) An emergency hatch in the car roof
e) Manufactured from non-combustible material
f) A two-way intercom
g) 1 hour fire-resisting doors of 0.8 m (W) x 2 m (H)
h) A max. of 60 sec to run full building height
i) Dual power supplies (normal + emergency)

2.1.7.2 Lift Traffic Control

Group of lifts is a number of lifts placed physically together, using the same signal system and under the command of a group lift control system. Group traffic control algorithms are from simple 2 lift control to very sophisticated and landing call allocation which is assign a lift to service a particular landing call. Below is the lift (group) control arrangement:

a) Operator
b) Single automatic
c) Down or up collective
d) Directional (up & down) collective
e) Group collective
f) Programmed control
g) AI (artificial intelligence) assisted control

i. Single Automatic Control [24]

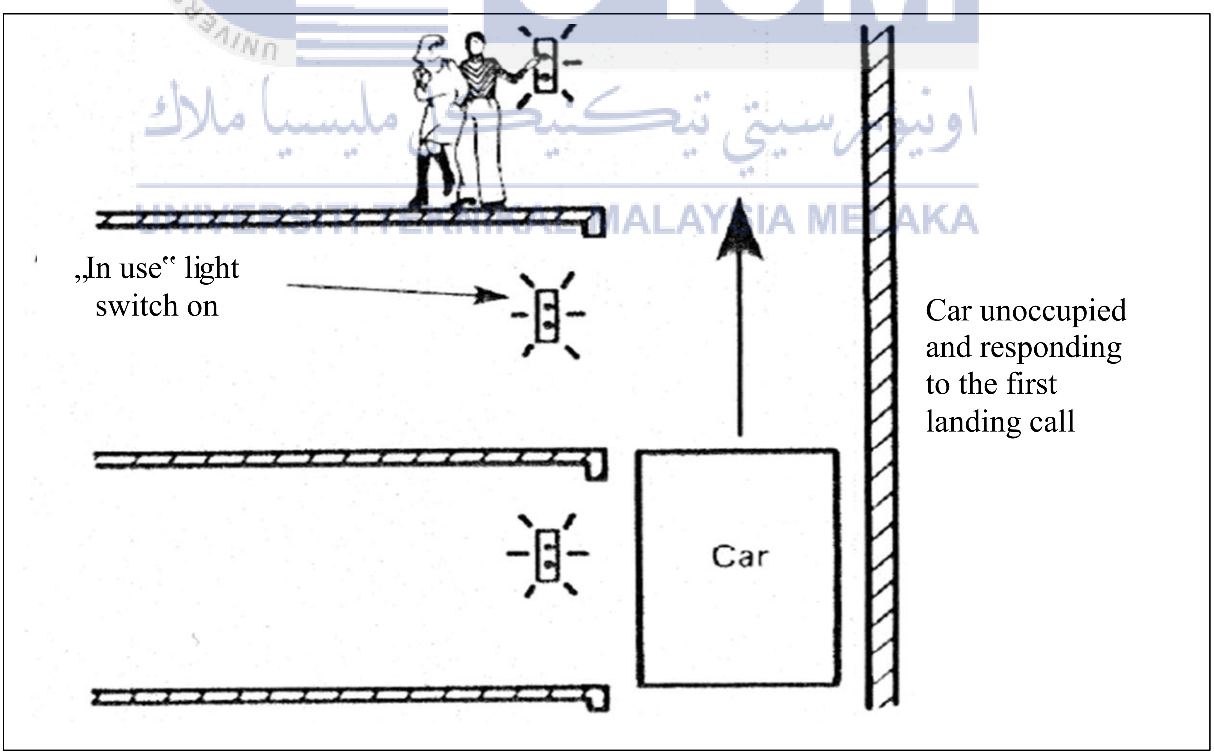

Figure 2.14: Lift car called to a floor. „In use" light switched on

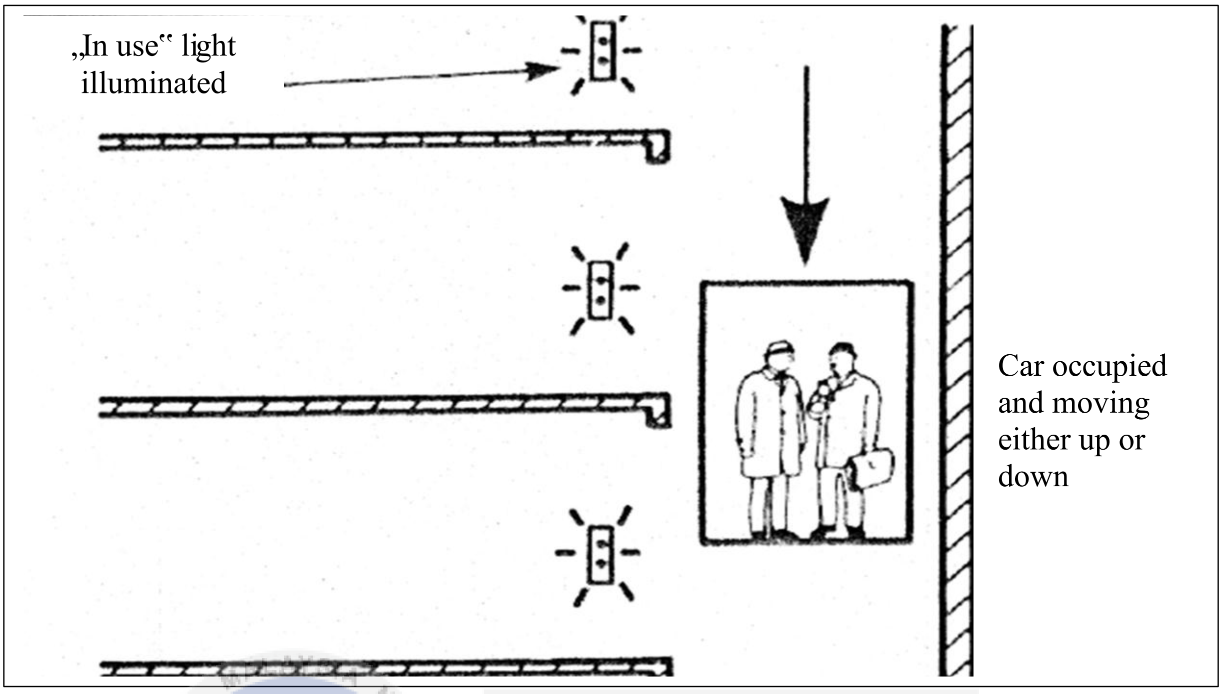

Figure 2.15: Lift car in control of occupant and cannot be called by other passengers

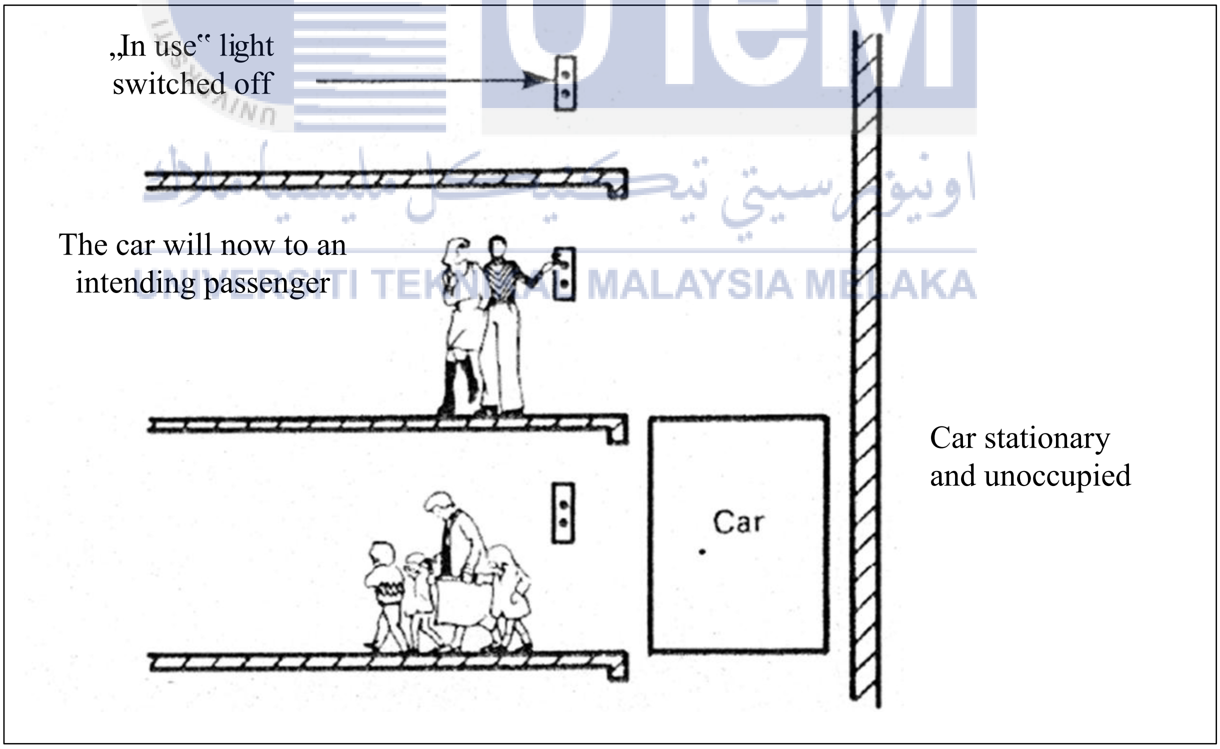

Figure 2.16: Lift car vacated. „In use" light switched off. Lift can now be called by other passengers

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ii. Down Collective Control [24]

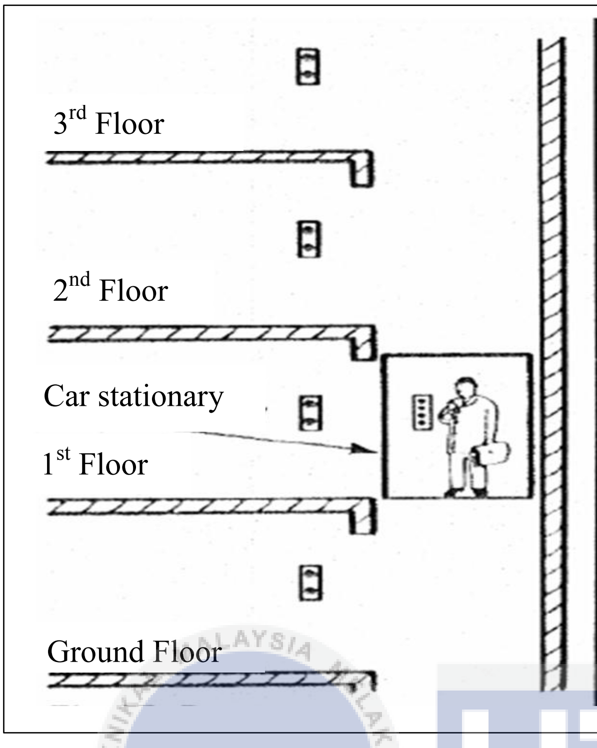

Figure 2.17: Passengers enter the car and press buttons to travel upwards

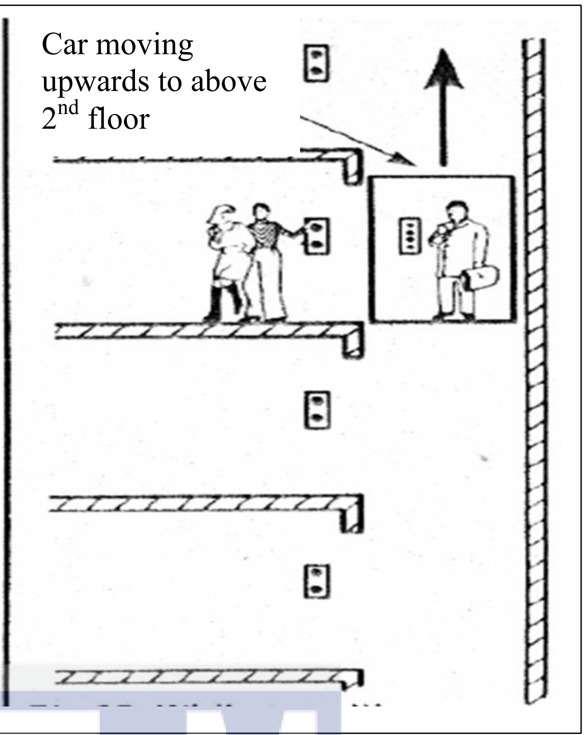

Figure 2.18: While travelling upwards all the landing calls are by-passed

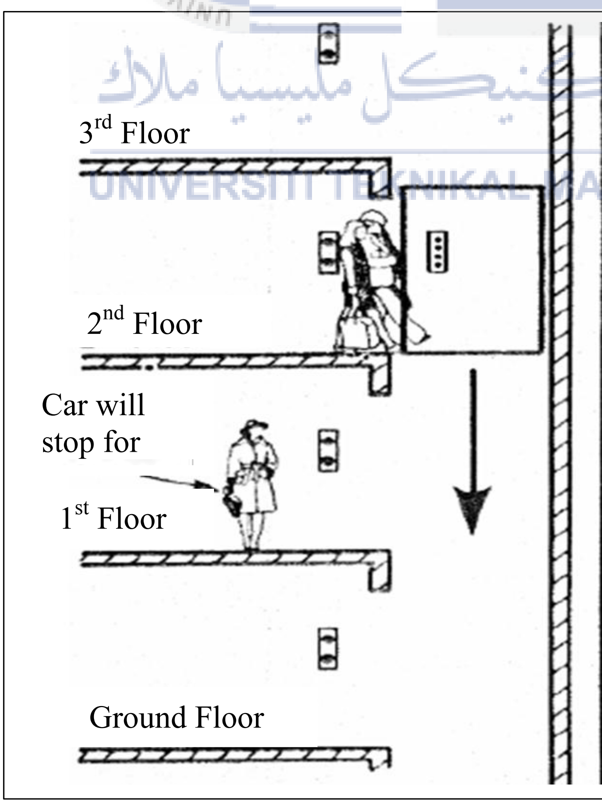

Figure 2.19: When the car moves down all landing calls are located floor by floor

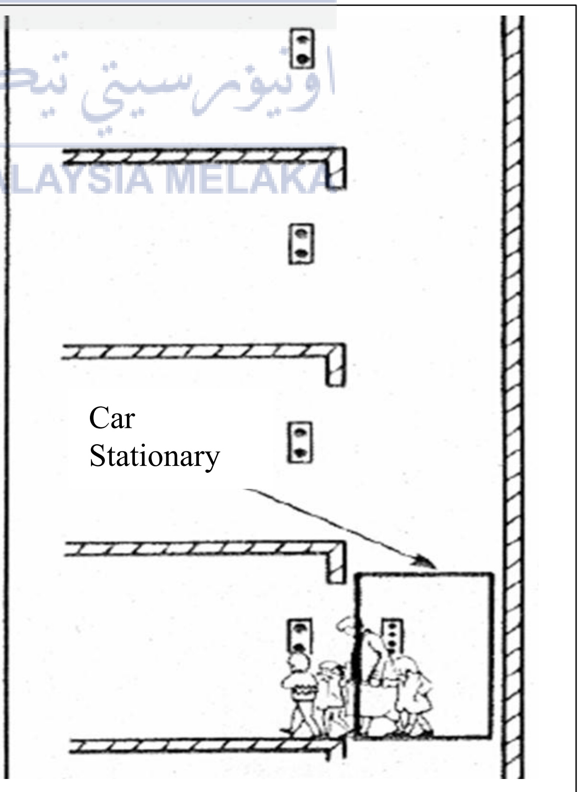

Figure 2.20: Passengers leave the car

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The purpose of this lift traffic control is:

a) To allocate the landing calls in an optimum way to individual lifts in the group
b) Minimize passenger waiting time
c) Minimize system response time
d) Minimize passenger journey time
e) Reduce „bunching‟ (lifts move around together, instead of being evenly separated, e.g. by sudden heavy traffic)
f) Minimize the variation in passenger waiting time

2.2 Review of previous related works

2.2.1 Green building fever fast spreading in Malaysia

According to this paper, the green building fever is fast catching on in Malaysia and now there are 200 development projects endorsed by Green Building Index (GBI) as being green buildings. Developers realize that even a small rise in building costs when they decide to make their projects a "green", there are marked advantages to do so, as they take on the properties of higher prices and developments relating to dignity. At this time, many developers see green certifications for their buildings as a fast ticket to greater profit and a mean to improve the gross development value of their projects [18].

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2.2.2 Calls for more green buildings

Based on [19], this paper discussed about the Green building is the way to go f or Kota Kinabalu as it strides forward to become a developed eco-tourism resort city, said Mayor Datuk Abidin Madingkir. He said City Hall viewed green buildings as vital tools in supporting the State‟s effort to strengthen its tourism sector and will continue to emphasize on sustainable development by adopting the Green Building Index as its only green building rating standard. As of November 15, GBI has received 492 applications for registrations and has certified 37 per cent of them, which translates to over 320,000 CO2 emission reductions per year, based on electrical energy saving alone.

2.2.3 Design and Development of Low Cost Certified Green Building for Non Residential Existing Building (NREB)

According to [20], the project basically is a renovation project of an existing double storey shop office building for ASR Padu Sdn. Bhd which is located in Taman Paya Emas, Melaka. ASR Padu building redevelopment consists of ground floor and first floor corner lot shop house which comprises room for director, chief operating officer (COO), workstation, discussion room, reception counter, printing room, account room, CEO room, meeting room, prayer room, for male and female which are consist two storey of office building. ASR Padu existing building objective is to obtain at least the minimum GBI Certified Rating. By establishing energy efficiency (EE) performance in the ASR Padu building redevelopment, the thermal comfort, energy consumption in the building could be reduced as well as carbon dioxide emission to the atmosphere will be reduced.

2.2.4 Critical Success Factors for Sustainable Building in Malaysia

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Based on [21], the concept of green building is emphasized upon the building per size. The term was found insufficient in terms of its definition and application. Consequently, the paradigm has gradually shifted to sustainable building. Sustainable building has gradually captured the headline since its introduction by the World Commission on Environment and Development (WCED) in 1987. The notion then develops rapidly over the last decade. The development is not limited to the building itself. For example, sustainable development was defined as a concern of attitudes and judgments in securing long term ecological, social and economic growth in society. Furthermore, the construction industry was not the innovative pioneer towards sustainable development, the increased awareness of sustainability has led it to consider its practices and move toward a practical interpretation targeted at construction activities. For the construction management practices in particular, it has no exception but comply with the dominant trend by placing greater emphasis on evaluating environmental impact. In the context of Malaysia construction industry, there are six fundamental criteria to assess the sustainability of building including energy efficiency, sustainable site planning and management, indoor environmental quality, material and resources, water efficiency and innovation.

2.2.5 Evaluation of Green Roof as Green Technology for Urban Stormwater Quantity and Quality Controls

Based on [22], the Urban Stormwater Management Manual for Malaysia (MSMA) was firstly introduced in 2001 as a guideline to adopt and design Best Management Practices (BMPs) in controlling stormwater in term of quantity and quality to achieve least impacts of post-development hydrologically. BMPs such as infiltration basin, swale, and constructed wetland are suggested as alternatives of soft engineering structures to deal with stormwater instead of having hard structures like concrete channel and concrete detention pond. Such BMPs are capable in augmenting coverage of green spaces in urban areas. MSMA second edition was released in 2012 whereby additional BMPs like bioretentio/biofilter has been featured and revised into the manual.

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2.2.6 Collaboration Initiative on Green Construction and Sustainability through Industrialized Buildings System (IBS) in the Malaysian Construction Industry

According to [23], this paper state that, Malaysia very own green building rating system has been launched on 21st May 2009 by the Work Minister, Datuk Shaziman Abu Mansor. The Green Building Index (GBI) developed to promote sustainability in the built environment and raise awareness among the industry players about environment issues. Building will be awarded GBI Malaysia rating score based on six key criteria. Both efforts in the UK and Malaysia provide fresh challenge for the construction industry to practice sustainable development and at the same time providing highest quality of affordable building particularly in house building industry.

2.3 Summary and Discussion of the Review

Integrating a green work culture with a working community can be proven to be very beneficial in terms of bringing together the community, but also promoting sustainable behaviors that improve people lifestyles. Not only is the green culture mutually advantageous to environment, but the community gains more insight and in-depth knowledge of climate change and sustainable actions. A green work culture can be started with just simple engagement tools that can help foster groundwork for people to be environmentally aware of their own actions and how they can change their routines to live more sustainably. Case studies have been shown that increasing participatory action within the community and workplace can stimulate a green mindset within the community culture. Institutions and organizations are working collaboratively together to develop green behavior programs to get more people involved in their communities.

Sustainable designs can be integrated with communities to build upon the communities cultural assets and work with those communities to implement sustainable actions while also preserving community cultural values. Green building design is a newly emerging movement that is working mutually with communities to not only benefit the building itself, but also the community that uses it.

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CHAPTER 3

METHODOLOGY

The right methodology must be taken to make sure the project that consists of software development will be successful. There are several phases or methods are used to achieve the objectives of the project.

3.1 Introduction

Electrical system installation and design has divided by three which is design for low voltage system, design for medium voltage system and design for low voltage system. For this project, it categorize as low voltage system 415V. Actually to design the electrical system for some building is depends on layout plan that giver from architect. In order to do that, the layout plan that given for architect is usually effect the electrical system installation and design. For the example at one room that given at layout plan, the electrical engineer that will doing the installation must be consider the length and height and also a several things to get the number of lamps that will be used in that room. Besides that, after getting the number of lamps, the arrangement of lamps must be consider making sure the installation look smart.

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Firstly, the distribution board (DB) will be built to collect all the type of load in that building for the example lighting, switch socket outlet (S/S/O), and air-conditioned. After that, the sub switch board (SSB) will build after the DB has complete. SSB is to collect all the DB to make in one place. At SSB, cable sizing, protective device, voltage drop must be considered. Finally the last stage for low voltage system design is main switch board (MSB). At MSB, collect all of SSB to MSB to make the one main switch to control the entire load. In this stage, the capacitor bank and current transformer will be considered.

3.2 Principles of the methods or techniques used in the previous work

The intent of the project is to use green product for electrical installation in residential building. The project methodology consists of seven main steps, the steps are:

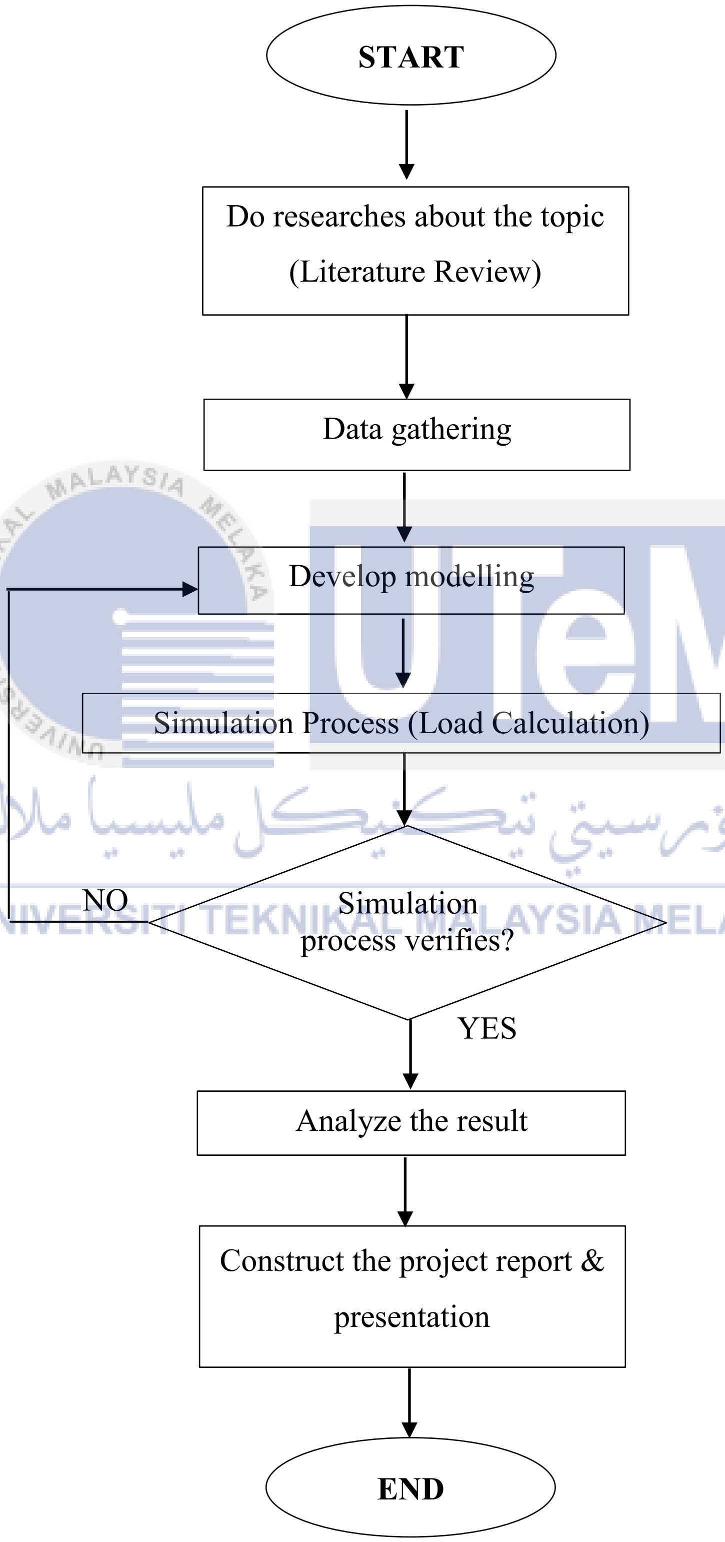

Figure 3.1: Flow Chart of Overall Methodology

3.2.1 Do researches about the topic (Literature Review)

The first part is carried out to review the recent researches that have been done by previous researchers which can be a guideline in this project. The best method or the most suitable approaches can be analyzed in order to achieve the best result. Besides that many references had be done in order to get the information and fact about the topic. In this part, the focus is about design strategies such as the lighting, switch socket outlet, air condition and protection devices. Discussion with the responsible person also takes part like supervisors, construction officers, lecturers, and the friends that expert in this field.

3.2.2 Data gathering

Data gathering consists of obtaining the relevant history for the variables that are to be forecast, including historical information on potential predictor variables. During this phase it is also useful to begin planning how the data collection and storage issues in the future will be handled so that the reliability and integrity of the data will be preserved. The data used in this project is the data energy of load from TNB in Penang. The data had been collected in daily and monthly on year 2011. Besides that, temperature data also use in this project as a factor of forecasting.

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3.2.3 Develop Modeling

In this project, there are some steps to achieve design strategies. The design will be done by using DIALux software and calculation. The steps for design process are:

3.2.3.1 Design Lighting

Design lighting system, the information that should be compile are length and width of the room, height of floor cavity, height of the ceiling cavity height of the room cavity and surface reflectance. There are two methods for the design lightning system procedure, manual calculation and using software.

a) Illumination

Illumination is one of the important criteria that need to be considered when to know the quantity lamps. Usually this value can be referring from the IES standard or JKR standard but for this project will be referring to the JKR standard. Different tasks under different conditions require different levels of illumination. Some area or office such as passageway, computer room, and others can be found in data-data sheet. Area or room that does not need demanding for work always offers excellent opportunity to economize on design lightning because of the lower illumination. The values determined in the illumination categories values in the space, not initial values.

b) Calculation of Quantity of lamps

This calculation need to use the illumination or known as average illuminance, lighting design lumen (LDL), coefficient of utilization (COU), maintenance factor (MF) and the area for the area. The quantity of the lamps was determined based on equation 3.0:

$$\text{Number of lamps} \quad \frac{\text{Average illuminance (lux)} \quad \text{area } (m^2)}{\text{LDL (lumen) COU} \quad \text{MF}} \tag{3.0}$$

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c) Calculation Room Index

Coefficient of Utilization (COU) is the ratio of the actual flux received on the working plain to the installed flux. To get this value, calculate first the Room index, K and choose the type of lamp that wants to be installs, then using Room Index value and reflection factor, the COU can be decided. The Room Index can be determined using:

$$\text{Room Index} \quad \frac{L(m) \; W \; (m)}{Hm \; (m) \; [\; L(m) \; W \; (m)]} \tag{3.1}$$

Notes that:

- L = Length
- W = Width
- Hm = Height mounting

The maintenance factor (MF) includes the life span of a lamp after a long period of time usage, dust deposited on a lamp and fitting and reduction election factor of the interior room. The lighting design lumen (LDL) is the value of the lumen for any type of lamps. This value usually will be prepared by the supplier for the lamps in the brochure or others medium or can be refer from the JKR standards.

Light Lost Factor (LLF) also is when a light fixture is activated, it produces light which must leave the lamp, then the fixture, then reach the work plane where it is needed. The parameter to measure Light Lost Factor (LLF) also considered. Here, Ballast Factor (BF) is to compares the ratio of light output of a lamp working by a specific ballast to the light output of the same lamp working by a standard reference ballast which set to 95%, Room Surface Dirt Depreciation (RSDD) is the value that accounts for dirt or dust that accumulates on all of the room surfaces especially on the upper walls and ceiling which is set to 97%, Lamp Lumen Depreciation (LLD) is the values reflect the overall performance of a lamp over its life which set to 85% and Luminaire Dirt Depreciation (LDD) is the light loss prior to cleaning dust which is set to 90%. These parameters stated above will be used to evaluate the lighting performance in order to achieve energy saving criteria. Based on [4], for the daylight factor, the energy saving type for the hostel can achieve minimum 1.0 percent, thus more than 75 percent of the habitable rooms have been achieved.

$$\text{Room Cavity Ratio (RCR)} \quad \frac{[(5 \quad \text{Room Cavity Height}) \times (\text{Length W idth})]}{(\text{Length} \times \text{Width})} \tag{3.2}$$

$$\text{LLF} = \text{BF} \quad \text{RSDD} \quad \text{LLD} \quad \text{LDD} \tag{3.3}$$

$$\text{No. of Luminaires} = \frac{(\text{desired luminance}) \times (\text{room area})}{(\text{lumen per luminaires}) \times \text{CU} \ \ \text{L LF}} \tag{3.4}$$

3.2.3.2 Exit Sign and Emergency Light

The emergency light and exit sign was installed in this project because of the requirement by the user and the safety standard. It is usually provided for safety reasons and to enable uninterrupted occupation of a building in times of breakdown of the main lighting. It also provides lighting for escapes routes in case evacuation at a building in necessary.

3.2.3.3 Heating, Ventilation, and Air Conditioning (HVAC)

Based on [41], some energy efficiency upgrades can improve occupant health by enhancing indoor air quality. Installing energy recovery ventilation equipment, for example, can reduce infiltration of air contaminants from outdoors while significantly reducing heating, ventilation, and air conditioning (HVAC) energy loads.

According to [42], building consume about one-third of the energy in the world and it is expected that the trend will continue to grow further until the year 2025. Among the buildings in Malaysia, office buildings use the most energy for air-conditioning system compared with shopping malls, hotels and residential buildings. Therefore, the owner of office building has to take action to save more energy in order to avoid unnecessary waste of energy. In general, building air-conditioning system can be classified into the following categories:

a) Split/Window units
b) Package units
c) Centralized air-conditioning systems

The split unit consists of the indoor unit and outdoor unit. An indoor unit installed inside in the area to be cooled. It can be ceiling or wall hung and consists of the evaporator and blower. The outdoor unit is installed outside the building and consists of the compressor, a condenser and blower. Package units are for higher capacity air-conditioning loads in the range of 3 to 15 tons. They consist of the filtration, cooling and drying as well as air handling components with water-cooled or air-cooled condensers. The system can be

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based on the direct expansion system or the indirect chilled water system [43]. Typically, this horsepower of air conditioner has been decided by using the equation stated below:

$$[(\text{Area length x Weight}) \times 25] + [\text{Windows x } 1000] + [\text{Human bodies x } 400] \quad (3.5)$$

3.2.3.4 Design Switch socket Outlet

The first step to design the switch socket outlet installation system is determining the location for the power point and how much the room or area needed those services. This is depending on the type of and activities in the area or room. For some area or room such as office will need more power point than other room or area such as toilet and store.

Type of power point at different location such as at under floor trunking using service box, located at ceiling or on the ceiling, and located at the wall different height will be taken in the design process. The under floor trunking system using service box and junction box is use in the large office, laboratory and etc. The location of the power point often be determined by refer to the furniture layout in the project drawing. Usually, the power point located at the ceiling is use for the overhead projector. Demand from the consumer also should be taken into the design stage process because sometime consumer had already plan for the building use. After that, the switch socket outlet circuits will install by radial or ring circuits depend on the design that selected.

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While the radial circuit, each socket outlet is fed from the previous one. Each radial circuit must not exceed the floor area stated and estimated load. A radial circuit using an over current protective device of 20A with 2.5 copper conductive PVC insulated cable. It will allow supplying to a maximum of two socket outlets only.

Ring circuit is very similar to the radius of the circuit in which each socket fed from the preceding but in the ring circuit, the latter will be wired return to the supply source. Each ring final circuit conductors must be looped into any socket or box with a ring form and shall be electrically continuous throughout its length. For ring circuits, standard 32 A more current protection appliances with wire size 2.5mm^2 copper PVC insulated conductive wires.

Table 3.1: 13A Switch Socket Outlet (BS 1363)

No.	Type of 13A Socket Outlets	Area	Cable sizing	Circuit Breaker
1.	Single socket Outlet	$20mm^2$	$2.5\ mm^2$ PVC cables	16A
2.	Double Socket Outlet	$20mm^2$	$2.5\ mm^2$ PVC cables	20A
3.	Ring (10Nos 13A socket outlet provided all area within an area not more than 1000 sq feet)	$100mm^2$	$2.5\ mm^2$ PVC cables	32A
4.	Radial (max 6 socket outlet)	$50mm^2$	$4\ mm^2$ PVC cables	32A

For industrial socket BS 60309-2 are heavy industrial type which is suitable in three phase (TPN) or single phase (SPN). The range of current rating for this socket is 16A to 125A as shown in Figure 3.2 and Figure 3.3 below.

Figure 3.2: Industrial Socket ($1_{\emptyset}$)

Figure 3.3: Industrial Socket ($3_{\emptyset}$)

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3.2.4 Simulation Process (Load Calculation)

Table 3.2 Load Demand for Preliminary Analysis

Type Of Load	**Average Demand**
Lighting in Building	10 to 35 W/m^2
General Purpose Socket Outlets	6 to 12 W/m^2
Air Conditioning in Commercial Building	30 to 80 W/m^2
Typical Textile Factory	120 W/m^2
Small Device Manufacturing	35 to 75 W/m^2
Typical Electronics Manufacturing	100 W/m^2
Industrial Lighting	10 to 80 W/m^2
Water Pump (10-storey)	10 to 45 kW
Fire Pump (10-storey)	65 to 100 kW

The first step before starting design the electrical system is the load calculation. This is very important for the submission to the TNB for the load demand proposal. Total load connections for this project were coming from the lighting; switch socket outlet, fan, mechanical devices, and many more.

The power consumed by a load was comprised of several individual power components which were apparent power (kVA), reactive power (kVAR) and real power (kW). The real powered installed power component of the load is the portion of load that performs real work. It is also the sum of the nominal power of all power consuming devices in the installation .the reactive power of a load is used to supply energy that stored in either a magnetic field or electric field.

