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Survey of Historic Sims in Thailand: An In-situ, Inter-institutional Lighting Study

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Current study was 3-day, exploratory site survey of historic Sims (small village temples used by monks) in Northeastern Thailand, conducted by team of professors/ researchers and students, hailing from universities in Thailand and USA, representing architecture and allied building disciplines. Existing conditions were documented via digital cameras. Measurements were conducted using: manual and laser tape measures. Reflected ceiling plans were developed. Light was measured using illuminance meter. Researchers compared findings to various lighting standards for various visual tasks. Luminaires and lighting techniques were noted. Sims were constructed between 1865-1953. 100% were renovated. Original illumination was natural light and candlelight. More recently, artificial sources, including fluorescent and LED were installed. Measured lighting levels exhibited variability. Some measurements did not comply with industry standards. Researchers speculated that some alterations were for practical reasons (i.e., using electric light in lieu of candles) or to reflect newer styles, (i.e. changes in height of temples) apparently to comply with new standards, over time. Researchers speculated that original candlelight produced variance with irregular flicker, creating mystery. Newer electric lighting was determined to be glaring and monotonous; mounted centrally overhead; producing relatively even light with no differentiation for important religious artifacts.

Keywords: *temple, interior, historic, Thailand, light*

Introduction

Sims are small village temples used mostly by Buddhist monks. These are often located in the rural villages of countries such as Thailand. Sims often contain a detailed and colorful mural and/or a large statue of Buddha.

In sacred buildings as well as other building types, light can illuminate interior environments, and enhance visual tasks (i.e., walking on uneven surfaces, reading from books, and viewing murals and other artwork, etc.) and can create a particular mood or ambience. Over time, however, lighting may evolve in historic structures. What was previously lit with daylight and candlelight may now be lit with modern electric replacements or supplements.

According to the Illuminating Engineering Society of North America (IESNA, also known as IES), lighting can play an important role in meeting the challenges of a building's end-users to see visual tasks and appropriate lighting can improve quality of life and promote health, well-being, and safety (DiLaura et al. 2011). In

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addition, the IES recommends that facilities view good lighting as a preventative measure and give priority consideration to facilities' lighting (DiLaura et al. 2011).

Lighting Terminology

Lighting is a complicated phenomenon and various authors and researchers have attempted to quantify and/or qualify aspects of illumination and make recommendations for lighting design. One seminal publication coined the term "compositional lighting techniques" (DiLaura et al. 2011). This speaks to the quality of the light. The authors wrote "In lighting design, composition refers to the organization of light and color to create brightnesses that pull the various parts of the design solution into a satisfying and visually logical whole." (DiLaura et al. 2011, p. 28). These techniques include: "highlighting" (illuminating art or object 3x or more than surround), "wallwashing" (even illumination of wall), "beam play" (beam of light is predominant), "shadow play" (shadows cast by light are predominant), "silhouetting" (sandwich the object being viewed between viewer and light source resulting in no frontal detail on object), "backlighting" (illuminate through a medium, such as a translucent lens), "structural lighting" (light fixtures are mounted on beams or other structural or built-in feature), "downlighting" (lighting is aimed in downward direction), "grazing" (light source is near a textured surface and emphasizes texture, i.e. on a brick wall), "uplighting" (light is aimed in upward direction), "sparkle" (bits of brightness), "light as art" (such as if the luminaire is decorative and dominant) (DiLaura et al. 2011, 30–36).

> Another aspect of lighting is illuminance. According to ERCO (1996-2004), "Illuminance (E) may be defined as "the quantity of light incident on a surface. It is the ratio of the incident luminous flux (Φ) to the size of the surface (A). The unit of measure of illuminance is lux (lx). This is defined as lumens per square meter ($1lx = 1lm/m^2$). Illuminance recedes with the square of the distance from the light source (photometric law of distance)...The illuminance falling on a surface can be measured with an illuminance meter (in lux)" (ERCO 1996–2004).

Lighting Standards

Recognized lighting standards have been developed by various credible organizations. These include: The Illuminating Engineering Association of Thailand which produced the *TIEA Guide of Recommended Interior Illumination level (*TIEA 2016). The Illuminating Engineering Society of North America produced *The Lighting Handbook* (DiLaura et al. 2011). The Commission Internationale de l'eclairage produced *CIE Standard* (CIE 2001) and *Lighting of Indoor Work Places* (CIE 2001); and The Chartered Institution of Building Services Engineers which produced the *Code for Lighting* (CIBSE 2002). These standards have all been adopted by various municipalities or other government entities around the world and are considered to be best practices and address illuminance levels (lux, lx) that are recommended for various visual tasks.

