

Toward Sustainable Residential Lighting in Taiwan

Ting-Chou Chen¹ and Ming-Yeh Hsieh²

¹ Design College, Chung Yuan Christian University

² Department of Architecture, Chung Yuan Christian University

Abstract. “One-lamp for one-room” is the most popular kind of residential lighting in Taiwan area. This kind of lighting is very easy to fulfill the basic illumination, but it is hard to improve the lighting quality and to satisfy green-energy concept. This study surveys the using conditions of residential lighting in Taiwan area 2012, including quantities, types, selecting factors, and maintenances of lighting fixtures in living room, main bedroom and dining room. Furthermore, this study not only compares with statistical data of 2001 and analyzes the evolution of residential lighting culture in recent decade, but also proposes future development alternatives and strategies for sustainable residential lighting. According to the surveying results, the average number of lighting fixtures is 4.3 in living room and more than of 2.5 in 2001, and there are 18.1% of samples use cove lighting in living room. For the bedroom and dining room, about 50~60% of samples keep using “one-lamp for one-room” type of lighting.

Keywords: Residential Lighting, Sustainable Lighting Strategy, Green Consciousness, Taiwan Area

1. Introduction

Lighting is closely related with human life pattern in track of civilization, from the purpose of bright demand in early days to the pursuit of artistic and quality desire in nowadays. Even though the social environment is changed in anyway, lighting equipments are still indispensable elements for human life. The pollution problems of interior environment caused by soot and odor from early lighting equipments weren't regarded and solved until the advancement of modern technology. The task of healthy and comfortable lighting environment is the main objective for electric lighting equipments in the present.

In general, the environment quality of a house is depended on the conditions of space scale, color, airflow and lighting, especially lighting quality is the most important influential condition. Due to the most activities of interior space are concentrated at night or holiday in the way of modern life, artificial lighting is the main lighting source for interior space. So it is important to select a suitable lighting mode in accordance with space characters and making mood for lighting design. According to the lighting surveys of apartment buildings in 2001 (Chen, 2001), “one-lamp for one-room” is the most popular kind of residential lighting in Taiwan area. It revealed that the most users' purpose of residential lighting was the basic illumination need for living and work, and ignored the decorating lighting of space mood. Lighting is closely related with human life pattern in track of civilization, from the purpose of bright demand in early days to the pursuit of artistic and quality desire in nowadays. Even though the social environment is changed in anyway, lighting equipments are still indispensable elements for human life. The pollution problems of interior environment caused by soot and odor from early lighting equipments weren't regarded and solved until the advancement of modern technology. The task of healthy and comfortable lighting environment is the main objective for electric lighting equipments in the present.

In general, the environment quality of a house is depended on the conditions of space scale, color, airflow and lighting, especially lighting quality is the most important influential condition. Due to the most activities of interior space are concentrated at night or holiday in the way of modern life, artificial lighting is the main lighting source for interior space. So it is important to select a suitable lighting mode in accordance with space characters and making mood for lighting design. According to the lighting surveys of apartment buildings in 2001 (Chen, 2001), “one-lamp for one-room” is the most popular kind of residential lighting in Taiwan area. It revealed that the most users' purpose of residential lighting was the basic illumination need

¹ Corresponding author. Tel.: + 886-03-699-1111 ext 1410; fax: +886-03-699-1111 ext 1412.
E-mail address: tcchen@cute.edu.tw

for living and work, and ignored the decorating lighting of space mood.

2. Evolution and present condition of residential lighting

2.1. Evolution and trend of lighting

The evolution of residential space lighting is related with the development history of energy. It was started from directly burning of natural materials, torch light, through the invention of candles by Phoenician in 400 A.D., and to the invention of Argand lamp by Geneva scientist Amie Argand in 1783, but gas lamp first was used in home till in 1840. The milestone of lighting history was emerged in 1879, the lighting went into a new era of electric power after Thomas Alva Edison invented Incandescent light bulb. Although a successful and significant revolution of interior lighting had spent about 10 decade from Argand lamp to Incandescent lamp, a variety of electric lighting sources were developed and used thereafter. The more typical lighting sources which influenced residential space quality were sequentially invented in 1900s, such as Hot-Cathode fluorescent lamp in 1938, compact fluorescent lamp in 1980, T5 fluorescent lamp in 1995, White Light-Emitting Diode (LED) in 1997, etc. Since LED has characteristics of energy saving and high efficiency, it is deeply expected being a new hope of lighting market in 21th century.

