DESL

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Erasmus+ Programme
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Developing Energy-Efficient and Smart Lighting Education in Vietnam & Myanmar

Need Assessment Report

Myanmar

VGU
Vietnamese-German University

Contents

LIST OF ABBREVIATIONS

Abbreviations	Meaning
LED	Light Emitting Diode
DESL	Developing energy efficient and smart lighting
VGU	Vietnamese German University
AC	Alternating Current
IMC	Industrial Machine and Control
PLC	Programmable Logic Controller
HCMUT	Ho Chi Minh City University of Technology
TDMUT	Thu Dau Mot University
EIU	Eastern International University
YTU	Yangon Technological University
MTU	Mandalay Technological University

INTRODUCTION

Background of Lighting and Illumination

Energy is one of the most important challenges currently we are facing. Myanmar is no exception, where both the national and city-level governments are grappling with considerable challenges concerning the management of energy due to industrialization and urbanization, and a deficiency of smart lighting and energy efficiency, among others. To address this, the Government of Myanmar, with the assistance of the World Bank Group and other donors, has adopted the National Electrification Plan, which aims to achieve universal access to sustainable electricity services by 2030 through a combination of grid extension and off-grid programs.

Myanmar's energy sector is developing rapidly. In 2016, more than 65 percent of Myanmar's population, a total of 7 million households, has no access to grid-based electricity services. In rural areas, more than two thirds of households rely on candles, kerosene, low-quality batteries and diesel generators to meet their energy needs. Nowadays, the development of electrical power is increasing and the supply requirement in most of the developing country cannot be met due to the high capital cost of generation and transmission. So, effective energy management strategies are needed to be developed at the national and city levels based on a holistic energy management approach.

The use of energy efficient lighting would help to decrease the electrical power demand and would help to minimize the difference between demand and supply of electrical power. Lighting in most of the residential as well as commercial buildings use incandescent lamps, or florescent tube lamps which are less efficient compared to the today available Compact Fluoresent lamp, LED lamps. The demand for light-emitting diode (LED) adversing boards is growing rapidly, largely fuelled by Myanmar's storage economic growth. More advertisers and business operators are using LED screens as a powerful advertising tool because they attract more eyeballs and effectively convey information to consumers. Myanmar's economy is robust with its gross domestic product growing at about 8% in 2019. LED products mainly come from countries like China, Italy and Japan although consumers prefer China-made products according to electronic goods suppliers. Italian and Japanese LEDs are better quality but their prices could be there times higher than Chinese products. Chinese LEDs could be both of high and low quality and most local importers only bring in Chinese products which come with a six-month warranty.

Illumination and Smart Lighting

Illumination refers to the use of a light source to view other objects by the light reflected from those objects, such as the general lighting found in most rooms or task lighting found on many desks. Among the many new concepts for lighting design, the first to be discussed is the new method of determining illuminance levels. In the past when illuminating engineers wanted to find the recommended illuminance level for a given task, they would look in the lighting handbook to find a recommended level and then design an illuminating system for the task using the value as a minimum. This procedure provides very little latitude for fine-turning an illumination design.

Smart lighting is a lighting technology designed for energy efficiency. This may include high efficiency fixtures and automated control that make adjustments based on conditions such as occupancy or daylight availability.

Energy Efficient Scenario in Myanmar

Energy Efficientcy is important for some main reasons such as reducing the operating costs and manage the electricity efficiently. This means that significant cost savings be achieved with energy efficiency improvements and due to continually improving equipment, lighting usually provides the highest return-on-investment of major upgrades. So, international and Myanmar-based companies are important to create a sustainable market for high-quality off-grid energy solutions, including solar lanterns, solar home systems, and potentially mini-grids. There are many researches conducting in-depth research on the off-grid market, using a variety of quantitative and qualitative approaches, to inform the market strategies of high-quality lighting companies.

The electrification rate of Myanmar is the second-lowest in Asia, so its improvement is an urgent matter. Since the country started opening up to world trade, Myanmar's growing economy has been receiving increasing attention in recent years. However, an electricity shortage hampers this economic growth. Only 35% of households had access to electricity as of 2016 as 70% of the population in Myanmar lives in rural areas. In 2015, the Government of Myanmar set a target to achieve 100 percent electrification by 2030. In 2018, the average electricity consumption per capita in areas served by the grid was 543 kWh/person and in off-grid areas 68 kWh/person. In 2019, only 66.26% of the population in Myanmar has access to electricity so Myanmar is still one of the lowest electricity traffics in the world.

About this report

The report presents the awareness status and the need assessment of Students, Engineers, Teachers, Employers and Researchers related to the field by the two universities YTU and MTU from April to May 2020. The first chapter introduces the current condition of lighting and illumination in Myanmar. The second chapter represents methods about the DESL survey for Academic Program, the response rate for the number of people invited to answered survey. Chapter three presents the Demographic profile of respondents. Chapter four pressents the results for required levels of technical expert in companies, availability of local lighting engieers and technicians for hiring in Myanmar, important challenge for the adoption of energy-efficient lighting technologies in Myanmar, programs which lighting course should be provided, important course for Electrical Engineering major, important devices for lighting lab of Electrical Engineerig major, the most important learning outcomes for illumination Engineering Course, the most important contents for illumination Engineering Course, important softwares for Designing and Simulating in Illumination Engineering, suggested courses to be a lighting Engineer and important projects which are on collaboration between an academic institution and an Industrial Company that the respondents have participated.

EXECCUTIVE SUMMARY

Key findings of the survey are as follows:

(1) Required levels of technical expert in companies
(2) Availability of local lighting engineers and technicians for hiring in Myanmar
(3) Important challenge for the adoption of energy-efficient lighting technologies in Myanmar
(4) Programs which lighting courses should be provided
(5) Important courses for Electrical Engineering Major
(6) Important devices for lighting lab for Electrical engineering major
(7) Important learning outcomes for illumination engineering course
(8) Important contents for illumination engineering course
(9) Important software for designing and simulating in illumination engineering
Suggested courses that an engineer working in lighting area should take (after graduating from electrical engineering major)
(10) Important collaborative projects between university and industry

1. Method

The questionnaires are prepared by the Vietnam' universities, HCMUT, VGU, TDMU, and EIU with the comments of the experts in the DESL project. This questionnaire survey was carried out in Mandalay Technological University and Yangon Technological University, Myanmar. The questionnaire was delivered to students, teachers, employers, researchers, engineer related to the lighting and illumination field. This survey was carried out in April-May of 2020. We received 61 responses from students, engineers, academia etc. in the energy related areas and made the calculation.

The online questionnaire was created using Google Form with the cooperation of VGU. Data were then collected and analyzed with Microsoft Excel software.

2. Response rate

The total number of respondents was 61 from the two universities including 13 people from YTU and 48 people from MTU respectively, shown in Table 1. This survey received 47% response rate when related people were invited to answer this survey.

Number of respondents

Program	Number of people invited to answered survey (n)	Number of responses (n)	Response rate (%)
YTU	50	13	26
MTU	80	48	60
Total	**130**	**61**	**47**

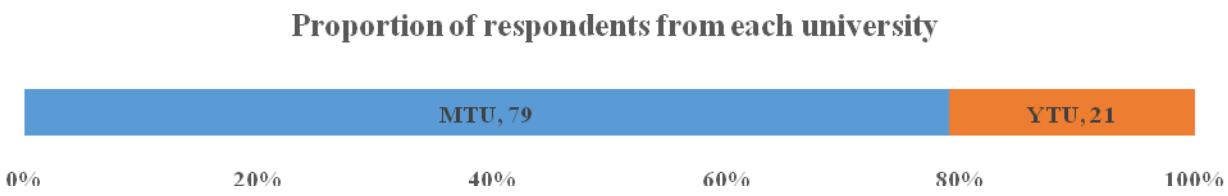
3. Demographic profile of respondents

The demographic profile of respondents was carried with five different portions which are university, gender, occupation, occupation and gender and occupation and age.