Based on [24], power factor (PF) is an index used to calculate the efficiency of energy consumption. This index is measured from 0 to 1. A higher index indicates the effectiveness of the use of electricity and vice versa. Low power factor shortens the lifespan of electrical equipment and causes power system losses to TNB.
The PF equation;

$$PF \quad \frac{P\ (kW)}{S(kVA)} \quad \cos \qquad (3.6)$$

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Demands factors or diversity factors (DF) is apply of the load due to the diversity of use that typically occurs in a load. The actual demand load for any load in this building was less than the sum of all connected load due to DF of equipment use.
The equation is;

$$\text{D.F} \quad \frac{\text{Maximum Demand (DB)}}{\text{Total Connected Board (switchboard)}} \tag{3.7}$$

Based on [16], maximum demand is the capacity of electricity consumption, and it serves to assess the level of capacity (load) of electricity used by customers. Maximum demand is measured in kilowatts, and it is calculated as double the highest amount of electricity used (in kilowatt-hours) in any consecutive period of thirty minutes in a month. The calculation of maximum demand varies depending on the customer tariff categories; however it is only applies to customers who use the supply of 6.6 kV and above. Maximum demand current I_b is divided by to level that have their own formulae which is at single phase ($I_{\emptyset}$) and three phase ($3_{\emptyset}$).

$$\text{Single Phase } (\text{I}_\text{b}) \quad \frac{\text{Maximum Demand (MD)}}{240 \times \cos} \tag{3.8}$$

$$\text{Three Phase } (\text{I}_\text{b}) \quad \frac{\text{Maximum Demand (MD)}}{\sqrt{3} \times 415 \times \cos\theta} \tag{3.9}$$

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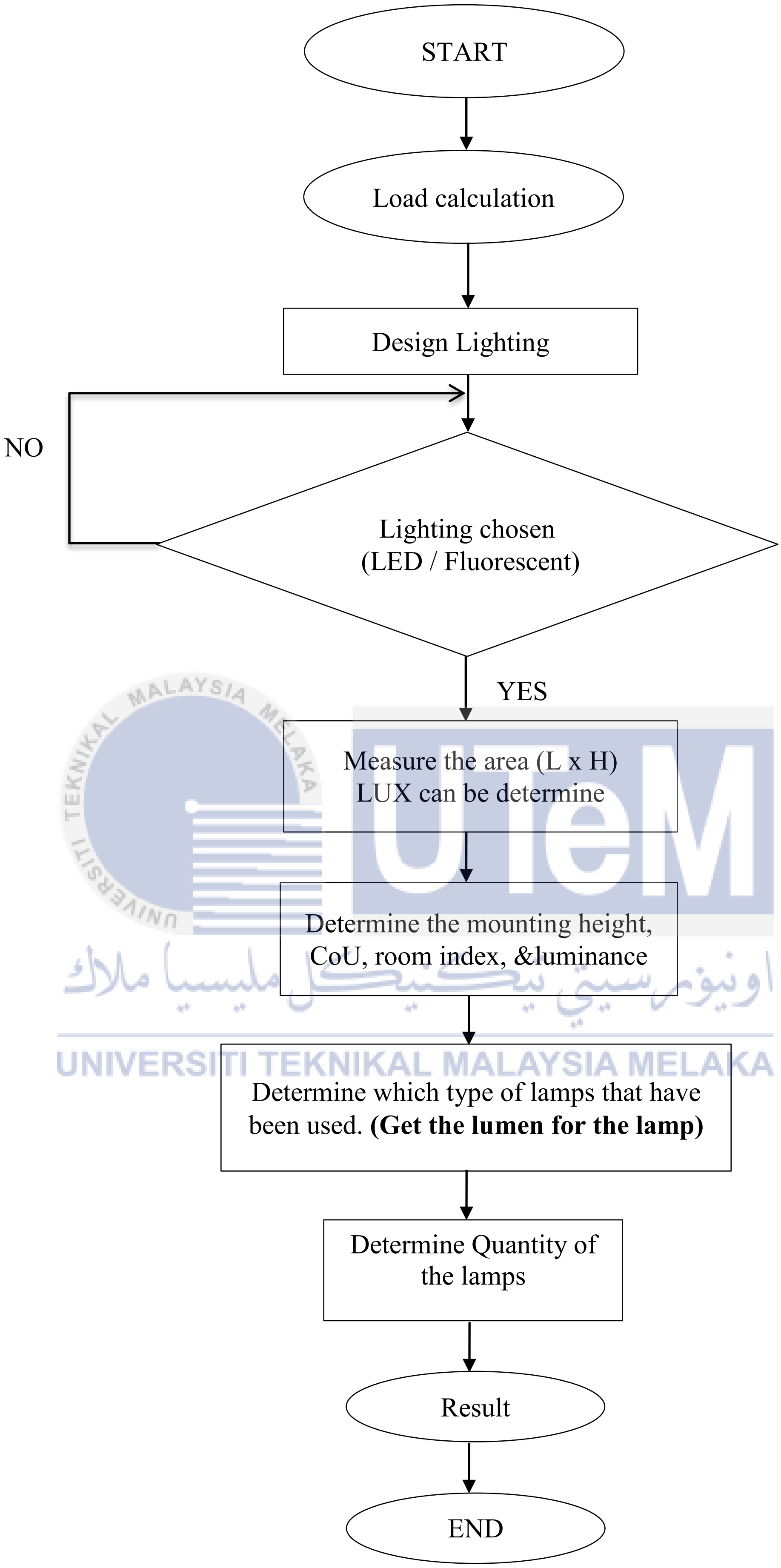

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Figure 3.4: General Flow Chart Calculation of Step to Determine the Number Luminaire

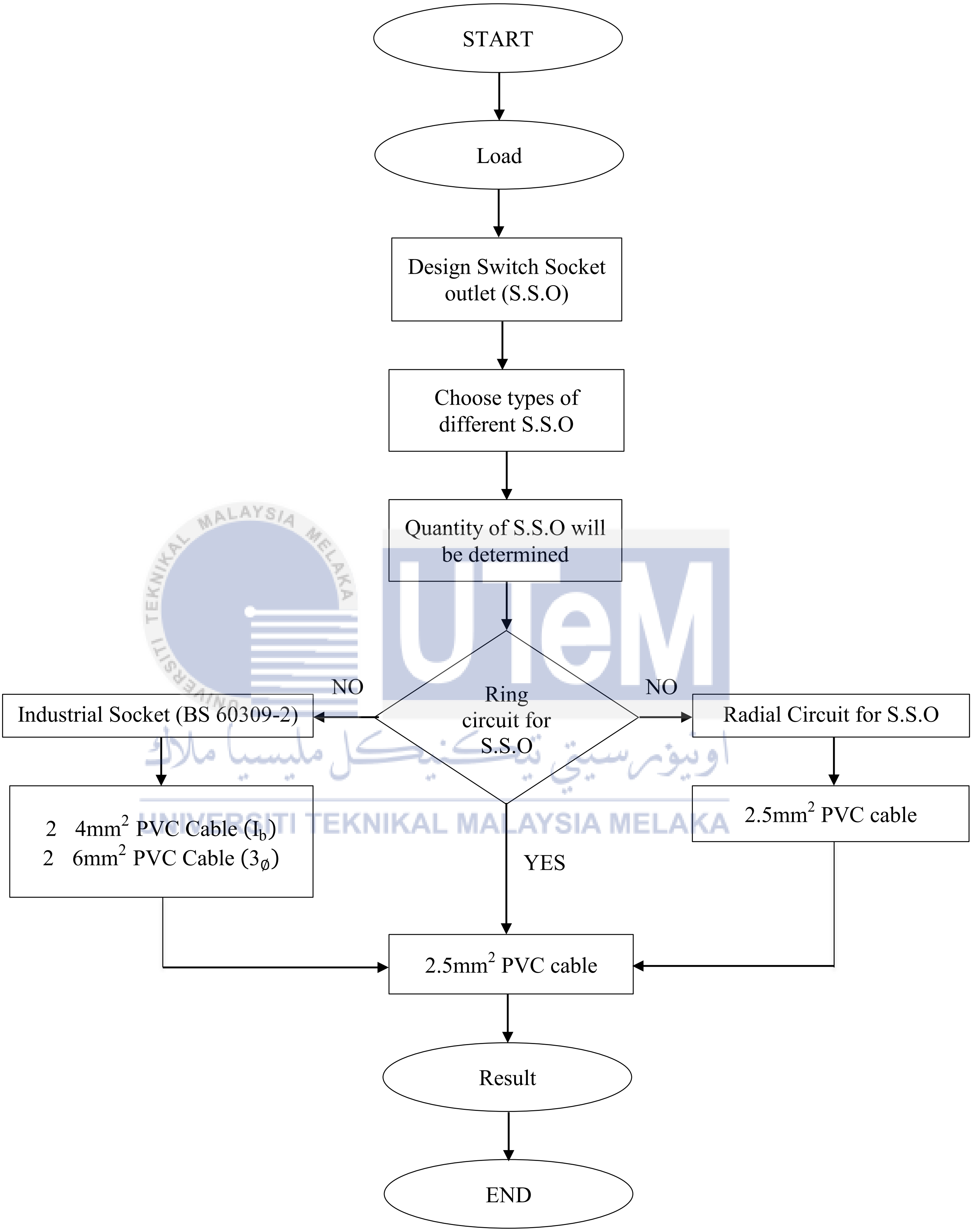

Figure 3.5: General Flow Chart of Load Calculation for S.S.O Connected Load.

3.2.5 Analyze the Result

3.2.5.1 Cable Sizing and Protective Device.

Cable can be defined as length of insulated single conductor or of two or more such conductors each provided with its own insulation which are placing together. Protective device is use to shield the cable against overload and short circuit. Cable selection shows the two main principles which are first, the cable should be able to carry the current load imposed on it without overheating and second, it should offer earthling sound enough to limit the voltage to a safe level exposure and allow the fault current trip the fuse or MCB in a short time.

To meet these requirements requires consideration of the circuit load current, the ambient temperature, cable length and thickness, and over-current protection device. Cable installations such as cable in trunking, cable ladder, cable tray and cable in underground are typically used in the wiring system.

Cable trunking is a manufacturer enclosure for protection of cables, normally of rectangular cross section which one side removable or hinged. It is normally used as submains or where loads are low and side tee off are few. The function of the cable ladder is to maintain consisting of a series of supporting elements. While the cable tray is a cable support made up of an incessant base with generated boundaries and do not have wrapper. It is used for heavy load submains.

Relevant symbols and rules that used in this regulation:

I = Current-carrying capacity of a cable under exacting installation condition

I_b= Design current of the circuit

I_n= Nominal current of the protecting device against overcurrent

I_2= Operating current of the device against overload

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- Rules 1

  $I_n \quad I_b$

- Rules 2

  $I_z \quad I_{\,n}$

- Rules

  $3\ I_2 \quad 1.45 I_z$

3.2.5.2 Procedure of Sizing of cable and Protective device

The current rating for the protective device must not be greater than the cable protected so it can protect the cable from overload. In that case, I_2 must not exceed 1.45 times I_z and I_z must be greater than I_n, all this means that the operating current of the protective device is a fuse or miniature circuit breaker. This requirement is satisfied by selecting I_z is greater than I_n. The current rating for the cable is determined by some correction factor, which the ambient temperature correction factor, C_a, grouping correction factor, C_g, and the thermal insulation correction factor, C_i will be used in the equation. The following equation is for calculating the minimum current rating of a cable:

$$I_{x,\,min} \quad \frac{I_n}{C_a \;\; C_g \;\; C_i} \tag{3.9}$$

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Calculated the design current, was determine by the power demand and power factor.

$$\text{Design Current, } I_b = \frac{\text{Maximum Demand (kW)}}{\sqrt{3}\;\; 4\;15\;\; c\;os} \tag{3.10}$$

In this project, the protection devices that have been used are moulded case circuit breaker (MCCB), air circuit Breaker (ACB) and residual current circuit breaker (RCCB). Rating of MCCB that used in this project is 30A to 600A and the rating of ACB that are used is 1000 A. For the rating of RCCB, air-condition and switch socket outlet used 100 mA and for the lighting 30 mA. For the industrial socket three phases the rating of RCCB is 300 mA.

The types of cable are to be chosen depends on the suitable situation. Typically, the cable selection for this project is shown below:

Table 3.3: Type of Load and Cable

No.	Type of load	Type of Cable
1.	Lighting and small power (indoor)	Single core PVC
2.	MSB to DB, feeder pillar, street, compound lighting panel	Multicore PVC/SWA/PVC
3.	MSB to SSB	4core XLPE/SWA/PVC

Step 1: Calculate the expected design in the circuit.

Step 2: Choose the type and rating of protective device to be used.

Step 3: Apply the ambient temperature correction factor, C_a, grouping correction factor, C_g, and thermal insulation correction factor, C_i.

Step 4: Choose the cable size.

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CHAPTER 4

RESULT AND DISCUSSION

4.1 Design Lighting

In this project, the design of the lobby is one of the most parts that should be considered. Lobby is the place where it occupied by the people. Therefore, a large area is needed for the users to do their work comfortably. The area of the lobby is 71.21 m^2 for the overall indoor lobby area. The design is drawn in AutoCAD software where it helps in designing the electrical system in order to ensure that the installation look smart and well-organized. One way to demonstrate energy efficiency in lighting design is to show the effectiveness of the luminaries. The efficacy of luminaires could be achieved by careful selection of lights, control equipment and power factor correction equipment.

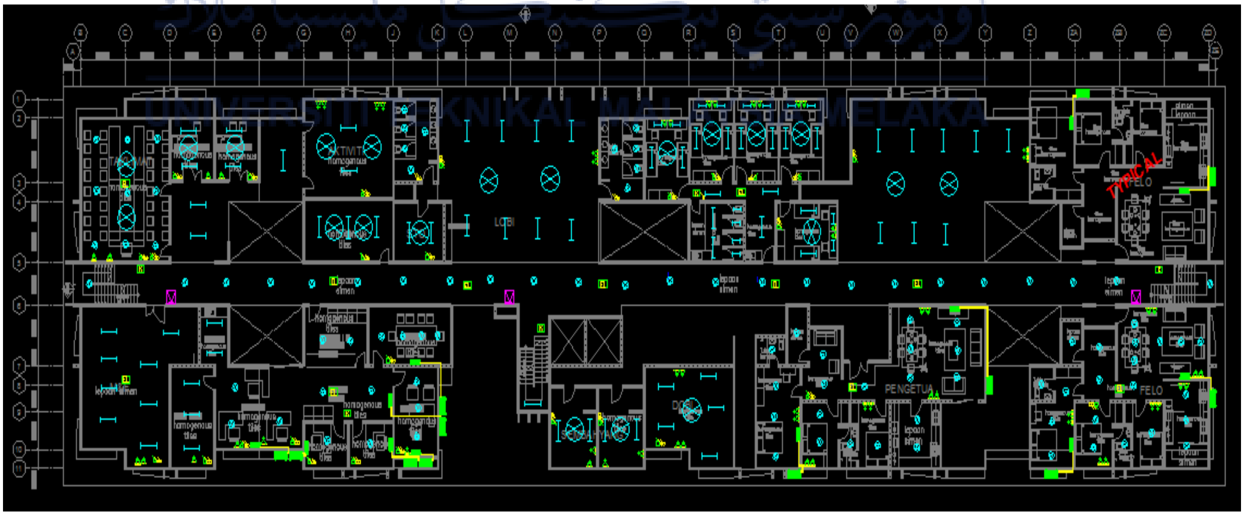

Figure 4.1: Design Layout for Ground Floor with Electrical Installation

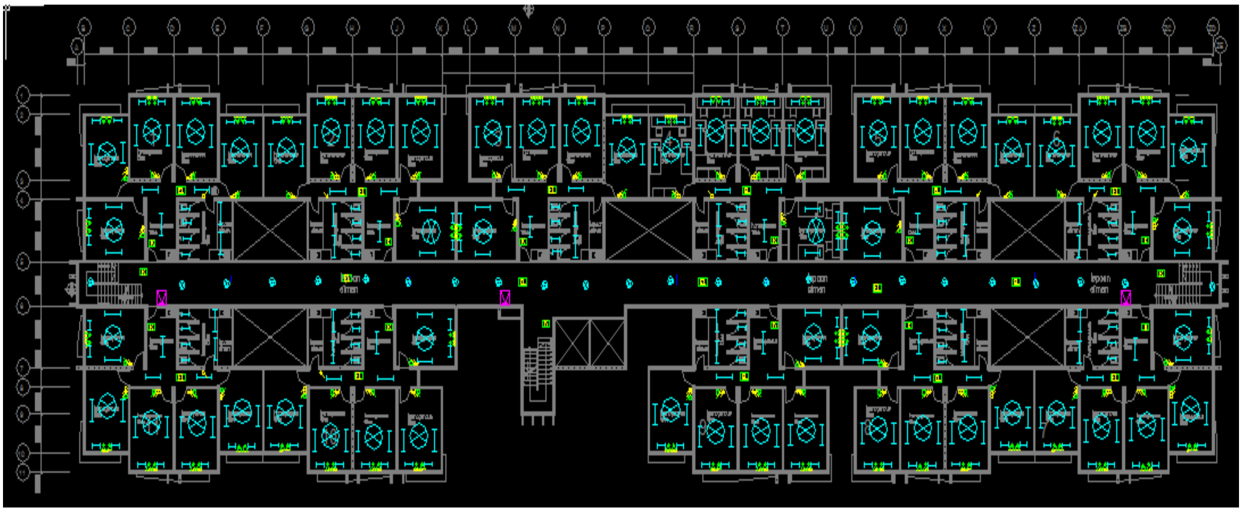

Figure 4.2: Design Layout for 1st Floor – 10th Floor with Electrical Installation

Figure 4.1 and Figure 4.2 show the AutoCAD layout plan that is implemented with a number of lamps for analysis.

In the general areas of the existing hostel, the conventional T12, 38 mm diameter, fluorescent lamps are used. But, in the green building hostel area energy efficient luminaires with T8 lamps with electronic control gear have been used in the first floor area, such as in the toilet, storage and switch room. T8 luminaires consume 25% less energy to provide the same light output with T12 lamps. T8 lamps use larger phosphor technology so they can produce the required light output from a smaller surface area and smaller diameter. A smaller diameter lamp consumes less energy, which in turn allows more efficient production of light in the lamp.

Most every hostel has a standard 40 watt T12 lamp on standard magnetic ballast and uses 172 watts of energy. The same installation with T8 lamps and new electronic ballast uses 112 watts of energy, which is a 35% reduction in energy usage. To replace existing fixture with the new ballasts is an easy process that requires very basic wiring knowledge. By removing two T12 ballasts, replace with T8 ballast, and replace old lamps with new lamp on the same sockets. Not only a 35% reduction in energy consumption, but also a dramatic difference in light output will be seen. The Standard T12 lamp produces 2,650 initial lumens per lamp. The standard T8 produces 2,800 initial lumens per lamp, 6% brighter. But the standard T12 lamp produces 2,300 lumens design and produces 2,660 lumens T8 design.

In this project, there are two types of lamps will be analyzed. All type of this lamp is selected from Philips Lighting Company catalogue. The lamps are:

1. Pentura Mini LED

This lamp is ultra-slim pattern that offers the energy saving benefits of LED technology, coupled with excellent lighting performance. The lighting is bright and uniform light with good color rendering. Pentura Mini LED is very easy to install, even where space is limited, e.g. under shelves in shops, and over worktops and workstations in the home and home office. Power cable, mounting clips and connection accessories are also supplied. Thin end-caps minimize black spots between the products, enabling consumers to create a continuous light-line.

Figure 4.3: Pentura Mini LED

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This Pentura Mini LED has a unity correction factor. It consists of luminous flux of 800 lm and the luminaire wattage of 10.5 W.

2. GreenSpace

This lamp has high efficiency and sustainable LED solution. People want an appropriate balance between initial investment and installation costs during its lifetime. GreenSpace is the light that used to replace conventional CFL downlights in general lighting applications in terms of cost efficient and sustainable downlight. It has consistently delivered light output, stable color performance and high color rendering.

Figure 4.4: GreenSpace Lamp

This GreenSpace lamp has a unity correction factor. It consists of luminous flux of 1100 lm and the luminaire wattage of 15 W.

From IES lighting design, some parameters were needed such as MF=0.8 and the value of COU is depend on room index that have been get in calculation and after that the value of COU will get and depends on catalogue of lamps that suitable.

The calculation to show the number of lamps required for some typical areas in some room or building.

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Calculation Method:

Case (i): Discussion Room at Ground Floor. Refer Equation (3.0).

GreenSpace 15W was selected where LDL = 1100 lumen, area = 21.54m^2, illuminance = 100, COU = 0.6 an3d MF = 0.8

$$\text{Number of lamps} = \frac{\text{Average illuminance (lux)} \times \text{area}(\text{m}^2)}{\text{LDL (lumen)} \times \text{COU} \times \text{MF}}$$

$$= \frac{100\ x\ 21.54\ m^2}{1100\ x\ 0.6\ x\ 0.8}$$

= 4.07

≈ 4 unit

Case (ii): File store room at Ground Floor. Refer Equation (3.0).

Pentura Mini LED 10.5W was selected where LDL = 800 lumen, area = 19.26m^2, illuminance = 50, COU = 0.6 and MF = 0.8

$$\text{Number of lamps} = \frac{\text{Average illuminance (lux)} \times \text{area}(\text{m}^2)}{\text{LDL (lumen)} \times \text{COU} \times \text{MF}}$$

$$= \frac{50\ x\ 19.26\ m^2}{800\ x\ 0.6\ x\ 0.8}$$

$$= 2.51$$

$$\approx 3 \text{ unit}$$

Case (iii): Pantry at Ground Floor. Refer Equation (3.0).

Pentura Mini LED 10.5W was selected where LDL = 800 lumen, area = 7.22m^2, illuminance = 100, COU = 0.6 and MF = 0.8

$$\text{Number of lamps} = \frac{\text{Average illuminance (lux)} \times \text{area}(\text{m}^2)}{\text{LDL (lumen)} \times \text{COU} \times \text{MF}}$$

$$= \frac{100\ x\ 7.22\ m^2}{800\ x\ 0.6\ x\ 0.8}$$

$$= 1.88$$

$$\approx 2 \text{ unit}$$

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Table 4.1 show the numbers of lighting that has been used for each floor in this project. The value of Lux and Lumen of some lamps is depend on JKR standard service and the value of room index for each lamp is depends on catalogue of lamps that have been used for the example 1 x 15W LED Green Space. The different type of lamps have a different value of room index is depends on catalogue. All the result of number of lamps was show on the Appendix C.

Table 4.1 Quantity of Lamp that Used for Each Floor and Type of Lamps

Type of Lighting	**Ground Floor**	**1st Floor – 10th Floor**
1 x 15W LED Green Space	123	2200
1 x 10.5 W Pentura Mini LED	83	1240

4.1.1 Lighting Simulation:

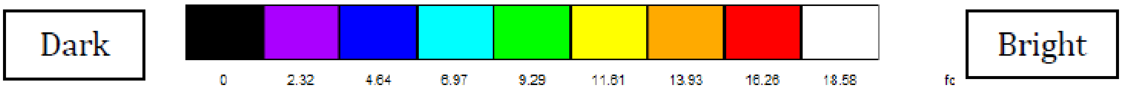
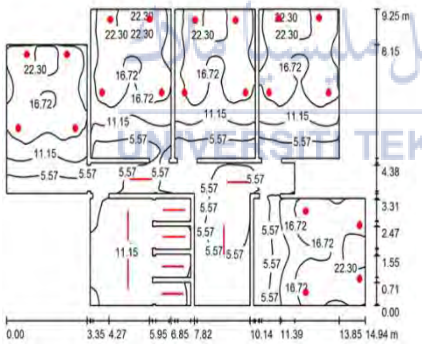
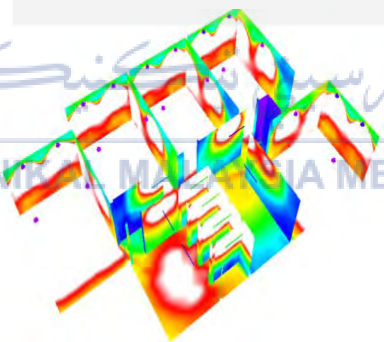
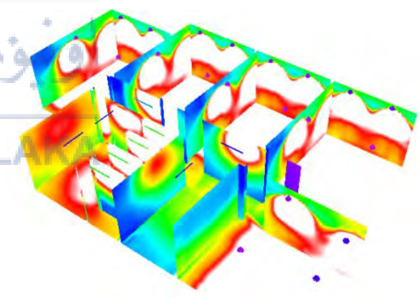
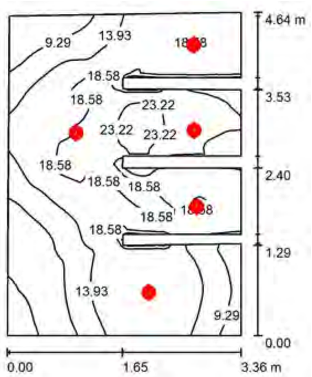
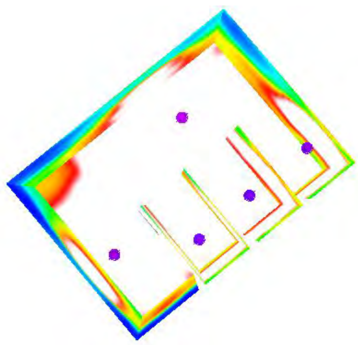
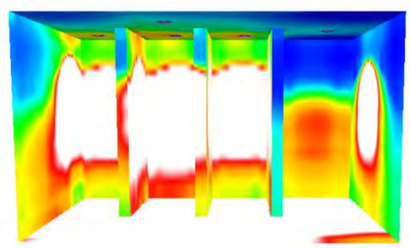


Figure 4.5: Color Rendering Index (CRI)

Figure 4.5 shows the color rendering index (CRI) that will measure how an artificial light source color display. CRI is determined by comparing the appearance of a colored object under artificial light source for appearance under incandescent light. The best possible rendition of colors is determined by a hundred, while the very poorest rendition is specified by a CRI of zero.

Table 4.2 show the result for light distribution and color rendering in every single part at the hostel:

Table 4.2: Room Light Distribution and Color Rendering for Hostel

	Lighting Distribution	Color Rendering	
Student House			
Public Toilet			

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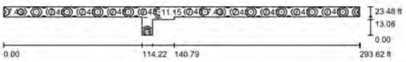
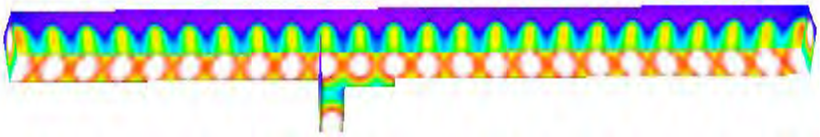
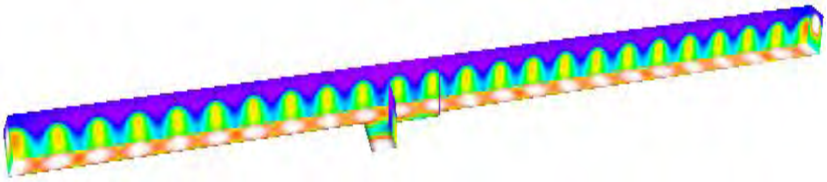
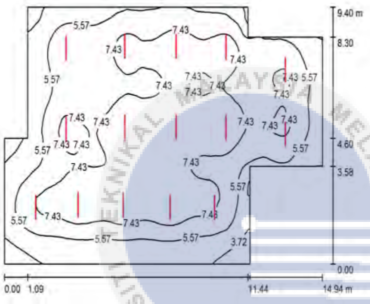
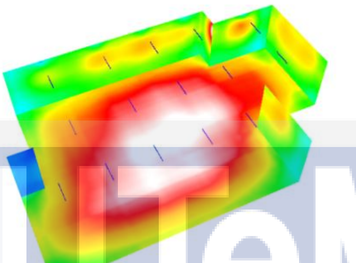
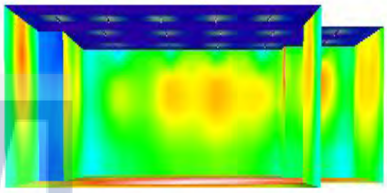
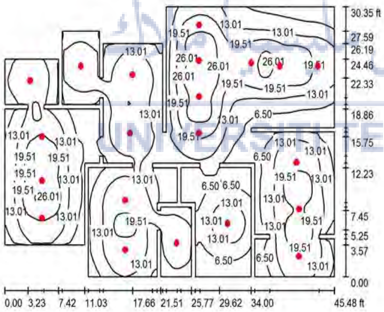
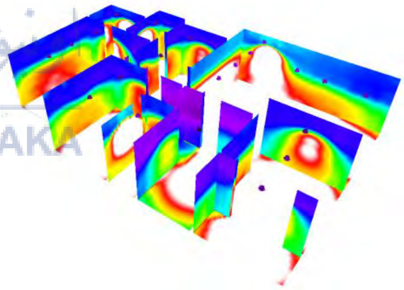
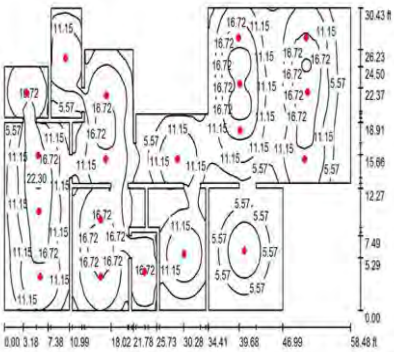
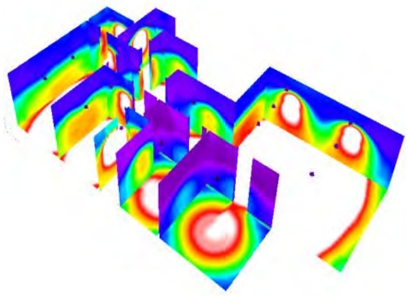
Corridor and Staircase		 	
Lobby			
Felo House			
Principle House			

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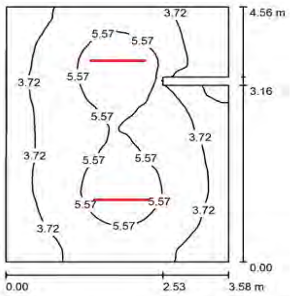
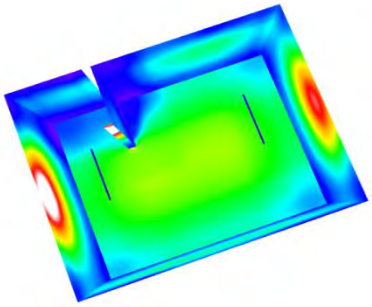
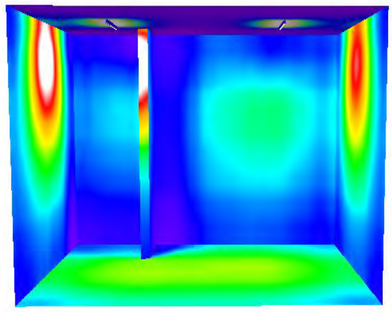
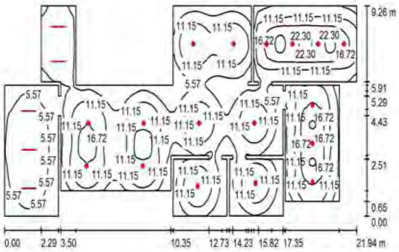
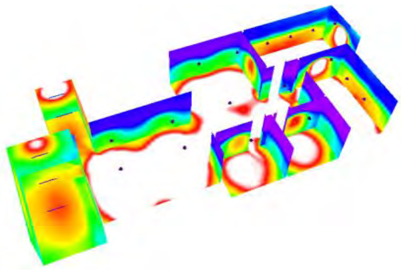
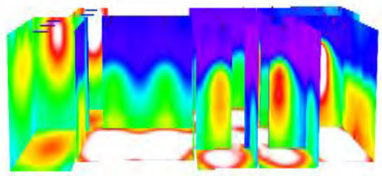
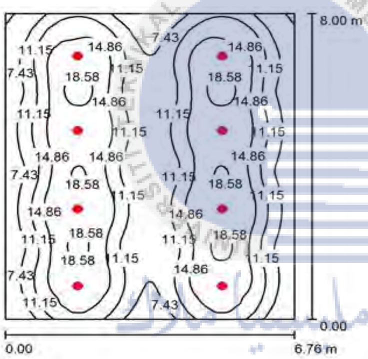
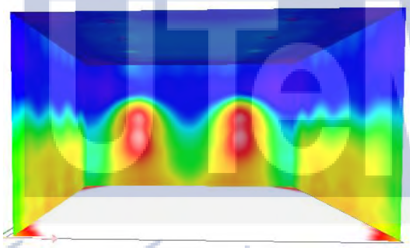
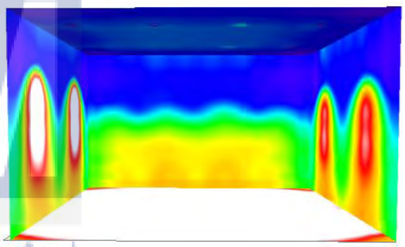
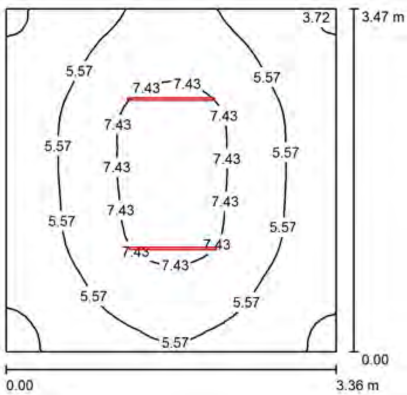
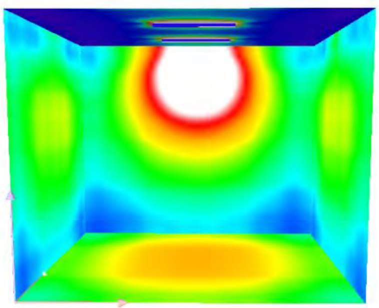
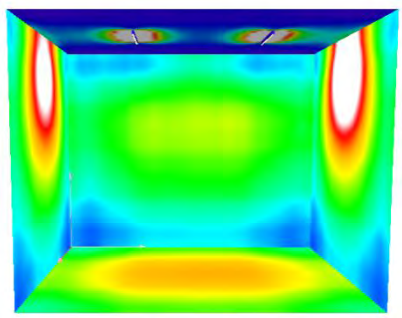
<tr><td>Prayer Room</td><td>
</td><td></td><td></td></tr>
<tr><td>Office</td><td>
</td><td></td><td></td></tr>
<tr><td>Briefing Room</td><td>
</td><td></td><td></td></tr>
<tr><td>Quarantine Room</td><td>
</td><td></td><td></td></tr>
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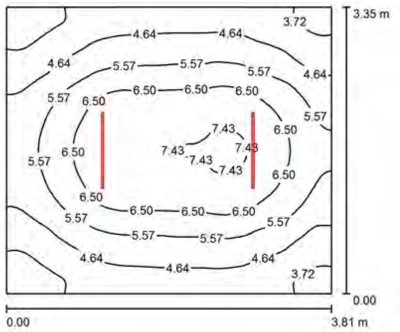
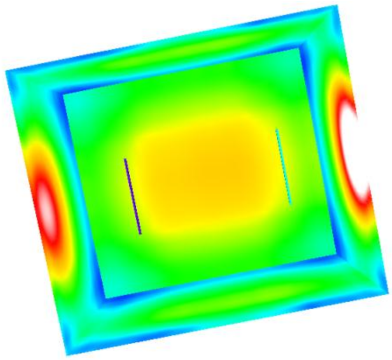
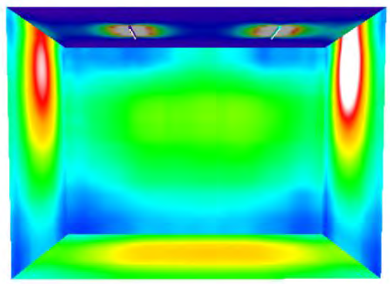
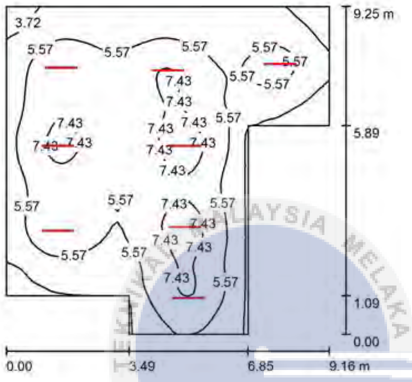
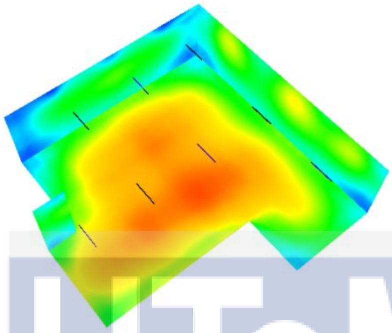
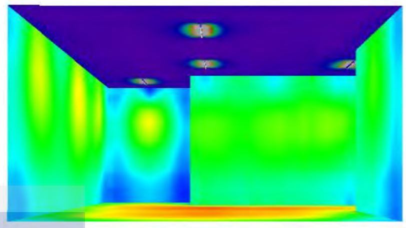
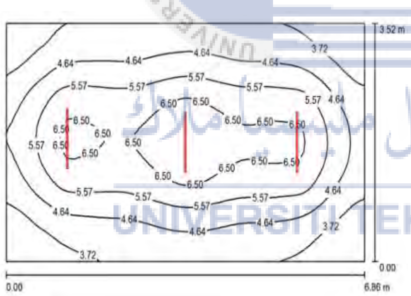
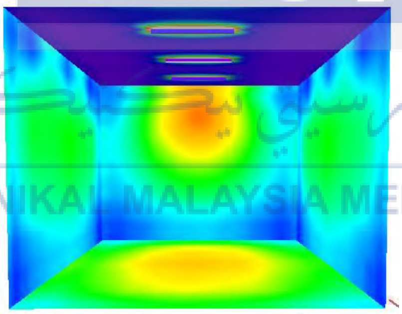
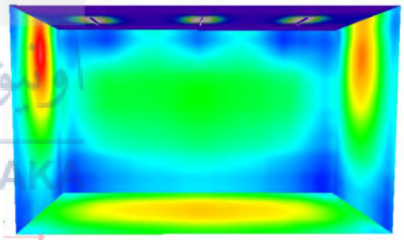
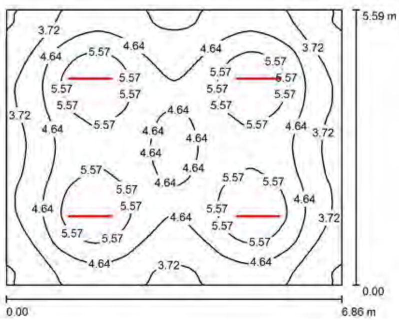
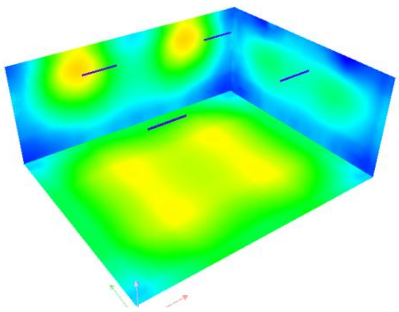
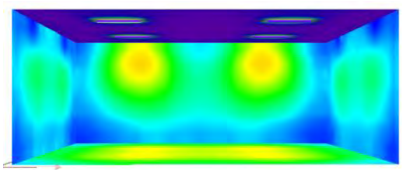
Store Room			
M&E Room			
TV Room			
Activity Room			

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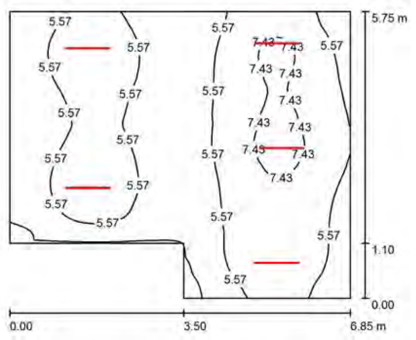
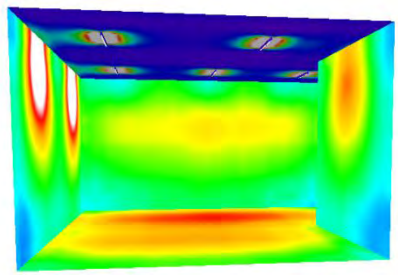
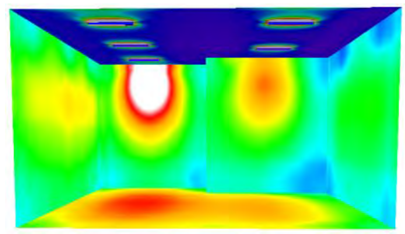
Washing Room			

Lighting Zone by DIALUX simulation:

The lighting strategies will be divided by 15 zones of lighting. Each of the zones will have the control circuit to enhance the energy saving consumption. The total energy usage for each area shown in Table 4.3 below:

Table 4.3: Total Energy Usage for Every Part in the Hostel

No.	**Area**	**Number of Luminaries**	**Watts/ Luminaire**	**Total Power (W)**	**Space Area (m^2)**	**Lighting Power Density (W/m^2)**
1.	Student House	20	15	395	108.10	3.654
		9	10.5			
2.	Public Toilet	5	15	75	14.60	5.137
3.	Corridor and Staircase	25	15	375	240.64	1.558
4.	Lobby	15	10.5	158	119.15	1.322
5.	Felo House	21	15	315	110.00	2.864
6.	Principle House	20	15	300	126.57	2.370
7.	Prayer Room	2	10.5	21	16.19	1.297
8.	Office	17	15	308	153.43	2.007
		5	10.5			
9.	Briefing Room	9	15	135	54.05	2.498
10.	Quarantine	2	10.5	21	11.66	1.801

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	Room					
11.	Store Room	2	10.5	21	12.77	1.644
12.	M&E Room	8	10.5	84	67.36	1.247
13.	TV Room	3	10.5	32	24.17	1.303
14.	Activity Room	4	10.5	42	30.3	1.386
15.	Washing Room	5	10.5	53	35.54	1.477

All the lighting been used is compiled for MS 1525:2007 standard to enhance the energy saving achievement. LED lighting is used to minimize the energy to improve energy efficiency in the hostel. The LED implementation will not reduce the capital cost due to installation, but it will give a better result in term of return of investment ROI.