As social environment and science technology go on, dwellers have to be taught and learn how to concern their residential lighting quality. Although the “one-lamp for one-room” way of residential lighting can easily fulfil the basic need of illumination, it really can’t meet diverse requirements of modern life. To analyzed difference requirements of lighting environment between book reading and music listening, Hsieh and Chen (2011) pointed out that source location and illuminating distribution of lighting will influence spatial mood and conscious emotion.

In addition, Matsushita (2008) indicated that residential lighting will have three trends in 21th century, including “from utensil to space”, “from quantity to quality”, and “from whole to individual”. On the other hand, it illustrated that future lighting culture will base on the “human” and focus on the relationship between user and spatial environment. Restated, the objectives of future lighting are to create the space by means of lighting design, to equally emphasize on quality and healthy lighting, and to meet the diverse life style requirements for dweller.

2.2. Present condition of residential lighting in Taiwan

This study surveys the using conditions of residential lighting in Taiwan area 2012, including quantities, types, hours of lighting, selecting factors, and maintenances of lighting fixtures in living room, main bedroom and dining room. The way of this survey was introduced with random sampling, and the total samples to surveying from May to August were 678 dwellers. Results of this study are illustrated below.

2.2.1. Relationship between Space and Lighting Fixture

According to the surveying results, the average number of lighting fixtures in living room is 4.1 (more than of 2.5 in 2001), and the using percentage over 3 lighting fixtures is about 52.1% (Table.1). It is about 75.2% of samples used ceiling-mounted lighting fixture ,and tied in open-reflector down light, track-mounted spot light, floor-mounted luminaire, wall-mounted luminaire etc., to design their lighting decoration. Furthermore, there are 18.3% of samples applied the way of architectural coves to mute and uniform the light of a whole room.

Table. 1 The Average Number of Lighting Fixtures (2001,2012)

Space	Year	Mean	SD	1	2	≥ 3
Living room	2012	4.1	4.20	27.7%	20.2%	52.1%
	2001	2.5	2.31	38.2%	33.1%	28.7%
Main bedroom	2012	2.4	1.97	48.5%	22.0%	29.5%
	2001	1.6	1.18	42.7%	38.9%	18.4%
Dining room	2012	2.1	1.67	54.4%	22.5%	23.1%
	2001	1.5	1.50	-	-	-

For main bedroom, the average number of lighting fixtures is 2.4 per room, but there are about 48.5% of samples just have one lighting fixture in their main bedroom. This feature is same as dining room, the average number of lighting fixtures is 2.1 per room, but there are about 54.4% of samples just have one lighting fixture. It illustrates that main bedroom and dining room belong to the lighting type of “one-lamp for one-room” because these spaces’ function is clear and simplex.

The amount of average hours of lighting is shown in Fig. 1. For living room, the average number is about 6~8 hours. Lighting time on holiday is more 1.5 hours on non-holiday. The percentage of lighting time which over 6 hours is increase from 31% to 57%. The results shown it is insufficient of natural lighting (daylight) . Lighting equipments are essential in living room. The increased time of lighting between holiday and non-holiday is similar for main bedroom and dining room.