3.1. University

The students, teachers, employers, researchers, engineer from YTU and MTU were surveyed. According to University, the number of respondents from MTU is more than YTU. The proportion of MTU respondents reached to 79 percent and YTU is 21% percent.

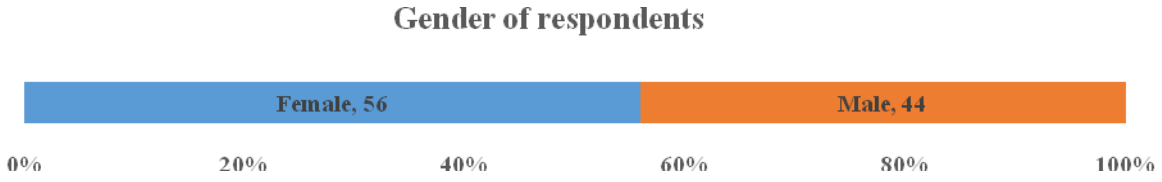
University	Number of respondents (n)	Proportion of respondents (%)
MTU	48	79
YTU	13	21
Total	**61**	**100**



3.2. Gender

When survery questionnaires are circulated throuth online, it was found that the Female are more responsed in DESL- survey questions for academic program. They reached to 56% of total participants while 44% male.

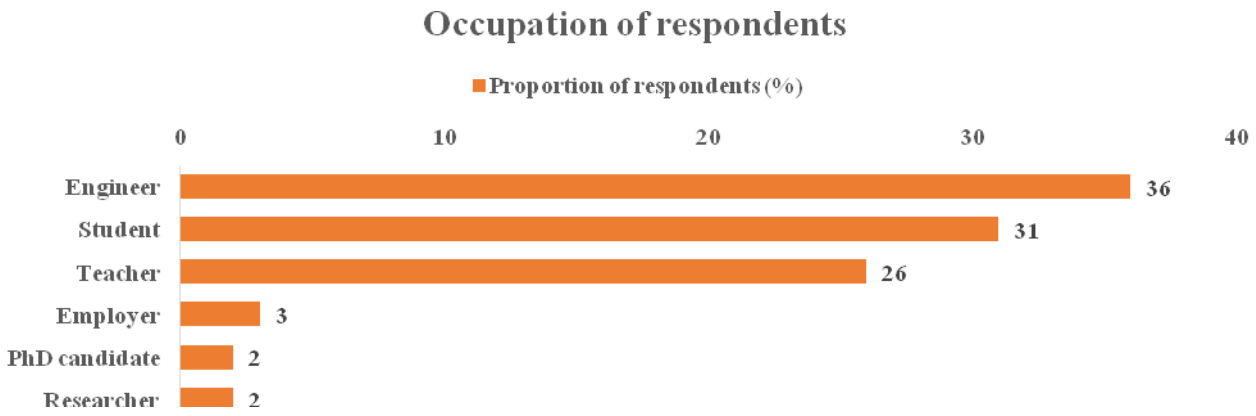
Gender	Number of respondents (n)	Proportion of respondents (%)
Female	34	56
Male	27	44
Total	**61**	**100**



3.3. Occupation

The number of respondents based on occupation was carried with the help of trained researchers for DESL- survey. The number of people occupation in the survey was presented in the following Table.

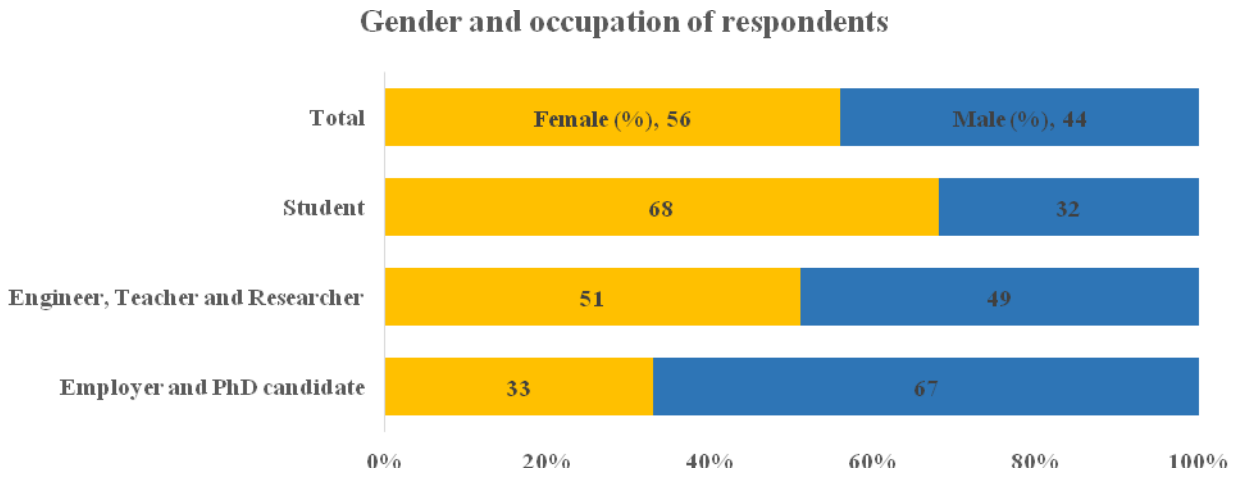
Occupation	Number of respondents (n)	Proportion of respondents (%)
Engineer	22	36
Student	19	31
Teacher	16	26
Employer	2	3
PhD candidate	1	2
Researcher	1	2
Total	**61**	**100**



3.4. Occupation and gender

Among the 61 surveyors, 56% are female and 44% are male. Engineer, Teacher and Researcher gave the 39 responses in this survey and 51% are female participants. According to survey, 67% are Male participants in employer and PhD candidate group, 68% Female participants in student group.

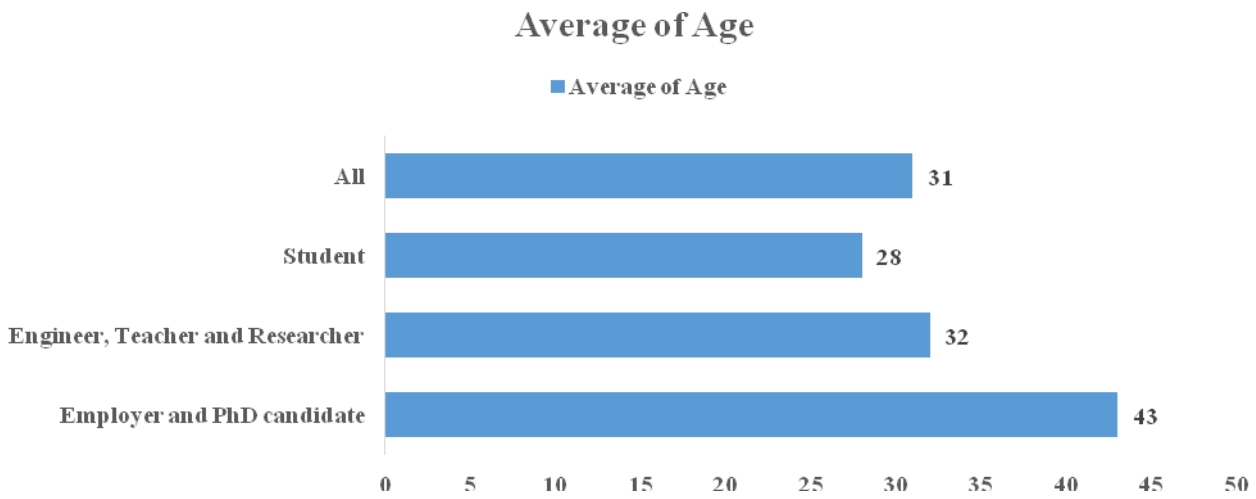
3 groups	Female (n)	Male (n)	Total (n)	Female (%)	Male (%)	Total (%)
Employer and PhD candidate	1	2	3	33	67	100
Engineer, Teacher and Researcher	20	19	39	51	49	100
Student	13	6	19	68	32	100
Total	**34**	**27**	**61**	**56**	**44**	**100**



3.5. Occupation and Age

In addition to gender, respondents were grouped by occupation and average of age for this survey. The average age of all participants is 31 while the average age of employer and PhD candidate group is 43, engineer, teacher and researcher group is 32 and student group is 28 .