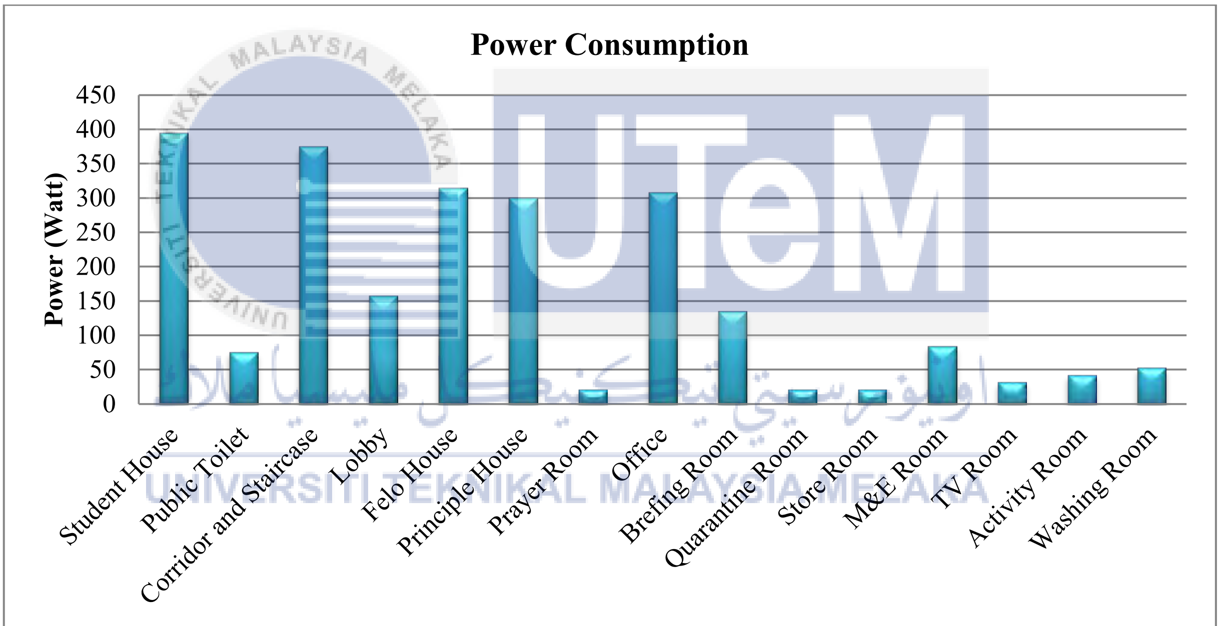


Figure 4.6: The Graph of Energy Used in Every Area in the Hostel

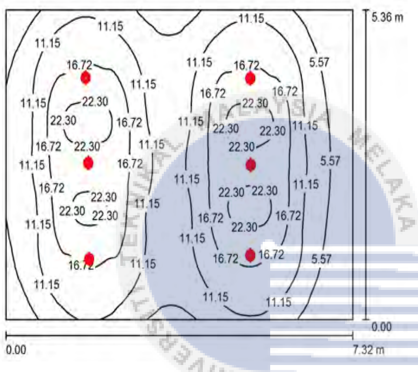
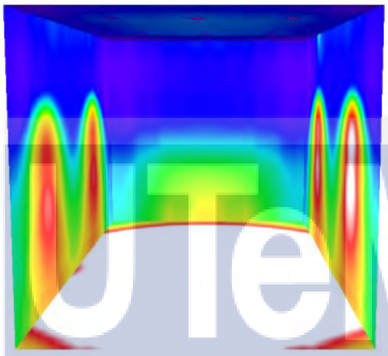
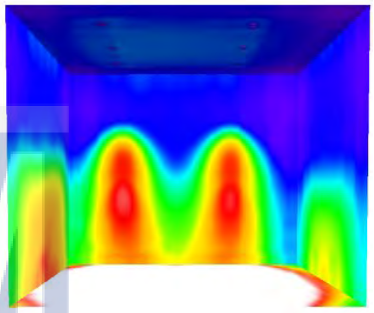
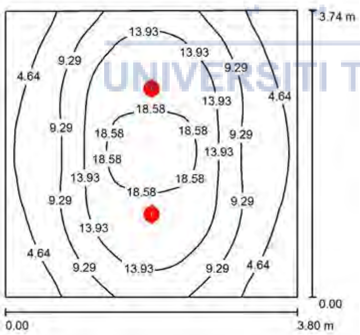
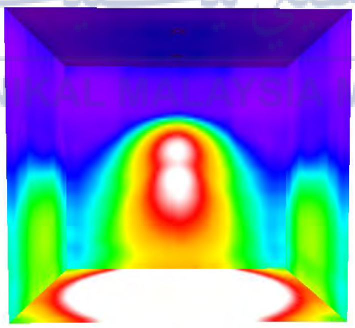
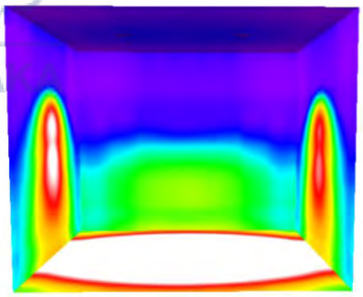
Based on the result in Figure 4.6 above, the critical area is student house, but only certain lamp is used at one time. So, the most critical area is corridors and staircase which use 375.0 watt because the duration of time use is about 12 hours per days. In this project, the lamp that used for corridor and staircase is green space lamp which has luminous flux of 1100 lm and the luminaire wattage of 15 W. This is because, by using this type of lamp not only reduces the quantity of the lamp but also can saving more energy efficiency compered if used T12 or T8 fluorescent lamps.

There is lighting simulation for Principle house, Felo house, Student house, and Office area because these zones have their own area.

a) Principle House

Table 4.4 show some of the result for light distribution and color rendering in every single part at the Principle House:

Table 4.4: Room Light Distribution and Color Rendering for Principle House

	Lighting Distribution	**Color Rendering**	
Living & Dining Room			
Kitchen			

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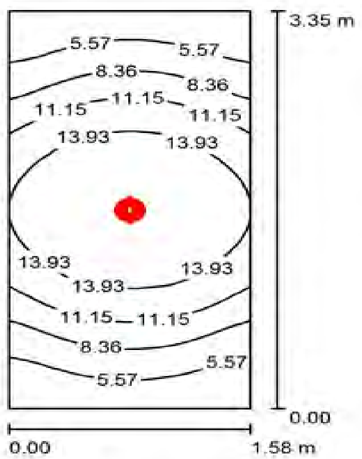
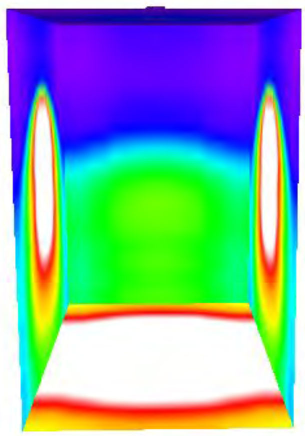
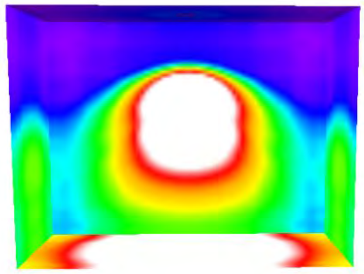
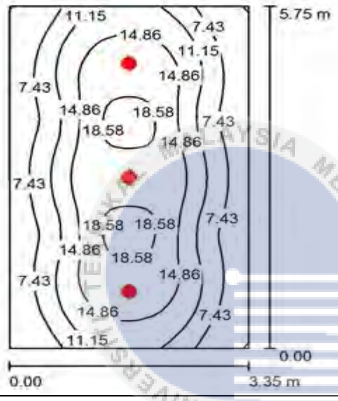
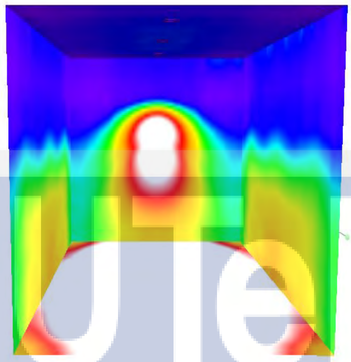
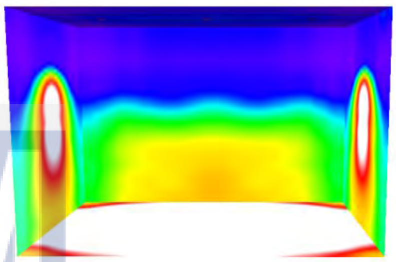
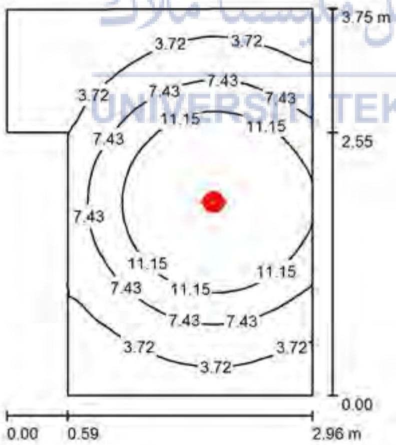
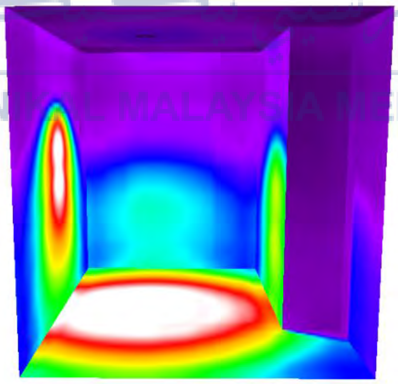
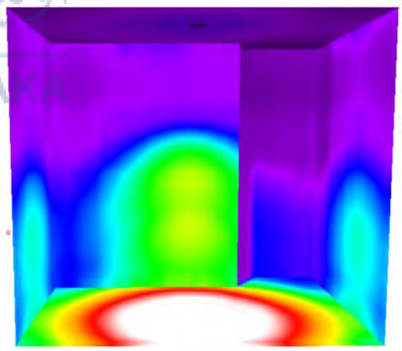
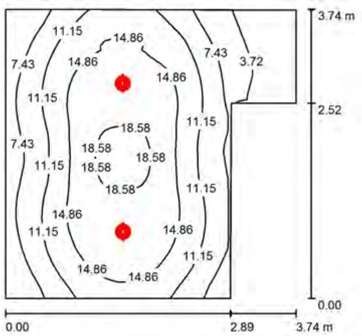
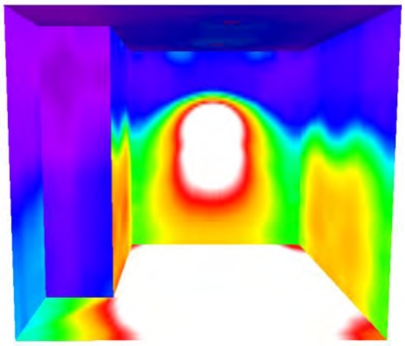
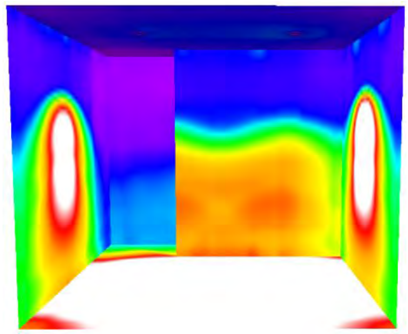
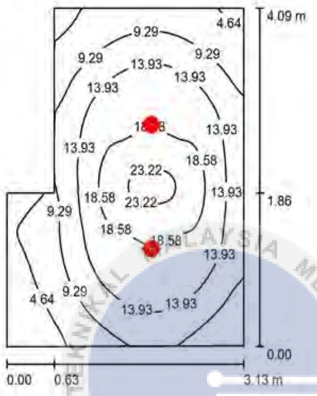
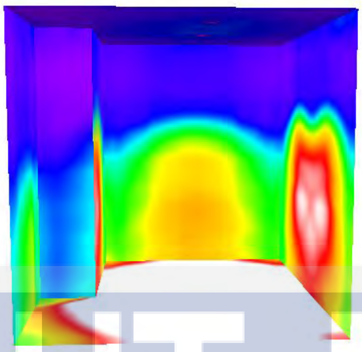
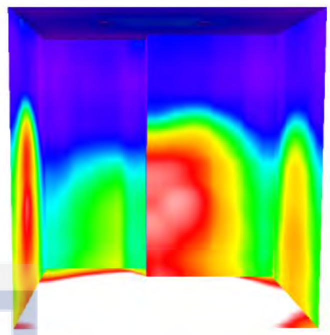
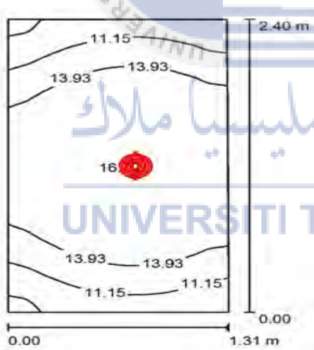
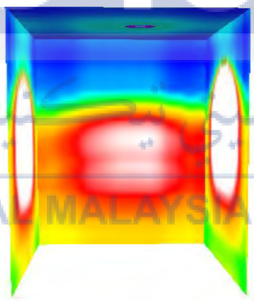
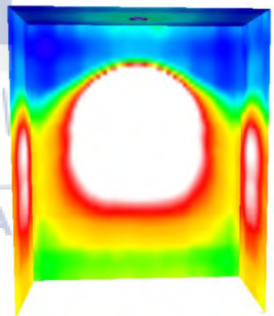
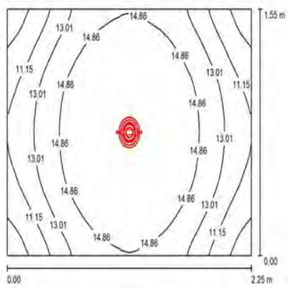
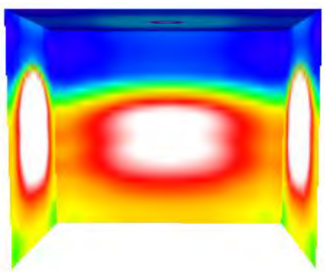
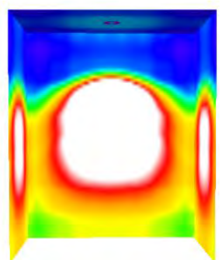
Store Room			
Master Bedroom			
Bedroom 1			

Bedroom 2			
Family Room			
Toilet 1			
Toilet 2			

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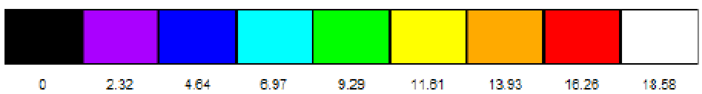

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Lighting Zone by DIALUX simulation:

For this principle house, the lighting strategies will be divided by nine zones of lighting. Each of the zones will have the control circuit to enhance the energy saving consumption. The total energy usage for each area shown in Table 4.5 below:

Table 4.5: Total Energy Usage for Every Part in the Principle House

Area	**Number of Luminaries**	**Watts/ Luminaire**	**Total Power (W)**	**Space Area (m^2)**	**Lighting Power Density (W/m^2)**
Living & Dining Room	6	15	90	39.26	2.292
Kitchen	2	15	30	14.20	2.113
Store Room	1	15	15	5.28	2.841
Master Bedroom	3	15	45	19.23	2.340
Bedroom 1	1	15	15	9.58	1.566
Bedroom 2	2	15	30	11.85	2.532
Family Room	2	15	30	11.39	2.634
Toilet 1	1	15	15	3.13	4.792
Toilet 2	1	15	15	3.49	4.298

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For this Principle house, the living and dining room use 6 lamps for the brightness of the area. Meanwhile for master bedroom, number of luminaries is three lamps. For kitchen, bedroom 2 and family room, these areas use only two lamps for each area. For store room, bedroom 1, toilet 1 and toilet 2, number of luminarie that been used only one lamp for each areas.

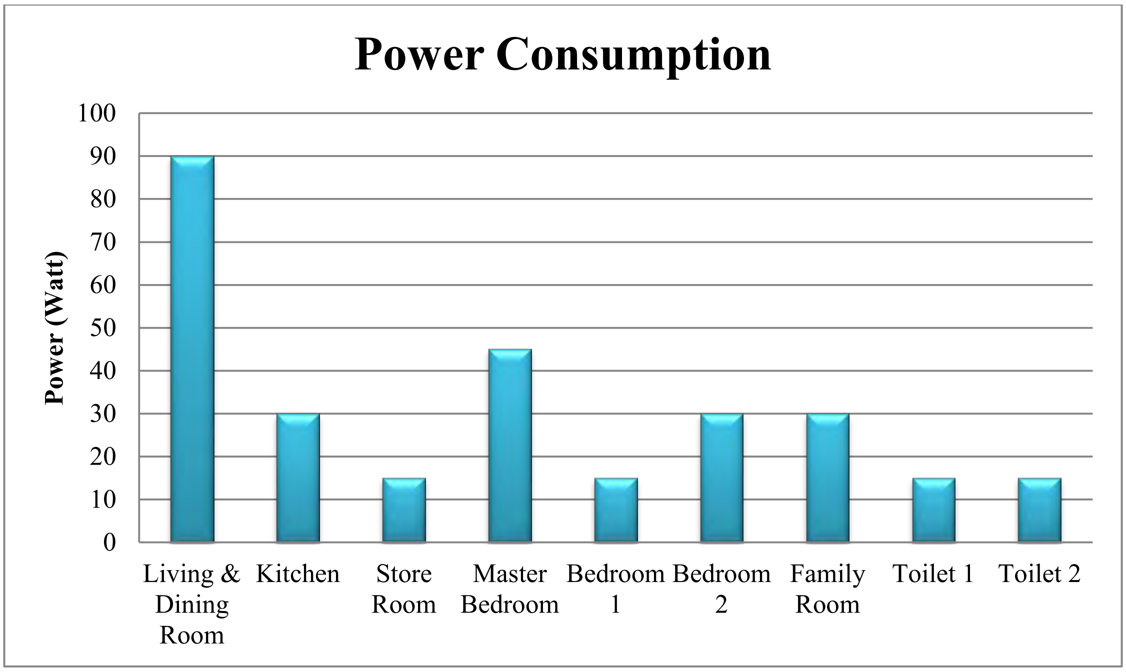

Figure 4.7: The Graph of Energy Used in Every Area in the Principle House

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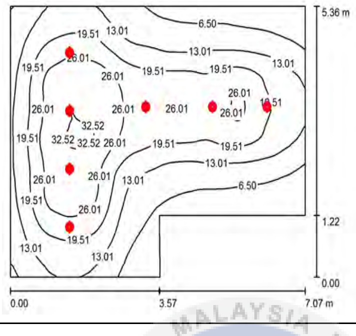
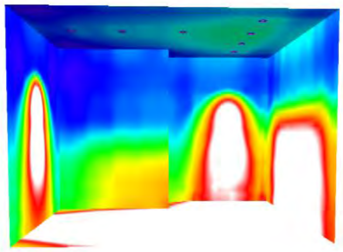
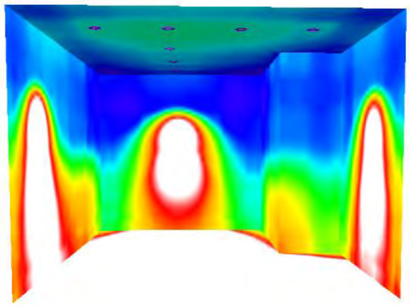
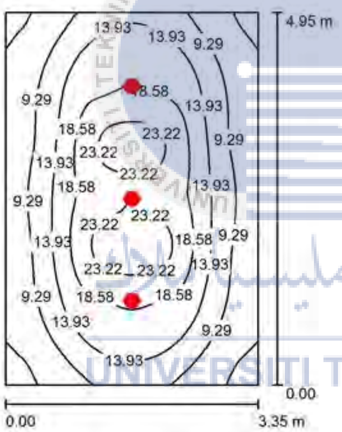
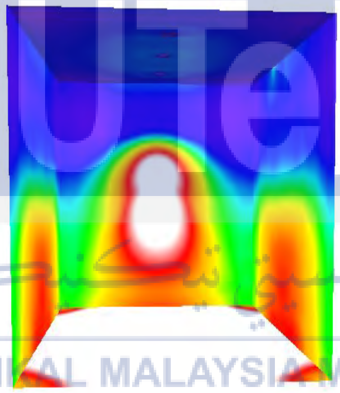
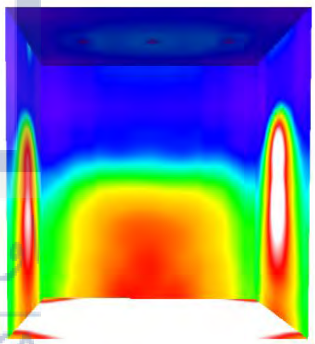
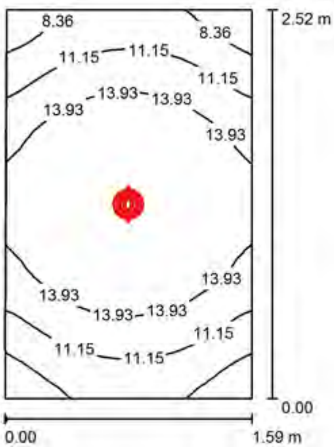
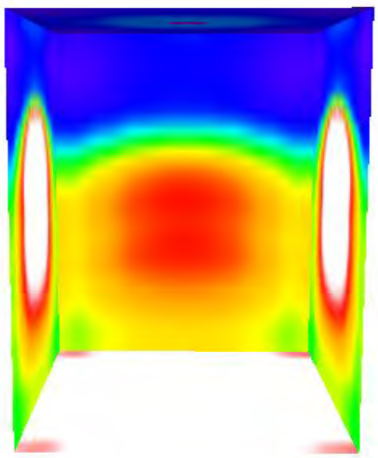
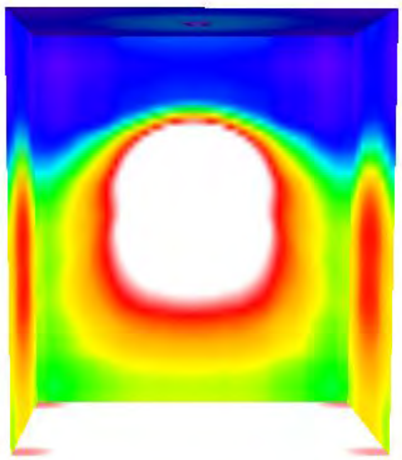
Based on the result in Figure 4.7 above, the living and dining room is the major part of assessment; this area had been consumed 90.0 watt by considering 2.30 W/m² at 39.26m². In kitchen area, the total energy usage is 30.0 watt at 2.11 W/m² in 14.20m² for ground area. In addition, store room consumed 15.0 watt at 2.84 W/m² in 5.28m² for ground area. Master bedroom consumed 45.0 watt at 2.32 W/m² in 19.26m² for ground level. Bedroom 1 consumed 15.0 watt at 1.57 W/m² in 9.58m² for ground area. Meanwhile the Bedroom 2 consumed 30.0 watt at 2.53 W/m² in 11.85m². Family room consumed 30.0 watt at 2.63 W/m^2 in 11.39m^2. For toilet 1, energy usage is 15.0 watt at 4.80 W/m^2 in 3.13m^2. Meanwhile, toilet 2 consumed 15.0 watt at 4.30 W/m^2 in 3.49m^2. In this principle house, the lamp that used for each area is green space lamp which has luminous flux of 1100 lm and the luminaire wattage of 15 W.

b) Felo House

Table 4.6 show some of the result for light distribution and color rendering in every single part at the Felo House:

Table 4.6: Room Light Distribution and Color Rendering for Felo House

	Lighting Distribution	**Color Rendering**	
Living & Dining Room			
Kitchen			
Store Room			

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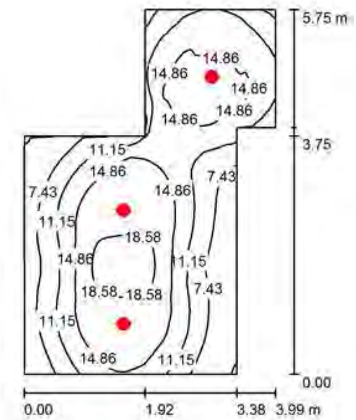
<td>
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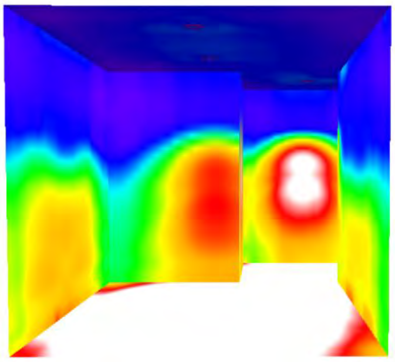
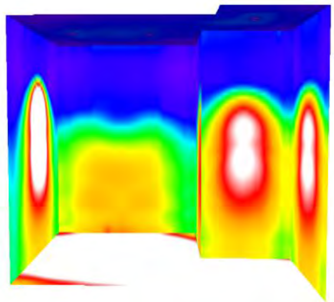
<td></td>
<td></td>
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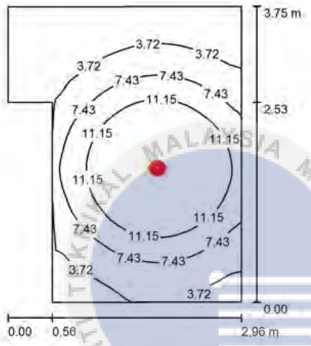
<td>
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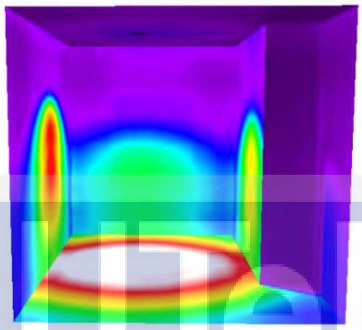
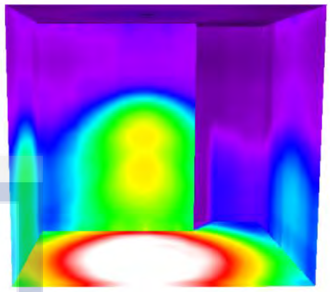
<td></td>
<td></td>
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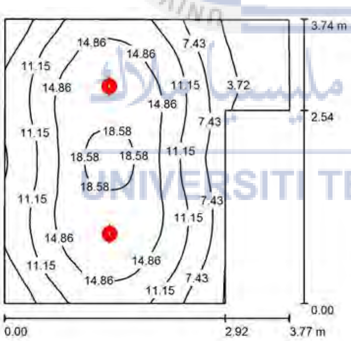
<td>
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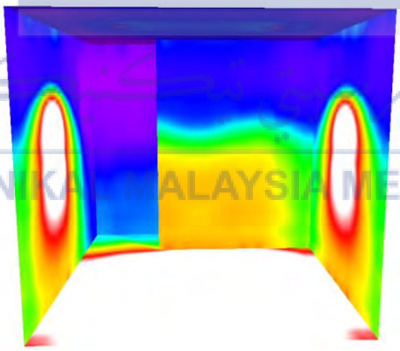
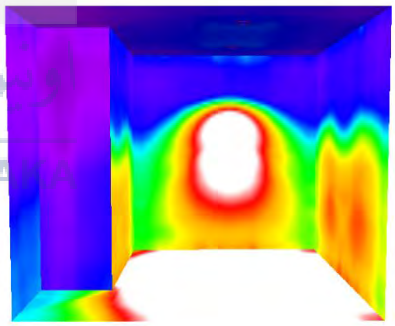
<td></td>
<td></td>
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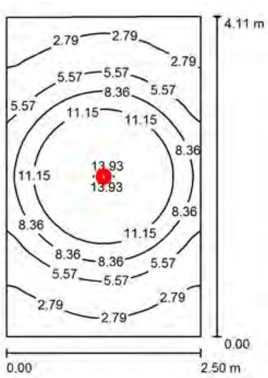
<td>
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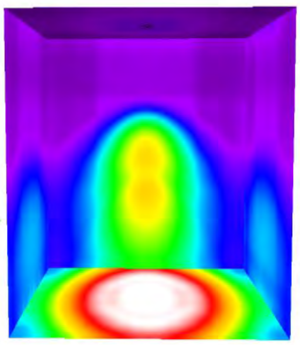
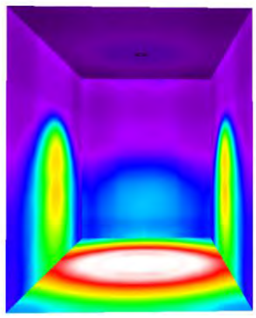
<td></td>
<td></td>
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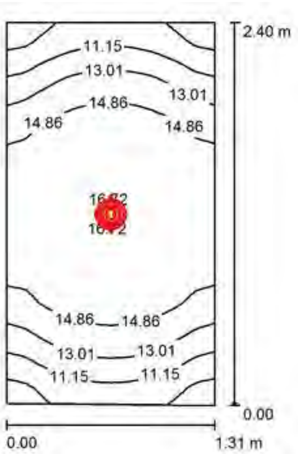
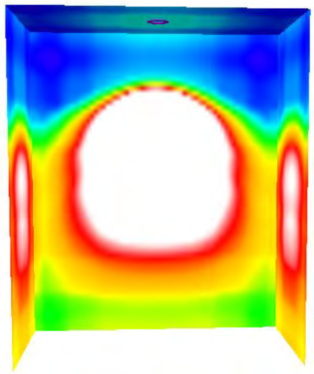
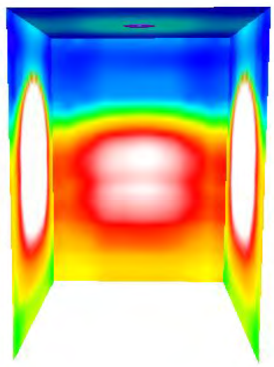
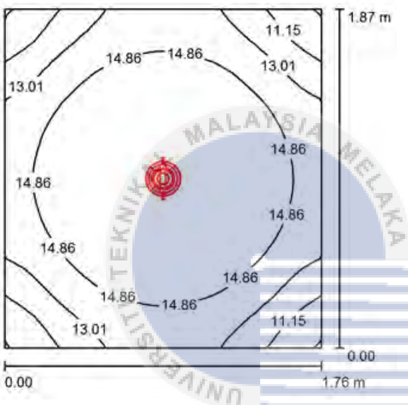
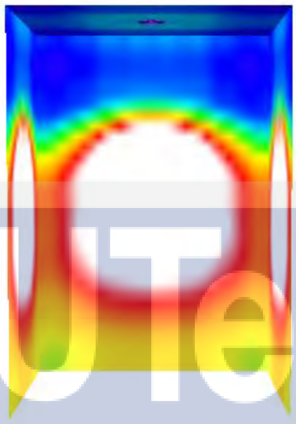
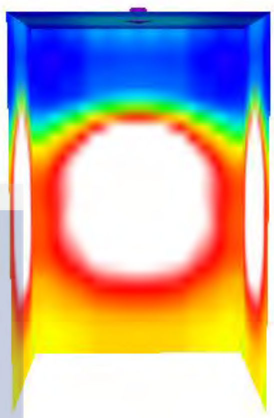
Toilet 1			
Toilet 2			

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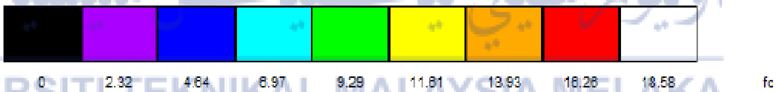

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Lighting Zone by DIALUX simulation:

For this Felo house, the lighting strategies will be divided by nine zones of lighting. Each of the zones will have the control circuit to enhance the energy saving consumption. The total energy usage for each area shown in Table 4.7 below:

Table 4.7: Total Energy Usage for Every Part in the Felo House

Area	**Number of Luminaries**	**Watts/ Luminaire**	**Total Power (W)**	**Space Area (m^2)**	**Lighting Power Density (W/m^2)**
Living & Dining Room	7	15	105	33.68	3.118
Kitchen	3	15	45	16.60	2.711
Store Room	1	15	15	3.99	3.759
Master Bedroom	3	15	45	16.69	2.696
Bedroom 1	1	15	15	9.63	1.558
Bedroom 2	2	15	30	11.89	2.523
Family Room	1	15	15	10.25	1.463
Toilet 1	1	15	15	3.14	4.777
Toilet 2	1	15	15	3.29	4.559

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For Felo House, the area that use many number of luminaries is living room and dining room which is seven lamps. For kitchen and master bedroom, both areas only use three lamps for each area. Meanwhile for the bedroom 2, the number of luminarie is two lamps, other area such as store room, bedroom1, family room, toilet 1 and toilet 2, these areas only used one lamp for each area.

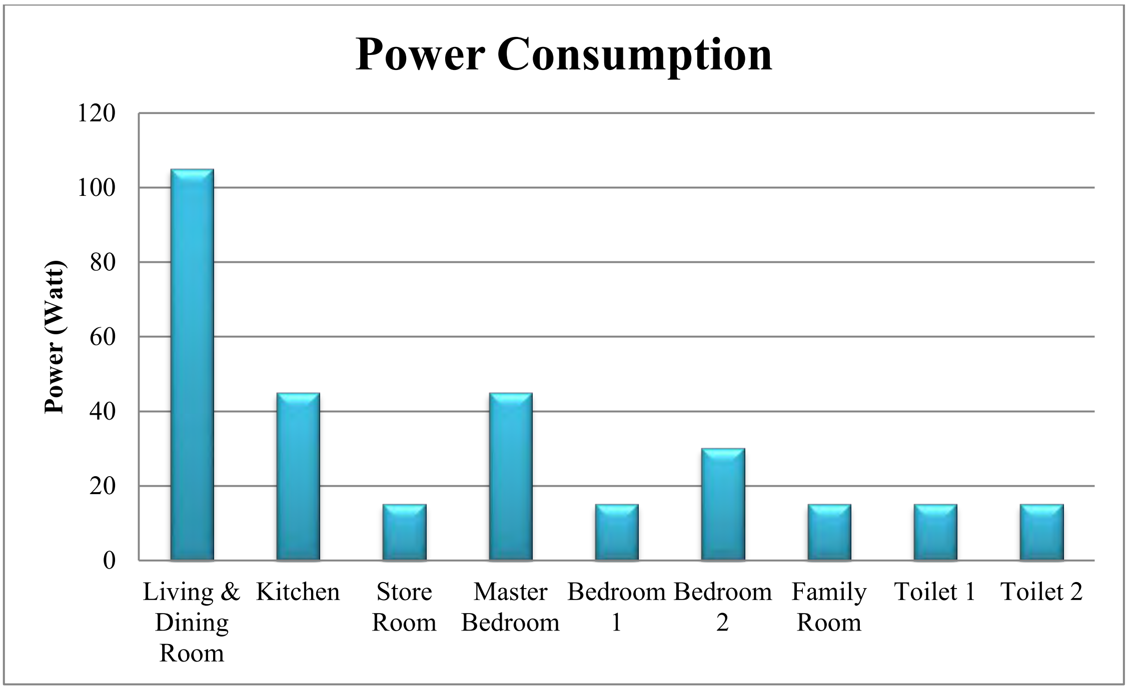


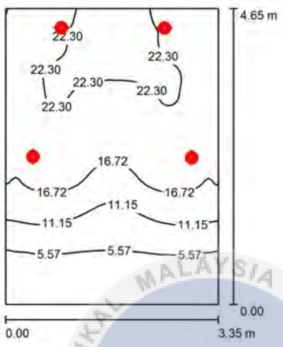
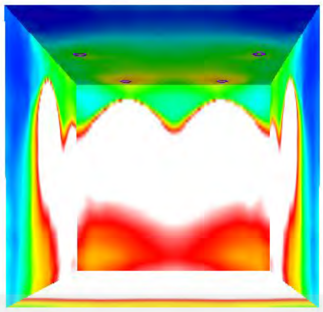
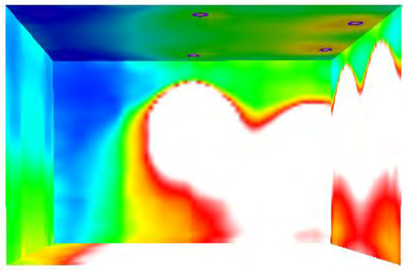
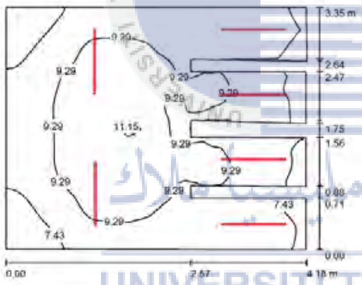
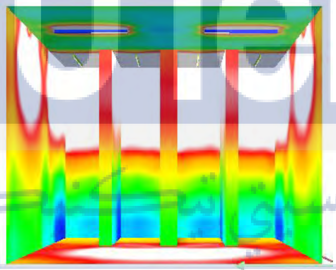
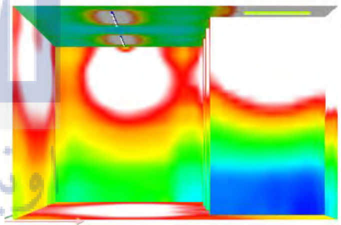
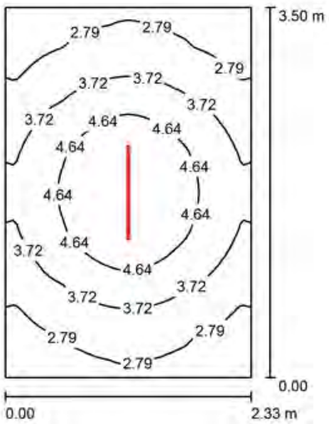
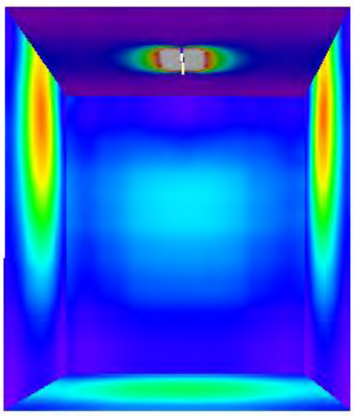
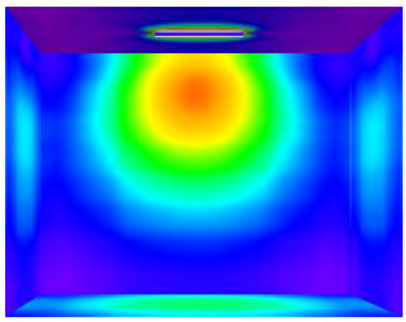
Figure 4.8: The Graph of Energy Used in Every Area in the Felo House

Based on the result in Figure 4.8 above, the living and dining room is the major part of assessment; this area had been consumed 105.0 watt by considering 3.12 W/m² at 33.68m² for ground area. In kitchen area, the total energy usage is 45.0 watt at 2.71 W/m² in 16.60m² for ground area. In addition, store room consumed 15.0 watt at 3.76 W/m² in 3.99 m² for ground area. Master bedroom consumed 45.0 watt at 2.70 W/m² in 16.69m² for ground level. Bedroom 1 consumed 15.0 watt at 1.56 W/m² in 9.63m² for ground area. Meanwhile the Bedroom 2 consumed 30.0 watt at 1.48 W/m² in 2.52m². Family room consumed 15.0 watt at 1.46 W/m^2 in $10.25m^2$. For toilet 1, energy usage is 15.0 watt at 4.78 W/m^2 in $3.14m^2$. Meanwhile, toilet 2 consumed 15.0 watt at 4.56 W/m^2 in $3.29m^2$. In this felo house, the lamp that used for each area is green space lamp which has luminous flux of 1100 lm and the luminaire wattage of 15 W.

c) Student House

Table 4.8 show some of the result for light distribution and color rendering in every single part at the Student House:

Table 4.8: Room Light Distribution and Color Rendering for Student House

	Lighting Distribution	**Color Rendering**	
Bedroom			
Toilet			
Pantry			

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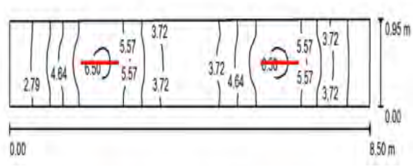
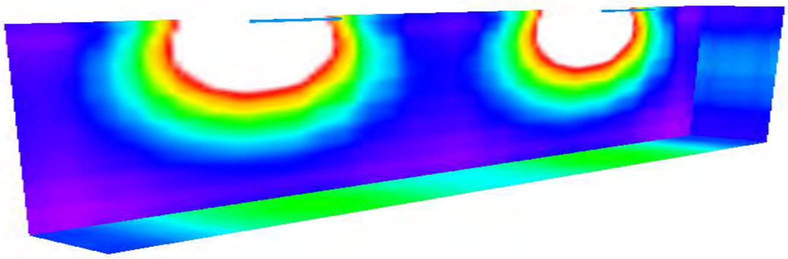
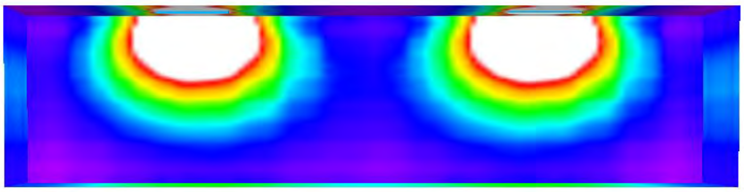
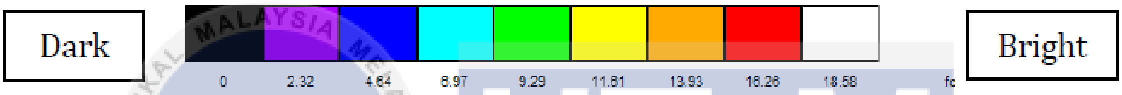
Other space		 



Lighting Zone by DIALUX simulation:

For this Student house, the lighting strategies will be divided by four zones of lighting. Each of the zones will have the control circuit to enhance the energy saving consumption. The total energy usage for each area shown in Table 4.9 below:

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Table 4.9: Total Energy Usage for Every Part in the Student House

Area	**Number of Luminaries**	**Watts/ Luminaire**	**Total Power (W)**	**Space Area (m^2)**	**Lighting Power Density (W/m^2)**
Bedroom	4	15	60	15.58	3.851
Toilet	6	10.5	63	13.08	4.817
Pantry	1	10.5	10.5	8.17	1.285
Other space	2	10.5	21	7.97	2.635

This Student House only use four lamps for each bedroom, six lamps in the toilet, one lamp for pantry and two lamps for other space.