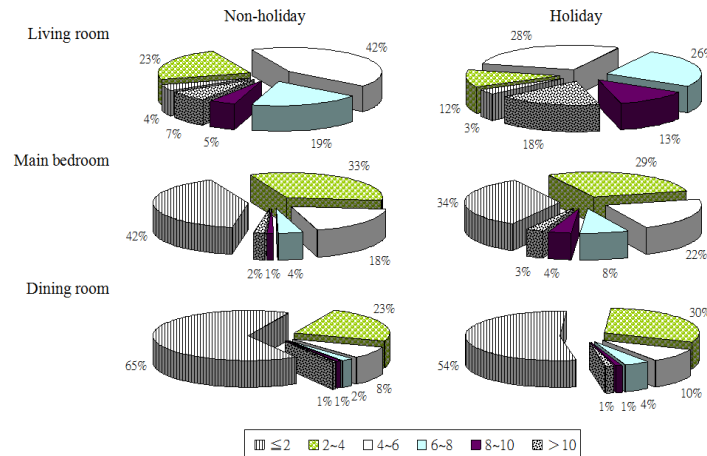


Fig. 1 The percentage of lighting time

2.2.2. Selecting Factors and Maintenances of Lighting Fixtures

The percentage of the selecting factor “energy-saving” (about 72.4% of samples) is the highest one in ten factors (Fig.2). The next factors successively are “convenient-maintaining” (42.0%), “low-priced” (41.6%), “durable and lasting” (40.7%), “form-pleasing” (34.2%) and “high-illumination” (31.0%). In general, the main difference between surveys of 2012 and 2001 is that users pay much attention to “energy-saving” more than “high-illumination”. For illumination of lighting, users prefer to utilize multi-lighting fixtures or multi-route modes to simulate different lighting scenarios.

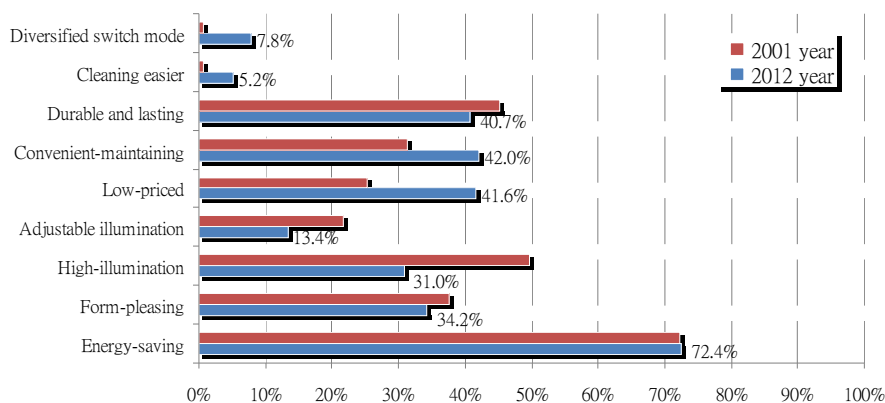


Fig 2. The percentage of the selecting factor (2001,2012)

As the results of analysis, only 9.9% of users maintained or changed lighting fixture routinely, but there are 45.7% and 36.9% of users maintained or changed lighting fixture when it glimmered or didn’t work. This feature explained that dwellers weren’t used to change or maintain lighting fixture until lighting quality decreased obviously and daily life influenced seriously.

2.3. Strategies for Sustainable Residential Lighting

For achieving the objective of sustainable and well-quality residential lighting, this study proposes two strategies according to the results foregoing.

2.3.1. Improvement in Quality and Quantity of Lighting Environment

To pursue evenly illumination for a space no longer fit in with the trend and demand of times. The central point of modern lighting design is to meet the users' visual and psychological recognition by way of multi lighting arrangements that including general lighting, wall lighting (Fig.3), and cove lighting (Ayşe Durak et al., 2007), likewise indirect lighting has been recommended as a way to accommodate lighting needs in offices (KI Fostervold and J Nersveen, 2008). In Taiwan area, after the decoration of a dwelling is finished, it won't be largely re-decorated in next 10-20 years. This situation is same as the lighting design.

This study shows that number of lighting fixture is increased and lighting arrangement is more various from 2001 to 2012 in Taiwan. The future residential lighting environment has to emphasize on enhancing the mood and artistic value and increasing the usage of cove lighting for improving user's physical and mental health.