Occupation	Average of Age
Employer and PhD candidate	43
Engineer, Teacher and Researcher	32
Student	28
All	**31**



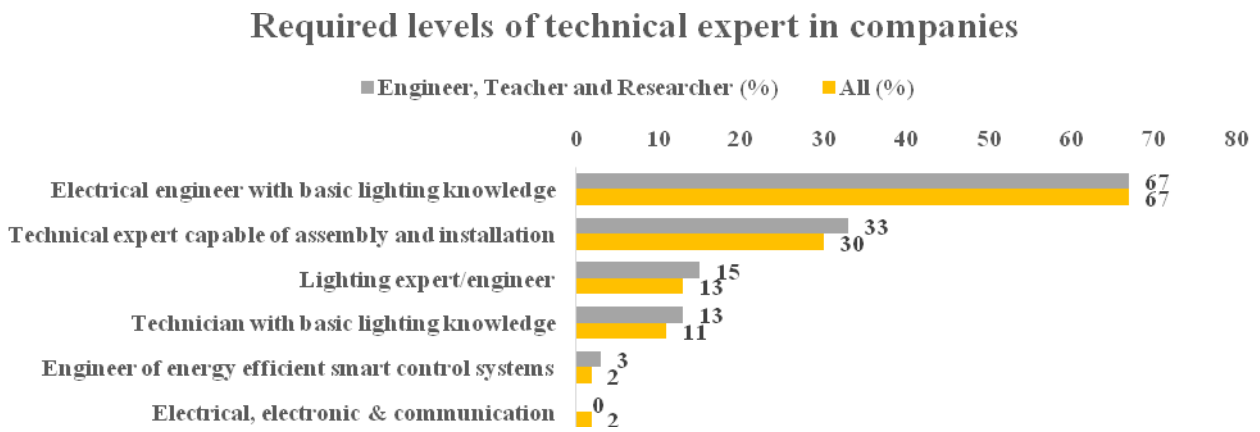
4. Results

The percentages of all respondents are calculated out of the total 61. The percentages of the group of Engineer, Teacher and Researcher are calculated out of the total people of this group 39.

4.1. Required levels of technical expert in companies

There are many engineers, teacher and researcher in YTU and MTU. Most of them have working on lighting and related projects. The requirement levels of technical expert from Universities varies depends on their specialization field. As shown in Table, 67% of engineer, teacher and researcher group stated that they require electrical engineers with basic lighting knowledge and they don't need the electrical, electronic and communication experts.

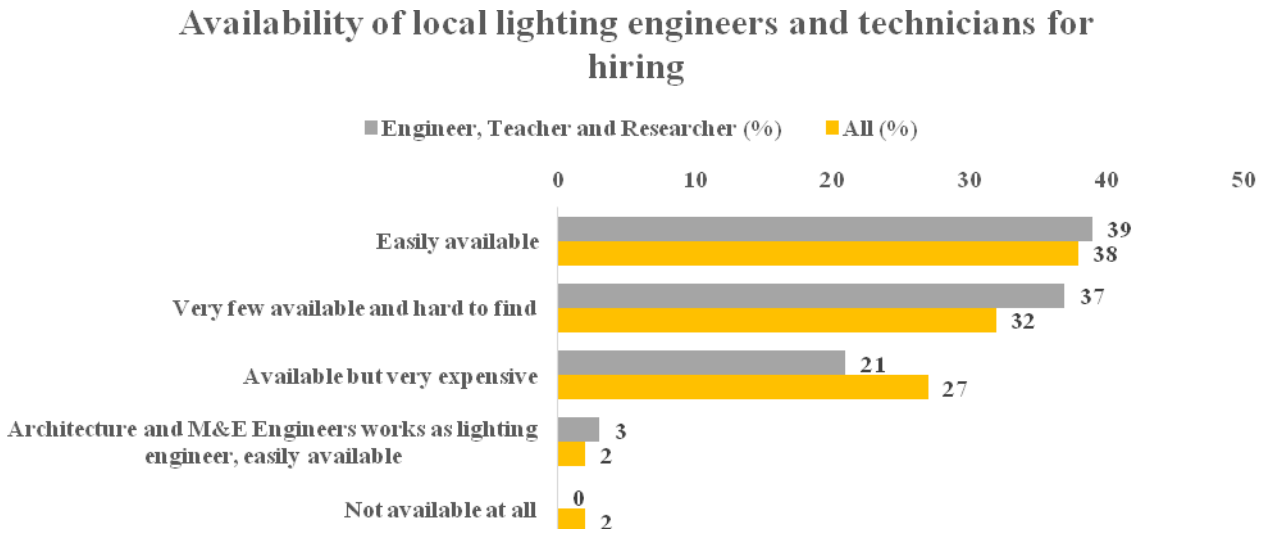
Levels of technical expert	Engineer, Teacher and Researcher (n)	All (n)	Engineer, Teacher and Researcher (%)	All (%)
Electrical engineer with basic lighting knowledge	26	41	67	67
Technical expert capable of assembly and installation	13	18	33	30
Lighting expert/engineer	6	8	15	13
Technician with basic lighting knowledge	5	7	13	11
Engineer of energy efficient smart control systems	1	1	3	2
Electrical, electronic & communication		1	0	2



4.2. Availability of local lighting engineers and technicians for hiring in Myanmar

The 39% of engineer, teacher and researcher claim that the local lighting engineers and technicians are easily available for hiring. And the 37% of engineer, teacher and researcher presented that it is very few available and hard to find for hiring. Some claim that it is available but very expensive. Only 2% of all participants stated that Architecture and M&E engineer who works as lighting engineer are easily available. Only 1% give response on Not available at all conditions.