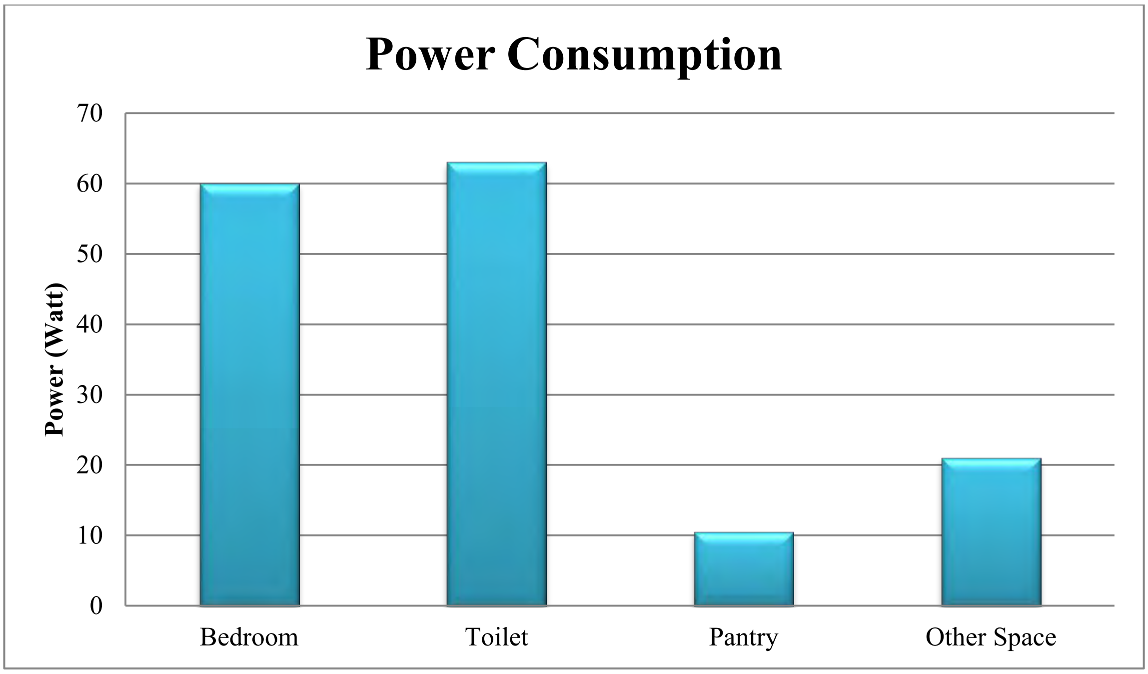


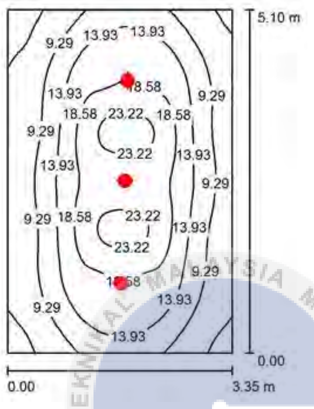
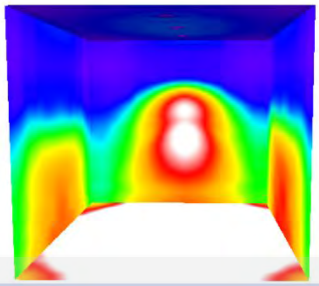
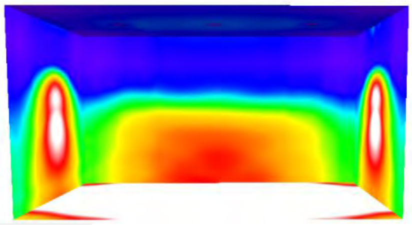
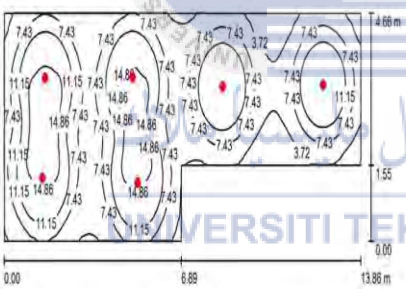
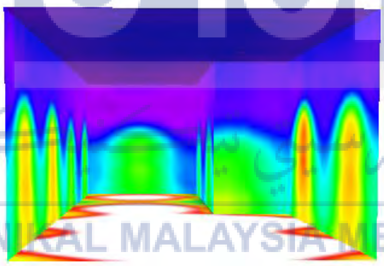
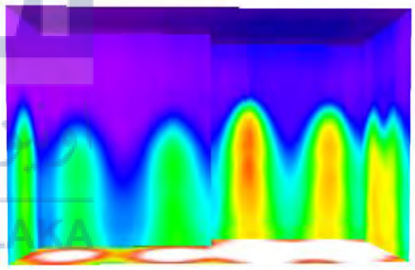
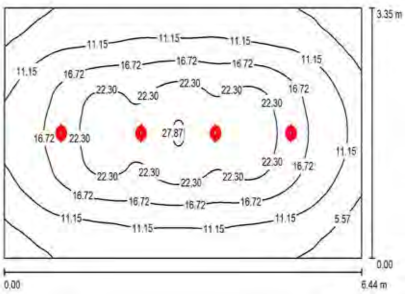
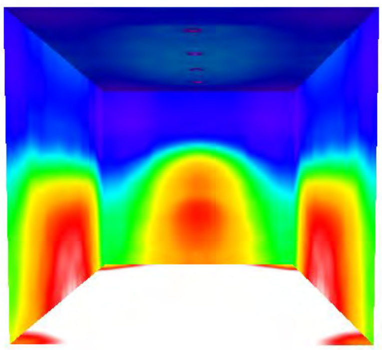
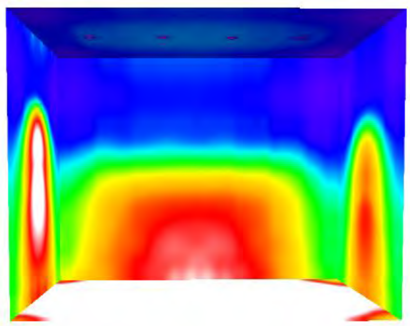
Figure 4.9: The Graph of Energy Used in Every Area in the Student House

Based on the result in Figure 4.9 above, the toilet is the major part of assessment; this area had been consumed 63.0 watt by considering 4.82 W/m^2 at $13.08m^2$. For bedroom area, the total energy usage is 60.0 watt at 3.85 W/m^2 in $15.58m^2$ for ground area. In addition, pantry consumed 10.5 watt at 1.29 W/m^2 in $8.17m^2$ for ground area. Meanwhile, other space consumed 21.0 watt at 2.64 W/m^2 in $7.97m^2$. In this student house, the lamp that used for bedroom area is green space lamp which has luminous flux of 1100 lm and the luminaire wattage of 15 W, and for toilet and other space this area used Pentura LED lamp which has luminous flux of 800 lm and the luminaire wattage of 10.5 W.

d) Office Area

Table 4.10 show some of the result for light distribution and color rendering in every single part at the Office Area:

Table 4.10: Room Light Distribution and Color Rendering for Office Area

	Lighting Distribution	**Color Rendering**	
Principle Office			
Lobby & Office Area			
Discussion Room			

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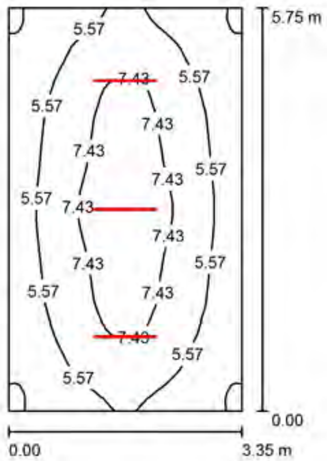
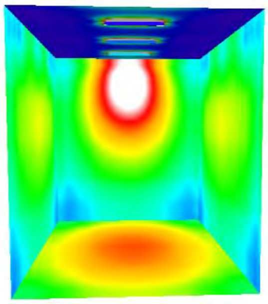
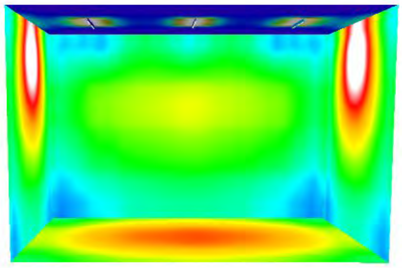
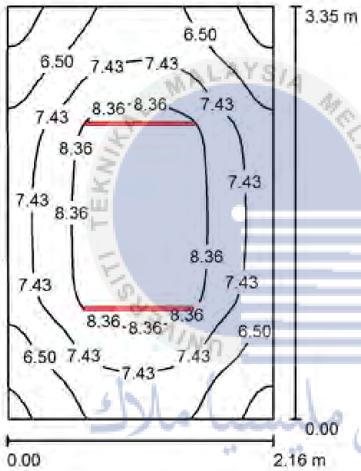
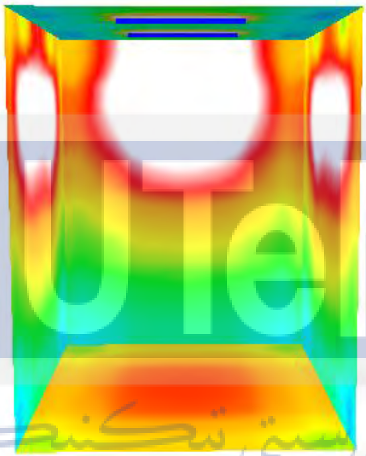
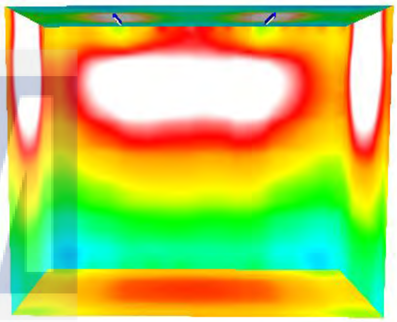
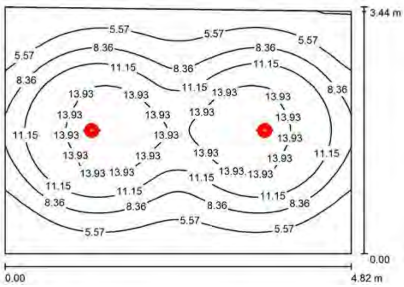
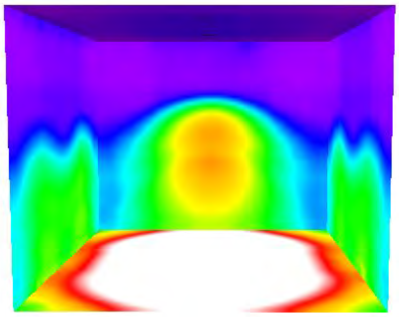
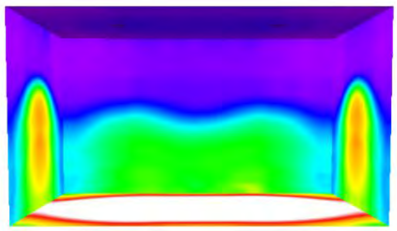
File Store Room			
Pantry			
Reception/ waiting			

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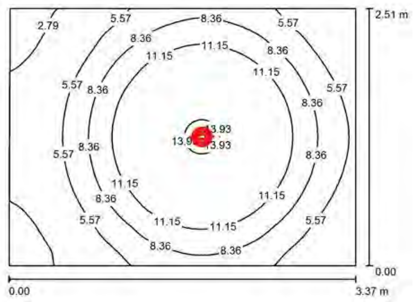
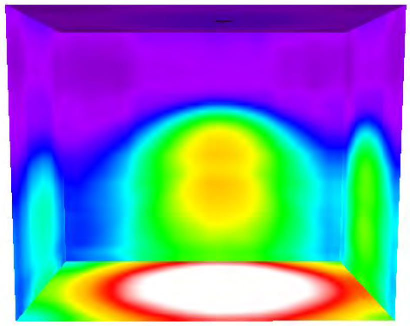
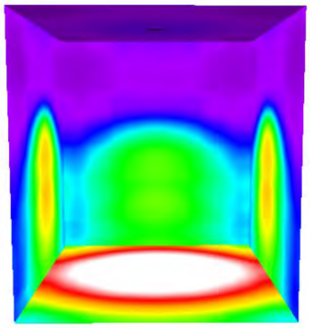
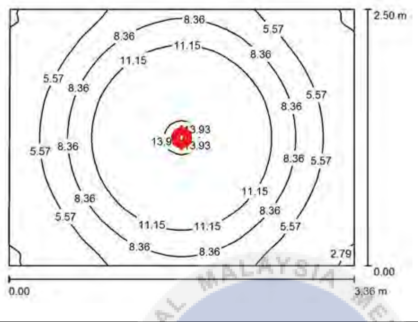
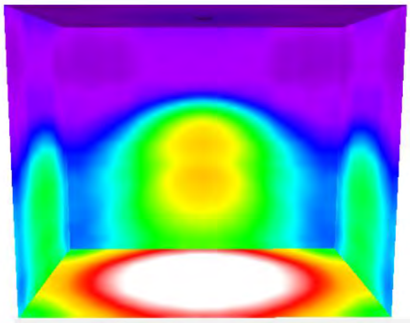
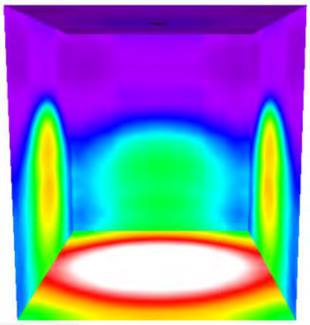
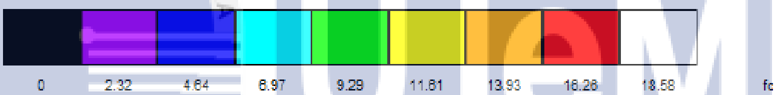
Room 1			
Room 2			

Dark



Bright

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Lighting Zone by DIALUX simulation:

For this Office area, the lighting strategies will be divided by eight zones of lighting. Each of the zones will have the control circuit to enhance the energy saving consumption. The total energy usage for each area shown in Table 4.11 below:

Table 4.11: Total Energy Usage for Every Part in the Office

Area	Number of Luminaries	Watts/ Luminaire	Total Power (W)	Space Area (m^2)	Lighting Power Density (W/m^2)
Principle Office	3	15	45	17.09	2.633
Lobby & Office Area	6	15	90	53.66	1.677
Discussion Room	4	15	60	21.54	2.786
File Store Room	3	10.5	32	19.26	1.636
Pantry	2	10.5	21	7.22	2.909
Reception/ waiting	2	15	30	16.42	1.827
Room 1	1	15	15	8.47	1.771
Room 2	1	15	15	8.40	1.786

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In this Office area, the total number of luminaries that been use is 22 lamps. The area that uses many lamps is lobby and office area which use six lamps. For the discussion room, number of luminaries that been use is four lamps. Meanwhile for principle office and file store room, these areas use three lamps of each area. For pantry and reception counter, both areas only use 2 lamps. For room 1 and room 2, only one lamp has been use for each area.

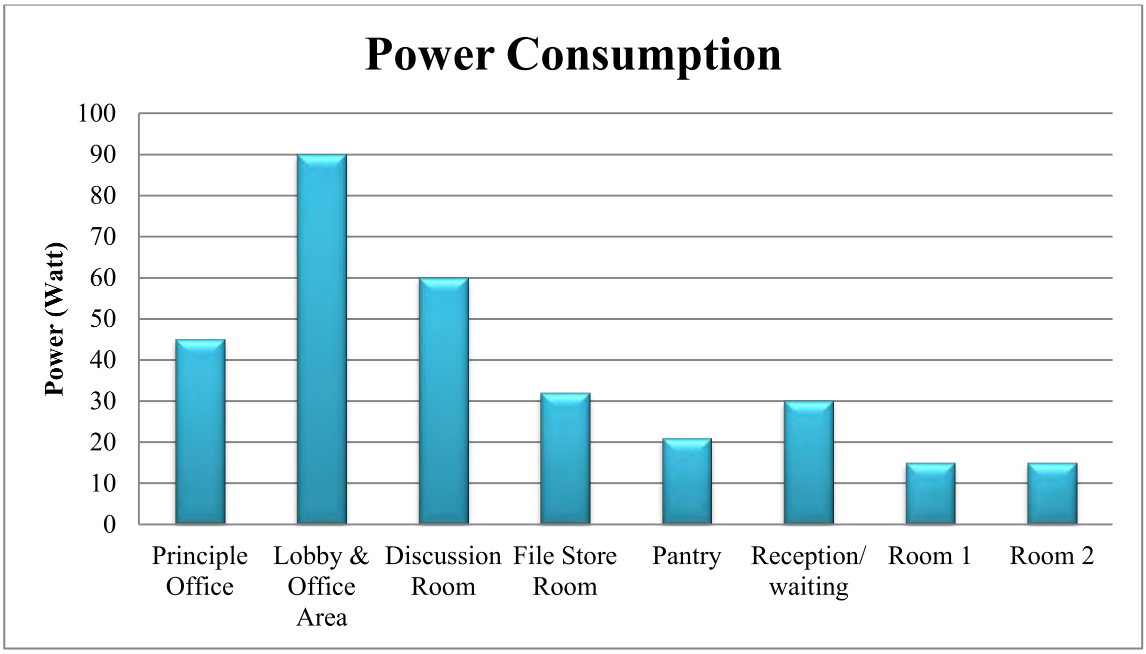

Figure 4.10: The Graph of Energy Used in Every Area in the Office Area

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Based on the result in Figure 4.10 above, the lighting strategies will be divided by eight zones of lighting. Each of the zones will have the control circuit to enhance the energy saving consumption. The lobby and office area is the major part of assessment; this area had been consumed 90.0 watt by considering 1.68 W/m² at 53.66m² for ground area. In principle office area, the total energy usage is 45.0 watt at 2.63 W/m² in 17.09m² for ground area. In addition, discussion room consumed 60.0 watt at 2.79 W/m² in 21.54m² for ground area. File store room consumed 32.0 watt at 1.64 W/m² in 19.26m² for ground level. Pantry consumed 21.0 watt at 2.91 W/m² in 7.22m² for ground area. Meanwhile the reception and waiting counter consumed 30.0 watt at 1.83 W/m² in 16.42m². In this office area, the pantry and file store room used Pentura LED lamp which has luminous flux of 800 lm and the luminaire wattage of 10.5 W. The rest area used green space lamp which has luminous flux of 1100 lm and the luminaire wattage of 15 W.

4.1.2 Daylight Factor

Daylighting is distinguished as a unique source of light, continuously varying color and distribution during the days. Daylighting can contribute significantly to human satisfaction. It provides comfort, a distinctive atmosphere and how to define architectural space. Daylight factor is expressed as a percentage of the ratio of internal illumination falling on the work plane divided by the outdoor lighting in a horizontal plane under an overcast sky. The daylight factors need to be improve to enhance the electrical energy efficiency performance in a closed space

The lighting design stage will begin with the proper planning from the building electrical plan. The building space and room concept will determine the lighting application that can be applied. Normally, the luminaires calculation will be conducted to determine the average luminaries for particular room or application that has been tested. Energy-efficient hostel building designs often use natural daylight to reduce the energy needed to light a building. Natural light has also been proven to have a positive impact on student achievement.

Based on the lighting simulation, the suitable lighting fitting can be chosen by considering lux and energy consumption elements. As shown in Figure 4.3 and Figure 4.4, both lamps shows different luminaries as Pentura Mini LED lamps gives a low luminaries level compared to the GreenSpace lamps. This is because the lighting been used is compiled for MS 1525:2007 standard to enhance the energy saving achievement. LED lighting is used to minimize the energy to improve energy efficiency in the hostel.

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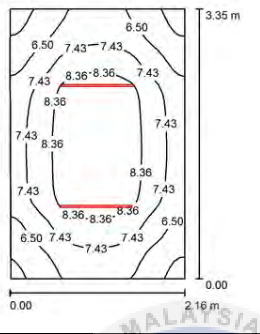
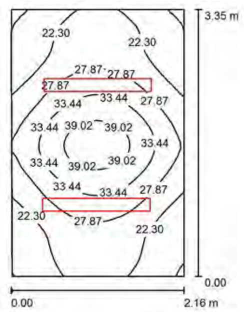
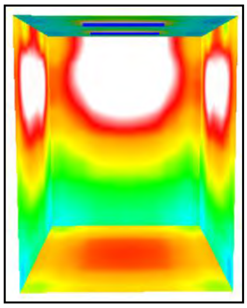
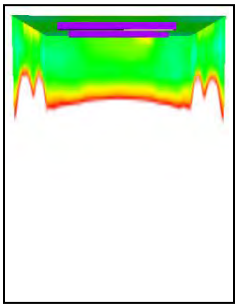
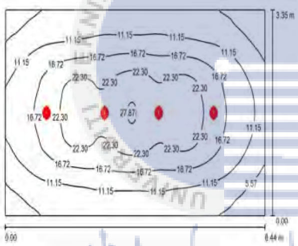
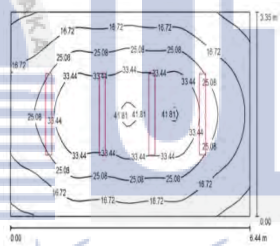
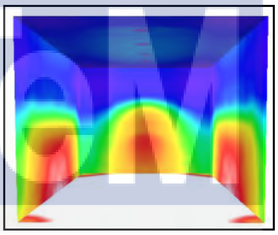
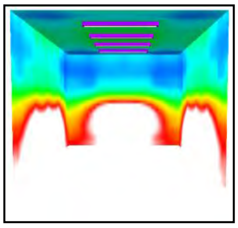
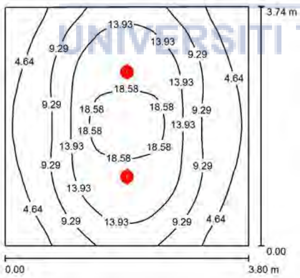
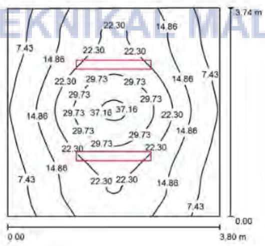
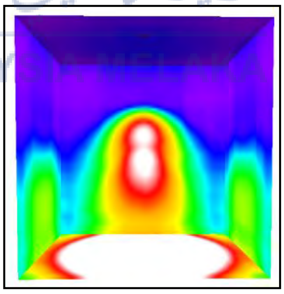
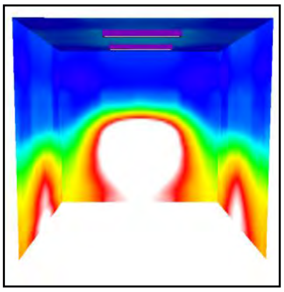
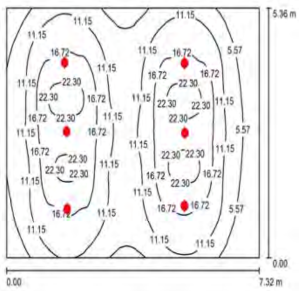
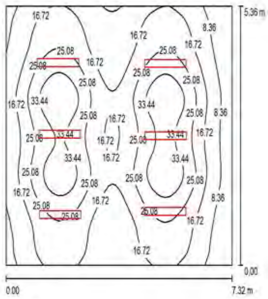
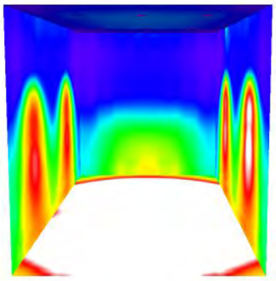
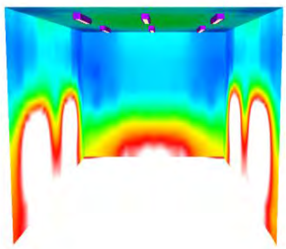
Table 4.12 shows some of the comparison between two lamp which is LED and Fluorescent lamp at every single part in hostel:

Table 4.12: Comparison between LED and Fluorescent Lamp

Item	**Lighting Distribution**		**Color Rendering**	
	LED	Fluorescent	LED	Fluorescent Lamp
Pantry				
Discussion Room				
Kitchen				
Living Room and Dining Room				

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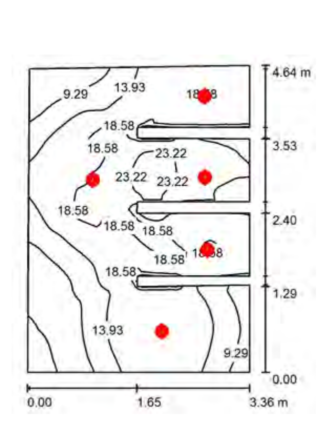
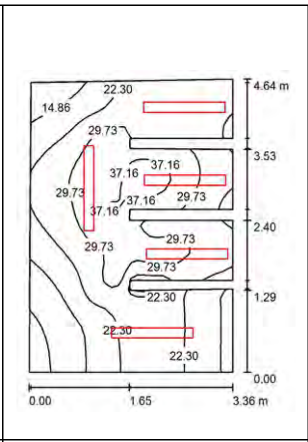
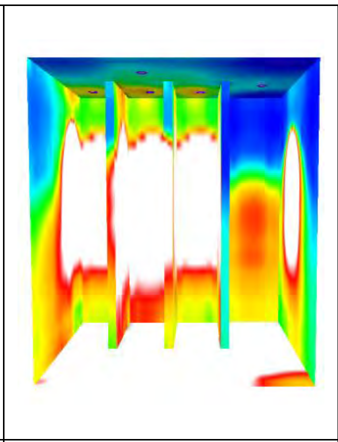
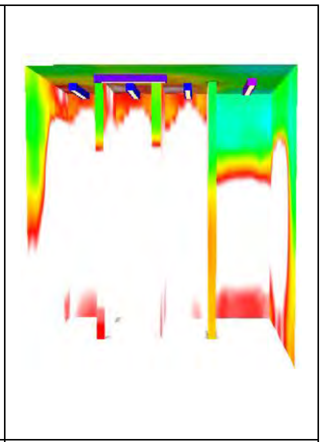
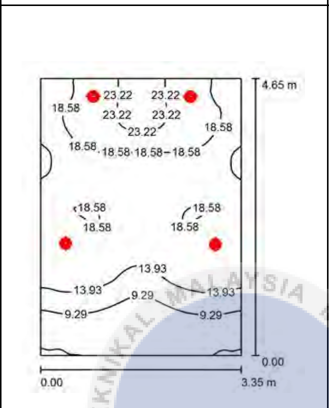
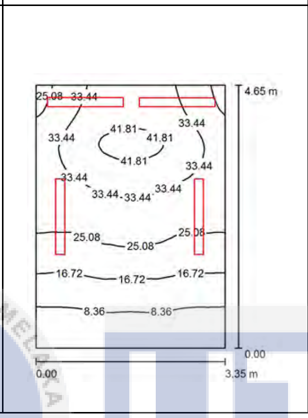
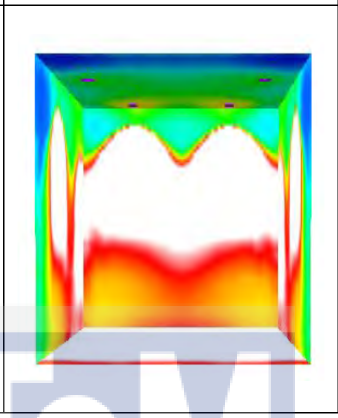
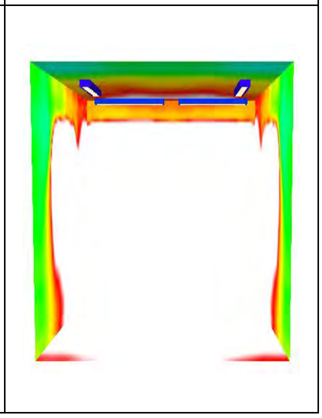
Public Toilet				
Student Room				

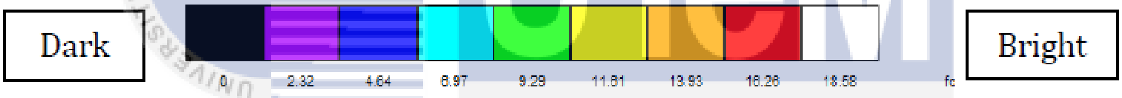


Table 4.12 shows the comparison between LED lamp and Fluorescent lamp. For the pantry, the total energy usage for LED lamp is 21.0 watt lower compared to the Fluorescent lamp which is 86.0 watt at 2.91 W/m^2 in 7.22m^2. Discussion Room consumed 60.0 watt for LED lamp lower than 172.0 watt for fluorescent lamp at 7.99 W/m^2 in 21.54m^2. In kitchen area, the energy usage is 30.0 watt lower for LED lamp compared to Fluorescent lamp which is 86.0 watt at 2.11 W/m2 in 14.20m^2 at principle house. The living room and dining room is a major part of assessment in this comparison session which has the energy usage for LED lamp is 90.0 watt lower than Fluorescent lamp which is 258.0 watt at 6.57 W/m^2 in 39.26m^2. Meanwhile for the public toilet, the energy usage for LED lamp is 75.0 watt lower compare to the Fluorescent lamp which use 215.0 watt at 5.14 W/m^2 in 14.60m^2 in ground floor. For student room, the energy used is 60.0 watt lower than fluorescent lamp which is 172.0 watt at 3.85 W/m^2 in 15.58m^2.

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Based on Table 4.12 above, LED lamp and Fluorescent lamp have are biggest different color rendering. For example at living room and dining room, the brightness of color rendering for fluorescent lamp is highest compared to the LED lamp. This is because the energy usage for fluorescent lamp is 43.0 watt highest compare to the LED lamp only used 15 watt for one bulb. Other than that, the luminaire for LED is 1100 lm and the fluorescent is 1749 lm. Although the luminaries for fluorescent lamp is highest than LED lamp, according to JKR standard the room illumination level for living room and dining room is 100 lux. Therefore, number of lamp required in this living and dining room is based on the calculation below:

<u>For LED lamp:</u>

GreenSpace 15W was selected where LDL = 1100 lumen, area = 39.26m^2, illuminance = 100, COU = 0.6 and MF = 0.8

$$\text{Number of lamps} = \frac{\text{Average illuminance (lux)} \times \text{area}(\text{m}^2)}{\text{LDL (lumen)} \times \text{COU} \times \text{MF}}$$

$$= \frac{100\ x\ 39.26\ m^2}{1100\ x\ 0.6\ x\ 0.8}$$

= 7.45

≈ 8 unit

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<u>For Fluorescent lamp:</u>

DIAL 3 BS 900-Leuchte 43W was selected where LDL = 1749 lumen, area = 39.26m^2, illuminance = 100, COU = 0.6 and MF = 0.8

$$\text{Number of lamps} = \frac{\text{Average illuminance (lux)} \times \text{area}(\text{m}^2)}{\text{LDL (lumen)} \times \text{COU} \times \text{MF}}$$

$$= \frac{100\ x\ 39.26\ m^2}{1749\ x\ 0.6\ x\ 0.8}$$

= 4.68

≈ 5 unit

If LED lamp is chosen, the number of lamp required is 8 units but if fluorescent lamp is chosen, number of lamp required is 5 units. However, in these green building strategies the suitable lighting that should be used is LED lamp. This is because, the energy usage for LED lamp is much lower compared to Fluorescent lamp. Besides, the use of LED lamp is longer than Fluorescent lamp because LED are small, very efficient solid bulbs, LED bulbs last up to 10 times as long as compact fluorescents, and far longer than ordinary incandescent.

While the LEDs are initially expensive, the cost is recouped over time and in battery savings. LED bulb use was first adopted commercially, where maintenance and replacement costs are expensive. But the cost of new LED bulbs has dropped significantly in recent years and continues to go down. Today, there are lots of new LED light bulbs for home use, and the cost is becoming less of an issue.

