EXPERT SYSTEM FOR ENERGY SAVING LIGHTING INSTALLATION FOR IN BUILDING

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APPROVAL

"Saya/kami akui bahawa saya telah membaca karya ini pada pandangan saya/kami karya ini adalah memadai dari skop dan kualiti untuk tujuan penanugerahan ijazah Sarjana Muda Kejuruteraan Elektrik (Kuasa Industri)."

Tandatangan : .....

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Tarikh : 09 March 2005

ACQUISITION

"Saya akui laporan ini adalah hasil kerja saya sendiri kecuali ringkasan dan petikan yang tiap-tiap satunya saya jelaskan sumbernya."

Tandatangan : .....

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Tarikh : 09 March 2005

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ABSRACT

Lighting system is one of the factor that can be rated to energy saving. This project to propose with the simulation for energy saving by the method optimum number of lamp to use can't be scratched the user comfort.

This project involved the efficient way on how to design a program that can calculate the amount of lamp and the installation cost for a building. Where every latest types and data is compile together into this program.

This expected result for this project is to operate the process on calculates the amount of lamp that have been installed and also the efficient method on saving the electricity.

ABSTRAK

Sistem pencahayaan adalah suatu faktor penting yang boleh dikaitkan dengan penjimatan tenaga. Tujuan utama projek ini ialah untuk memberi suatu pendekatan simulasi bagi penjimatan tenaga dengan kaedah mengoptimakan bilangan lampu yang digunakan tanpa menjejaskan keselesaan pengguna.

Bidang kajian ini melibatkan cara untuk membangunkan suatu aturcara yang dapat mengira bilangan lampu dan kos pemasangan dalam sesebuah bangunan. Jenis dan data-data lampu yang terkini dimuatkan.

Projek ini dijangka dapat menjalankan proses pengiraan lampu yang dipasang, kos pemasangan dan kos penjimatan tenaga elektrik bila ada perbezaan lampu yang dipasang.

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CHAPTER 1

INTRODUCTION

1.1 Project overview

This project, entitled Expert System for Energy Saving Lighting Installation for in Building is mainly to develop software. From the title, it can be divided into three major parts. Firstly in term of expert system, secondly energy saving and lastly lighting installation. All of this term will be implemented for high rise building.

Expert system means a system that is easy to managed, user friendly and effective to be used. With just input simple data and pressing 'enter' the software will do everything that you need to know. Than, there will be no complex calculation anymore to calculate lamp suitable for each room. This is the main objective of the project.

Lighting uses mach energy in commercial structures, in typical office buildings for example, it accounts for 30% to 50% of the electricity consumption. Because lighting system are major energy users, they can yield high return though improvement in efficiency. A well-designed lighting system should attain the desired lighting performance (light levels, color quality and etc.) using energy efficient means. Technological advances, such as electronic ballast and compact fluorescent lamp, have increased the energy efficiency of lighting components.

As an example if new buildings were to be build, a well designed consideration need to be taken into account. Due to this need, perfect system implementation software developed to solve this task.

With all system in a building, proper operation and maintenance of luminaries and control increase system life and ensures long term energy saving. As lamp approach the end of their useful lives they produce less and less light. Such depreciation may cause a number of problems:

- Weak lights cause occupants discomfort, which can result in significant losses in productivity and revenue.
- Due to low ambient light level, occupants will turn on their own table lamps. Table lamp uses incandescent lamp which draws mare energy use.
- In certain retail situation lumen depreciation may adversely affect how products appear to customer, giving the impression of dimly lit spaces of distorting the color of the merchandise.

When this problem happens we need to replace the lamp. Replacement of all lamp is more cost effective then replacing individual lamp so lighting designer then must worked on to ret a most cost effective and longer useful life lamp so that it will gain a higher return. Sometimes redesign lighting system in a building need to be done although it is costly to get a long-term benefit. Due to the problem encounter above, this shows the importance of this project is to the lighting designer, installer (contractor), electrician and other production term in technical planning process.