How are local lighting engineers and technicians available for hiring	Engineer, Teacher and Researcher (n)	All (n)	Engineer, Teacher and Researcher (%)	All (%)
Easily available	15	23	39	38
Very few available and hard to find	14	19	37	32
Available but very expensive	8	16	21	27
Architecture and M&E Engineers works as lighting engineer, easily available	1	1	3	2
Not available at all		1	0	2
Total	**38**	**60**	**100**	**101**

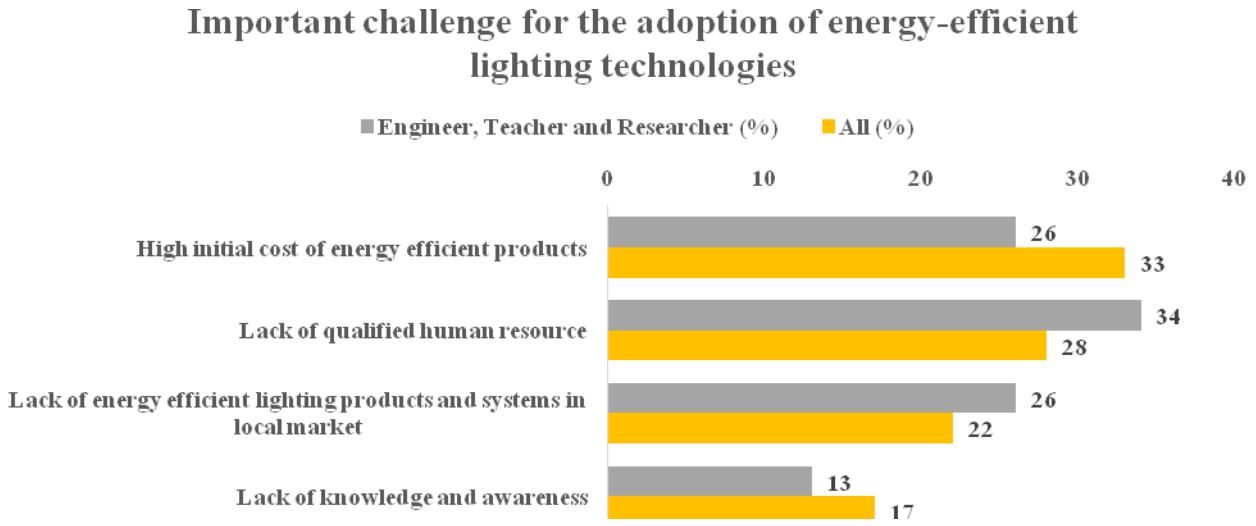


4.3. Important challenge for the adoption of energy-efficient lighting technologies in Myanmar

High initial cost of energy efficient products is the major challenge in Myanmar. Moreover, 28% of responses stated that the lack of qualified human resource is also the important challenge for adoption of energy-efficient lighting technologies in Myanmar. But 34% of engineer, teacher and researcher told lack of qualified human resource is the major challenge and 26% told that the

second most important challenge is high initial cost of energy efficient products and then, lack of energy efficient lighting products and systems in local market. The least is lack of knowledge and awareness in 13% of engineer, teacher and researcher.

Challenge	Engineer, Teacher and Researcher (n)	All (n)	Engineer, Teacher and Researcher (%)	All (%)
High initial cost of energy efficient products	10	20	26	33
Lack of qualified human resource	13	17	34	28
Lack of energy efficient lighting products and systems in local market	10	13	26	22
Lack of knowledge and awareness	5	10	13	17
Total	**38**	**60**	**99**	**100**

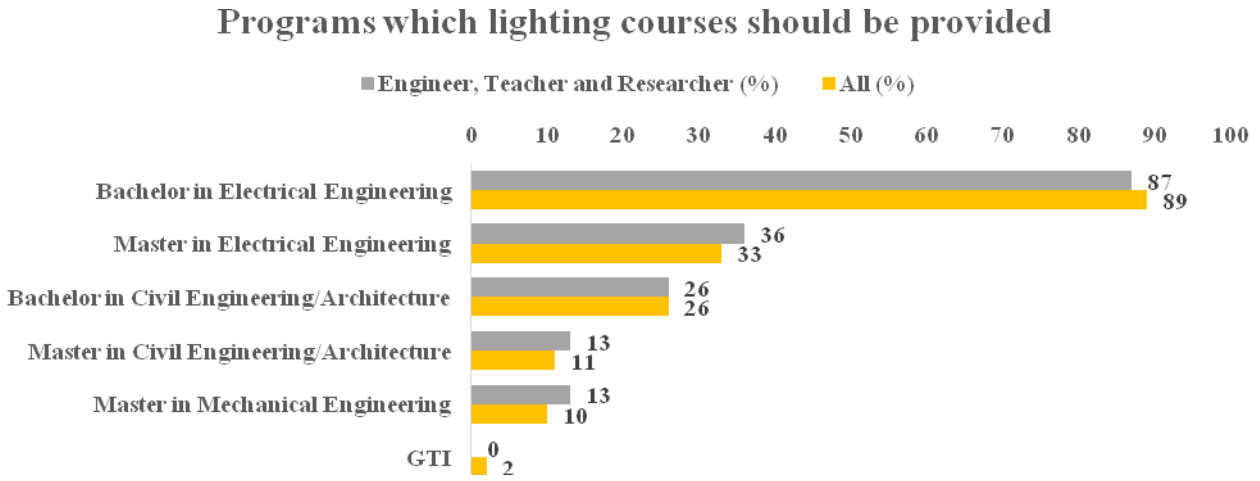


4.4. Programs which lighting courses should be provided

In this survey, 87% of engineer, teacher and researcher recomanded that the lighting course should be provided in the electrical engineering subjects of undergraduate program. On the other hand, 36% recomanded the lighting course should also be provided in electrical engineering Master program. Some claimed that lighting courses should be offered in undergraduate program of civil engineering /architecture. The 13% of engineer, teacher and researcher group recommanded to provide in master degree program of both civil engineering/architecture and mechanical engineering. It is not recommanded to provide lighting course in deploma program.

Program	Engineer, Teacher and Researcher (n)	All (n)	Engineer, Teacher and Researcher (%)	All (%)

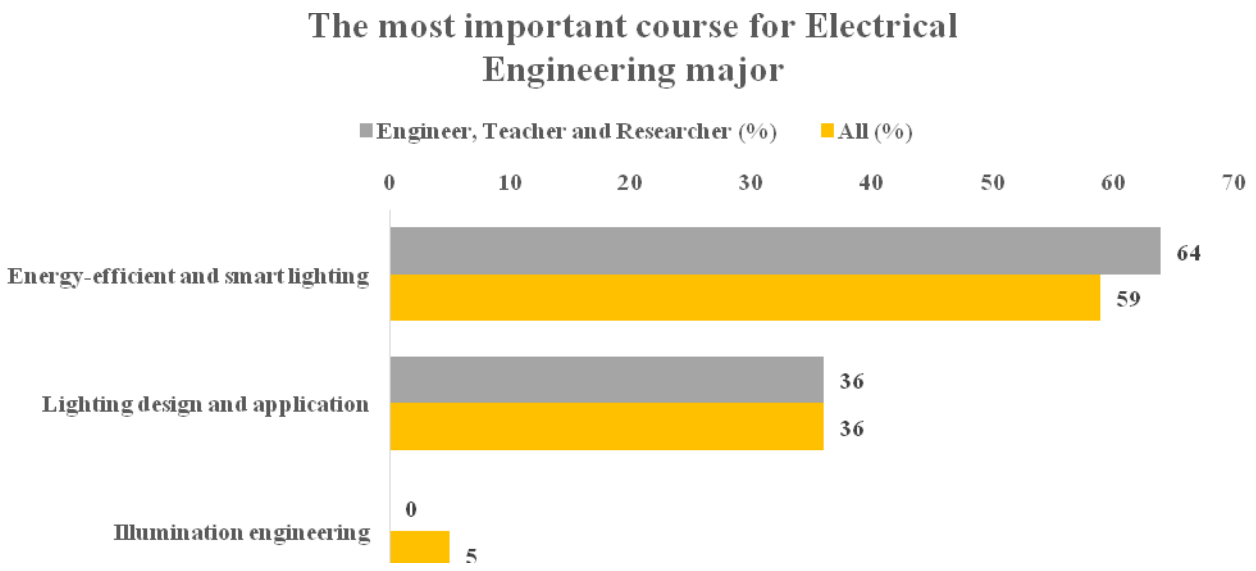
Bachelor in Electrical Engineering	34	54	87	89
Master in Electrical Engineering	14	20	36	33
Bachelor in Civil Engineering/Architecture	10	16	26	26
Master in Civil Engineering/Architecture	5	7	13	11
Master in Mechanical Engineering	5	6	13	10
GTI		1	0	2



4.5. Important courses for Electrical Engineering major

In this survey, responses were taken on three electrical courses. The 64% of engineer, teacher and researcher selected energy-efficient and smart lighting as the most important course for Electrical Engineering program. And lighting design and application is recommended by 36% of engineer, teacher and researcher. Illumination engineering was not recommended by engineer, teacher and researcher.