Table 4.13 Load Details-Energy Saving Type for LED Lamps

Item	Description	Unit Load (kW)	Qty	Connected Load (kW)	Diversity Factor	Maximum Demand (kW)
Principle Office	PHILIPS DN450B 1xDLM1100/830	0.015	3	0.045		0.0297
Lobby & Office Area	PHILIPS DN450B 1xDLM1100/830	0.015	2	0.030		0.0198
	PHILIPS DN450B 1xDLM1100/830		4	0.060		0.0396
Pantry	PHILIPS BN130C 1xLED8S/830 L885	0.0105	2	0.021	0.66	0.01386
Meeting Room	PHILIPS DN450B 1xDLM1100/830	0.015	4	0.060		0.0396
Reception /Waiting Room	PHILIPS DN450B 1xDLM1100/830	0.015	2	0.030		0.0198
Room 1	PHILIPS DN450B 1xDLM1100/830	0.015	1	0.015		0.0099
Room 2	PHILIPS DN450B 1xDLM1100/830	0.015	1	0.015		0.0099
File Store Room	PHILIPS BN130C 1xLED8S/830 L885	0.0105	3	0.0315		0.02079
Total				**0.3075**		**0.20295**

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Table 4.14 Load Details-Energy Saving Type for Fluorescent Lamps

<table>
<tr><th>Item</th><th>Description</th><th>Unit Load (kW)</th><th>Qty</th><th>Connected Load (kW)</th><th>Diversity Factor</th><th>Maximum Demand (kW)</th></tr>
<tr><td>Principle Office</td><td>DIAL 3 BS 900-Leuchte</td><td>0.043</td><td>3</td><td>0.129</td><td rowspan="10">0.66</td><td>0.08514</td></tr>
<tr><td rowspan="2">Lobby & Office Area</td><td>DIAL 3 BS 900-Leuchte</td><td>0.043</td><td>2</td><td>0.086</td><td>0.05676</td></tr>
<tr><td>DIAL 3 BS 900-Leuchte</td><td>0.043</td><td>4</td><td>0.172</td><td>0.11352</td></tr>
<tr><td>Pantry</td><td>DIAL 3 BS 900-Leuchte</td><td>0.043</td><td>2</td><td>0.086</td><td>0.05676</td></tr>
<tr><td>Meeting Room</td><td>DIAL 3 BS 900-Leuchte</td><td>0.043</td><td>4</td><td>0.172</td><td>0.11352</td></tr>
<tr><td>Reception /Waiting Counter</td><td>DIAL 3 BS 900-Leuchte</td><td>0.043</td><td>2</td><td>0.086</td><td>0.05676</td></tr>
<tr><td>Room 1</td><td>DIAL 3 BS 900-Leuchte</td><td>0.043</td><td>1</td><td>0.043</td><td>0.02838</td></tr>
<tr><td>Room 2</td><td>DIAL 3 BS 900-Leuchte</td><td>0.043</td><td>1</td><td>0.043</td><td>0.02838</td></tr>
<tr><td>File Store Room</td><td>DIAL 3 BS 900-Leuchte</td><td>0.043</td><td>3</td><td>0.129</td><td>0.08514</td></tr>
<tr><td colspan="4">Total</td><td>0.946</td><td>0.624</td></tr>
</table>

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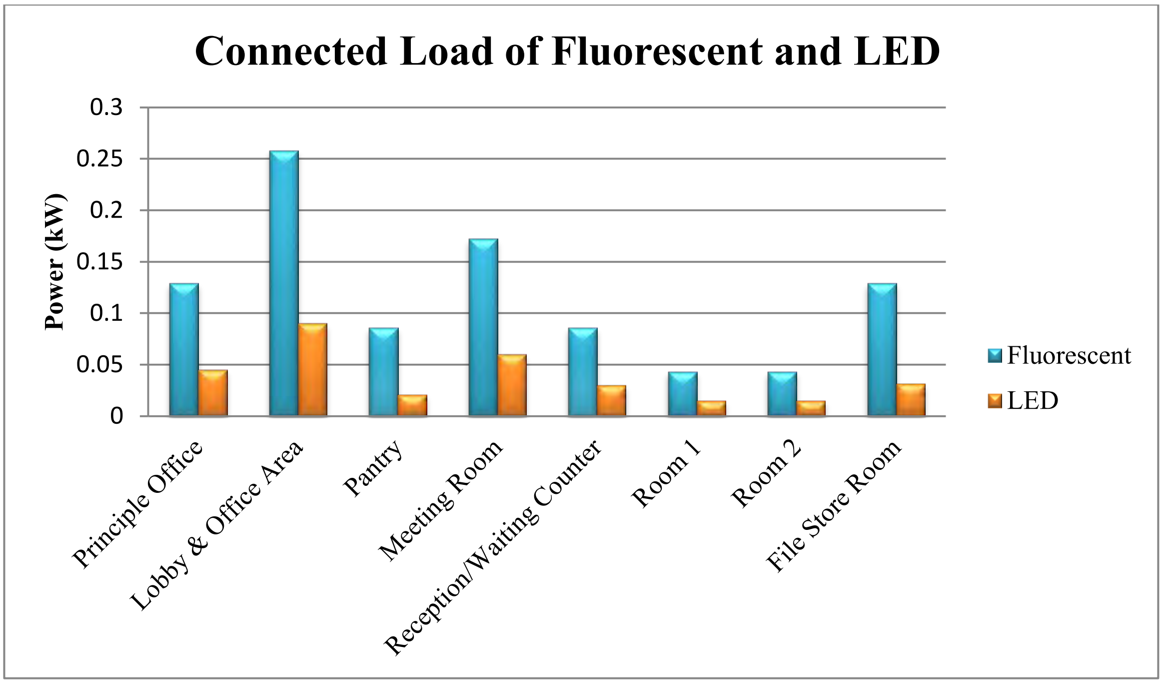

Figure 4.11: The Graph of Comparison between LED and Fluorescent

According to the Figure 4.11, the graph shows the comparison between two types of lamps which is LED and fluorescent of saving watt in order to achieve the GBI standard award. Based on the graph shown above, the lobby and office area has much difference between type of lamps where LED lamps is 0.09kW more save than fluorescent lamp with 0.258kW. Second highest is meeting room where the different number is 0.06kW for LED and fluorescent 0.172kW. The difference between both kinds of lamp is in watts which have the same brightness between LED and fluorescent lamp. However, LED lamp is more save with 15W compared to 43W fluorescent lamp.

4.1.3 Light sensor, motion sensor and controller:

Light sensor can be classified into two major classes that are photosensor and passive infrared sensor (pyroelectric sensor). Well, in this case study passive infrared sensor was highly recommended. The basis function of passive infrared sensor is to detect the temperature. For an example, a human body with skin temperature that will normally emitted infrared in wavelength of micrometer which can be easily detected by the passive infrared sensor since it was very high in sensitivity with change of infrared intensity. So, after the sensor detected the change of infrared, it will automatically turn on the light and turn off upon the time set in the timer. So, it does not waste energy if someone forgot to turn off the light after leaving the room.

Passive infrared sensor normally set up in dinning and kitchen and so on. By this way, it could save up to 50% of electrical. Also, the light can be manually turn on as well and turn off automatically upon the time set after some modification being made. The motion sensor can be obtained in so many types available in the market. Infrared motion sensor is the new 180 degree ceiling mount PIR detector that can be operated automatically to on the light when needed and turn light off when leave. It consumed only 0.45 watt at static 0.1 watt required. Working humidity is less than 93% of relative humidity. It can be easily adjusted by tuning the lux and timer for certain application depends on the location. Otherwise, another option is embedded motion sensor complete with LED tube can be applied to achieve GBI required in order to meet gold score mark. Therefore, motion sensor had been used in prayer rooms, toilet, and store rooms for this building.

4.1.4 Insulative Paint

Insulative paint is the paint containing ceramic micro-spheres which possess heat reflect properties. This function work same as the applied on the tiles on space shuttle but space shuttle used ceramic based material instead of ceramic micro-spheres. When the paint dried after painted, the ceramic micro-spheres inside the paint were able to reflect, refract and dissipates heat rapidly thus it will make the house maintain it room temperature because the extra heat from sunlight does not penetrate into the house. For an example, a product from Nippon weather bond solar reflect was designed by Nippon Paint Company was applicable GBI credit. This type of paint can help in reflect heat and reduce surface temperature of the wall and maintain the house in lower temperature.

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4.2 Heating, Ventilation, and Air Conditioning (HVAC)

Table 4.15 shows the area and type of air conditioner (horse power) that should be used in this project. Lobby and office area used the higher horse power which is 1.5hp compare to the others area only use 1 hp. In order to reduce cooling load, many improvement should be made outside of the HVAC system. For example, by using reflective windows on the south and west sides of the buildings, it will receive direct solar. Other than that, temporary plastic films also can be installed on the inside of the frame of any window. When installed on poorly performing windows, these films will reduce heat loss by 25% to 40%. By balancing the cost of the windows with the potential savings, this option can be a more economic option for reducing the energy needs of larger buildings.

Table 4.15: Air Conditioner calculation for the area in the hostel

Area	**Calculation**	**Horse Power Type**
Lobby	(10.40 x 22.97 x 25) + (3 X 400) = 7172.2 btu	745 W
Office & Lobby	(15.30 x 22.51 x 25) + (2 x 1000) + (3 x 400) =11810.1 btu	1117.5W
Room 1	(8.21 x 11.03 x 25) + (1 x 1000) + (1 x 400) = 3663.9 btu	745 W
Room 2	(8.25 x 11.03 x 25) + (1 x 1000) + (1 x 400) = 3674.9 btu	745 W
Principle Room	(16.74 x 10.99 x 25) + (1 x 1000) + (1 x 400) = 5999.3 btu	745 W
Discussion Room	(10.99 x 21.07 x25) + (10 x 400) = 9788.9 btu	745 W
Principle - Living Room	(17.59 x 13.87 x 25) + (2 x 1000) + (4 x 400) = 9699.3 btu	745 W
Principle- Bedroom	(18.91 x 11.07 x 25) + (2 x 1000) + (2 x 400) = 8033.3 btu	745 W
Felo-Living Room	(13.60 x 13.87 x 25) + (1 x 1000) + (4 x 400) = 7315.8 btu	745 W
Felo- Bedroom	(18.86 x 13.09 x 25) + (1 x 1000) + (2 x 400) = 7971.9 btu	745 W
	Total	**7822.5 W**

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4.3 Calculation and Total Connected Load

After getting the number of lamps that have been used, total connected load will be calculated for each distribution board to get the MCB rating and cable sizing that is suitable. Total connected load (TCL) will be getting after by summing up each of the load. While Maximum Demand (MD) will be get by multiple with diversity factor. All of the calculation and result are shown in table load quantity which in the appendix. Table 4.14 and Table 4.15 below are the TCL and MD that was calculated in this project.

Table 4.16: The result of Total Connected Load (TCL) and Maximum Demand (MD) for SSB at Ground Floor. Refer to Appendix E

Item	Type of Load	Total Connected Load (TCL) (kW)	Maximum Demand (MD) (kW)
1.1	SSB GF (lighting)	2.72	1.79
2.1	SSB GF (S.S.O)	23.50	13.00
3.1	SSB GF (fan and exhaust fan)	3.12	2.26
4.1	SSB GF (AIR-COND)	15.57	10.11
	Total Load	**38.66**	**22.64**

Table 4.17: The result of Total Connected Load (TCL) and Maximum Demand (MD) for SSB at 1st until 10th Floor. Refer to Appendix F

Item	Type of Load	Total Connected Load (TCL) (kW)	Maximum Demand (MD) (kW)
1.	SSB GF (lighting)	46.02	30.37
2.	SSB GF (S.S.O)	275.00	110.00
3.	SSB GF (fan and exhaust fan)	52.80	37.84
	Total Load	**373.82**	**178.21**

4.4 Cable Sizing and Protective Device.

Table 4.16 and Table 4.17 show the value of total connected load and maximum demand. After getting all the calculation for Sub Switch Breaker (SSB), the calculation of cable sizing and protective device will be calculate is depends on value of maximum demand.

Case (i): SSB for Ground Floor.

To determine the cable sizing, firstly calculate the value of current maximum demand that is depending on the value of maximum demand that was calculated before. When the value is TCL = 38.66 kW and MD = 22.64 kW. The calculation of the maximum demand current was shown below:

Refer Equation (3.10)

$$Design\ Current, I_b = \frac{Maximum\ Demand\ (kW)}{\sqrt{3}\ \times 415\ \times cos\theta}$$

$$= \frac{22.64kW}{\sqrt{3}\ \times 415\ \times 0.85}$$

$$= 37.06\ \text{A}$$

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Miniature circuit breaker, MCB rating at rated 40A TPN was chosen for the SSB of Ground Floor is refereed on IEE Wiring Regulation 7th edition.

Next step, apply the correction factor before the size of cable was chosen. All cables and current carrying conductors shall be of copper type. All power cables and control cables installed underground, whether for electrical, mechanical or other services, shall be of steel wire armoured PVC covered types. Proper ducting and manhole systems shall be provided for the underground cables so as to minimise excavation required for inspection, testing and maintenance purposes.

For this case the ambient temperature $C_a = 1$, correction factor $C_g = 1$ and thermal insulation correction factor $C_i = 1$. The calculation is shown below:

$$I_z = \frac{I_n}{C_a \times C_g \times C_i}$$

$$= \frac{40}{1 \times 1 \times 1}$$

$= 40A$

The IEE Regulation 7th edition required the condition $I_n \leq I_z$ refer for table size selection. So the size of cable that was selected is $10mm^2$ as well.

Case (ii): SSB for 1st – 10th Floor.

To determine the cable sizing, firstly calculate the value of current maximum demand that is depending on the value of maximum demand that was calculated before. The type of cable that has been used is 4core XLPE/SWA/PVC. When the value is TCL = 38.66 kW and MD = 22.64 kW. The calculation of the maximum demand current was shown below:

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Refer Equation (3.10)

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$$Design\ Current, I_b = \frac{Maximum\ Demand\ (kW)}{\sqrt{3}\ \times 415\ \times cos\theta}$$

$$= \frac{178.21kW}{\sqrt{3}\ \times 415\ \times 0.85}$$

$= 291.68$ A

Moulded case circuit breaker, MCCB rating at rated 300A was chosen for the SSB of 1st until 10th Floor is refereed on IEE Wiring Regulation 7th edition. The distribution board(s) for 13A single phase socket outlet shall be protected by 30mA sensitivity RCCB(s) and the distribution board(s) for single phase lighting shall be protected by 100mA sensitivity RCCB(s). All MCCB with rating exceeding 100 amps shall be provided with the overload relays and earth leakage relays. The relay shall have adjustable settings as mentioned above.

The earth leakage relay shall be of direct acting type with adjustable earth leakage sensitivity/selectivity and time delay. The sensitivity shall be from 30mA onwards.

Next step, apply the correction factor before the size of cable was chosen. All cables and current carrying conductors shall be of copper type. All power cables and control cables installed underground, whether for electrical, mechanical or other services, shall be of steel wire armoured PVC covered types. Proper ducting and manhole systems shall be provided for the underground cables so as to minimize excavation required for inspection, testing and maintenance purposes.

For this case, the ambient temperature $C_a = 1$, correction factor $C_g = 1$ and thermal insulation correction factor $C_i = 1$. The calculation is shown below:

$$I_z = \frac{300}{C_a \times C_g \times C_i}$$

$$= \frac{300}{1 \times 1 \times 1}$$

$$= 300\text{A}$$

The IEE Regulation 7th edition required the condition $I_n \leq I_z$ refer for table size selection. So the size of cable that was selected is 240mm^2 as well.

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4.5 Protection System

4.5.1 Lightning Protection System

Lightning protection systems using copper conductors shall be provided and it shall comply with BS6651:1992 "Protection of Structure against Lightning". However buildings and structures required to be protected due to security reason or safety reason or locations on high ground or environmental requirements shall be provided with lightning systems regardless of the heights.

The Faraday cage concept together with the earthed reinforcements of the building structure and foundations shall form the basis of the lightning protection system for the office building. An air termination networks and the bonding of all external metallic fixtures/structures to the reinforcements and down conductors, together with the earth electrodes shall be an integral component of the lightning protection scheme.

The bonding between the reinforcement and the external connections shall be way of Cadweld or Furse type bond. Lightning counters shall also be provided. Separate Centralised Earthing Bars of appropriate size shall be provided for the Main Switch Boards, generators, Telecommunication System, CATV/Security/AV System, Data and Computer System which are in turn bonded to the building reinforcement as well as to external earth electrodes. Metal pipes for all services shall also be bonded to the single point grounding system. Earth electrodes shall be of 16mm diameter copper jacketed rod and the earth inspection chambers shall be of heavy duty precast concrete similar to Furse type.

4.5.2 Surge Protection Systems and Voltage Stabilizing System

Surge protection devices (SPDs) shall be provided for the main electrical distribution system including sub-switch boards and distribution boards, computers, electronic equipment, fire alarm panel, PABX equipment, UPS equipment, CCTV equipment, MATV equipment, card access equipment, etc. which are susceptible to lightning and switching surges. The proposed surge protection system shall consist of Classes One, Two and Three Surge Suppressors and shall be suitable for the use with computerised equipment. They shall be installed in various locations of low voltage and equipment installation.

The SPDs shall be one-port type compatible with the 240/415 V, 3 phase, 4 wire, 50 Hz with solidly earthed neutral supply system it is protecting. The SPDs modes of protection shall be each phase-to-neutral, each phase-to-earth and neutral-to-earth for either single phase or three phase supply system. However, for cases where the incoming feeder circuit breaker in the main switchboard is rated 600A or less, SPDs with modes of protection at each phase-to-neutral and neutral-to-earth may be allowed to be installed in the whole electrical installation. SPDs for three phase supply system installation shall be of mono block or modular type. Unless otherwise specified, SPDs shall be of the type complying with MS IEC 61643-1 and MS IEC 61643-12 and in accordance with recommendations of IEC 62305 and the relevant parts and sections of MS IEC 60364.

The SPDs shall be of voltage limiting type with metal oxide varistors (MOVs) or combination type with MOVs and gas discharge tube (GDT)/spark gap. MOVs and GDT/spark gap shall comply with MS IEC 61643-331 and MS IEC 61643-311 respectively. The normal operating voltage shall be 240V and the maximum continuous operating voltage (U_c) of SPDs shall be minimum 275V (phase-to-neutral, phase-to-earth and neutral-to-earth). The continuous operating current (I_c) for each mode of protection shall not exceed 3 mA. In the case where the MOVs are used, the SPDs shall be provided with integrated thermal protection function to avoid thermal runaway due to degradation.

The impulse current (I_{imp}), nominal discharge current (I_n), maximum discharge current (Imax) and open-circuit voltage (U_{oc}) rating per mode of protection of SPD and the respective voltage protection level (U_p) shall be as indicated in Table 4.16. Unless otherwise specified, the class of SPDs to be installed with respect to the location of switchboard and/or distribution board shall be as in Table 4.18.

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The size of connecting leads shall be as recommended by the SPD manufacturer. The connecting leads shall be as short as possible and shall be tightly bound together throughout the whole length with cable-ties or other approved means. Either a four-pole moulded case circuit breaker (MCCB) or a fuse of rating as recommended by the SPD manufacturer shall be provided for disconnecting the SPDs from the system in the event of SPDs failure or for maintenance. In the case where an MCCB is used, the breaking capacity of the MCCB shall comply with the a.c. interrupting capacity of the switchboard or distribution board.

Table 4.18: Classification of Surge Protection Devices SPDs

Location of Switchboard / Distribution Board	**Switchboard Receiving Energy from the Licensee or Other Building**		**Sub-Switchboard and/or Distribution Board Receiving Energy from Switchboard Located in the Same Building**	**Final Distribution Board Receiving Energy from Sub-Switchboard or Distribution Board Located in the Same Building**
Impulse Test Classification (MS IEC 61643-1)	Class I	Class II	Class II	Class III
Impulse Current, I_{imp} (10/350 μs) per mode	10 kA			
Nominal Discharge Current, I_n (8/20 μs) per mode		20 kA	10 kA	
Maximum Discharge Current, I_{max} (8/20 μs) per mode		65 kA	40 kA	
Open-Circuit Voltage, U_{oc} (1.2/50 μs) per mode				6 kV
Voltage Protection Level, U_p (L-N, L-E, N-E) at I_{imp} or I_n or U_{oc}	2000 V	2000 V	1500 V	1000 V

Equipment susceptible to voltage variations shall be provided with suitable surge protection and automatic voltage regulating systems.

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CHAPTER 5

CONCLUSIONS AND RECOMMENDATION

This chapter will discuss summary & conclusion for this project. The conclusion made is based on the whole analysis focusing on the Green Building Strategies. Recommendation will be suggested based on this project analysis for future research and development.

5.1 Conclusion

For the conclusion, this project describes the basic study of indoor lighting performance at the hostel for the residential building development. The basic study of illumination is conducted through calculation by using illuminance formula which has been used nowadays. The number of luminaires can be obtained by installing energy saving tube/bulb at particular room in the building. It is shown that the LED lamps with less wattage can also brighten the room with the illuminances that is fixed in the IES Standards Illumination Level. The DIALux software also been used in this paper to evaluate the lighting effect for each room in the building by using a false color rendering method. Besides, by focusing in indoor lighting, the performance of energy saving can improve the appearance and environmental quality while increasing sense of comfort for people who stay indoors. All the layout of the plan such as lighting system, air-condition, switch socket outlet (SSO), protection system and cable selection in the residential building (hostel) need the energy performance. By improving the energy performance it can provide rapid benefits for an organization by maximizing the use of its energy sources and energy-related assets, thus reducing both energy cost and consumption. It will also make positive contributions toward reducing the flaw of energy resources and decrease worldwide effects of energy use, such as global warming. Nowadays, the buildings (hostel) on campus are gradually turned into the state of Green Buildings. Not only planting green plants and used simple water saving equipment, people can put more equipment that effectively mitigates the negative effects on the environment. Thus, it will not only save

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the world, but also provides students more healthful and comfortable environment to learn. Therefore, from the information above, green buildings have many advantages for the environment. By proceeding the development of Green Building, a student may have a great chance to live in a natural and healthful environment in the future.

5.2 Recommendation

This project show that the increase in the number of commercial buildings and development projects in residential area has a major impact on development, but it also increases the energy demand. There is a need to study more about how to use energy more efficiently, especially as seen from the results for lobby and office area. Both zones have been installed with centralized air-conditioning system; this will cause a waste of energy. My recommendation are, by installing control system to the variations in heat load could save energy for the air-conditioning system. Furthermore, installing a Fault Detection and Diagnosis (FDD) system to detect and localized damage failure may also be beneficial to the air-conditioning system. According to [33], a successful FDD can save up to 40% of heating, ventilating and air-conditioning (HVAC) energy consumption and reduces unnecessary energy wastage.

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Design for daylight also requires climatic data but unfortunately, the sky luminance and illumination that is received on surfaces are not measured systematically anywhere in Malaysia. So, I suggest for future research and design applications, luminance and illumination measurement can be included in this project.

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APPENDIX A: SUMMARY OF DIALUX

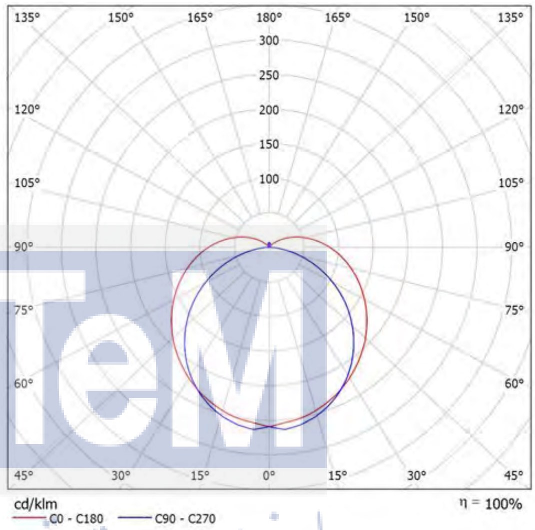
Project 1 DIALux

24.05.2015

Operator
Telephone
Fax
e-Mail

PHILIPS BN130C 1xLED8S/830 L885 / Luminaire Data Sheet

Luminous emittance 1:



Luminaire classification according to CIE: 89
CIE flux code: 39 68 88 89 100

Pentura Mini LED – ultra-slim batten
Pentura Mini LED is an extremely slim batten that offers the energy-saving benefits of LED technology, coupled with excellent lighting performance – bright, uniform light with good color rendering
Pentura Mini LED is very easy to install, even where space is limited, e.g. under shelves in shops, and over worktops and workstations in the home and home
office. Thanks to its integrated driver and through-wiring, installation time is reduced to a minimum. Power cable, mounting clips and connection accessories are
also supplied. Thin end-caps minimize black spots between the products, enabling
consumers to create a continuous light-line

Luminous emittance 1:

Glare Evaluation According to UGR

ρ Ceiling		70	70	50	50	30	70	70	50	50	30
ρ Walls		50	30	50	30	30	50	30	50	30	30
ρ Floor		20	20	20	20	20	20	20	20	20	20
Room Size X	Y	Viewing direction at right angles to lamp axis					Viewing direction parallel to lamp axis				
2H	2H	19.6	20.9	20.1	21.3	21.8	18.8	20.1	19.3	20.5	21.0
	3H	21.8	23.0	22.3	23.5	24.0	20.3	21.5	20.8	22.0	22.4
	4H	22.9	24.1	23.4	24.5	25.1	20.9	22.0	21.4	22.5	23.0
	6H	24.1	25.1	24.6	25.6	26.1	21.3	22.4	21.8	22.9	23.4
	8H	24.6	25.6	25.1	26.1	26.7	21.5	22.5	22.0	23.0	23.5
	12H	25.1	26.1	25.7	26.6	27.2	21.5	22.5	22.1	23.0	23.6
4H	2H	20.3	21.4	20.8	21.9	22.4	19.7	20.8	20.2	21.3	21.8
	3H	22.7	23.7	23.2	24.2	24.8	21.4	22.4	21.9	22.9	23.4
	4H	24.0	24.9	24.6	25.4	26.0	22.2	23.0	22.7	23.6	24.2
	6H	25.3	26.1	25.9	26.7	27.3	22.7	23.5	23.3	24.1	24.7
	8H	26.0	26.7	26.6	27.3	27.9	22.9	23.7	23.5	24.2	24.9
	12H	26.6	27.3	27.2	27.9	28.5	23.1	23.7	23.7	24.3	25.0
8H	4H	24.4	25.1	25.0	25.7	26.3	22.8	23.5	23.4	24.1	24.8
	6H	25.9	26.5	26.5	27.1	27.8	23.7	24.3	24.3	24.9	25.6
	8H	26.7	27.3	27.4	27.9	28.6	24.1	24.6	24.7	25.2	25.9
	12H	27.6	28.0	28.2	28.7	29.4	24.3	24.8	25.0	25.4	26.1
12H	4H	24.4	25.1	25.0	25.7	26.3	23.0	23.6	23.6	24.2	24.9
	6H	26.0	26.6	26.7	27.2	27.9	24.0	24.5	24.6	25.1	25.8
	8H	26.9	27.4	27.6	28.0	28.8	24.5	24.9	25.1	25.6	26.3
Variation of the observer position for the luminaire distances S											
S = 1.0H		+0.1 / -0.1					+0.1 / -0.1				
S = 1.5H		+0.2 / -0.2					+0.2 / -0.3				
S = 2.0H		+0.3 / -0.4					+0.3 / -0.5				
Standard table		BK10					BK14				
Correction Summand		11.0					7.8				
Corrected Glare Indices referring to 800lm Total Luminous Flux											

Figure A1: Summary of DIALux for Pentura Mini LED

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APPENDIX A: SUMMARY OF DIALUX

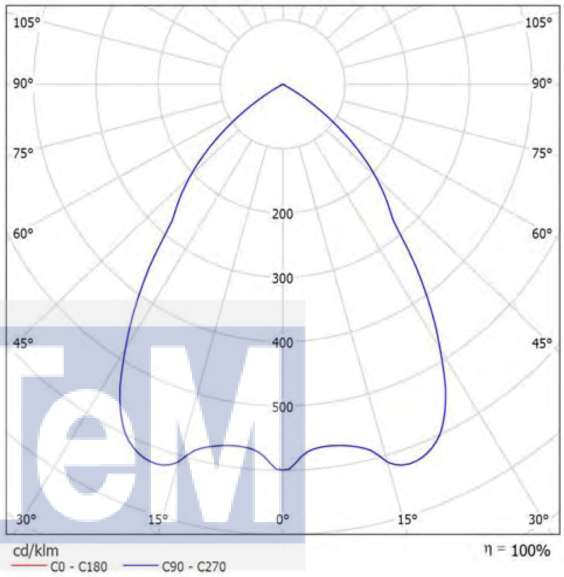
Project 1

DIALux

24.05.2015

Operator
Telephone
Fax
e-Mail

Luminous emittance 1:



Luminaire classification according to CIE: 100
CIE flux code: 77 99 100 100 100

GreenSpace – high-efficiency sustainable LED solution
Customers want to strike the ideal balance between their initial investment and the cost of the installation during its lifetime. GreenSpace is a cost-efficient and sustainable downlight that can be used to replace conventional CFL downlights in general lighting applications. It features the latest LED technology, which enables extremely low power consumption, while delivering consistent light output, stable color performance and high color rendering. The product's long lifetime makes it a true 'fit and forget' solution

Luminous emittance 1:

Glare Evaluation According to UGR

ρ Ceiling		70	70	50	50	30	70	70	50	50	30
ρ Walls		50	30	50	30	30	50	30	50	30	30
ρ Floor		20	20	20	20	20	20	20	20	20	20
Room Size X	Y	Viewing direction at right angles to lamp axis					Viewing direction parallel to lamp axis				
2H	2H	20.1	21.0	20.3	21.2	21.4	20.1	21.0	20.3	21.2	21.4
	3H	19.9	20.7	20.2	21.0	21.2	19.9	20.7	20.2	21.0	21.2
	4H	19.9	20.6	20.2	20.9	21.1	19.9	20.6	20.2	20.9	21.1
	6H	19.8	20.5	20.1	20.8	21.1	19.8	20.5	20.1	20.8	21.1
	8H	19.8	20.4	20.1	20.7	21.0	19.8	20.4	20.1	20.7	21.0
	12H	19.7	20.3	20.1	20.7	21.0	19.7	20.3	20.1	20.7	21.0
4H	2H	20.0	20.7	20.3	21.0	21.2	20.0	20.7	20.3	21.0	21.2
	3H	19.8	20.4	20.2	20.7	21.1	19.8	20.4	20.2	20.7	21.1
	4H	19.8	20.3	20.1	20.6	21.0	19.8	20.3	20.1	20.6	21.0
	6H	19.7	20.1	20.1	20.5	20.9	19.7	20.1	20.1	20.5	20.9
	8H	19.6	20.1	20.1	20.4	20.8	19.6	20.1	20.1	20.4	20.8
	12H	19.6	20.0	20.0	20.4	20.8	19.6	20.0	20.0	20.4	20.8
8H	4H	19.6	20.0	20.1	20.4	20.8	19.6	20.0	20.1	20.4	20.8
	6H	19.6	19.9	20.0	20.3	20.8	19.6	19.9	20.0	20.3	20.8
	8H	19.5	19.8	20.0	20.2	20.7	19.5	19.8	20.0	20.2	20.7
	12H	19.5	19.7	19.9	20.2	20.7	19.5	19.7	19.9	20.2	20.7
12H	4H	19.6	20.0	20.0	20.4	20.8	19.6	20.0	20.0	20.4	20.8
	6H	19.5	19.8	20.0	20.2	20.7	19.5	19.8	20.0	20.2	20.7
	8H	19.5	19.7	19.9	20.2	20.7	19.5	19.7	19.9	20.2	20.7
Variation of the observer position for the luminaire distances S											
S = 1.0H		+1.2 / -2.8					+1.2 / -2.8				
S = 1.5H		+3.1 / -18.3					+3.1 / -18.3				
S = 2.0H		+5.0 / -21.2					+5.0 / -21.2				
Standard table		BK00					BK00				
Correction Summand		1.5					1.5				
Corrected Glare Indices referring to 1100lm Total Luminous Flux											

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Figure A2: Summary of DIALux for GreenSpace Lamp

APPENDIX B: NUMBER OF LAMPS

No.	Item	No. of Unit	Green Space Lamp	Pentura LED lamp	Total
1.	Felo House	2	21	-	42
2.	Principle House	1	20	-	20
3.	Office Area	1	17	5	22
4.	M&E Room	1	-	8	8
5.	Briefing Room	1	9	-	9
6.	Quarantine Room	2	-	2	4
7.	Prayer Room	2	-	2	4
8.	Activity Room	1	-	4	4
9.	TV Room	1	-	3	3
10.	Washing Room	1	-	5	5
11.	Lobby	1	-	8	8
12.	Store	1	-	2	2
13.	Public Toilet	2	5	-	10
14.	Corridor	1	25	-	25
15.	Others space	1	-	11	11
16.	Student House	1	20	9	29
Total					206

Figure B1: Number of lamps for Ground Floor

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No.	Item	No. of Unit	Green Space Lamp	Pentura LED Lamp	Total
1.	Student Rooms	550	4	-	2200
2.	Toilet	110	-	6	660
3.	Other space in student house	110	-	2	220
4.	Corridors and Stairs	10	-	25	250
5.	Pantry	110	1		110
Total					3440

Figure B2: Number of lamps for First Floor – 10th Floor

APPENDIX C: NUMBER OF SOCKET OUTLET

No.	Item	No. of Unit	13A 3 PIN S/S/O (SINGLE)	15A 3 PIN S/S/O (SINGLE)	Total
17.	Felo House	2	12	2	28
18.	Principle House	1	10	2	12
19.	Office Area	1	8	6	14
20.	M&E Room	1	2	-	2
21.	Briefing Room	1	2	-	2
22.	Quarantine Room	2	1	-	2
23.	Prayer Room	2	2	-	4
24.	Activity Room	1	4	-	4
25.	TV Room	1	2	-	2
26.	Washing Room	1	4	-	4
27.	Lobby	1	4	-	4
28.	Store	1	-	-	-
29.	Public Toilet	2	-	-	-
30.	Corridor	1	-	-	-
31.	Others space	1	-	-	-
32.	Student House	1	10	-	10
Total					88

Figure C1: Number of Socket Outlet for Ground Floor

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No.	Item	No. of Unit	13A 3 PIN S/S/O (SINGLE)	15A 3 PIN S/S/O (SINGLE)	Total
6.	Student Rooms	550	2	-	1100
7.	Toilet	110	-	-	-
8.	Other space in student house	110	-	-	-
9.	Corridors and Stairs	10	-	-	-
10.	Pantry	110	1	-	110
Total					1210

Figure C2: Number of Socket Outlet for First Floor – 10th Floor

APPENDIX D: LOAD PROFILE

Item	Load Category SSB	Qty.	Load/Unit (kW)	Total Connected Load (TCL)(kW)	D.F.	Maximum Demand (MD)(kW)	Monthly Peak MD (kW)	Daily operating Hours	Monthly Consumption Hours/Month (kW)	Load Factor	Estimated Monthly Consumption (kWh)
1	LIGHTING POINT (15W)	123	0.015	1.845	0.66	1.218	1.22	12	439.20	0.66	289.872
2	LIGHTING POINT (10.5W)	83	0.011	0.872	0.66	0.575	0.58	12	208.80	0.66	137.808
3	15A 3 PIN S/S/O (SINGLE)	12	0.500	6.000	1	6.000	6.00	12	2160.00	1	2160
4	13A 3 PIN S/S/O (SINGLE)	70	0.250	17.500	0.4	7.000	7.00	12	2520.00	0.4	1008
5	CEILING FAN POINT (60W)	30	0.080	2.400	0.7	1.680	1.68	12	604.80	0.7	423.36
6	EXHAUST FAN POINT	9	0.080	0.720	0.8	0.576	0.58	24	417.60	0.8	334.08
7	AIRCOND POINT (1HP = 746W)	11	0.746	8.206	0.6	4.924	4.29	8	1029.60	0.6	617.76
8	AIRCOND POINT (1.5HP = 1119)	1	1.119	1.119	0.6	0.671	0.67	8	160.80	0.6	96.48
	Total Load (kW)			**38.662**		**22.644**			**7540.80**		**5067.36**

Item	Load Category SSB	Qty.	Load/Unit (kW)	Total Connected Load (TCL)(kW)	D.F.	Maximum Demand (MD)(kW)	Monthly Peak MD (kW)	Daily operating Hours	Monthly Consumption Hours/Month (kW)	Load Factor	Estimated Monthly Consumption (kWh)
1	LIGHTING POINT (15W)	123	0.015	1.85	0.66	1.218	1.22	12	439.20	0.66	289.872
2	LIGHTING POINT (10.5W)	83	0.011	0.87	0.66	0.575	0.58	12	208.80	0.66	137.808
	Total Load (kW)			**2.72**		**1.793**			**648.00**		**427.68**

Item	Load Category SSB	Qty.	Load/Unit (kW)	Total Connected Load (TCL)(kW)	D.F.	Maximum Demand (MD)(kW)	Monthly Peak MD (kW)	Daily operating Hours	Monthly Consumption Hours/Month (kW)	Load Factor	Estimated Monthly Consumption (kWh)
3	15A 3 PIN S/S/O (SINGLE)	12	0.500	6.00	1	6.000	6.00	12	2160.00	1	2160
4	13A 3 PIN S/S/O (SINGLE)	70	0.250	17.50	0.4	7.000	7.00	12	2520.00	0.4	1008
	Total Load (kW)			**23.50**		**13.000**			**4680.00**		**3168**

Item	Load Category SSB	Qty.	Load/Unit (kW)	Total Connected Load (TCL)(kW)	D.F.	Maximum Demand (MD)(kW)	Monthly Peak MD (kW)	Daily operating Hours	Monthly Consumption Hours/Month (kW)	Load Factor	Estimated Monthly Consumption (kWh)
5	CEILING FAN POINT (60W)	30	0.080	2.400	0.7	1.680	1.68	12	604.80	0.7	423.36
6	EXHAUST FAN POINT	9	0.080	0.720	0.8	0.576	0.58	24	417.60	0.8	334.08
	Total Load (kW)			**3.120**		**2.256**			**1022.40**		**757.44**

Item	Load Category SSB	Qty.	Load/Unit (kW)	Total Connected Load (TCL)(kW)	D.F.	Maximum Demand (MD)(kW)	Monthly Peak MD (kW)	Daily operating Hours	Monthly Consumption Hours/Month (kW)	Load Factor	Estimated Monthly Consumption (kWh)
7	AIRCOND POINT (1HP = 746W)	11	0.746	8.206	0.6	4.924	4.29	8	1029.60	0.6	617.76
8	AIRCOND POINT (1.5HP = 1119)	1	1.119	1.119	0.6	0.671	0.67	8	160.80	0.6	96.48
	Total Load (kW)			**15.565**		**10.107**			**3235.20**		**2229.12**

Figure D1: Load Profile for Ground Floor

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APPENDIX D: LOAD PROFILE

Item	Load Category SSB	Qty.	Load/Unit (kW)	Total Connected Load (TCL)(kW)	D.F.	Maximum Demand (MD)(kW)	Monthly Peak MD (kW)	Daily operating Hours	Monthly Consumption Hours/Month (kW)	Load Factor	Estimated Monthly Consumption (kWh)
1	LIGHTING POINT (15W)	2200	0.015	33.0	0.66	21.78	21.78	12	7840.80	0.66	5174.93
2	LIGHTING POINT (10.5W)	1240	0.011	13.0	0.66	8.59	8.59	12	3092.40	0.66	2040.98
3	15A 3 PIN S/S/O (SINGLE)	0	0.500	0.0	1	0.00	0.00	12	0.00	1	0.00
4	13A 3 PIN S/S/O (SINGLE)	1100	0.250	275.0	0.4	110.00	110.00	12	39600.00	0.4	15840.00
5	CEILING FAN POINT (60W)	550	0.080	44.0	0.7	30.80	30.80	12	11088.00	0.7	7761.60
6	EXHAUST FAN POINT	110	0.080	8.8	0.8	7.04	7.04	24	5068.80	0.8	4055.04
	Total Load (kW)			**373.82**		**178.21**			**66690.00**		**34872.55**

Item	Load Category SSB	Qty.	Load/Unit (kW)	Total Connected Load (TCL)(kW)	D.F.	Maximum Demand (MD)(kW)	Monthly Peak MD (kW)	Daily operating Hours	Monthly Consumption Hours/Month (kW)	Load Factor	Estimated Monthly Consumption (kWh)
1	LIGHTING POINT (15W)	2200	0.015	33.0	0.66	21.78	21.78	12	7840.80	0.66	5174.93
2	LIGHTING POINT (10.5W)	1240	0.011	13.0	0.66	8.59	8.59	12	3092.40	0.66	2040.98
	Total Load (kW)			**46.02**		**30.37**			**10933.20**		**7215.91**

Item	Load Category SSB	Qty.	Load/Unit (kW)	Total Connected Load (TCL)(kW)	D.F.	Maximum Demand (MD)(kW)	Monthly Peak MD (kW)	Daily operating Hours	Monthly Consumption Hours/Month (kW)	Load Factor	Estimated Monthly Consumption (kWh)
3	15A 3 PIN S/S/O (SINGLE)	0	0.500	0.0	1	0.00	0.00	12	0.00	1	0.00
4	13A 3 PIN S/S/O (SINGLE)	1100	0.250	275.0	0.4	110.00	110.00	12	39600.00	0.4	15840.00
	Total Load (kW)			**275.00**		**110.00**			**39600.00**		**15840.00**

Item	Load Category SSB	Qty.	Load/Unit (kW)	Total Connected Load (TCL)(kW)	D.F.	Maximum Demand (MD)(kW)	Monthly Peak MD (kW)	Daily operating Hours	Monthly Consumption Hours/Month (kW)	Load Factor	Estimated Monthly Consumption (kWh)
5	CEILING FAN POINT (60W)	550	0.080	44.0	0.7	30.80	30.80	12	11088.00	0.7	7761.60
6	EXHAUST FAN POINT	110	0.080	8.8	0.8	7.04	7.04	24	5068.80	0.8	4055.04
	Total Load (kW)			**52.80**		**37.84**			**16156.80**		**11816.64**

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Figure D2: Load Profile for 1st – 10th Floor

PROJECT PLANNING													
List major activities involved in the proposed project. Indicate duration of each activity to the related month (s)													
	2014							2015					
Project Activities	**June**	**July**	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**	**Jan.**	**Feb.**	**Mac.**	**Apr.**	**May**	**June**
Confirmation for FYP title				■									
Research				■	■	■							
Proposal writing					■								
Data gathering					■	■	■						
Do the project								■	■				
Submit progress report to supervisor										■	■	■	
Repair report								■	■	■	■	■	■
Presentation							■						■

Figure E1: Project Planning

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

APPENDIX F: SUMMARY OF DIALUX FOR EACH PART IN HOSTEL

Project 1 DIALux

24.05.2015

Operator
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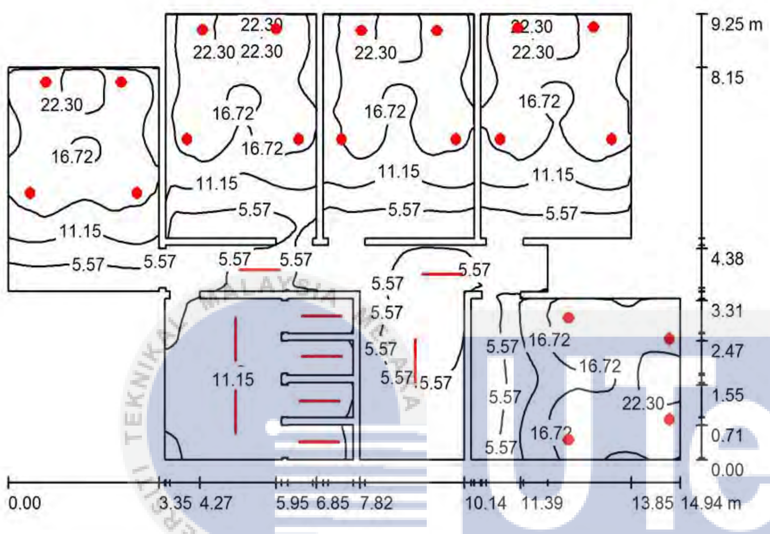
Room 1 / Summary



Height of Room: 2.743 m, Mounting Height: 2.743 m, Light loss factor: 0.80 Values in Footcandles, Scale 1:119

Surface	ρ [%]	E_{av} [fc]	E_{min} [fc]	E_{max} [fc]	u0
Workplane	/	13	1.90	26	0.150
Floor	20	11	1.92	19	0.179
Ceiling	80	3.42	1.02	27	0.299
Walls (87)	50	6.50	1.06	106	/

Workplane:
Height: 0.760 m
Grid: 128 x 128 Points
Boundary Zone: 0.000 m
Illuminance Quotient (according to LG7): Walls / Working Plane: 0.574, Ceiling / Working Plane: 0.270.