1.2 Aim

The aim of this project is to develop software for calculating number of lamp and cost of each installation. It also would display a wide variety type of lamp and suggest the recommended one to the users. This software will be focusing lighting installation in high rise building to achieve energy saving.

1.3 Objectives

The objectives of this project are:

1. To develop software that would calculate and display cost of each installation and appropriate number of lamp that should be used for any given area.
2. To apply a system that can reduce cost of lighting installation.
3. To practice energy saving for lighting installation.
4. Make the budget calculation for installation become easier.
5. Determine the expected energy saving that been used by the consumer.
6. This Software is easily to be understand and simple to operate (User Friendly).
7. Obtain a good knowledge about the use of the visual basic program.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter presents some of the theoretical background related to the project development. It consists of all theory concerning Expert Lighting software design.

2.2 Light

Light is defined as that part of the electromagnetic radiation spectrum that can be perceived by the human eye. This ranges from blue light (at wavelengths, ? around 475 nanometers 'nm') thought green, yellow and orange light (from ? = 525nm though 625nm) to red light (at about 675nm) and into violet (above 725nm). White light is the combination of the entire wavelength.[1]

2.2.1 Light sources

Nowadays electric lamps are widely used as a source to produce light. From this device electric energy will be converted into light. There are four categories of electric lamp that has its' own ways of conversion from electric energy to light.[2]

- Incandescence type of lamp

  Current passes thought coiled filament raises its temperature. Then it will gives out light by incandescence. The gas or vacuum sealed in bulb prevents oxidation; therefore the lamp gives higher efficacy and longer operating life. Tungsten halogen lamp that used in projector is one of these types of lamp.

- Fluorescent lamp

  A fluorescent lamp is a glass tube with cathode at each end. The tube of this lamp is filled with low-pressure mercury vapor. Mercury vapor then will produce small amount of visible and ultraviolet light due to discharge. By adding phosphor to the bulb layer ultraviolet light will be absorbed and change to a bulk of light output. This type of lamp mostly used in indoor installation because it offers good saving in energy cost and several time of life expectancy compare to incandescent lamp. Table 2: Example for lamp type[4]

Table 1: Example for lamp type

Lamp Example	Lamp Type	Power Consumed Per Lamp	Light Produced (in Lumens)	Average Initial Cost (US)	Average Life Per Lamp	Power Cost per 24 hours of use (Assuming $0.08 US per /KWH)	Cost to Own and Operate for 20,000 hours
#1	Incandescent	60 Watts	800	$0.60	1,000 Hours	$0.12	(20 lamps X $0.60) + $96 power = $108 US
#2	Compact Fluorescent Warm White	13 Watts	800	$4.00	10,000 Hours	$0.03	(2 lamps X $4.00)+$20.80 power = $28.80 US
#3	Incandescent Halogen	60 Watts	1080	$3.00	3,000 Hours	$0.12	(6.67 lamps X $3.00) + $96 power = $116 US

#4	Compact Fluorescent Warm White	23 Watts	1400	$4.50	10,000 Hours	$0.04	(2 lamps X $4.50)+$36.80 power = $45.80 US
#5	Compact Fluorescent Warm White (2700K/82CRI)	26 Watts	1580	$4.95	10,000 Hours	$0.05	(2 lamps X $4.95)+$41.67 power = $51.57 US
#6	Incandescent	40 Watts	490	$0.60	1,000 Hours	$0.08	(20 lamps X $0.60) + $64 power = $76 US
#7	4 Foot Fluorescent Warm White	40 Watts	3200	$4.00	20,000 Hours	$0.08	(1 lamp X $4.00) + $64 power = $68 US

Here is a general rule of thumb for the main 48" lamp types:

Table 2: color of lamp

Lamp Color	**Color Temperature**	**Watts**	**Minimum Acceptable Lumens**	**Best Available Lumens**
Warm White	3,000K to 3,500K	40	2,880	3,300
Cool White	4,100K to 4,200K	40	2,880	3,300
Full Spectrum	4,800K to 5,500K	40	2,950	3,250
Daylight	6,000K to 7,000K	40	2,000	2,180