Courses	Engineer, Teacher and Researcher (n)	All (n)	Engineer, Teacher and Researcher (%)	All (%)
Energy-efficient and smart lighting	25	36	64	59
Lighting design and application	14	22	36	36
Illumination engineering		3	0	5
Total	**39**	**61**	**100**	**100**

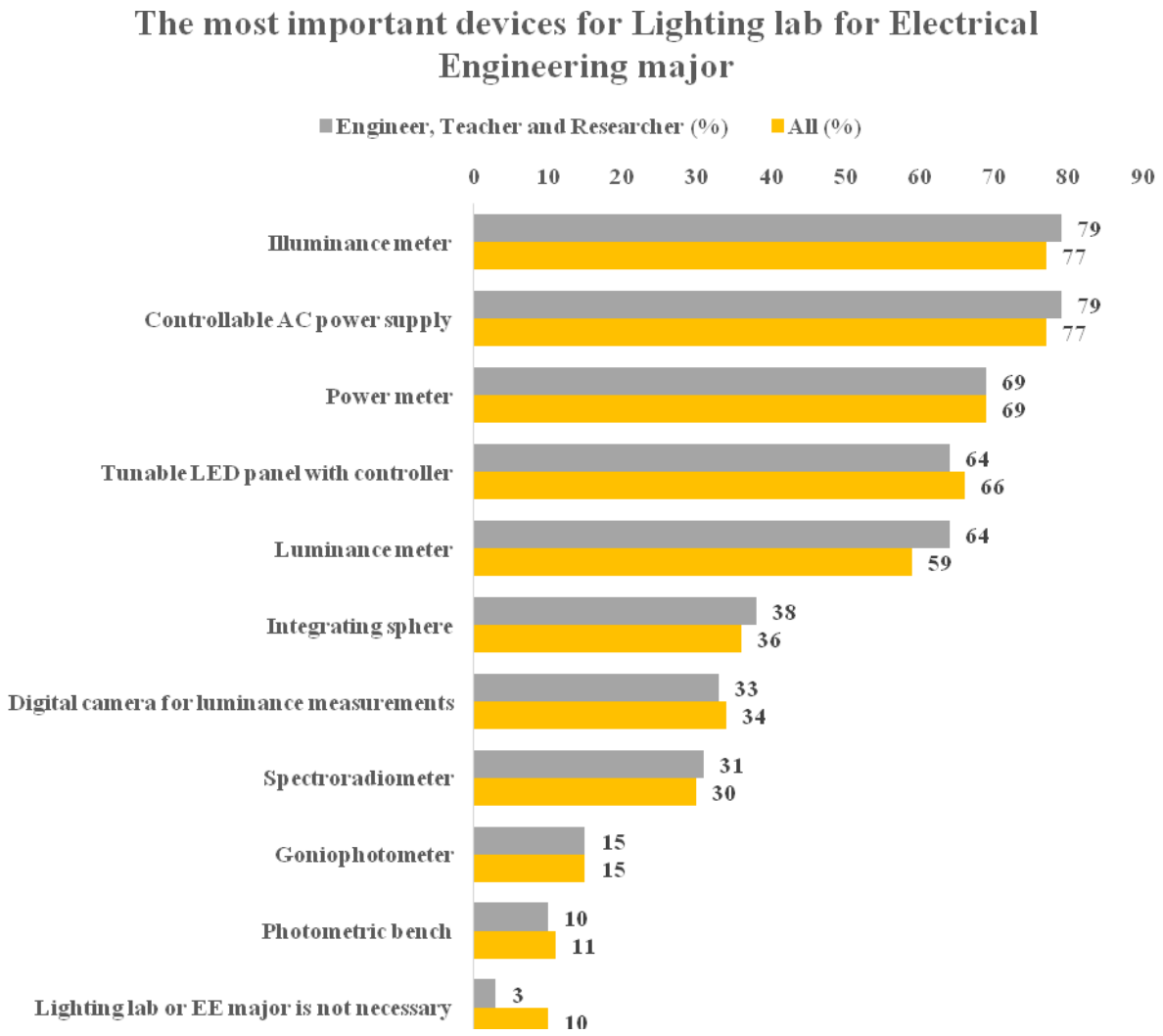


4.6. Important devices for lighting lab for Electrical Engineering major

Electrical engineers are required to work in hazardous environments near energized equipment. Therefore, tools or devices required to carry out the job effectively and safety without causing any harm to themselves and their environment. By questionnaires survey, the most important devices for lighting lab are considered for electrical engineering major. The 79% of engineer, teacher and researcher recommended choosing luminance meter and Controllable AC power supply as the most important devices. Over 60% of engineer, teacher and researcher advised to pick up Power meter and Tunable LED panel with controller and luminance meter as the second. The third most important devices are integrating sphere, Digital camera for luminance measurements and Spectroradiometer.

Device	Engineer, Teacher and Researcher (n)	All (n)	Engineer, Teacher and Researcher (%)	All (%)
Illuminance meter	31	47	79	77
Controllable AC power supply	31	47	79	77
Power meter	27	42	69	69
Tunable LED panel with controller	25	40	64	66
Luminance meter	25	36	64	59
Integrating sphere	15	22	38	36
Digital camera for luminance measurements	13	21	33	34
Spectroradiometer	12	18	31	30
Goniophotometer	6	9	15	15