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	9	PHILIPS BN130C 1xLED8S/830 L885 (1.000)	800	800	10.5
2	20	PHILIPS DN450B 1xDLM1100/830 (1.000)	1100	1100	15.0
			Total: 29200	Total: 29200	394.5

Specific connected load: 3.65 W/m² = 2.88 W/m²/10 fc (Ground area: 108.10 m²)

Figure F1: Summary of DIALux for Student House

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

APPENDIX F: SUMMARY OF DIALUX FOR EACH PART IN HOSTEL

Project 1 DIALux

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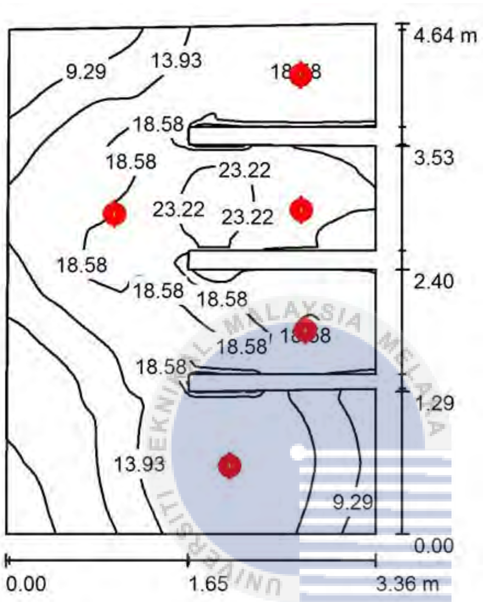

Height of Room: 2.743 m, Mounting Height: 2.743 m, Light loss factor: 0.80 Values in Footcandles, Scale 1:60

Surface	ρ [%]	E_{av} [fc]	E_{min} [fc]	E_{max} [fc]	u0
Workplane	/	15	3.61	25	0.239
Floor	20	11	5.05	18	0.450
Ceiling	80	3.02	1.61	5.78	0.532
Walls (16)	50	7.43	1.75	51	/

Workplane:
Height: 0.760 m
Grid: 64 x 64 Points
Boundary Zone: 0.000 m
Illuminance Quotient (according to LG7): Walls / Working Plane: 0.539, Ceiling / Working Plane: 0.200.

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	5	PHILIPS DN450B 1xDLM1100/830 (1.000)	1100	1100	15.0
			Total: 5500	Total: 5500	75.0

Specific connected load: 5.14 W/m² = 3.40 W/m²/10 fc (Ground area: 14.60 m²)

Figure F2: Summary of DIALux for Public Toilet

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APPENDIX F: SUMMARY OF DIALUX FOR EACH PART IN HOSTEL

Project 1 DIALux

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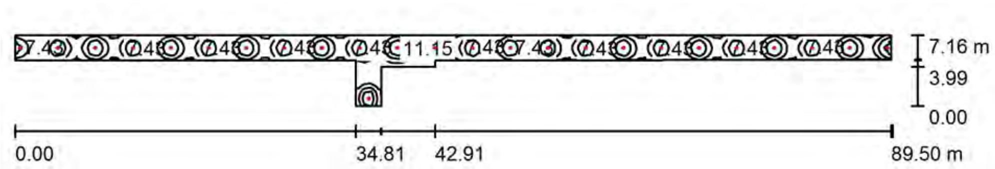
Room 1 / Summary



Height of Room: 2.743 m, Mounting Height: 2.743 m, Light loss factor: 0.80   Values in Footcandles, Scale 1:640

Surface	ρ [%]	E_{av} [fc]	E_{min} [fc]	E_{max} [fc]	u0
Workplane	/	7.79	1.20	16	0.154
Floor	20	6.69	2.40	9.16	0.359
Ceiling	80	1.19	0.84	2.47	0.705
Walls (10)	50	2.59	0.76	37	/

Workplane:
Height: 0.760 m
Grid: 128 x 128 Points
Boundary Zone: 0.000 m

Illuminance Quotient (according to LG7): Walls / Working Plane: 0.295, Ceiling / Working Plane: 0.153.

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	25	PHILIPS DN450B 1xDLM1100/830 (1.000)	1100	1100	15.0
			Total: 27500	Total: 27500	375.0

Specific connected load: 1.56 W/m² = 2.00 W/m²/10 fc (Ground area: 240.64 m²)

Figure F3: Summary of DIALux for Corridor and Staircase

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

APPENDIX F: SUMMARY OF DIALUX FOR EACH PART IN HOSTEL

Project 1 DIALux

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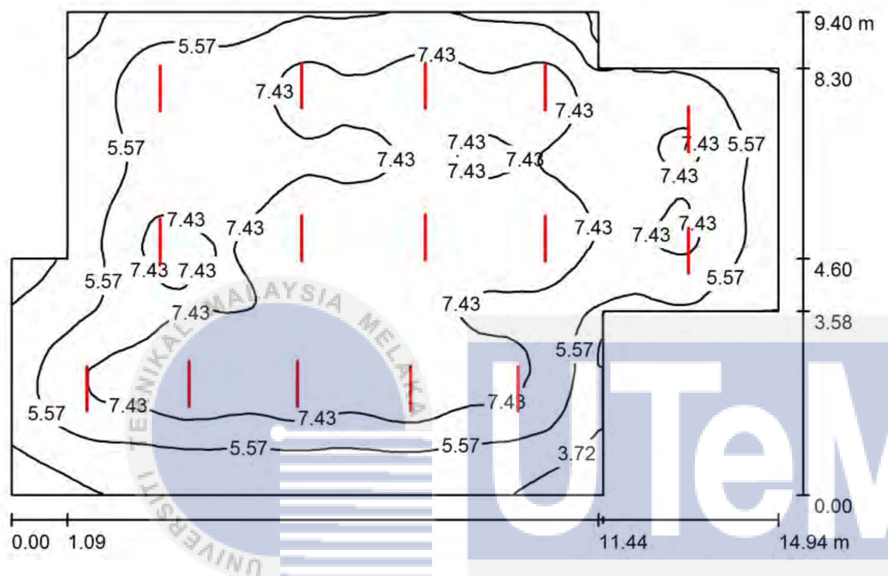
Room 1 / Summary



Height of Room: 2.743 m, Mounting Height: 2.743 m, Light loss factor: 0.80 Values in Footcandles, Scale 1:121

Surface	ρ [%]	E_{av} [fc]	E_{min} [fc]	E_{max} [fc]	u0
Workplane	/	6.62	2.62	9.13	0.396
Floor	20	5.98	3.08	7.70	0.516
Ceiling	80	2.23	1.30	20	0.584
Walls (10)	50	3.90	2.04	7.53	/

Workplane:
Height: 0.760 m
Grid: 128 x 128 Points
Boundary Zone: 0.000 m
Illuminance Quotient (according to LG7): Walls / Working Plane: 0.608, Ceiling / Working Plane: 0.340.

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	15	PHILIPS BN130C 1xLED8S/830 L885 (1.000)	800	800	10.5
			Total: 12000	Total: 12000	157.5

Specific connected load: 1.32 W/m² = 2.00 W/m²/10 fc (Ground area: 119.15 m²)

Figure F4: Summary of DIALux for Lobby

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

APPENDIX F: SUMMARY OF DIALUX FOR EACH PART IN HOSTEL

Project 1 DIALux
24.05.2015

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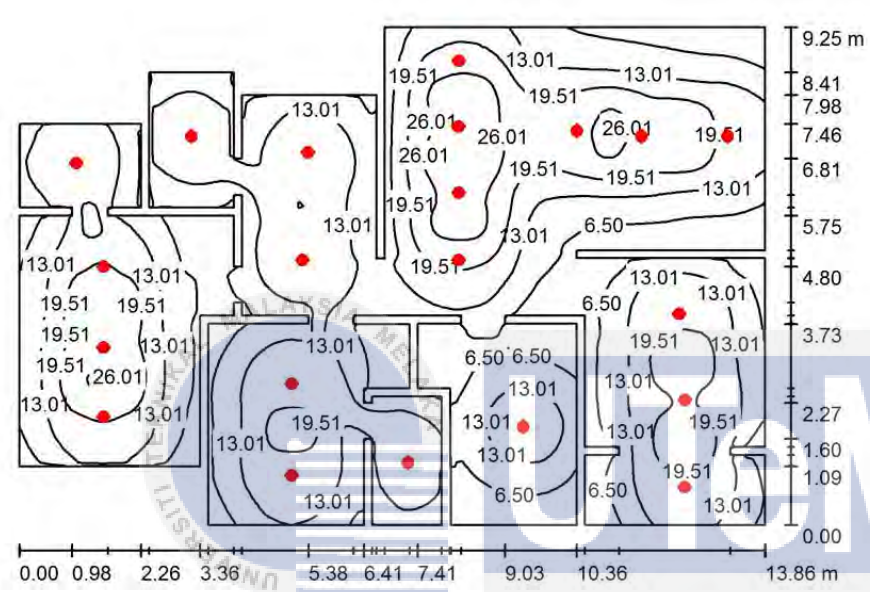
Room 1 / Summary



Height of Room: 2.743 m, Mounting Height: 2.743 m, Light loss factor: 0.80 Values in Footcandles, Scale 1:119

Surface	ρ [%]	E_{av} [fc]	E_{min} [fc]	E_{max} [fc]	u0
Workplane	/	14	0.73	32	0.053
Floor	20	12	0.88	24	0.075
Ceiling	80	1.96	0.82	3.28	0.419
Walls (76)	50	3.88	0.66	19	/

Workplane:
Height: 0.760 m
Grid: 128 x 128 Points
Boundary Zone: 0.000 m
Illuminance Quotient (according to LG7): Walls / Working Plane: 0.249, Ceiling / Working Plane: 0.142.

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	21	PHILIPS DN450B 1xDLM1100/830 (1.000)	1100	1100	15.0
			Total: 23100	Total: 23100	315.0

Specific connected load: 2.86 W/m² = 2.09 W/m²/10 fc (Ground area: 110.00 m²)

Figure F5: Summary of DIALux for Felo House

APPENDIX F: SUMMARY OF DIALUX FOR EACH PART IN HOSTEL

Project 1 DIALux
24.05.2015

Operator
Telephone
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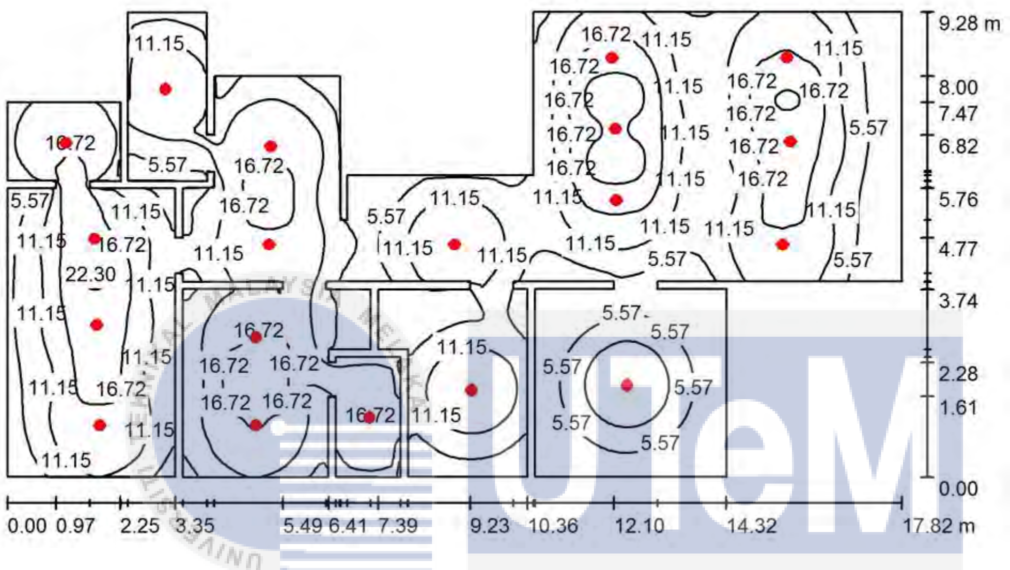
Room 1 / Summary



Height of Room: 2.743 m, Mounting Height: 2.743 m, Light loss factor: 0.80 Values in Footcandles, Scale 1:128

Surface	ρ [%]	E_{av} [fc]	E_{min} [fc]	E_{max} [fc]	u0
Workplane	/	11	0.52	26	0.047
Floor	20	9.44	0.62	18	0.066
Ceiling	80	1.59	0.62	3.11	0.390
Walls (73)	50	3.21	0.53	19	/

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Workplane:
Height: 0.760 m
Grid: 128 x 128 Points
Boundary Zone: 0.000 m
Illuminance Quotient (according to LG7): Walls / Working Plane: 0.262, Ceiling / Working Plane: 0.145.

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	19	PHILIPS DN450B 1xDLM1100/830 (1.000)	1100	1100	15.0
			Total: 20900	Total: 20900	285.0

Specific connected load: 2.25 W/m² = 2.05 W/m²/10 fc (Ground area: 126.57 m²)

Figure F6: Summary of DIALux for Principle House

APPENDIX F: SUMMARY OF DIALUX FOR EACH PART IN HOSTEL

Project 1 DIALux

24.05.2015

Operator
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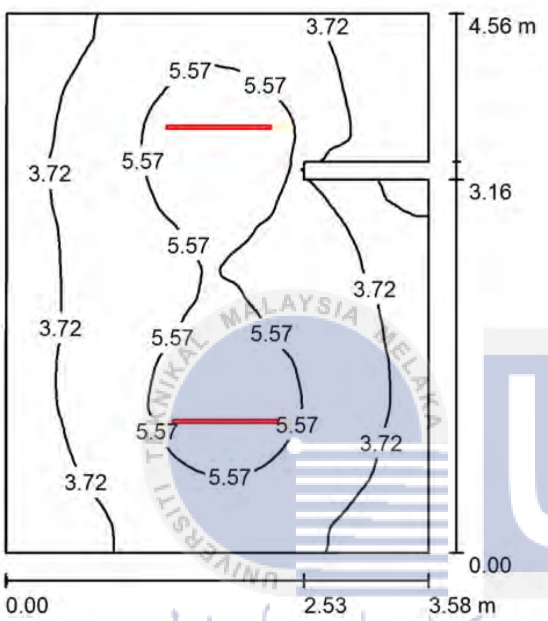
Room 1 / Summary



Height of Room: 2.743 m, Mounting Height: 2.743 m, Light loss factor: 0.80 Values in Footcandles, Scale 1:59

Surface	ρ [%]	E_{av} [fc]	E_{min} [fc]	E_{max} [fc]	u0
Workplane	/	4.43	1.66	6.37	0.375
Floor	20	3.45	1.61	4.72	0.467
Ceiling	80	2.00	0.84	19	0.423
Walls (8)	50	2.70	1.00	10	/

Workplane:
Height: 0.760 m
Grid: 128 x 128 Points
Boundary Zone: 0.000 m
Illuminance Quotient (according to LG7): Walls / Working Plane: 0.667, Ceiling / Working Plane: 0.451.

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	2	PHILIPS BN130C 1xLED8S/830 L885 (1.000)	800	800	10.5
			Total: 1600	Total: 1600	21.0

Specific connected load: 1.30 W/m² = 2.94 W/m²/10 fc (Ground area: 16.15 m²)

Figure F7: Summary of DIALux for Prayer Room

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

APPENDIX F: SUMMARY OF DIALUX FOR EACH PART IN HOSTEL

Project 1 DIALux

24.05.2015

Operator
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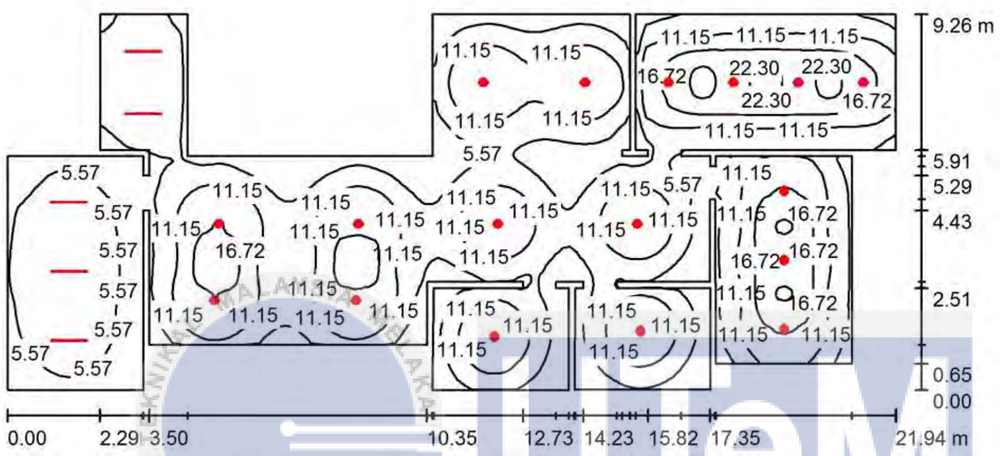
Room 1 / Summary



Height of Room: 2.743 m, Mounting Height: 2.743 m, Light loss factor: 0.80 Values in Footcandles, Scale 1:157

Surface	ρ [%]	E_{av} [fc]	E_{min} [fc]	E_{max} [fc]	u0
Workplane	/	9.76	1.70	25	0.174
Floor	20	8.49	2.64	17	0.311
Ceiling	80	1.78	0.72	21	0.405
Walls (56)	50	3.34	0.87	12	/

Workplane:
Height: 0.760 m
Grid: 128 x 128 Points
Boundary Zone: 0.000 m
Illuminance Quotient (according to LG7): Walls / Working Plane: 0.311, Ceiling / Working Plane: 0.182.

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	5	PHILIPS BN130C 1xLED8S/830 L885 (1.000)	800	800	10.5
2	17	PHILIPS DN450B 1xDLM1100/830 (1.000)	1100	1100	15.0
			Total: 22700	Total: 22700	307.5

Specific connected load: 2.00 W/m² = 2.05 W/m²/10 fc (Ground area: 153.43 m²)

Figure F8: Summary of DIALux for Office

APPENDIX F: SUMMARY OF DIALUX FOR EACH PART IN HOSTEL

Operator
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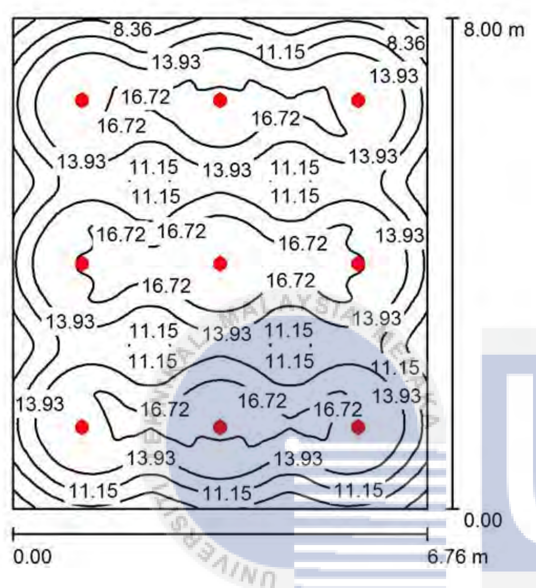
e-Mail

Room 1 / Summary



Height of Room: 2.743 m, Mounting Height: 2.743 m, Light loss factor: 0.80   Values in Footcandles, Scale 1:103

Surface	ρ [%]	E_{av} [fc]	E_{min} [fc]	E_{max} [fc]	u0
Workplane	/	14	4.60	18	0.335
Floor	20	13	6.20	16	0.496
Ceiling	80	2.24	1.56	2.66	0.697
Walls (4)	50	4.15	1.64	7.23	/

Workplane:
Height: 0.760 m
Grid: 128 x 128 Points
Boundary Zone: 0.000 m

UGR	Lengthways-	Across	to luminaire axis
Left Wall	20	20	
Lower Wall	20	20	
(CIE, SHR = 0.25.)			

Illuminance Quotient (according to LG7): Walls / Working Plane: 0.265, Ceiling / Working Plane: 0.163.

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	9	PHILIPS DN450B 1xDLM1100/830 (1.000)	1100	1100	15.0
			Total: 9900	Total: 9900	135.0

Specific connected load: 2.50 W/m² = 1.82 W/m²/10 fc (Ground area: 54.05 m²)

Figure F9: Summary of DIALux for Briefing Room

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APPENDIX F: SUMMARY OF DIALUX FOR EACH PART IN HOSTEL

Project 1 DIALux

24.05.2015

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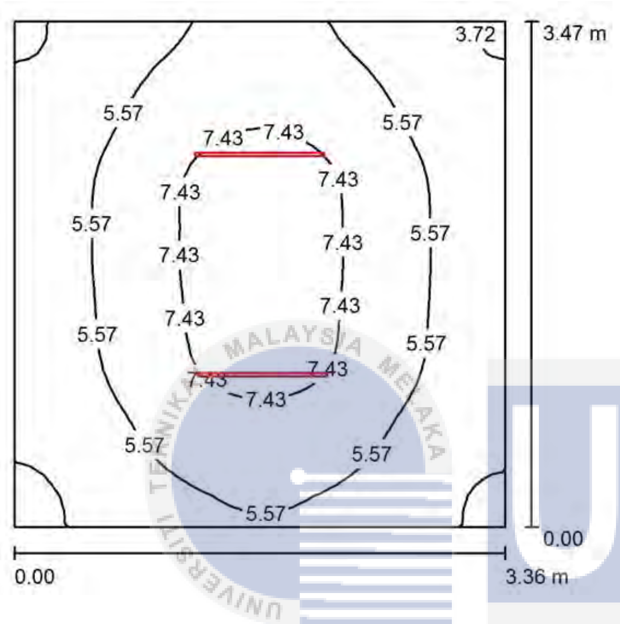
Room 1 / Summary



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Height of Room: 2.743 m, Mounting Height: 2.743 m, Light loss factor: 0.80 Values in Footcandles, Scale 1:45

Surface	ρ [%]	E_{av} [fc]	E_{min} [fc]	E_{max} [fc]	u0
Workplane	/	5.84	3.36	8.14	0.575
Floor	20	4.43	3.03	5.49	0.682
Ceiling	80	2.73	1.36	20	0.498
Walls (4)	50	3.78	2.10	10	/

Workplane:
Height: 0.760 m
Grid: 32 x 32 Points
Boundary Zone: 0.000 m
Illuminance Quotient (according to LG7): Walls / Working Plane: 0.709, Ceiling / Working Plane: 0.467.

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	2	PHILIPS BN130C 1xLED8S/830 L885 (1.000)	800	800	10.5
		Total:	1600	Total: 1600	21.0

Specific connected load: 1.80 W/m² = 3.08 W/m²/10 fc (Ground area: 11.66 m²)

Figure F10: Summary of DIALux for Quarantine Room

APPENDIX F: SUMMARY OF DIALUX FOR EACH PART IN HOSTEL

Project 1 DIALux
24.05.2015

Operator
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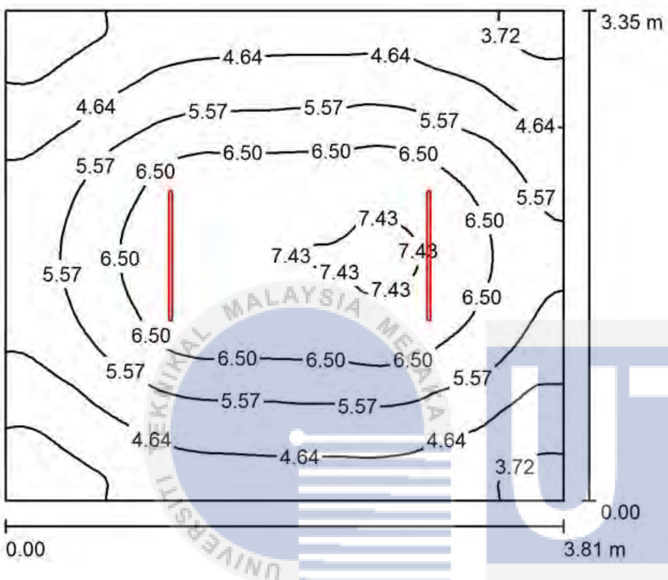
Room 1 / Summary



Height of Room: 2.743 m, Mounting Height: 2.743 m, Light loss factor: 0.80 Values in Footcandles, Scale 1:44

Surface	ρ [%]	E_{av} [fc]	E_{min} [fc]	E_{max} [fc]	u0
Workplane	/	5.48	3.13	7.59	0.571
Floor	20	4.20	2.80	5.20	0.665
Ceiling	80	2.53	1.26	23	0.499
Walls (4)	50	3.52	1.99	9.75	/

Workplane:
Height: 0.760 m
Grid: 64 x 64 Points
Boundary Zone: 0.000 m
Illuminance Quotient (according to LG7): Walls / Working Plane: 0.703, Ceiling / Working Plane: 0.461.

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	2	PHILIPS BN130C 1xLED8S/830 L885 (1.000)	800	800	10.5
			Total: 1600	Total: 1600	21.0

Specific connected load: 1.65 W/m² = 3.00 W/m²/10 fc (Ground area: 12.77 m²)

Figure F11: Summary of DIALux for Store Room

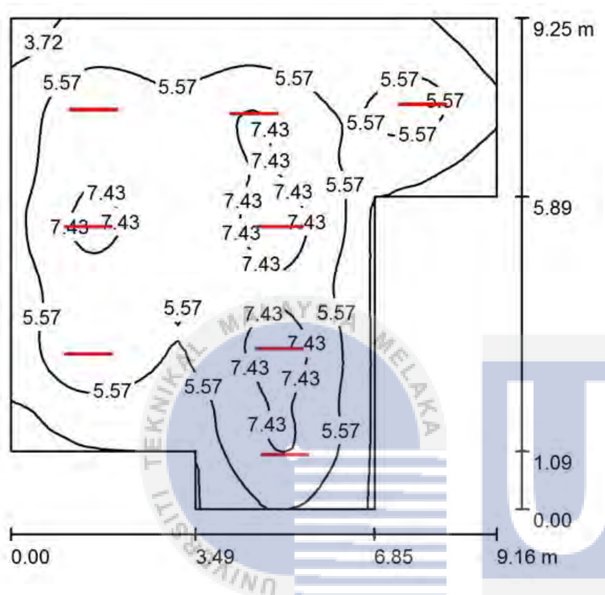
APPENDIX F: SUMMARY OF DIALUX FOR EACH PART IN HOSTEL

Project 1 DIALux

24.05.2015

Operator
Telephone
Fax
e-Mail

Room 1 / Summary



Height of Room: 2.743 m, Mounting Height: 2.743 m, Light loss factor: 0.80 Values in Footcandles, Scale 1:119

Surface	ρ [%]	E_{av} [fc]	E_{min} [fc]	E_{max} [fc]	u0
Workplane	/	5.76	2.53	8.16	0.440
Floor	20	5.01	2.54	6.43	0.508
Ceiling	80	2.11	1.15	20	0.546
Walls (8)	50	3.52	1.88	8.73	/

Workplane:
Height: 0.760 m
Grid: 64 x 64 Points
Boundary Zone: 0.000 m
Illuminance Quotient (according to LG7): Walls / Working Plane: 0.643, Ceiling / Working Plane: 0.367.

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	8	PHILIPS BN130C 1xLED8S/830 L885 (1.000)	800	800	10.5
			Total: 6400	Total: 6400	84.0

Specific connected load: 1.25 W/m² = 2.17 W/m²/10 fc (Ground area: 67.36 m²)

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Figure F12: Summary of DIALux for M&E Room

APPENDIX F: SUMMARY OF DIALUX FOR EACH PART IN HOSTEL

Project 1 DIALux
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Operator
Telephone
Fax
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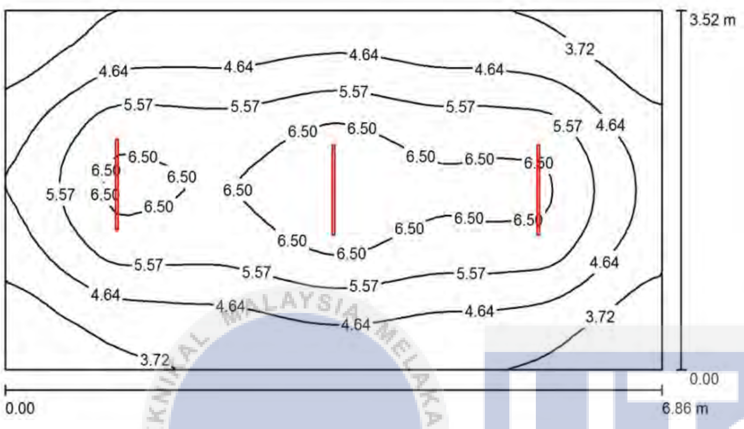
Room 1 / Summary



Height of Room: 2.743 m, Mounting Height: 2.743 m, Light loss factor: 0.80 Values in Footcandles, Scale 1:50

Surface	ρ [%]	E_{av} [fc]	E_{min} [fc]	E_{max} [fc]	u0
Workplane	/	5.07	2.79	7.33	0.551
Floor	20	4.09	2.60	5.25	0.634
Ceiling	80	2.02	1.13	19	0.557
Walls (4)	50	3.09	1.95	6.74	/

Workplane:
Height: 0.760 m
Grid: 64 x 32 Points
Boundary Zone: 0.000 m
Illuminance Quotient (according to LG7): Walls / Working Plane: 0.648, Ceiling / Working Plane: 0.399.

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Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	3	PHILIPS BN130C 1xLED8S/830 L885 (1.000)	800	800	10.5
			Total: 2400	Total: 2400	31.5

Specific connected load: 1.30 W/m² = 2.57 W/m²/10 fc (Ground area: 24.17 m²)

Figure F13: Summary of DIALux for TV Room

APPENDIX F: SUMMARY OF DIALUX FOR EACH PART IN HOSTEL

Project 1 DIALux

24.05.2015

Operator
Telephone
Fax
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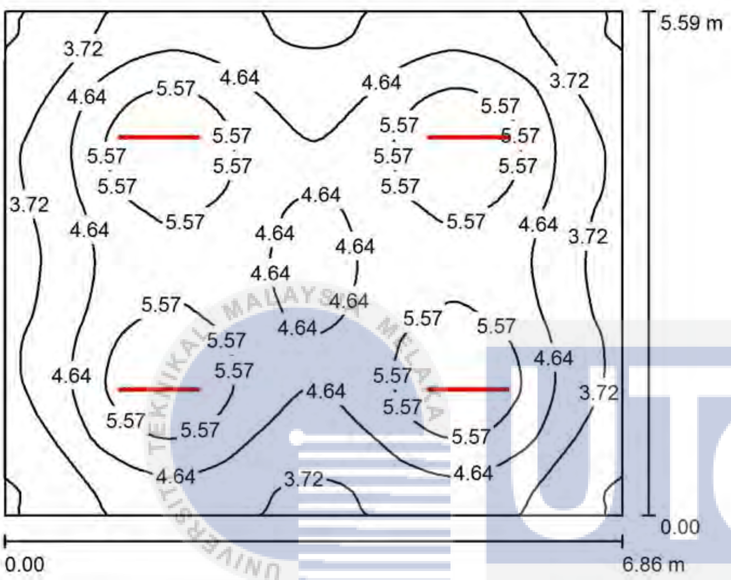
Room 1 / Summary



Height of Room: 2.743 m, Mounting Height: 2.743 m, Light loss factor: 0.80 Values in Footcandles, Scale 1:72

Surface	ρ [%]	E_{av} [fc]	E_{min} [fc]	E_{max} [fc]	u0
Workplane	/	4.68	2.63	6.47	0.563
Floor	20	3.96	2.58	4.69	0.652
Ceiling	80	1.80	1.07	19	0.594
Walls (4)	50	2.99	1.76	5.13	/

Workplane:
Height: 0.760 m
Grid: 64 x 64 Points
Boundary Zone: 0.000 m
Illuminance Quotient (according to LG7): Walls / Working Plane: 0.677, Ceiling / Working Plane: 0.386.

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	4	PHILIPS BN130C 1xLED8S/830 L885 (1.000)	800	800	10.5
			Total: 3200	Total: 3200	42.0

Specific connected load: 1.10 W/m² = 2.35 W/m²/10 fc (Ground area: 38.30 m²)

Figure F14: Summary of DIALux for Activity Room

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APPENDIX F: SUMMARY OF DIALUX FOR EACH PART IN HOSTEL

Project 1 DIALux

24.05.2015

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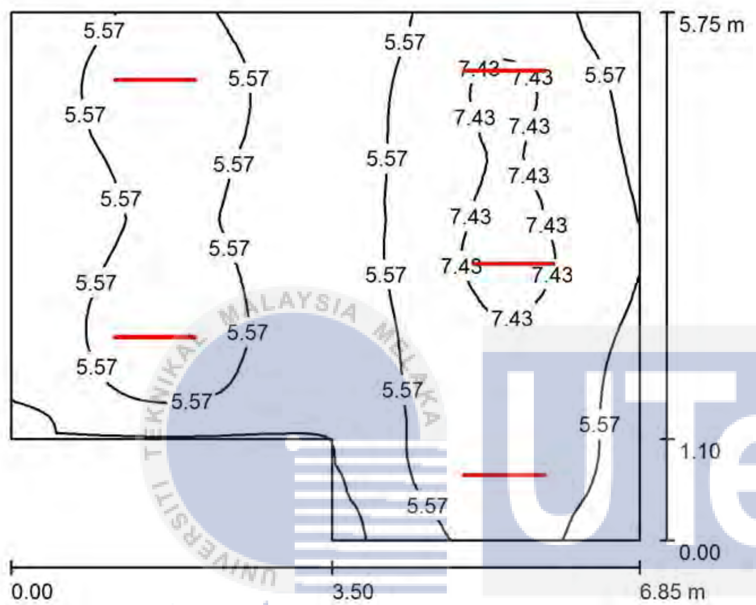
Room 1 / Summary



Height of Room: 2.743 m, Mounting Height: 2.743 m, Light loss factor: 0.80 Values in Footcandles, Scale 1:74

Surface	ρ [%]	E_{av} [fc]	E_{min} [fc]	E_{max} [fc]	u0
Workplane	/	5.76	3.40	8.07	0.590
Floor	20	4.85	3.17	6.02	0.654
Ceiling	80	2.46	1.23	21	0.500
Walls (6)	50	4.05	2.29	17	/

Workplane:
Height: 0.760 m
Grid: 64 x 64 Points
Boundary Zone: 0.000 m
Illuminance Quotient (according to LG7): Walls / Working Plane: 0.775, Ceiling / Working Plane: 0.427.