- Electric discharge/ mercury/ metal halide lamp

  Electric will discharge though a number of gases or mercury vapor result in light emission. Radiation will be emitted at number of definite wavelength or lines spectrum. This light spectrum is in blue, green, red, and yellow regions. Due to shortage wavelengths and discontinuity of red region will make poor colors rendering produce by this lamp. To overcome this problem inside and outer bulb will be coated with phosphor. The function of this phosphor is to absorb some

ultraviolet and convert it to red light. Metal halide lamps offer further improvement in color rendering compare to mercury type.[4]

- Other lamp

  This include poor color, low pressure sodium discharge lamp that normally used in highway lighting and the newly developed high pressure discharge lamp with vary good color, normally used for interior lighting. Another is like xenon tubes and electroluminescent panel.

At present time the most widely used lamp for interior lighting is incandescent, color corrected mercury, tabular fluorescent and high-pressure sodium types. For more overview table below shows the comparison between this types of lamp.

Table 3: comparison for each lamp

Source	Efficacy (lm/W)	Lamp life (hr)	Lamp lumen depreciation	Color (K)
Incandescent general services	17.5	750-1500	0.79-0.89	2300-3500
Incandescent tungsten halogen	20.0	2000	0.96	2300-3500
Fluorescent rapid start	65-80	10,000-20,000	0.84-0.88	3500-6500
Low pressure sodium	120-150	18,000-24,000		
Mercury vapor	50	16,000-24,000	0.68-0.92	3600-7000
Metal halide	85	20,000		4500
High pressure sodium	105	24,000		2100

2.2.2 Term used in lighting

2.2.2.1 Intensity

Intensity is a standard measurement of light produce by the source. It standardized instrumentation unit/S.I unit of measurement is *candela*, *Cd*. The word *candela* arises from with early the commonest source of light, the candle. Now luminous intensity is standardized to give greatest possible precision in defining standard source.

2.2.2.2 Luminous flux

We know light produce by sources but how much light will flow into complete spaces around it. In lighting design this is very important so we need to know it. So luminous flux term is used to represent total light from source reached surfaces. *Lumens* are used as a unit of luminous flux. One lumens means flow of light through an area of one square meter on the surfaces of a sphere of one meter radius with a uniform point source one candela at its center.[12]

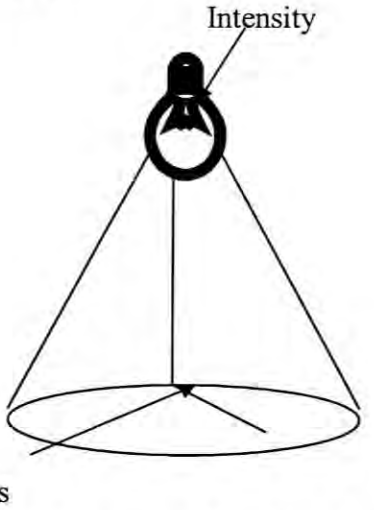

Figure 1: Example of luminous flux

Sphere area = 4 x pi x radius

= 4 x pi

Therefore light output = 4 x pi x intensity (m)

2.2.2.3 Illuminate

Illuminate is a measure of the concentration of light falling on surfaces. In metric unit it is measured in lumens per square meter or *lux*.

2.2.2.4 Luminance

When light strikes a surface its will be reflected back. Say 800 lux reached a surface, the reflected light now will not stay 800lux rather chare because of reflection factor "RF" of the surfaces. Reflection factor is the ratio of reflected light to the incident light. This factor depends on color of surfaces, for this data we can refer to BS4800 'paint color for building purpose'. Unit for luminance is *apostilbs*. Its relationship between illuminate can be summarizes as below.[9]

Illuminate (*lux*) x RF = luminance (*apostilbs*)

2.3 Efficient energy in lighting

2.3.1 A highly effective energy conservation strategy

Triphosphor fluorescent lamp uses less electricity than typical fluorescent lamp, and provide color rendition to incandescent lamp. Compact fluorescent lamps can save 60% to 75% of the electricity use of typical incandescent lamps.