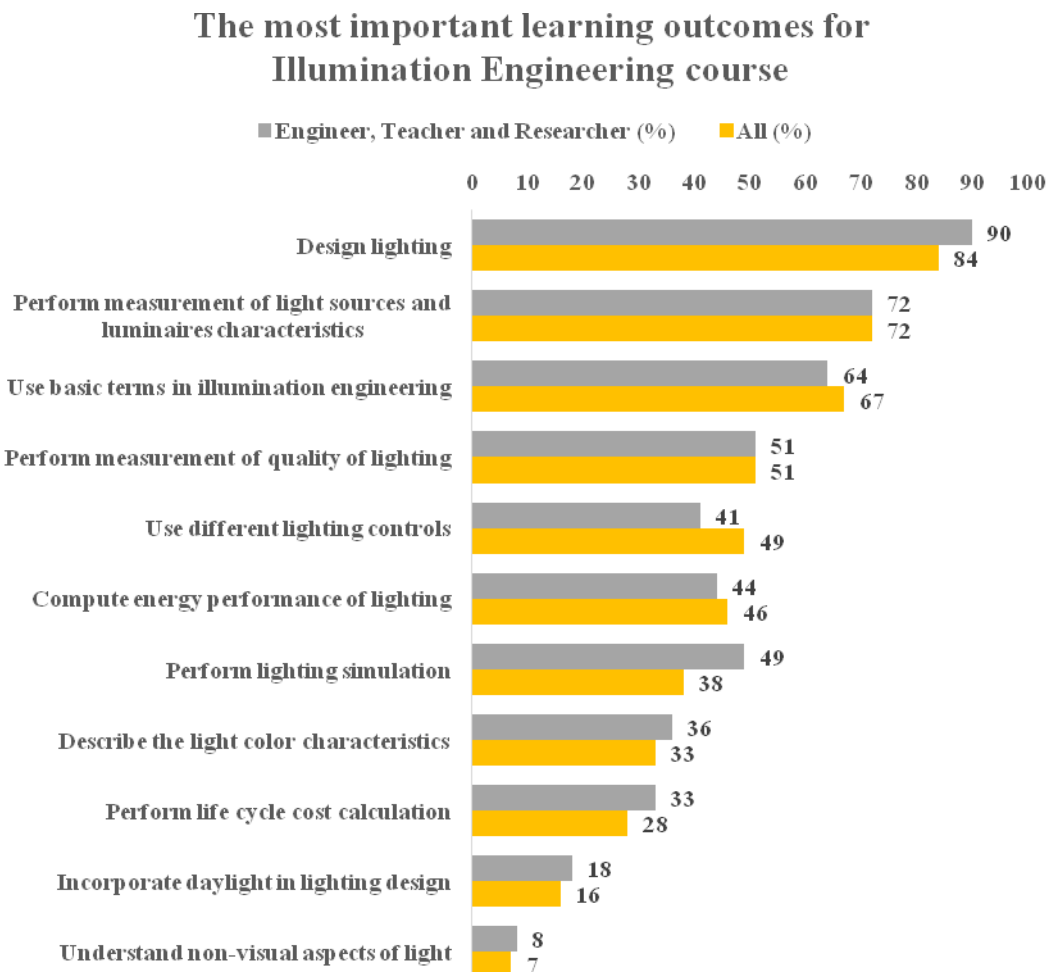
Photometric bench	4	7	10	11
Lighting lab or EE major is not necessary	1	6	3	10



4.7. Important learning outcomes for Illumination Engineering course

In learning outcomes for illumination engineering course, about 90% of Engineer, Teacher and Researcher pointed out Design Lighting. This design lighting received 84% of all the response as the most important outcome. The second most important outcome should be Perform Measurement of Light Sources and Luminaires Characteristics with About 72% of Engineer, Teacher and Researcher (72% out of all the surveyors) followed by Use Basic Terms in Illumination Engineering with 64% of Engineer, Teacher and Researcher (67% out of all the surveyors). 8% of Engineer, Teacher and Researcher (7% out of all the responses) rated as lowest to Understand Non-Visual Aspects of Light.

Learning outcome	Engineer, Teacher and Researcher (n)	All (n)	Engineer, Teacher and Researcher (%)	All (%)
Design lighting	35	51	90	84
Perform measurement of light sources and luminaires characteristics	28	44	72	72
Use basic terms in illumination engineering	25	41	64	67
Perform measurement of quality of lighting	20	31	51	51
Use different lighting controls	16	30	41	49
Compute energy performance of lighting	17	28	44	46
Perform lighting simulation	19	23	49	38
Describe the light color characteristics	14	20	36	33
Perform life cycle cost calculation	13	17	33	28
Incorporate daylight in lighting design	7	10	18	16
Understand non-visual aspects of light	3	4	8	7

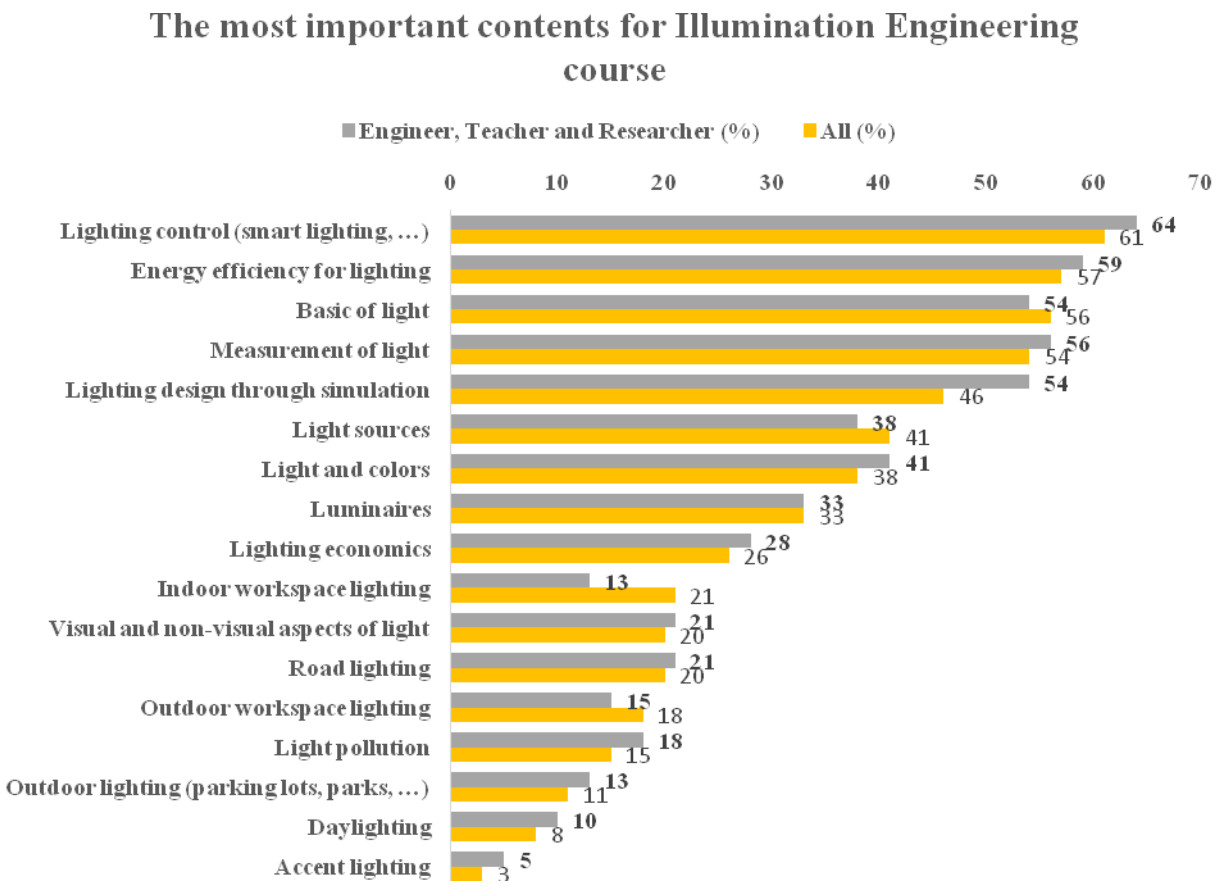


4.8. Important contents for Illumination Engineering course

In the most important contents for Illumination Engineering Course was Lighting control. It was accepted by about 64% of Engineer, Teacher and Researcher and 61% out of all the people who gave responses in this survey. It was followed by Energy efficiency for lighting (57%), Basic of light(56%), Measurement of light(54%), Lighting Design through Simulation(46%), Light Sources(41%), Light and Colors(38%), Luminaires(33%), Lighting Economic(26%), Indoor Work Space Lighting (21%), Road Lighting(20%), Outdoor Work Space Lighting(18%), Light Pollution(15%), Outdoor Lighting(11%), Day Lighting(8%), and Accent Lighting is the lowest rating with 3% of the responses. About 59% of Engineer, Teacher and Researcher convinced Energy Efficiency for Lighting content, and about 56% in Measurement of Light.