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	5	PHILIPS BN130C 1xLED8S/830 L885 (1.000)	800	800	10.5
			Total: 4000	Total: 4000	52.5

Specific connected load: 1.48 W/m² = 2.56 W/m²/10 fc (Ground area: 35.54 m²)

Figure F15: Summary of DIALux for Washing Room

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

APPENDIX G: SUMMARY OF DIALUX FOR EACH PART IN PRINCIPLE HOUSE

Project 1 DIALux
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Operator
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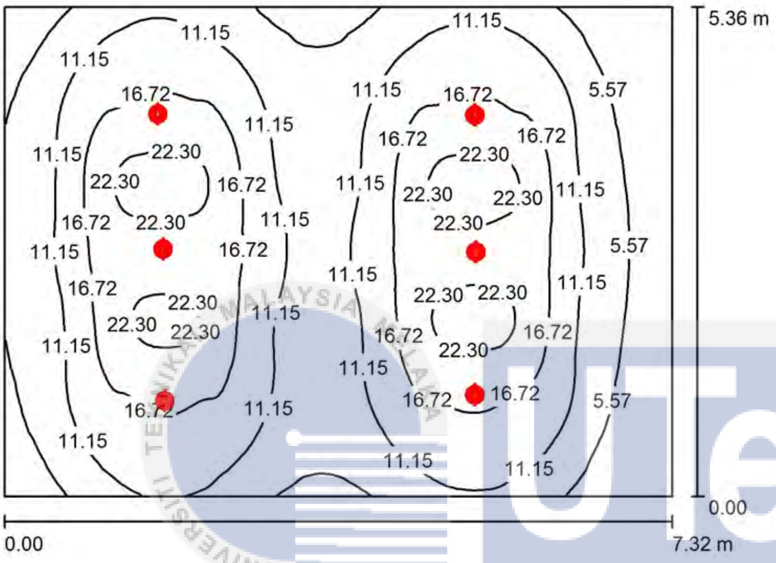
Room 1 / Summary



Height of Room: 2.743 m, Mounting Height: 2.743 m, Light loss factor: 0.80 Values in Footcandles, Scale 1:69

Surface	ρ [%]	E_{av} [fc]	E_{min} [fc]	E_{max} [fc]	u0
Workplane	/	13	2.07	25	0.163
Floor	20	11	3.38	17	0.294
Ceiling	80	1.90	1.21	2.38	0.635
Walls (4)	50	3.27	1.29	7.73	/

Workplane:
Height: 0.760 m
Grid: 128 x 128 Points
Boundary Zone: 0.000 m
Illuminance Quotient (according to LG7): Walls / Working Plane: 0.218, Ceiling / Working Plane: 0.150.

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	6	PHILIPS DN450B 1xDLM1100/830 (1.000)	1100	1100	15.0
			Total: 6600	Total: 6600	90.0

Specific connected load: 2.29 W/m² = 1.81 W/m²/10 fc (Ground area: 39.26 m²)

Figure G1: Summary of DIALux for Living and Dining Room

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APPENDIX G: SUMMARY OF DIALUX FOR EACH PART IN PRINCIPLE HOUSE

Project 1 DIALux

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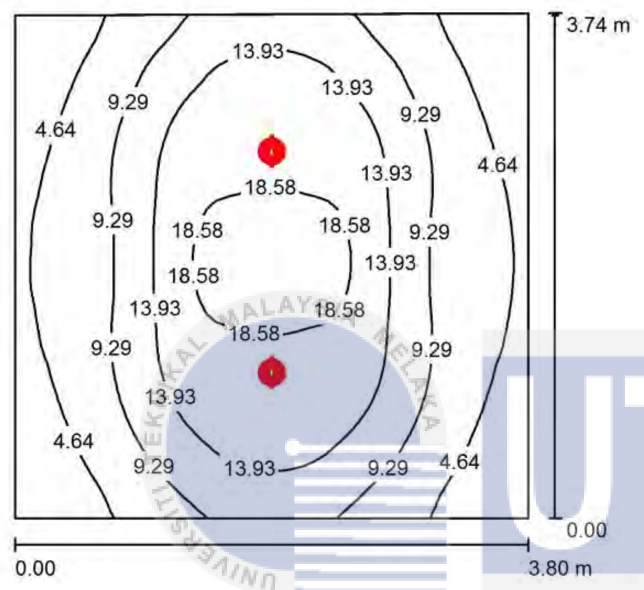
Room 1 / Summary



Height of Room: 2.743 m, Mounting Height: 2.743 m, Light loss factor: 0.80 Values in Footcandles, Scale 1:49

Surface	ρ [%]	E_{av} [fc]	E_{min} [fc]	E_{max} [fc]	u0
Workplane	/	11	2.76	23	0.259
Floor	20	8.90	3.73	14	0.419
Ceiling	80	1.39	0.96	1.80	0.691
Walls (4)	50	2.82	1.03	7.78	/

Workplane:
Height: 0.760 m
Grid: 64 x 64 Points
Boundary Zone: 0.000 m
Illuminance Quotient (according to LG7): Walls / Working Plane: 0.223, Ceiling / Working Plane: 0.131.

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	2	PHILIPS DN450B 1xDLM1100/830 (1.000)	1100	1100	15.0
			Total: 2200	Total: 2200	30.0

Specific connected load: 2.11 W/m² = 1.99 W/m²/10 fc (Ground area: 14.20 m²)

Figure G2: Summary of DIALux for Kitchen

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APPENDIX G: SUMMARY OF DIALUX FOR EACH PART IN PRINCIPLE HOUSE

Project 1 DIALux

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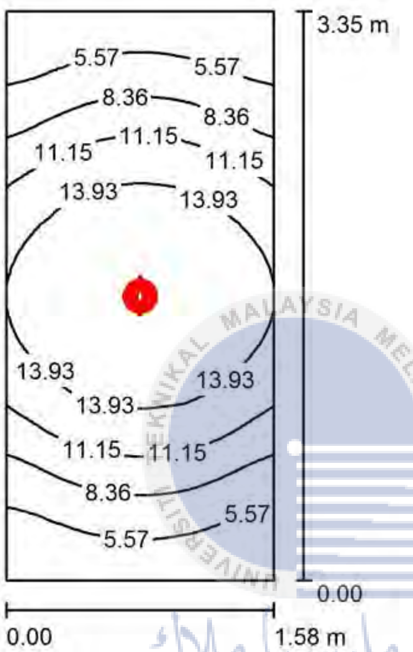
Room 1 / Summary



Height of Room: 2.743 m, Mounting Height: 2.743 m, Light loss factor: 0.80 Values in Footcandles, Scale 1:44

Surface	ρ [%]	E_{av} [fc]	E_{min} [fc]	E_{max} [fc]	u0
Workplane	/	10	3.83	16	0.368
Floor	20	7.41	4.51	9.06	0.608
Ceiling	80	1.48	1.04	2.04	0.699
Walls (4)	50	3.59	1.06	12	/

Workplane:		**UGR**	Lengthways-	Across	to luminaire axis
Height:	0.760 m	Left Wall	20	20	
Grid:	32 x 64 Points	Lower Wall	20	20	
Boundary Zone:	0.000 m	(CIE, SHR = 0.25.)			

Illuminance Quotient (according to LG7): Walls / Working Plane: 0.332, Ceiling / Working Plane: 0.143.

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	1	PHILIPS DN450B 1xDLM1100/830 (1.000)	1100	1100	15.0
		Total:	1100	Total: 1100	15.0

Specific connected load: 2.84 W/m² = 2.73 W/m²/10 fc (Ground area: 5.28 m²)

Figure G3: Summary of DIALux for Store Room

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

APPENDIX G: SUMMARY OF DIALUX FOR EACH PART IN PRINCIPLE HOUSE

Project 1 DIALux

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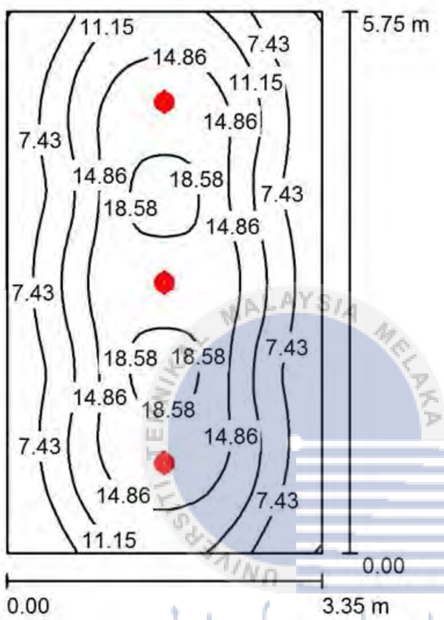
Room 1 / Summary



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Height of Room: 2.743 m, Mounting Height: 2.743 m, Light loss factor: 0.80 Values in Footcandles, Scale 1:74

Surface	ρ [%]	E_{av} [fc]	E_{min} [fc]	E_{max} [fc]	u0
Workplane	/	12	3.61	20	0.304
Floor	20	10	4.96	14	0.491
Ceiling	80	1.66	1.19	2.02	0.720
Walls (4)	50	3.35	1.20	8.58	/

Workplane:
Height: 0.760 m
Grid: 64 x 64 Points
Boundary Zone: 0.000 m
Illuminance Quotient (according to LG7): Walls / Working Plane: 0.241, Ceiling / Working Plane: 0.139.

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	3	PHILIPS DN450B 1xDLM1100/830 (1.000)	1100	1100	15.0
			Total: 3300	Total: 3300	45.0

Specific connected load: 2.34 W/m² = 1.97 W/m²/10 fc (Ground area: 19.23 m²)

Figure G4: Summary of DIALux for Master Bedroom

APPENDIX G: SUMMARY OF DIALUX FOR EACH PART IN PRINCIPLE HOUSE

Project 1 DIALux

24.05.2015

Operator
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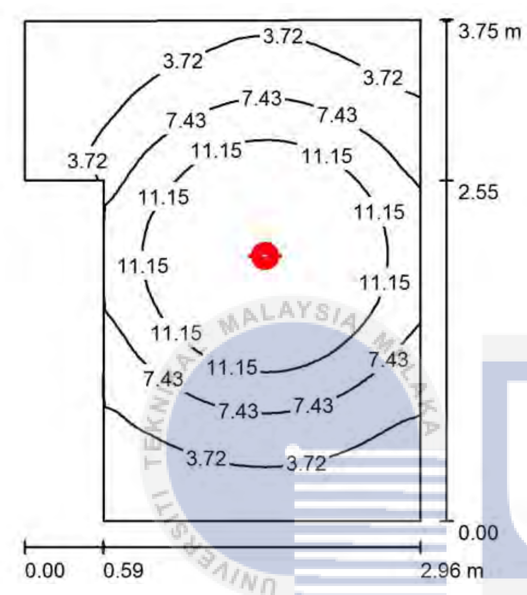
Room 1 / Summary



Height of Room: 2.743 m, Mounting Height: 2.743 m, Light loss factor: 0.80 Values in Footcandles, Scale 1:49

Surface	ρ [%]	E_{av} [fc]	E_{min} [fc]	E_{max} [fc]	u0
Workplane	/	7.36	0.50	15	0.068
Floor	20	5.80	0.62	8.13	0.107
Ceiling	80	0.89	0.55	1.25	0.619
Walls (6)	50	1.92	0.43	5.79	/

Workplane:
Height: 0.760 m
Grid: 64 x 64 Points
Boundary Zone: 0.000 m
Illuminance Quotient (according to LG7): Walls / Working Plane: 0.218, Ceiling / Working Plane: 0.120.

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	1	PHILIPS DN450B 1xDLM1100/830 (1.000)	1100	1100	15.0
			Total: 1100	Total: 1100	15.0

Specific connected load: 1.57 W/m² = 2.13 W/m²/10 fc (Ground area: 9.58 m²)

Figure G5: Summary of DIALux for Bedroom 1

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

APPENDIX G: SUMMARY OF DIALUX FOR EACH PART IN PRINCIPLE HOUSE

Project 1 DIALux

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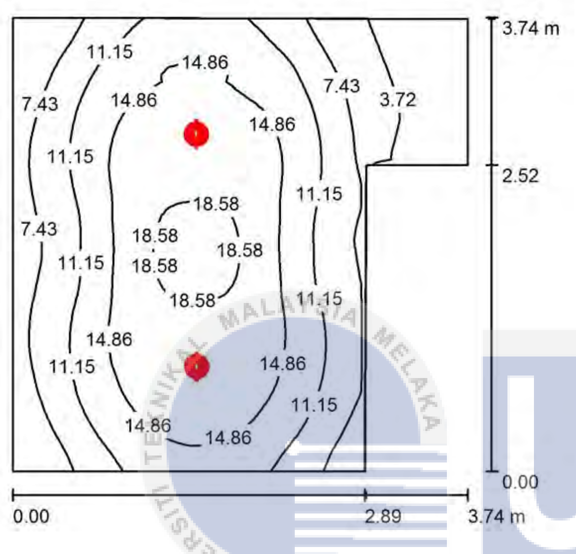
e-Mail

Room 1 / Summary



Height of Room: 2.743 m, Mounting Height: 2.743 m, Light loss factor: 0.80 Values in Footcandles, Scale 1:49

Surface	ρ [%]	E_{av} [fc]	E_{min} [fc]	E_{max} [fc]	u0
Workplane	/	12	1.86	20	0.158
Floor	20	9.47	2.66	14	0.281
Ceiling	80	1.61	0.86	2.14	0.530
Walls (6)	50	3.43	0.73	10	/

Workplane:
Height: 0.760 m
Grid: 64 x 64 Points
Boundary Zone: 0.000 m
Illuminance Quotient (according to LG7): Walls / Working Plane: 0.258, Ceiling / Working Plane: 0.137.

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	2	PHILIPS DN450B 1xDLM1100/830 (1.000)	1100	1100	15.0
			Total: 2200	Total: 2200	30.0

Specific connected load: 2.53 W/m² = 2.16 W/m²/10 fc (Ground area: 11.85 m²)

Figure G6: Summary of DIALux for Bedroom 2

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

APPENDIX G: SUMMARY OF DIALUX FOR EACH PART IN PRINCIPLE HOUSE

Project 1 DIALux

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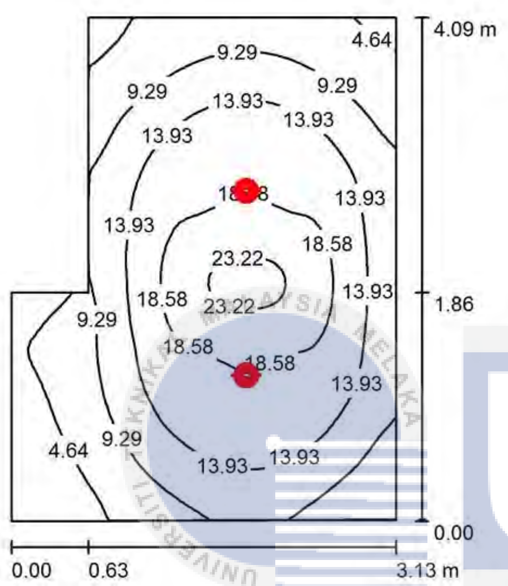
Room 1 / Summary



Height of Room: 2.743 m, Mounting Height: 2.743 m, Light loss factor: 0.80 Values in Footcandles, Scale 1:53

Surface	ρ [%]	E_{av} [fc]	E_{min} [fc]	E_{max} [fc]	u0
Workplane	/	13	2.62	24	0.209
Floor	20	10	3.81	15	0.380
Ceiling	80	1.60	1.09	2.07	0.686
Walls (6)	50	3.47	1.03	7.39	/

Workplane:
Height: 0.760 m
Grid: 64 x 64 Points
Boundary Zone: 0.000 m
Illuminance Quotient (according to LG7): Walls / Working Plane: 0.235, Ceiling / Working Plane: 0.127.

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	2	PHILIPS DN450B 1xDLM1100/830 (1.000)	1100	1100	15.0
			Total: 2200	Total: 2200	30.0

Specific connected load: 2.64 W/m² = 2.10 W/m²/10 fc (Ground area: 11.39 m²)

Figure G7: Summary of DIALux for Family Room

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

APPENDIX G: SUMMARY OF DIALUX FOR EACH PART IN PRINCIPLE HOUSE

Project 1 DIALux

24.05.2015

Operator
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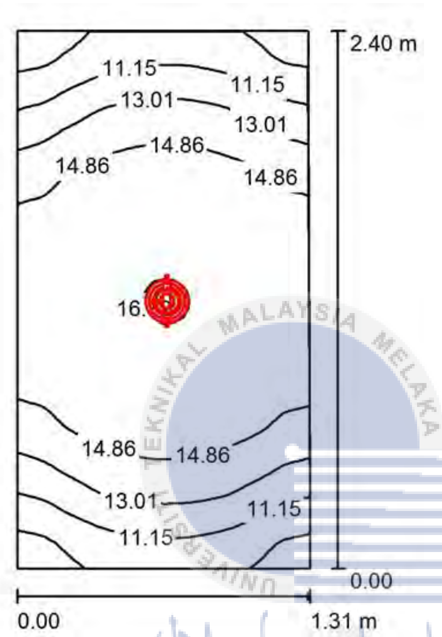
Room 1 / Summary



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Height of Room: 2.743 m, Mounting Height: 2.743 m, Light loss factor: 0.80 Values in Footcandles, Scale 1:31

Surface	ρ [%]	E_{av} [fc]	E_{min} [fc]	E_{max} [fc]	u0
Workplane	/	14	8.07	17	0.580
Floor	20	8.94	7.49	9.86	0.838
Ceiling	80	2.34	1.69	3.00	0.723
Walls (4)	50	5.75	1.70	19	/

Workplane:
Height: 0.760 m
Grid: 32 x 64 Points
Boundary Zone: 0.000 m
Illuminance Quotient (according to LG7): Walls / Working Plane: 0.428, Ceiling / Working Plane: 0.168.

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	1	PHILIPS DN450B 1xDLM1100/830 (1.000)	1100	1100	15.0
			Total: 1100	Total: 1100	15.0

Specific connected load: 4.79 W/m² = 3.44 W/m²/10 fc (Ground area: 3.13 m²)

Figure G8: Summary of DIALux for Toilet 1

APPENDIX G: SUMMARY OF DIALUX FOR EACH PART IN PRINCIPLE HOUSE

Project 1 DIALux

24.05.2015

Operator
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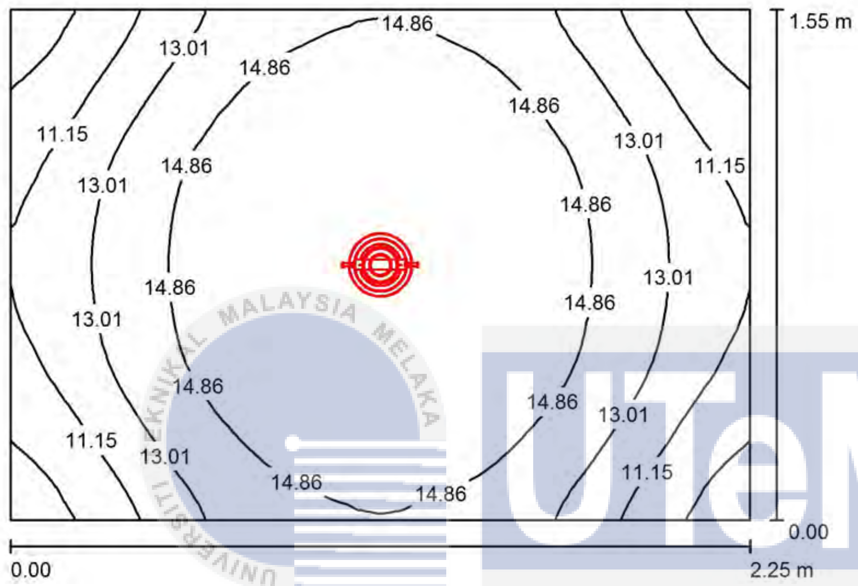
Room 1 / Summary



Height of Room: 2.743 m, Mounting Height: 2.743 m, Light loss factor: 0.80 Values in Footcandles, Scale 1:20

Surface	ρ [%]	E_{av} [fc]	E_{min} [fc]	E_{max} [fc]	u0
Workplane	/	14	8.13	17	0.595
Floor	20	8.86	7.46	9.78	0.841
Ceiling	80	2.07	1.48	2.59	0.714
Walls (4)	50	5.29	1.53	13	/

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Workplane:
Height: 0.760 m
Grid: 32 x 32 Points
Boundary Zone: 0.000 m
Illuminance Quotient (according to LG7): Walls / Working Plane: 0.385, Ceiling / Working Plane: 0.151.

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	1	PHILIPS DN450B 1xDLM1100/830 (1.000)	1100	1100	15.0
			Total: 1100	Total: 1100	15.0

Specific connected load: 4.30 W/m² = 3.15 W/m²/10 fc (Ground area: 3.49 m²)

Figure G9: Summary of DIALux for Toilet 2

APPENDIX H: SUMMARY OF DIALUX FOR EACH PART IN FELO HOUSE

Project 1 DIALux

24.05.2015

Operator
Telephone
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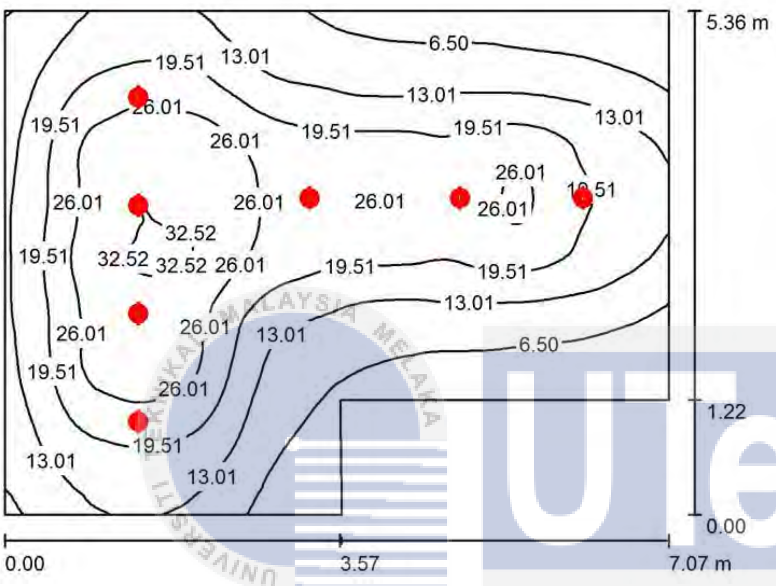
e-Mail

Room 1 / Summary



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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Height of Room: 2.743 m, Mounting Height: 2.743 m, Light loss factor: 0.80 Values in Footcandles, Scale 1:69

Surface	ρ [%]	E_{av} [fc]	E_{min} [fc]	E_{max} [fc]	u0
Workplane	/	17	2.02	34	0.120
Floor	20	15	3.91	26	0.260
Ceiling	80	2.45	1.33	3.20	0.542
Walls (6)	50	4.36	1.56	11	/

Workplane:
Height: 0.760 m
Grid: 128 x 128 Points
Boundary Zone: 0.000 m
Illuminance Quotient (according to LG7): Walls / Working Plane: 0.221, Ceiling / Working Plane: 0.146.

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	7	PHILIPS DN450B 1xDLM1100/830 (1.000)	1100	1100	15.0
			Total: 7700	Total: 7700	105.0

Specific connected load: 3.12 W/m² = 1.86 W/m²/10 fc (Ground area: 33.68 m²)

Figure H1: Summary of DIALux for Living and Dining Room

APPENDIX H: SUMMARY OF DIALUX FOR EACH PART IN FELO HOUSE

Project 1 DIALux
24.05.2015

Operator
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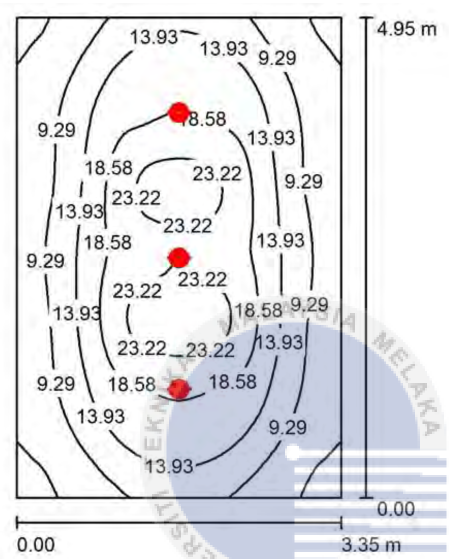
e-Mail

Room 1 / Summary



Height of Room: 2.743 m, Mounting Height: 2.743 m, Light loss factor: 0.80 Values in Footcandles, Scale 1:64

Surface	ρ [%]	E_{av} [fc]	E_{min} [fc]	E_{max} [fc]	u0
Workplane	/	14	3.64	27	0.263
Floor	20	12	5.16	17	0.441
Ceiling	80	1.83	1.30	2.27	0.709
Walls (4)	50	3.66	1.32	8.63	/

Workplane:
Height: 0.760 m
Grid: 64 x 64 Points
Boundary Zone: 0.000 m
Illuminance Quotient (according to LG7): Walls / Working Plane: 0.221, Ceiling / Working Plane: 0.132.

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	3	PHILIPS DN450B 1xDLM1100/830 (1.000)	1100	1100	15.0
			Total: 3300	Total: 3300	45.0

Specific connected load: 2.71 W/m² = 1.96 W/m²/10 fc (Ground area: 16.60 m²)

Figure H2: Summary of DIALux for Kitchen

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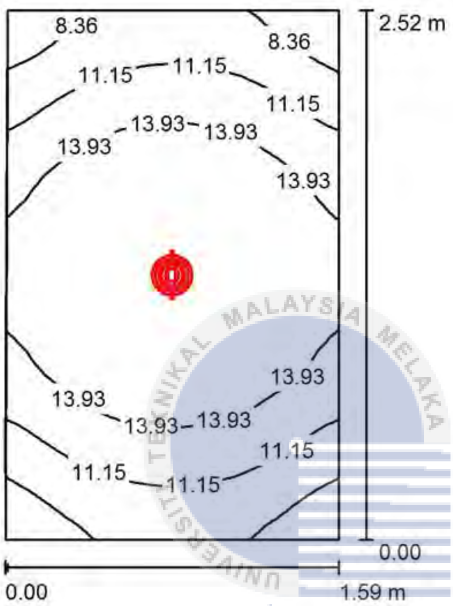
APPENDIX H: SUMMARY OF DIALUX FOR EACH PART IN FELO HOUSE

Project 1 DIALux

24.05.2015

Operator
Telephone
Fax
e-Mail

Room 1 / Summary



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Height of Room: 2.743 m, Mounting Height: 2.743 m, Light loss factor: 0.80 Values in Footcandles, Scale 1:33

Surface	ρ [%]	E_{av} [fc]	E_{min} [fc]	E_{max} [fc]	u0
Workplane	/	13	6.51	16	0.513
Floor	20	8.48	6.81	9.48	0.803
Ceiling	80	1.85	1.32	2.37	0.713
Walls (4)	50	4.69	1.35	12	/

Workplane:
Height: 0.760 m
Grid: 32 x 32 Points
Boundary Zone: 0.000 m
Illuminance Quotient (according to LG7): Walls / Working Plane: 0.363, Ceiling / Working Plane: 0.146.

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	1	PHILIPS DN450B 1xDLM1100/830 (1.000)	1100	1100	15.0
			Total: 1100	Total: 1100	15.0

Specific connected load: 3.76 W/m² = 2.96 W/m²/10 fc (Ground area: 3.99 m²)

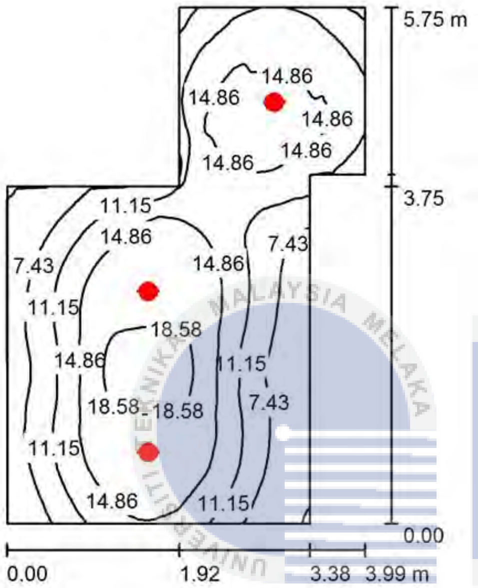
Figure H3: Summary of DIALux for Store Room

APPENDIX H: SUMMARY OF DIALUX FOR EACH PART IN FELO HOUSE

Project 1 DIALux
24.05.2015

Operator
Telephone
Fax
e-Mail

Room 1 / Summary



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Height of Room: 2.743 m, Mounting Height: 2.743 m, Light loss factor: 0.80 Values in Footcandles, Scale 1:74

Surface	ρ [%]	E_{av} [fc]	E_{min} [fc]	E_{max} [fc]	u0
Workplane	/	12	3.50	22	0.281
Floor	20	10	4.78	15	0.472
Ceiling	80	1.76	1.32	2.29	0.751
Walls (8)	50	3.89	1.26	12	/

Workplane:
Height: 0.760 m
Grid: 128 x 128 Points
Boundary Zone: 0.000 m
Illuminance Quotient (according to LG7): Walls / Working Plane: 0.281, Ceiling / Working Plane: 0.141.

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	3	PHILIPS DN450B 1xDLM1100/830 (1.000)	1100	1100	15.0
			Total: 3300	Total: 3300	45.0

Specific connected load: 2.70 W/m² = 2.17 W/m²/10 fc (Ground area: 16.69 m²)

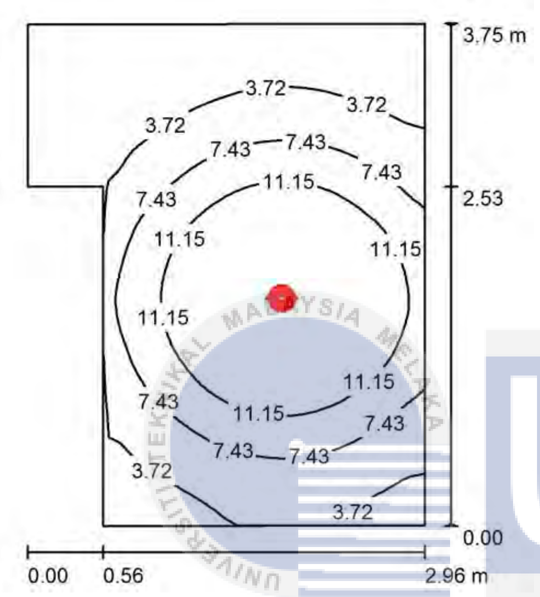
Figure H4: Summary of DIALux for Master Bedroom

APPENDIX H: SUMMARY OF DIALUX FOR EACH PART IN FELO HOUSE

Project 1 DIALux
24.05.2015

Operator
Telephone
Fax
e-Mail

Room 1 / Summary



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Height of Room: 2.743 m, Mounting Height: 2.743 m, Light loss factor: 0.80 Values in Footcandles, Scale 1:49

Surface	ρ [%]	E_{av} [fc]	E_{min} [fc]	E_{max} [fc]	u0
Workplane	/	7.28	0.46	15	0.063
Floor	20	5.74	0.55	8.19	0.097
Ceiling	80	0.90	0.53	1.28	0.592
Walls (6)	50	1.97	0.40	6.65	/

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Workplane:
Height: 0.760 m
Grid: 64 x 64 Points
Boundary Zone: 0.000 m
Illuminance Quotient (according to LG7): Walls / Working Plane: 0.229, Ceiling / Working Plane: 0.124.

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	1	PHILIPS DN450B 1xDLM1100/830 (1.000)	1100	1100	15.0
		Total:	1100	Total: 1100	15.0

Specific connected load: 1.56 W/m² = 2.14 W/m²/10 fc (Ground area: 9.63 m²)

Figure H5: Summary of DIALux for Bedroom 1

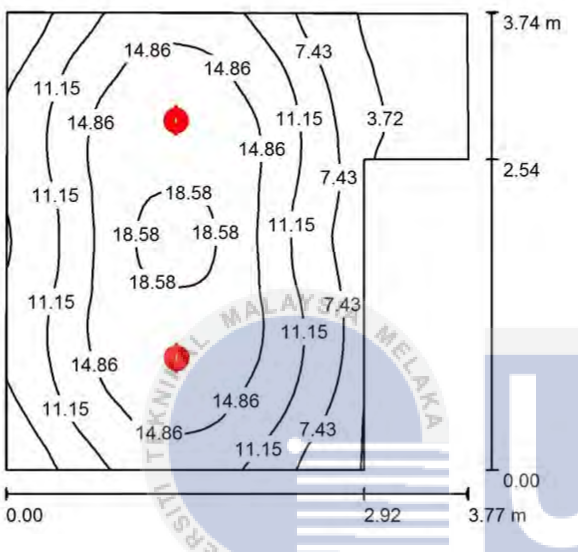
APPENDIX H: SUMMARY OF DIALUX FOR EACH PART IN FELO HOUSE

Project 1 DIALux

24.05.2015

Operator
Telephone
Fax
e-Mail

Room 1 / Summary



Height of Room: 2.743 m, Mounting Height: 2.743 m, Light loss factor: 0.80 Values in Footcandles, Scale 1:49

Surface	ρ [%]	E_{av} [fc]	E_{min} [fc]	E_{max} [fc]	u0
Workplane	/	12	1.63	20	0.140
Floor	20	9.41	2.53	14	0.268
Ceiling	80	1.63	0.88	2.12	0.538
Walls (6)	50	3.46	0.70	9.98	/

Workplane:
Height: 0.760 m
Grid: 64 x 64 Points
Boundary Zone: 0.000 m
Illuminance Quotient (according to LG7): Walls / Working Plane: 0.263, Ceiling / Working Plane: 0.139.

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	2	PHILIPS DN450B 1xDLM1100/830 (1.000)	1100	1100	15.0
			Total: 2200	Total: 2200	30.0

Specific connected load: 2.52 W/m² = 2.16 W/m²/10 fc (Ground area: 11.89 m²)

Figure H6: Summary of DIALux for Bedroom 2

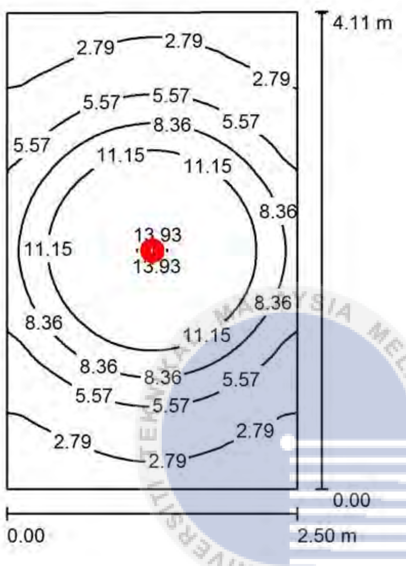
UNIVERSITI TEKNIKAL MALAYSIA MELAKA

APPENDIX H: SUMMARY OF DIALUX FOR EACH PART IN FELO HOUSE

Project 1 DIALux
24.05.2015

Operator
Telephone
Fax
e-Mail

Room 1 / Summary



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Height of Room: 2.743 m, Mounting Height: 2.743 m, Light loss factor: 0.80 Values in Footcandles, Scale 1:53

Surface	ρ [%]	E_{av} [fc]	E_{min} [fc]	E_{max} [fc]	u0
Workplane	/	7.06	1.63	14	0.231
Floor	20	5.63	2.32	8.00	0.412
Ceiling	80	0.85	0.59	1.18	0.694
Walls (4)	50	1.86	0.63	5.14	/

Workplane:
Height: 0.760 m
Grid: 64 x 64 Points
Boundary Zone: 0.000 m
Illuminance Quotient (according to LG7): Walls / Working Plane: 0.219, Ceiling / Working Plane: 0.121.

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	1	PHILIPS DN450B 1xDLM1100/830 (1.000)	1100	1100	15.0
			Total: 1100	Total: 1100	15.0

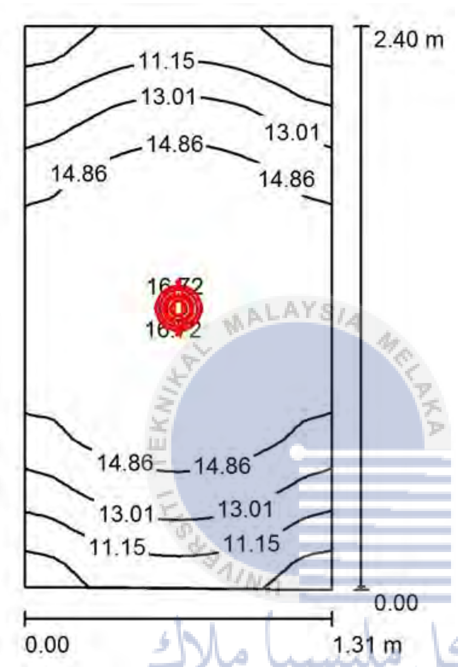
Specific connected load: 1.46 W/m² = 2.07 W/m²/10 fc (Ground area: 10.25 m²)

Figure H7: Summary of DIALux for Family Room

APPENDIX H: SUMMARY OF DIALUX FOR EACH PART IN FELO HOUSE

Operator
Telephone
Fax
e-Mail

Room 1 / Summary



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Height of Room: 2.743 m, Mounting Height: 2.743 m, Light loss factor: 0.80 Values in Footcandles, Scale 1:31

Surface	ρ [%]	E_{av} [fc]	E_{min} [fc]	E_{max} [fc]	u0
Workplane	/	14	8.18	17	0.589
Floor	20	8.91	7.53	9.83	0.845
Ceiling	80	2.30	1.67	2.94	0.726
Walls (4)	50	5.69	1.65	18	/

Workplane:
Height: 0.760 m
Grid: 64 x 32 Points
Boundary Zone: 0.000 m
Illuminance Quotient (according to LG7): Walls / Working Plane: 0.424, Ceiling / Working Plane: 0.165.