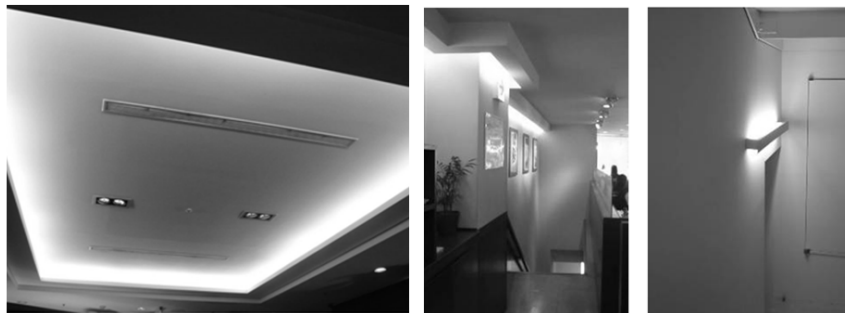


Fig. 3 Lighting arrangements (general lighting, wall lighting, and cove lighting)

2.3.2. Respond with the Trend of Green Energy and Conservation

Taiwan is located in subtropical regions. The cooling load is increased because sunlight directly into the chamber throughout the year. Therefore, the methods of taking indirect lighting which import light such as sunroof and high ceiling fanlight are useful in Taiwan. In addition to the reduce greenhouses load, indirect skylight which being controlled is gentle, stable and comfortable than direct sunlight.

According this study, the electricity consumption of residential lighting has to save more because that number and type of lighting fixture is mostly not energy-saving in Taiwan. Although nearly 30% of users had used T5 fluorescent lamps and LED lamps, it is still not popular for general users. The energy efficiency of lighting needs be raised with the Government's price hike policy, to encourage users to use energy saving lamps. Simultaneously, to change the users' habits of electricity consumption through advocacy and education will contribute to reach the goal of sustainable development.

3. Conclusion

As the national income increases year by year, people's living standards are being raised, which bring about the popularity of electrical appliances, and make power consumption continue to go up. Lighting takes the lead of power consumption in average household electric appliances, accounting for 30% of the energy consumption. Base on the concept of energy-saving and green energy, this study has proceeded a series comparison and analysis with survey data of 2012 and statistic data of 2001. The residential lighting culture has been gradually paid attention in Taiwan area, not only because of the raise of economic level, but also more attention to home quality for users. Most of users believe that well-lighting can make more healthy and comfortable environmental quality, and fulfil the body, mind, and spirit demands in home life. In summary, this study proposes that instead of "one-lamp for one-room" type of lighting, multi-function space is suitable for "multi-lamp for one-room" type of lighting and cove lighting.

Furthermore, introducing day light, using energy-saving lighting, multiple low-wattage lighting with scattered distribution, and improving lighting technology can all be well strategies for sustainable residential lighting. These strategies may increase the set up costs initially, but it should more fit in with the development trend of modern lighting base on a timely and appropriate design principle. This study can

hopefully enhance our understanding of residential lighting issues and strategies, simultaneously remind our green consciousness of energy saving and sustainable development.

4. References

- [1] Ting-Chou Chen. A Study on Saving Energy of Residential Indirect Lighting. *2012 Proceeding of the energy conservation, Taiwan Power Company*. Taipei City, 2012.
- [2] Ming-Yeh Hsieh and Chao-Yu Chen. The Effects of Interior Illuminance Distribution on Spatial Impression. *Journal of Architecture*. 2011, **75**: 81-98.
- [3] Ting-Chou Chen and Ding-Chin Chou. A Study of Green Lights for Residential Buildings, *Proceeding of 13th AIROC Research Reports*, Kaohsiung City, 2001.
- [4] Susumu Matsushita. よくわかる最新照明の基本と仕組み—照明計画の意味と役割を基礎から学ぶ 住空間と光環境. Shuwa System Co Ltd, 2008
- [5] Ayşe Durak, Nilgün Camgöz Olguntürk, Cengiz Yener, Dilek Güvenç, Yusuf Gürçınar. Impact of lighting arrangements and illuminances on different impressions of a room. *Building and Environment*. 2007, **42**: 3476-3482.
- [6] KI Fostervold and J Nersveen. Proportions of direct and indirect indoor lighting – The effect on health, well-being and cognitive performance of office workers. *Lighting Res. Technol*. 2008, **40**: 175–200