Content	Engineer, Teacher and Researcher (n)	All (n)	Engineer, Teacher and Researcher (%)	All (%)
Lighting control (smart lighting, …)	25	37	64	61

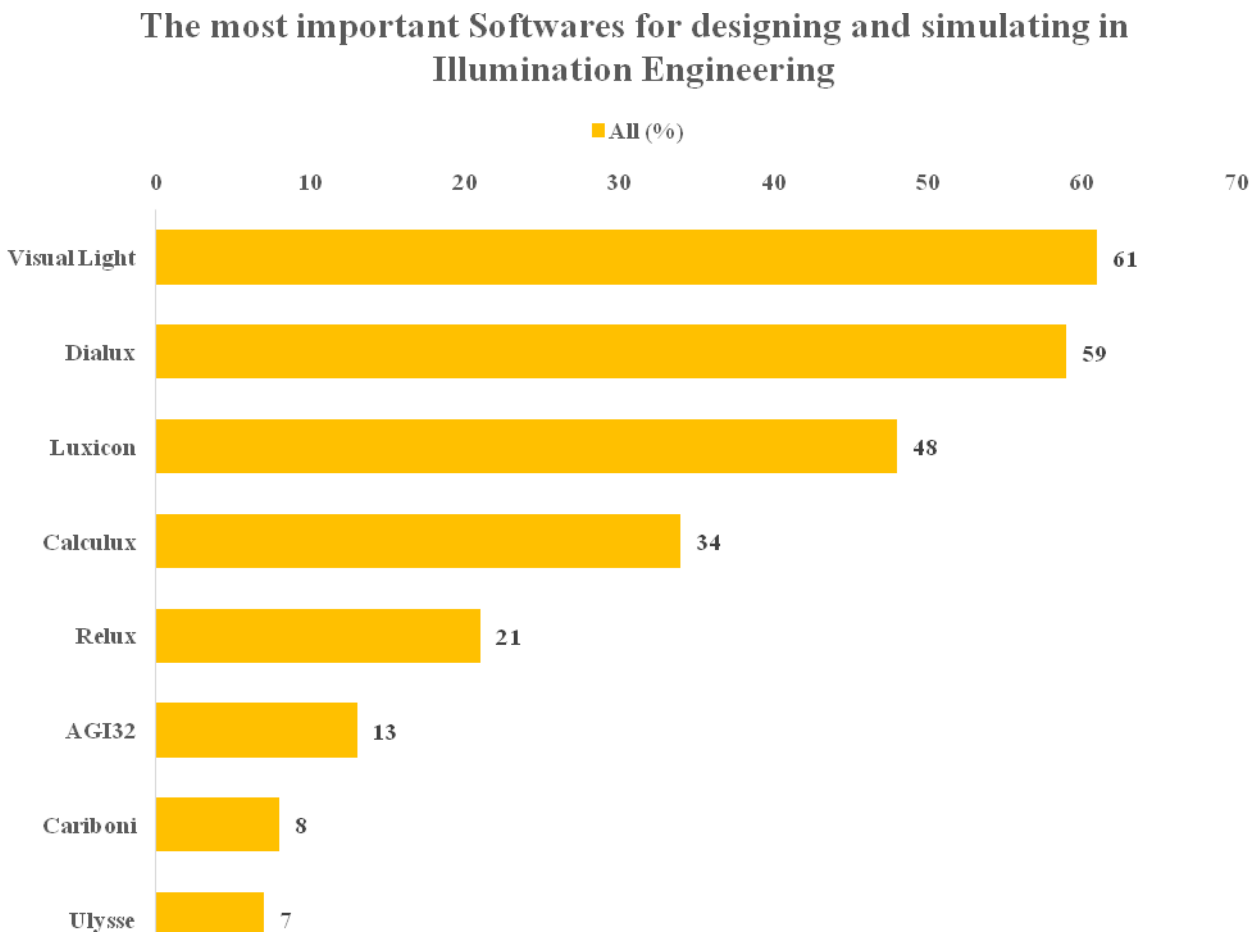
Energy efficiency for lighting	23	35	59	57
Basic of light	21	34	54	56
Measurement of light	22	33	56	54
Lighting design through simulation	21	28	54	46
Light sources	15	25	38	41
Light and colors	16	23	41	38
Luminaires	13	20	33	33
Lighting economics	11	16	28	26
Indoor workspace lighting	5	13	13	21
Visual and non-visual aspects of light	8	12	21	20
Road lighting	8	12	21	20
Outdoor workspace lighting	6	11	15	18
Light pollution	7	9	18	15
Outdoor lighting (parking lots, parks, …)	5	7	13	11
Daylighting	4	5	10	8
Accent lighting	2	2	5	3



4.9. Important software for designing and simulating in Illumination Engineering

The important software for designing and simulation in illumination are shown in table with their percentage. Firstly, visual light is pointed out by 90% of engineer, teacher and researcher and 61% of all surveyors. It was followed by Dialux with 83% of engineer, teacher and researcher and 59% of all surveyors chosen Dialux software. And then 76% of engineer, teacher and researcher (48% of all surveyors) chosen Luxicon software. Ulysse reached lowest preference in this survey with 14% of engineer, teacher and researcher and 7% of all rating.

Software	Engineer, Teacher and Researcher (n)	All (n)	Engineer, Teacher and Researcher (%)	All (%)
Visual Light	26	37	90	61
Dialux	24	36	83	59
Luxicon	22	29	76	48
Calculux	15	21	52	34
Relux	8	13	28	21
AGI32	5	8	17	13
Cariboni	4	5	14	8
Ulysse	4	4	14	7



4.10. Suggested courses to be lighting engineer

Electrical Engineering Major graduates suggested the following courses should take the Engineering Working in Lighting Area.

- Advanced Energy Efficient Design for Smart Building
- AutoCAD, Dialux Software, Microsoft Excel
- Country's Rules and Regulations upon Lighting area.
- Courses especially in lighting area
- Different lighting control
- Economic lighting
- Electrical Design and safety
- Electrical Estimating and Design Calculation for Lighting and Illumination
- Energy Efficient Light Sources
- Energy Efficient Lighting Design
- Energy Efficient Smart Lighting System Design
- Energy-efficient and smart lighting
- Environmental engineering

- Estimating, production
- Estimation
- Illumination fundamental course
- Lighting Control Systems
- Lighting costs to estimate well and to perform good lighting.
- Lighting design
- Lighting design and calculation, Mab lab
- Lighting design and installation course
- Lighting design for Energy and cost efficient
- Lighting fundamentals
- Lighting, illumination and environmental concern according to the international standards
- Luminaries, Lighting design through simulation
- M&E course
- M&E: AutoCAD :Electrical Control :Electrical Design and Calculation
- Need practical, design and troubleshooting methods
- Power Usage Design & Solar Power System
- Practical training should be provided
- Practical jobs should make after graduating from EE major.
- Quickly estimating for electrical and luminance and design lighting using lighting software
- Require to check illumination, light intensity
- Safety course for electrical installation
- Safety from electric shock & fire damage
- Singapore Standard for lighting calculation
- Smart Lighting
- Wiring course and electrical estimated
- Work after graduate

4.11. Important collaborative projects between university and industrial

The following projects are collaboration between an academic institution and an industrial company that the respondents have participated in.

- 5 stars Hotel Lighting and Power Installation (Internship); Electrical Distribution System about Substations(Field Trip); AGC of Interconnected Connections including Excitation System(Group Project)
- Banking Data Center Project (4)/Government Project(2)
- City Golf Resort, 1. Ngwe Thaw Tar, 2. Mya ken Ther
- Compute energy performance for lighting; Lighting design by using different simulation; Energy efficient for lighting
- Electrical effective GSM based Substation Monitoring and Control System; ZigBee Based Solar Powered Forest Fire Detection and Control System; Android Based

Electrical Appliance Control.