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	1	PHILIPS DN450B 1xDLM1100/830 (1.000)	1100	1100	15.0
			Total: 1100	Total: 1100	15.0

Specific connected load: 4.78 W/m² = 3.44 W/m²/10 fc (Ground area: 3.14 m²)

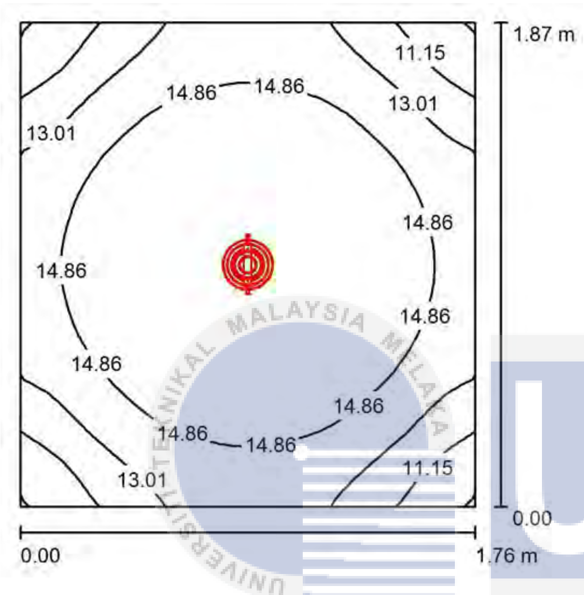
Figure H8: Summary of DIALux for Toilet 1

APPENDIX H: SUMMARY OF DIALUX FOR EACH PART IN FELO HOUSE

Project 1 DIALux
24.05.2015

Operator
Telephone
Fax
e-Mail

Room 1 / Summary



Height of Room: 2.743 m, Mounting Height: 2.743 m, Light loss factor: 0.80   Values in Footcandles, Scale 1:25

Surface	ρ [%]	E_{av} [fc]	E_{min} [fc]	E_{max} [fc]	u0
Workplane	/	14	9.20	17	0.644
Floor	20	9.13	7.88	9.90	0.862
Ceiling	80	2.17	1.55	2.63	0.714
Walls (4)	50	5.63	1.63	11	/

Workplane:
Height: 0.760 m
Grid: 32 x 32 Points
Boundary Zone: 0.000 m
Illuminance Quotient (according to LG7): Walls / Working Plane: 0.392, Ceiling / Working Plane: 0.152.

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	1	PHILIPS DN450B 1xDLM1100/830 (1.000)	1100	1100	15.0
			Total: 1100	Total: 1100	15.0

Specific connected load: 4.56 W/m² = 3.19 W/m²/10 fc (Ground area: 3.29 m²)

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Figure H9: Summary of DIALux for Toilet 2

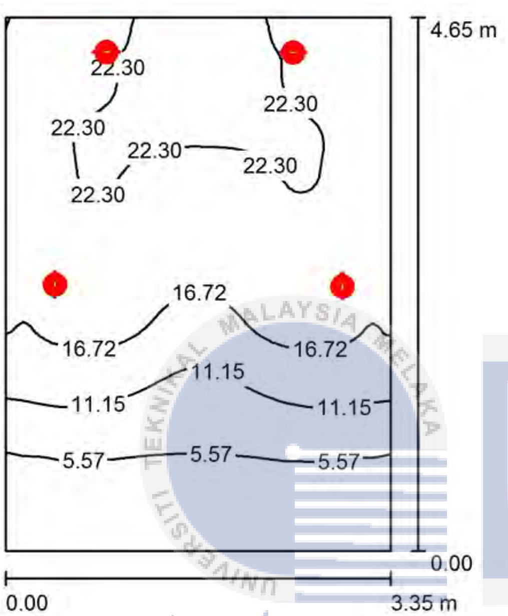
APPENDIX I: SUMMARY OF DIALUX FOR EACH PART IN STUDENT HOUSE

Project 1 DIALux

24.05.2015

Operator
Telephone
Fax
e-Mail

Room 1 / Summary



Height of Room: 2.743 m, Mounting Height: 2.743 m, Light loss factor: 0.80   Values in Footcandles, Scale 1:60

Surface	ρ [%]	E_{av} [fc]	E_{min} [fc]	E_{max} [fc]	u0
Workplane	/	15	2.91	27	0.188
Floor	20	13	4.15	21	0.314
Ceiling	80	3.29	1.64	5.47	0.499
Walls (4)	50	6.88	1.92	74	/

Workplane:
Height: 0.760 m
Grid: 64 x 64 Points
Boundary Zone: 0.000 m
Illuminance Quotient (according to LG7): Walls / Working Plane: 0.473, Ceiling / Working Plane: 0.213.

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	4	PHILIPS DN450B 1xDLM1100/830 (1.000)	1100	1100	15.0
			Total: 4400	Total: 4400	60.0

Specific connected load: 3.85 W/m² = 2.49 W/m²/10 fc (Ground area: 15.58 m²)

Figure I1: Summary of DIALux for Bedroom

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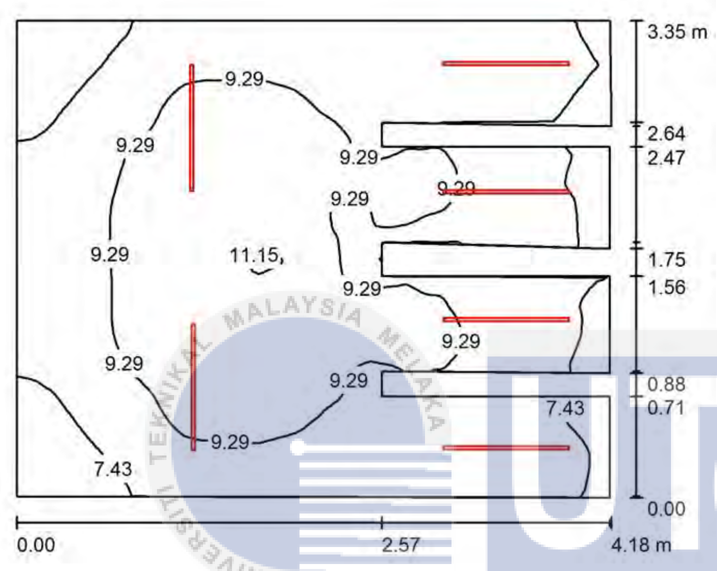
APPENDIX I: SUMMARY OF DIALUX FOR EACH PART IN STUDENT HOUSE

Project 1 DIALux

24.05.2015

Operator
Telephone
Fax
e-Mail

Room 1 / Summary



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Height of Room: 2.743 m, Mounting Height: 2.743 m, Light loss factor: 0.80 Values in Footcandles, Scale 1:44

Surface	ρ [%]	E_{av} [fc]	E_{min} [fc]	E_{max} [fc]	u0
Workplane	/	8.83	6.26	11	0.709
Floor	20	6.52	4.52	8.51	0.694
Ceiling	80	6.97	2.63	27	0.377
Walls (16)	50	8.05	1.85	49	/

Workplane:
Height: 0.760 m
Grid: 128 x 128 Points
Boundary Zone: 0.000 m
Illuminance Quotient (according to LG7): Walls / Working Plane: 1.125, Ceiling / Working Plane: 0.789.

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	6	PHILIPS BN130C 1xLED8S/830 L885 (1.000)	800	800	10.5
			Total: 4800	Total: 4800	63.0

Specific connected load: 4.82 W/m² = 5.45 W/m²/10 fc (Ground area: 13.08 m²)

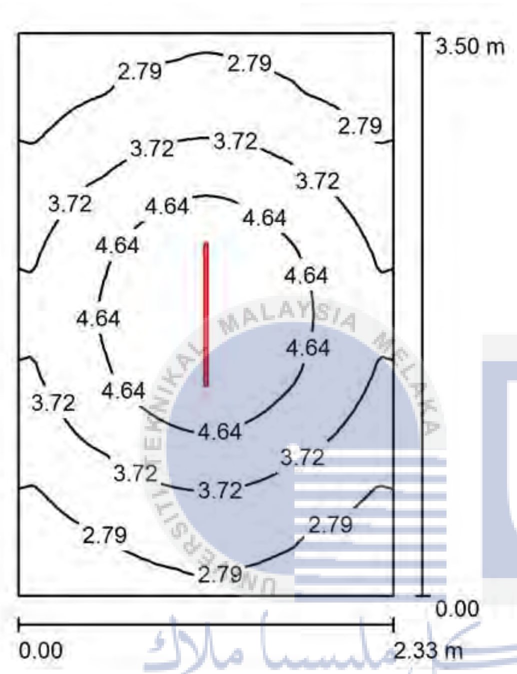
Figure I2: Summary of DIALux for Toilet

APPENDIX I: SUMMARY OF DIALUX FOR EACH PART IN STUDENT HOUSE

Project 1 DIALux
24.05.2015

Operator
Telephone
Fax
e-Mail

Room 1 / Summary



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Height of Room: 2.743 m, Mounting Height: 2.743 m, Light loss factor: 0.80   Values in Footcandles, Scale 1:45

Surface	ρ [%]	E_{av} [fc]	E_{min} [fc]	E_{max} [fc]	u0
Workplane	/	3.69	2.16	5.57	0.584
Floor	20	2.67	1.92	3.39	0.718
Ceiling	80	1.89	0.89	19	0.473
Walls (4)	50	2.42	1.18	5.94	/

Workplane:
Height: 0.760 m
Grid: 64 x 64 Points
Boundary Zone: 0.000 m
Illuminance Quotient (according to LG7): Walls / Working Plane: 0.733, Ceiling / Working Plane: 0.512.

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	1	PHILIPS BN130C 1xLED8S/830 L885 (1.000)	800	800	10.5
			Total: 800	Total: 800	10.5

Specific connected load: 1.28 W/m² = 3.48 W/m²/10 fc (Ground area: 8.17 m²)

Figure I3: Summary of DIALux for Pantry

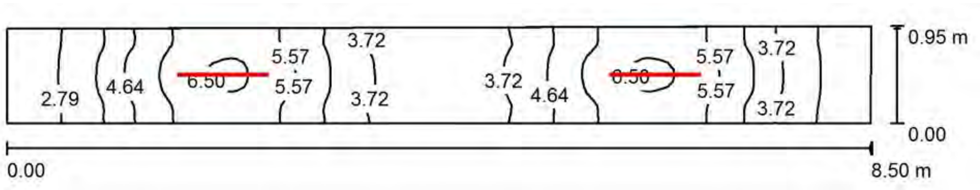
APPENDIX I: SUMMARY OF DIALUX FOR EACH PART IN STUDENT HOUSE

Project 1 DIALux

24.05.2015

Operator
Telephone
Fax
e-Mail

Room 1 / Summary



Height of Room: 2.743 m, Mounting Height: 2.743 m, Light loss factor: 0.80 Values in Footcandles, Scale 1:61

Surface	ρ [%]	E_{av} [fc]	E_{min} [fc]	E_{max} [fc]	u0
Workplane	/	4.43	2.24	6.65	0.505
Floor	20	3.08	1.96	3.83	0.636
Ceiling	80	3.67	0.86	20	0.235
Walls (4)	50	3.63	0.89	27	/

Workplane:
Height: 0.760 m
Grid: 128 x 16 Points
Boundary Zone: 0.000 m

Illuminance Quotient (according to LG7): Walls / Working Plane: 1.006, Ceiling / Working Plane: 0.828.

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	2	PHILIPS BN130C 1xLED8S/830 L885 (1.000)	800	800	10.5
			Total: 1600	Total: 1600	21.0

Specific connected load: 2.64 W/m² = 5.94 W/m²/10 fc (Ground area: 7.97 m²)

Figure I4: Summary of DIALux for Other Space

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

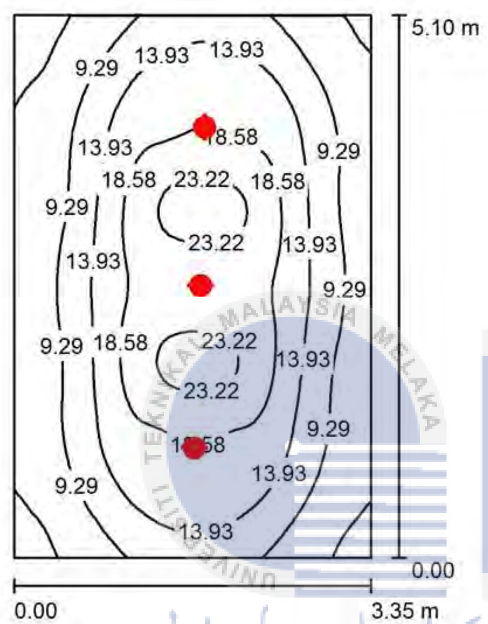
APPENDIX J: SUMMARY OF DIALUX FOR EACH PART IN OFFICE

Project 1 DIALux

24.05.2015

Operator
Telephone
Fax
e-Mail

Room 1 / Summary



Height of Room: 2.743 m, Mounting Height: 2.743 m, Light loss factor: 0.80 Values in Footcandles, Scale 1:66

Surface	ρ [%]	E_{av} [fc]	E_{min} [fc]	E_{max} [fc]	u0
Workplane	/	13	3.34	25	0.248
Floor	20	11	4.80	17	0.422
Ceiling	80	1.79	1.25	2.22	0.700
Walls (4)	50	3.57	1.30	7.94	/

Workplane:
Height: 0.760 m
Grid: 64 x 64 Points
Boundary Zone: 0.000 m
Illuminance Quotient (according to LG7): Walls / Working Plane: 0.222, Ceiling / Working Plane: 0.133.

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	3	PHILIPS DN450B 1xDLM1100/830 (1.000)	1100	1100	15.0
			Total: 3300	Total: 3300	45.0

Specific connected load: 2.63 W/m² = 1.96 W/m²/10 fc (Ground area: 17.09 m²)

Figure J1: Summary of DIALux for Principle Office

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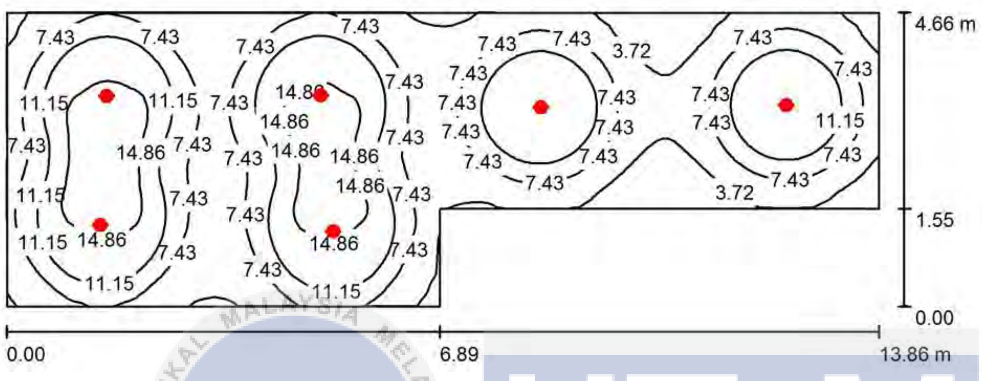
APPENDIX J: SUMMARY OF DIALUX FOR EACH PART IN OFFICE

Project 1 DIALux

24.05.2015

Operator
Telephone
Fax
e-Mail

Room 1 / Summary



Height of Room: 2.743 m, Mounting Height: 2.743 m, Light loss factor: 0.80   Values in Footcandles, Scale 1:100

Surface	ρ [%]	E_{av} [fc]	E_{min} [fc]	E_{max} [fc]	u0
Workplane	/	9.09	2.04	18	0.225
Floor	20	8.09	3.15	14	0.390
Ceiling	80	1.37	0.80	1.83	0.585
Walls (6)	50	2.54	0.79	6.02	/

Workplane:
Height: 0.760 m
Grid: 128 x 128 Points
Boundary Zone: 0.000 m
Illuminance Quotient (according to LG7): Walls / Working Plane: 0.234, Ceiling / Working Plane: 0.150.

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	6	PHILIPS DN450B 1xDLM1100/830 (1.000)	1100	1100	15.0
			Total: 6600	Total: 6600	90.0

Specific connected load: 1.68 W/m² = 1.84 W/m²/10 fc (Ground area: 53.66 m²)

Figure J2: Summary of DIALux for Lobby and Office Area

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

APPENDIX J: SUMMARY OF DIALUX FOR EACH PART IN OFFICE

Project 1 DIALux

24.05.2015

Operator
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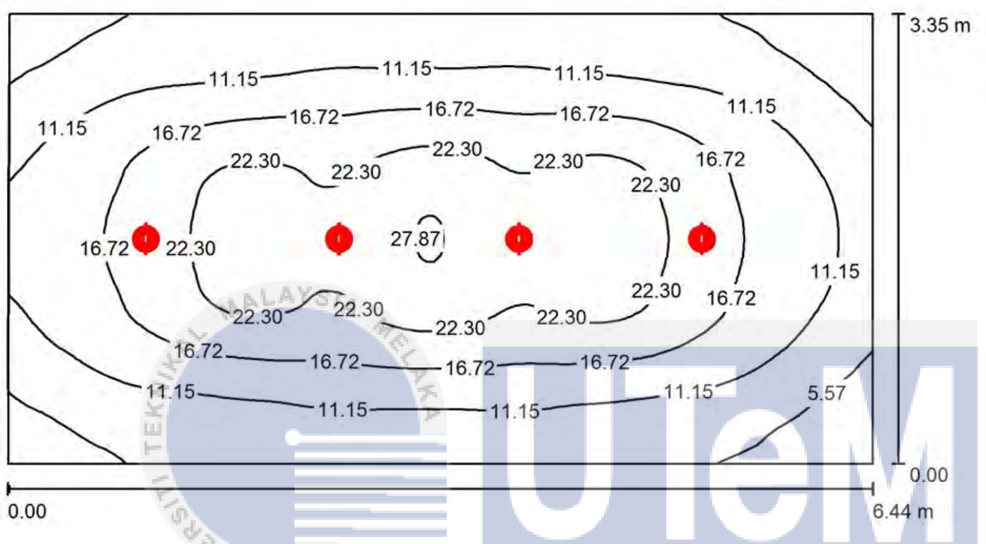
e-Mail

Room 1 / Summary



Height of Room: 2.743 m, Mounting Height: 2.743 m, Light loss factor: 0.80 — Values in Footcandles, Scale 1:47

Surface	ρ [%]	E_{av} [fc]	E_{min} [fc]	E_{max} [fc]	u0
Workplane	/	15	3.32	28	0.227
Floor	20	13	4.74	19	0.375
Ceiling	80	1.96	1.32	2.43	0.677
Walls (4)	50	3.73	1.37	8.32	/

Workplane:
Height: 0.760 m
Grid: 128 x 64 Points
Boundary Zone: 0.000 m
Illuminance Quotient (according to LG7): Walls / Working Plane: 0.209, Ceiling / Working Plane: 0.133.

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	4	PHILIPS DN450B 1xDLM1100/830 (1.000)	1100	1100	15.0
			Total: 4400	Total: 4400	60.0

Specific connected load: 2.79 W/m² = 1.90 W/m²/10 fc (Ground area: 21.54 m²)

Figure J3: Summary of DIALux for Discussion Room

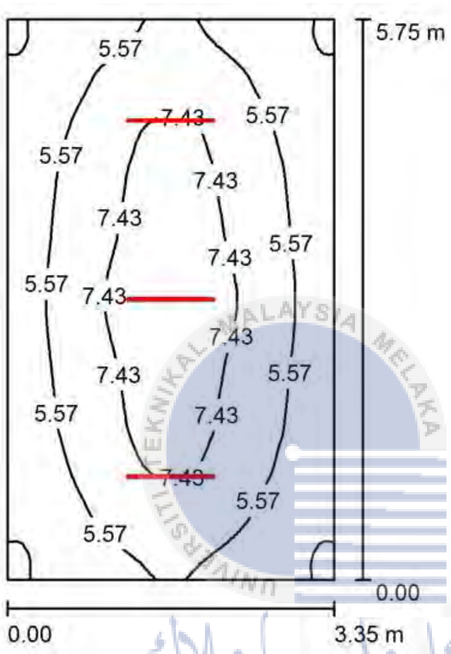
UTeM UNIVERSITI TEKNIKAL MALAYSIA MELAKA

APPENDIX J: SUMMARY OF DIALUX FOR EACH PART IN OFFICE

Project 1 DIALux
24.05.2015

Operator
Telephone
Fax
e-Mail

Room 1 / Summary



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Height of Room: 2.743 m, Mounting Height: 2.743 m, Light loss factor: 0.80 Values in Footcandles, Scale 1:74

Surface	ρ [%]	E_{av} [fc]	E_{min} [fc]	E_{max} [fc]	u0
Workplane	/	6.04	3.55	8.45	0.587
Floor	20	4.81	3.34	6.09	0.694
Ceiling	80	2.58	1.44	20	0.558
Walls (4)	50	3.77	2.29	8.49	/

Workplane:
Height: 0.760 m
Grid: 64 x 64 Points
Boundary Zone: 0.000 m
Illuminance Quotient (according to LG7): Walls / Working Plane: 0.671, Ceiling / Working Plane: 0.427.

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	3	PHILIPS BN130C 1xLED8S/830 L885 (1.000)	800	800	10.5
			Total: 2400	Total: 2400	31.5

Specific connected load: 1.64 W/m² = 2.71 W/m²/10 fc (Ground area: 19.26 m²)

Figure J4: Summary of DIALux for File Store Room

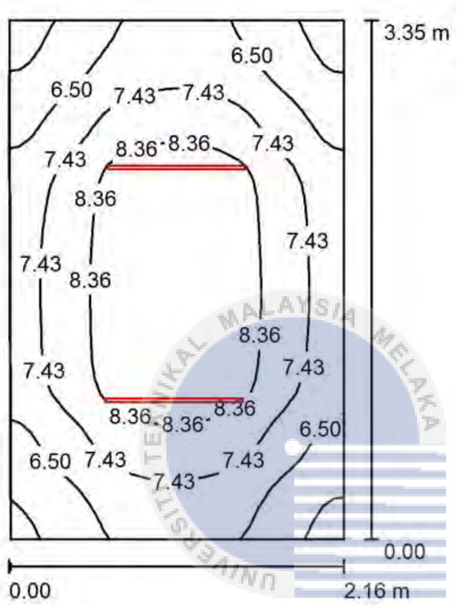
APPENDIX J: SUMMARY OF DIALUX FOR EACH PART IN OFFICE

Project 1 DIALux

24.05.2015

Operator
Telephone
Fax
e-Mail

Room 1 / Summary



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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Height of Room: 2.743 m, Mounting Height: 2.743 m, Light loss factor: 0.80 Values in Footcandles, Scale 1:44

Surface	ρ [%]	E_{av} [fc]	E_{min} [fc]	E_{max} [fc]	u0
Workplane	/	7.48	5.16	9.19	0.689
Floor	20	5.37	4.17	6.22	0.777
Ceiling	80	4.25	2.34	21	0.549
Walls (4)	50	5.43	2.55	11	/

Workplane:
Height: 0.760 m
Grid: 32 x 32 Points
Boundary Zone: 0.000 m
Illuminance Quotient (according to LG7): Walls / Working Plane: 0.831, Ceiling / Working Plane: 0.569.

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	2	PHILIPS BN130C 1xLED8S/830 L885 (1.000)	800	800	10.5
			Total: 1600	Total: 1600	21.0

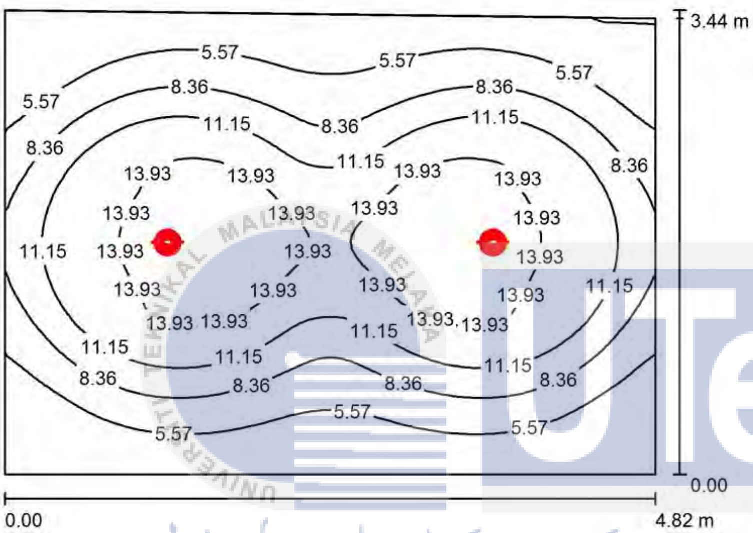
Specific connected load: 2.91 W/m² = 3.89 W/m²/10 fc (Ground area: 7.22 m²)

Figure J5: Summary of DIALux for Pantry

APPENDIX J: SUMMARY OF DIALUX FOR EACH PART IN OFFICE

Operator
Telephone
Fax
e-Mail

Room 1 / Summary



Height of Room: 2.743 m, Mounting Height: 2.743 m, Light loss factor: 0.80 Values in Footcandles, Scale 1:45

Surface	ρ [%]	E_{av} [fc]	E_{min} [fc]	E_{max} [fc]	u0
Workplane	/	9.31	2.73	15	0.293
Floor	20	7.83	3.65	12	0.466
Ceiling	80	1.24	0.85	1.56	0.690
Walls (4)	50	2.51	0.92	5.69	/

Workplane:
Height: 0.760 m
Grid: 64 x 64 Points
Boundary Zone: 0.000 m
Illuminance Quotient (according to LG7): Walls / Working Plane: 0.225, Ceiling / Working Plane: 0.133.

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	2	PHILIPS DN450B 1xDLM1100/830 (1.000)	1100	1100	15.0
			Total: 2200	Total: 2200	30.0

Specific connected load: 1.83 W/m² = 1.96 W/m²/10 fc (Ground area: 16.42 m²)

Figure J6: Summary of DIALux for Reception/Waiting Counter

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

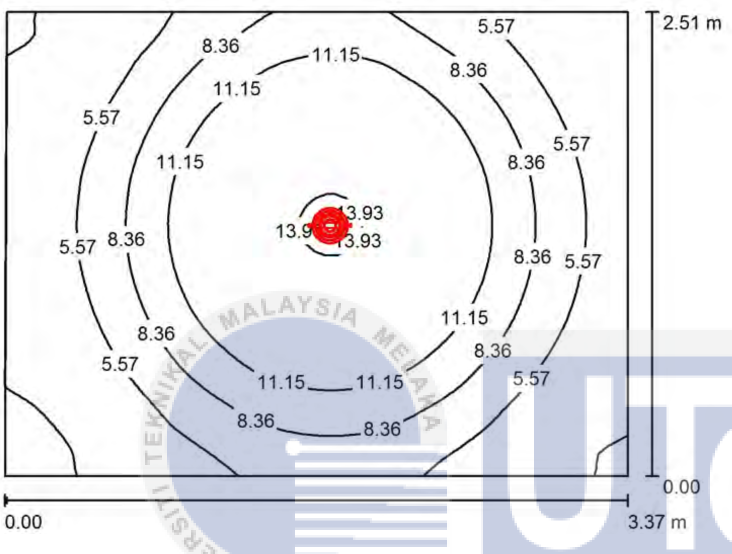
APPENDIX J: SUMMARY OF DIALUX FOR EACH PART IN OFFICE

Project 1 DIALux

24.05.2015

Operator
Telephone
Fax
e-Mail

Room 1 / Summary



Height of Room: 2.743 m, Mounting Height: 2.743 m, Light loss factor: 0.80 Values in Footcandles, Scale 1:33

Surface	ρ [%]	E_{av} [fc]	E_{min} [fc]	E_{max} [fc]	u0
Workplane	/	8.22	2.18	15	0.265
Floor	20	6.37	2.89	8.18	0.454
Ceiling	80	0.99	0.72	1.30	0.734
Walls (4)	50	2.27	0.74	5.89	/

Workplane:
Height: 0.760 m
Grid: 64 x 64 Points
Boundary Zone: 0.000 m
Illuminance Quotient (according to LG7): Walls / Working Plane: 0.232, Ceiling / Working Plane: 0.120.

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	1	PHILIPS DN450B 1xDLM1100/830 (1.000)	1100	1100	15.0
		Total:	1100	Total: 1100	15.0

Specific connected load: 1.77 W/m² = 2.15 W/m²/10 fc (Ground area: 8.47 m²)

Figure J7: Summary of DIALux for Room 1

UTeM UNIVERSITI TEKNIKAL MALAYSIA MELAKA

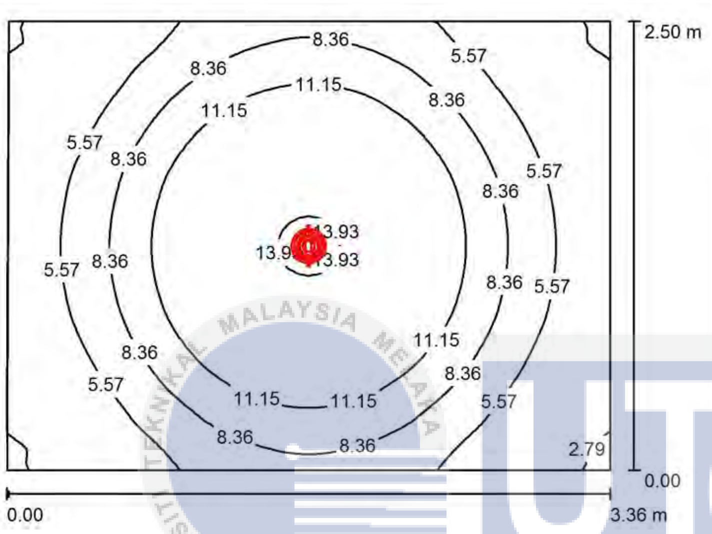
APPENDIX J: SUMMARY OF DIALUX FOR EACH PART IN OFFICE

Project 1 DIALux

24.05.2015

Operator
Telephone
Fax
e-Mail

Room 1 / Summary



Height of Room: 2.743 m, Mounting Height: 2.743 m, Light loss factor: 0.80 Values in Footcandles, Scale 1:33

Surface	ρ [%]	E_{av} [fc]	E_{min} [fc]	E_{max} [fc]	u0
Workplane	/	8.30	2.63	15	0.318
Floor	20	6.42	3.37	8.16	0.524
Ceiling	80	0.99	0.72	1.30	0.722
Walls (4)	50	2.29	0.75	5.29	/

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Workplane:
Height: 0.760 m
Grid: 64 x 64 Points
Boundary Zone: 0.000 m
Illuminance Quotient (according to LG7): Walls / Working Plane: 0.232, Ceiling / Working Plane: 0.120.

Luminaire Parts List

No.	Pieces	Designation (Correction Factor)	Φ (Luminaire) [lm]	Φ (Lamps) [lm]	P [W]
1	1	PHILIPS DN450B 1xDLM1100/830 (1.000)	1100	1100	15.0
			Total: 1100	Total: 1100	15.0

Specific connected load: 1.79 W/m² = 2.15 W/m²/10 fc (Ground area: 8.40 m²)

Figure J8: Summary of DIALux for Room 2

APPENDIX K: CABLE SIZING

Item	Load Category SSB	Qty.	Load/Unit (kW)	Total Connected Load (TCL)(kW)	D.F.	Maximum Demand (MD)(kW)	I_b (A)	Protection Device	I_n (A)	Size Cable (mm^2)
1	Lighting Point (15W)	123	0.015	1.845	0.66	1.218	1.994	MCB	2.0	1.0
2	Lighting Point (10.5W)	83	0.011	0.872	0.66	0.575	0.941	MCB	2.0	1.0
3	15A 3 PIN S/S/O (Single)	12	0.500	6.000	1	6.000	9.820	MCB	10.0	1.0
4	13A 3 PIN S/S/O (Single)	70	0.250	17.500	0.4	7.000	11.457	MCB	16.0	2.5
5	Ceiling Fan Point (80W)	30	0.080	2.400	0.7	1.680	2.749	MCB	4.0	1.0
6	Exhaust Fan Point	9	0.080	0.720	0.8	0.576	0.941	MCB	4.0	1.0
7	Aircond Point (1HP = 746W)	11	0.746	8.206	0.6	4.924	8.059	MCB	10.0	1.0
8	Aircond Point (1.5HP = 1119)	1	1.119	1.119	0.6	0.671	1.098	MCB	2.0	1.0
	Total Load (kW)			**38.662**		**22.644**	37.059	MCCB	40.0	10.0

Figure K1: Cable Sizing for Ground Floor

APPENDIX K: CABLE SIZING

Item	Load Category	Qty.	Load/Unit (kW)	Total Connected Load (TCL)(kW)	D.F	Maximum Demand (MD)(kW)	I_b (A)	Protection Device	I_n (A)	Size Cable (mm^2)
	SSB									
1	Lighting Point (15W)	2200	0.015	33.0	0.66	21.780	35.646	MCB	40.0	10.0
2	Lighting Point (10.5W)	1240	0.011	13.0	0.66	8.593	14.059	MCB	16.0	2.5
3	13A 3 PIN S/S/O (Single)	1100	0.250	275.0	0.40	110.000	180.038	MCCB	200.0	95.0
4	Ceiling Fan Point (80W)	550	0.080	44.0	0.70	30.800	50.411	MCB	63.0	16.0
5	Exhaust Fan Point	110	0.080	8.8	0.80	7.040	11.522	MCB	16.0	2.5
	Total Load (kW)			**373.82**		**178.21**	291.679	MCCB	300.0	240.0

Figure K2: Cable Sizing for 1st - 10th Floor

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

APPENDIX K: CABLE SIZING

Item	Load Category	Qty.	Load/Unit (kW)	Total Connected Load (TCL)(kW)	D.F	Maximum Demand (MD)(kW)	I_b (A)	Protection Device	I_n (A)	Size Cable (mm^2)
	SSB									
1	Lighting Point (15W)	220	0.015	3.30	0.66	2.178	3.568	MCB	4.0	1.0
2	Lighting Point (10.5W)	124	0.011	1.30	0.66	0.859	1.408	MCB	2.0	1.0
3	13A 3 PIN S/S/O (Single)	110	0.250	27.50	0.40	11.00	18.004	MCB	20.0	2.5
4	Ceiling Fan Point (80W)	55	0.080	4.40	0.70	3.080	5.041	MCB	6.0	1.0
5	Exhaust Fan Point	11	0.080	0.88	0.80	0.704	1.152	MCB	2.0	1.0
	Total Load (kW)			**37.38**		**17.82**	29.173	MCB	32.0	6.0

Figure K3: Cable Sizing for 1st Floor

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

APPENDIX K: CABLE SIZING

Item	Load Category	Qty.	Load/Unit (kW)	Total Connected Load (TCL)(kW)	D.F	Maximum Demand (MD)(kW)	I_b (A)	Protection Device	I_n (A)	Size Cable (mm^2)
	SSB									
1	Lighting Point (15W)	21	0.015	0.3	0.66	0.21	0.344	MCB	2.0	1.0
2	15A 3 PIN S/S/O (Single)	2	0.500	1.0	1	1.00	1.637	MCB	2.0	1.0
3	13A 3 PIN S/S/O (Single)	12	0.250	3.0	0.4	1.20	1.964	MCB	2.0	1.0
4	Ceiling Fan Point (80W)	3	0.080	0.2	0.7	0.17	0.278	MCB	2.0	1.0
5	Exhaust Fan Point	2	0.080	0.2	0.8	0.13	0.213	MCB	2.0	1.0
6	Aircond Point (1HP)	2	0.746	1.5	0.6	0.90	1.473	MCB	2.0	1.0
	Total Load (kW)			**6.21**		**3.60**	5.892	MCB	6.0	1.0

Figure K4: Cable Sizing for Felo House

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

APPENDIX K: CABLE SIZING

Item	Load Category	Qty.	Load/Unit (kW)	Total Connected Load (TCL)(kW)	D.F	Maximum Demand (MD)(kW)	I_b (A)	Protection Device	I_n (A)	Size Cable (mm^2)
	SSB									
1	Lighting Point (15W)	20	0.015	0.30	0.66	0.20	0.327	MCB	2.0	1.0
2	15A 3 PIN S/S/O (Single)	2	0.500	1.00	1.00	1.00	1.637	MCB	2.0	1.0
3	13A 3 PIN S/S/O (Single)	10	0.250	2.50	0.40	1.00	1.637	MCB	2.0	1.0
4	Ceiling Fan Point (80W)	3	0.080	0.24	0.70	0.17	0.278	MCB	2.0	1.0
5	Exhaust Fan Point	2	0.080	0.16	0.80	0.13	0.213	MCB	2.0	1.0
6	Aircond Point (1HP)	2	0.746	1.49	0.60	0.90	1.473	MCB	2.0	1.0
	Total Load (kW)			**5.69**		**3.39**	5.548	MCB	6.0	1.0

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Figure K5: Cable Sizing for Principle House

APPENDIX K: CABLE SIZING

Item	Load Category / SSB	Qty.	Load/Unit (kW)	Total Connected Load (TCL)(kW)	D.F	Maximum Demand (MD)(kW)	I_b (A)	Protection Device	I_n (A)	Size Cable (mm^2)
1	Lighting Point (15W)	17	0.015	0.26	0.66	0.17	0.278	MCB	2.0	1.0
2	Lighting Point (10.5W)	5	0.011	0.05	0.66	0.03	0.049	MCB	2.0	1.0
3	15A 3 PIN S/S/O (Single)	6	0.500	3.00	1.00	3.00	4.910	MCB	6.0	1.0
4	13A 3 PIN S/S/O (Single)	8	0.250	2.00	0.40	0.80	1.309	MCB	2.0	1.0
5	Aircond Point (1HP)	5	0.746	3.73	0.60	2.24	3.666	MCB	4.0	1.0
6	Aircond Point (1.5HP)	1	1.119	1.12	0.60	0.67	1.097	MCB	2.0	1.0
	Total Load (kW)			**10.16**		**6.91**	11.309	MCCB	16.0	2.5

Figure K6: Cable Sizing for Office

APPENDIX K: CABLE SIZING

Item	Load Category	Qty.	Load/Unit (kW)	Total Connected Load (TCL)(kW)	D.F	Maximum Demand (MD)(kW)	I_b (A)	Protection Device	I_n (A)	Size Cable (mm^2)
	SSB									
1	Lighting Point (15W)	20	0.015	0.3	0.66	0.198	0.324	MCB	2.0	1.0
2	Lighting Point (10.5W)	9	0.011	0.1	0.66	0.062	0.101	MCB	2.0	1.0
3	13A 3 PIN S/S/O (Single)	10	0.250	2.5	0.40	1.000	1.637	MCB	2.0	1.0
4	Ceiling Fan Point (80W)	5	0.080	0.4	0.70	0.280	0.458	MCB	2.0	1.0
5	Exhaust Fan Point	1	0.080	0.1	0.80	0.064	0.104	MCB	2.0	1.0
	Total Load (kW)			**3.37**		**1.60**	2.619	MCCB	4.0	1.0

Figure K7: Cable Sizing for Student House

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