Electronic lamps save about 70% of the electricity use of incandescent lamps spot lighting application and last 60,000 hours. Infrared reflective halogen lamps save about 30% of the electricity use of their typical counterparts. Day strategies can reduce lighting electricity use by 30% to 50%.[3]

2.3.2 Principles of energy efficient luminaries

In technical term, the equipment needed to produce and distribute light is designated as luminaries. Definition cited earlier list components of luminaries, housing lamps, electrical wiring and ballast. Over the past decade the most important advances have involved lamps and ballast.[3]

2.3.3 Lighting equipment applications

Over the past decade, lamp and ballast became increasingly efficient. This section focuses on energy saving achievable with the new technologies, discusses their applicability and present case studies. The discussion addresses as follow.[2]

2.3.3.1 High efficiency lamps

The development and widespread availability of high efficiency fluorescent lamps had a major role in reducing the energy use in buildings. Compacts fluorescent lamp further advanced the opportunities for electricity savings, by displacing incandescent family, extends the trends for higher efficiency and longer life in spot lighting.

Fluorescent lamp is no means the solution for all lighting situations. In some applications incandescent or high intensity discharge lamps more appropriate. The energy efficiency of both these lamp types has also improved significantly in the recent past. Most notables are the infrared reflective technology for incandescent lamps.

2.3.3.2 High efficiency fluorescent lamps

It is one at the most cost effective to increase lighting efficiency. Compared to conventional fluorescent model, these lamps produce 10% to20% lighter for the same electricity use 70 to 95 lumens per watt versus 65 to 75 lumens per watt. Noted that typical incandescent lamp by contrast only provide 8 to 17 lumens per watt only. So like all fluorescent lamps, the efficiency types can be dimmed, further saving electricity.[4]

This energy conservation requires no modification to housing, wiring or avers all design of the luminaries. The saving accrues over the 20,000 to 30,000 hours of operation.

2.4 Lighting installation

Light sources and lamps have their own particular characteristics. Because of that, lamps are placed within some kind fixture that ranges from the simplest socket to some specialized systems. There are general categories of fixtures for particular applications, and then there are detail to be learned about mounting and safety with different fixture application. Two types of circuits may be wired, in series or in parallel. But mostly, electrical fixtures are wired in parallel.[3]

2.4.1 General fixtures types

Fixtures of every different light source were often developed to be used for a particular category of functions. A brief introduction of the types is based on their function as below.

- Direct downlight

  Are the simplest functions of all. They are intended to illuminate a horizontal surface under the fixture. They are often used in stairs landings, in lines down hallways, or in grids in an open area. When used to illuminate walls, downlight create scallop of light on the wall surfaces and leave the top of the wall in darkness.

- Indirect uplights

  Use the ceiling as a reflector and are intended to illuminate large horizontal surfaces with a diffuse light. They require a high reflectance ceiling in order to function properly.

- Wall washers

  Intended to evenly and smoothly illuminates an entire vertical wall surface. This is in contrast to downlight that cause scalloping on the wall. This is also in contrast to adjustable downlight, which illuminate one area.

- Adjustable downlights

  Intended to light object or specific, wall or floor focus areas.

- Sconces

  Are light that are attached to a wall and illuminate an area or a pattern on the wall surfaces, sometimes in addition to lighting a segment of floor or ceiling. Decorative sconces provide an image or illuminate themselves in a manner that may be used as part of the design concept.

- Ambient uplight

  Ambient uplight are freestanding light typically used in offices as indirect uplight illuminating the office work surfaces with light reflected from the ceiling.

- Furniture integrated lighting

  An ambient uplight is often included on top of storage cabinet, desk, cupboards, wall partition and so on. Task lighting may also be integrated into the office furniture or display shelving.

- Torchieres

  Freestanding decorative fixture typically used as there lighting or uplighting.

- Table, desk and floor lamp

  Are freestanding fixtures used of flexible area lighting or task lighting? Such fixtures may or may not be within the designer's scope of works but