- Electrical engineer at Nawaday Housing project,Yangon , Myanmar.
- Electrical Safety Awareness(PME Co.Ltd; Mitsubishi), JICA EEHE Project, student project with UNSW(Australia)
- House Wiring; Estimate of Wiring; Design Plan
- IMC,PLC, Generation Transmission & Distribution, Electrical Automation
- Introduction of energy efficient lighting; Room lighting efficiency; Energy efficient lighting system design for building
- Japan-Myanmar, China-Myanmar,EU-Myanmar
- Lighting Design and Control; Energy efficient sources; Luminaries
- Lighting installation project; Solar project; Renewable energy project
- Paung Laung, Lawpita Beluchaung 1,2,3
- Plan, sharing (include all) and support
- Smart Meter
- Solar power for house; Wiring installation of house; Motor control
- Static Var Compensator, Capacitor bank and Lighting with relay switches projects
- Study working experience of lighting and estimating lighting design using lighting software and course of using lighting software for student
- Traffic Light, Hydro-Power and Earthing
- Vehicle Assembly Factory; Hospital; Street Lighting
- Wind energy, Auto Water filling system with PLC, Lift and control
- Ye Ywa Dam Excursion, Kyun Chaung Gas Turbine Plant, Internship at Star M&E Engineering Company Ltd

5. Recommendation

About 64% of the teacher, engineer, researcher, 31% of student and 5% of Ph.D student and employee participated in the survey and they believe that lighting courses should be taught at the universities and very helpful to graduates. It is also pointed out by surveying different target groups survey and experts that two or three courses on energy efficient lighting needs to be formulated for YTU and MTU in Myanmar. The courses should focus on the basics of energy efficient lighting, sizing and design and well as the technology of energy efficient lighting, control and installation.

For YTU, there are three courses focus on lighting & illumination. The first one is Illumination Engineering (for architecture) and the other two--(Illumination Engineering I & II) are for the electrical power engineering. The first course includes basic of light, optical characteristics, effects of light on human and introduction to lighting design with simulation software. Illumination Engineering I for EP is related for light sources and lighting applications; and Illumination Engineering II course is for energy efficient and smart lighting.

MTU has two courses focused on lighting & illumination and advanced measurement & illumination. Lighting & illumination should be focused to know the nature of lighting science theory, ability to know how to design the installation of electrical devices in load area and ability

to understand how to choose light point in work space. Advanced measurement & illumination was focused ability to understand, how to measure voltage, current and resistance by using potentiometers, ability to understand, how to measure voltage, current and resistance by using instrument transformer, ability to know lighting theory and calculate lighting design, ability to understand sizing of conductor and ability to choose conductor size when short-circuit current occurs.

The first course to meet the illumination fundamental, lighting design, light in design and application guide, practical guide for outdoor lighting and industrial illumination systems. The second course to meet the potentiometer, instrument transformers, magnetic measurements, lighting science, theory and calculation and cable and sizing of conductors.

The new courses should include new software for designing and simulating in illumination engineering and then estimation, design, calculation, installation, wiring course, safety and protection.

APPENDIX

Survey Questionnaires for Academic Program

The survey has been given online in Google form with the content below.

Personal Information

Gender: male, female, other;

Age: _____

Which of the following categories best represents you: student, teacher, employer, researcher, engineer, salesperson, manager, governor, others.

General Information:

- ✓ *The questionnaires are intended to get the best feedback from stakeholders to aid the process of designing appropriate syllabus/course modules to be delivered to students/trainees at universities or training centers.*
- ✓ *The collected data will be maintained confidential. Contact details are for record purpose only.*
- ✓ *For any clarification/queries please contact chan.ttd@vgu.edu.vn.*

Please skip questions in which you feel not sure.

1) Which levels of technical expert below are required in your institutions/companies?

- ☐ Technician with basic lighting knowledge
- ☐ Electrical engineer with basic lighting knowledge
- ☐ Technical expert capable of assembly and installation
- ☐ Lighting expert/engineer
- ☐ Others, please propose: _____

2) How are local lighting engineers and technicians available for hiring in your country?

- ☐ Easily available
- ☐ Available but very expensive
- ☐ Very few available and hard to find

Not available at all

☐ Others, please propose: _____

3) What is the most important challenge for the adoption of energy-efficient lighting technologies in your country? (Please select only one option.)

☐ Lack of knowledge and awareness

☐ Lack of qualified human resource

☐ High initial cost of energy efficient products

Lack of energy efficient lighting products and systems in local market

☐ Others, please propose: _____

4) Please choose all programs below you think in which lighting courses should be provided.

☐ Bachelor in Electrical Engineering ☐ Master in Electrical Engineering

☐ Bachelor in Mechanical Engineering ☐ Master in Mechanical Engineering

☐ Others, please propose:_____ ☐ Master in Civil Engineering/Architecture

_____

5) Please select the most important one among the courses below for Electrical Engineering major.

☐ Illumination engineering

☐ Lighting design and application

☐ Energy-efficient and smart lighting

☐ Courses in lighting for EE major are not necessary

☐ Others, please propose: _____

6) Please select 5 most important devices for Lighting lab for Electrical Engineering major

☐ Integrating sphere

☐ Spectroradiometer

☐ Power meter

- ☐ Controllable AC power supply
- ☐ Tunable LED panel with controller
- ☐ Illuminance meter
- ☐ Goniophotometer
- ☐ Luminance meter
- ☐ Photometric bench
- ☐ Digital camera for luminance measurements
- ☐ Others, please propose: _____
- ☐ Lighting lab or EE major is not necessary

7) Please choose 5 most important learning outcomes for Illumination Engineering course.
After successfully completing the course, the students will be able to:

- ☐ Use basic terms in illumination engineering;
- ☐ Perform measurement of light sources and luminaires characteristics;
- ☐ Perform measurement of quality of lighting;
- ☐ Describe the light color characteristics;
- ☐ Design lighting;
- ☐ Perform lighting simulation;
- ☐ Compute energy performance of lighting;
- ☐ Perform life cycle cost calculation;
- ☐ Use different lighting controls;
- ☐ Understand non-visual aspects of light;
- ☐ Incorporate daylight in lighting design;
- ☐ Others, please propose: _____

8) Please select 5 most important contents for Illumination Engineering course

- ☐ Basic of light
- ☐ Measurement of light

- ☐ Visual and non-visual aspects of light
- ☐ Light and colors
- ☐ Light sources
- ☐ Luminaires
- ☐ Lighting control (smart lighting, …)
- ☐ Indoor workspace lighting
- ☐ Outdoor workspace lighting
- ☐ Outdoor lighting (parking lots, parks, …)
- ☐ Accent lighting
- ☐ Road lighting
- ☐ Daylighting
- ☐ Lighting design through simulation
- ☐ Energy efficiency for lighting
- ☐ Lighting economics
- ☐ Light pollution
- ☐ Others, please propose: _____

9) Please select 3 most important Softwares for designing and simulating in Illumination Engineering.

- ☐ Visual Light
- ☐ Luxicon
- ☐ Dialux
- ☐ Relux
- ☐ Ulysse
- ☐ Calculux
- ☐ Cariboni
- ☐ AGI32
- ☐ Others, please propose: _____

10) Please suggest any courses that an engineer working in lighting area should take (after graduating from Electrical Engineering major).

_____
_____
_____

11) Please list 3 most important projects which are a collaboration between an academic institution and an industrial company that you have participated in.

_____
_____
_____

If willing, you can provide your personal information below.

Name _____ email: _____ Phone No.: _____

Name of the organization_____ Position at organization_____