Literature Review

Lighting in the interior environment is very important. It is especially critical when a segment of the anticipated building's end-users (DiLaura et al. 2011) (i.e., Sim temple end-users, (i.e., Buddhist monks, or villagers, visitors and tourists), tend to be older individuals). As one ages, more light (illuminance) is needed to see at the same level as a younger person (DiLaura et al. 2011). Regarding lighting and older adults, lighting design directly impacts quality of life (DiLaura et al. 2011). Older people's "quality of life experiences (are)…expressed in their perceptions, evaluations, and satisfactions…" (Campbell et al. 1976). Other researchers found a close relationship between lighting and quality of life in relation to older people and also suggested that lighting for older adults be studied and improved (Sörensen and Brunnström 1995).

Generally, prior to the current research, a dearth of published studies regarding the documentation and/or analysis of the illumination of historic, Sim building interiors, located in Thailand, was noted. A few conference presentations regarding field studies conducted in Thailand were found which examined the 1) illumination in a Catholic chapel (Hébert et al. 2017) and 2) illumination in a museum (Hébert and Chaiyakul 2020). One conference presentation (Hébert et al. 2023) examined the illumination of historic Thai Sims' interiors. However, several recent, scholarly, in-situ studies, examining existing lighting at other building types, in Australia, India, Malaysia and the USA, were found (Hébert et al. 2023, Hebert and Tanfield 2024, Stall-Meadows et al. 2011, Hébert and Erdley 2019)

Further, examinations of existing lighting at various sites in the USA, which utilized a range of measuring devices and digital tools, in-situ, including a Smart Spectrometer Data Logger, to gather empirical data, were found (Hébert and Thompsen 2011, Hébert et al. 2021, Hébert et al. 2023, Hébert et al. 2018) one published study examined the architecture of temples in Taiwan (Chen 2024). One examined the plans of Buddhist temples in Mongolia Haoribao et al. 2022). Previously, other researchers studied folk Buddhism in Taiwan in mountain temples (Mei-Rong and Quan-Zheng 2004).

Methodology

The current study consisted of three days of exploratory, site surveys during which eight different historic Sims (small village temples used mostly by monks) located in Northeastern Thailand were examined. Refer to Figure 1 for a map of where the sites are located.

Figure 1. *Map of Northeastern Thailand and Sim Site Locations*

The site survey was conducted by an international team (Americans and Thai) consisting of 18 members. The team was inter-institutional, representing four universities. Professors/researchers, undergraduate students and graduate students comprised the team. They represented architecture & allied building disciplines. Existing conditions at the Sim temple sites in Northeastern Thailand were visually documented via digital phone cameras.

Field measurements were conducted using: manual and laser tape measures: 1) Krucker manual tape measure, 2) PromaLEO250 tape measure and 3) CEM laser tape measure. Refer to Figure 2 for images of the Tape Measure Tools. These building measurements were utilized by the researchers to inform the reflected ceiling and lighting plans they created after their site visits. The reflected ceiling and lighting plans were created using AutoCAD computer-aided design software.

Figure 2. *Tape Measure Tools*

Source: Authors.

Lighting was empirically measured using an Illuminance Meter CL-500A Illuminance and industry practices. Refer to Figure 3 for a photograph of the illuminance meter.

Figure 3. *Illuminance Meter*

Source: Authors.

Light meter readings of illuminance levels were taken in the interior at each of the temples at the following locations: 1) Navigating the walkway (horizontal orientation, 0 meters (m.) above finished floor (AFF) for walking tasks), 2) Reading books (horizontal orientation, 0.50 m. AFF at "work plane height" for reading tasks and 3) Viewing mural (vertical orientation, 1.50 m. AFF). Researchers utilized descriptive statistics to determine the mean levels for their in-situ light level readings. They later compared these average levels to multiple lighting standards to check for compliance. They utilized: 1) Illuminating Engineering Association of Thailand's the *TIEA Guide of Recommended Interior Illumination level* (TIEA 2016). 2) The Illuminating Engineering Society of North America publication, *The Lighting Handbook* (DiLaura et al. 2011); 3) The Commission Internationale de l'eclairage's *CIE Standard Lighting of Indoor Work Places* (CIE 2001); and 4) The Chartered Institution of Building Services Engineers' publication entitled the *Code for Lighting* (CIBSE 2002). These aforementioned lighting standards all provided illumination recommendations regarding the quantity of light recommended for various visual tasks, (i.e., walking, reading or viewing artwork).

Researchers also identified and noted the light source types (i.e., fluorescent); luminaire types (AKA light fixtures or light fitting, i.e. open can, bare strip) and the locations of the interior luminaires (i.e., surface mounted, pendant mounted) in the Sims. They identified the associated compositional lighting techniques, utilizing Smith and Bertolone's (1986) quality of light classifications as a guide.

Figure 4. *Sim A: Chai Sri Temple, Khon Kaen*

Source: Authors.

Figure 5. *Sim B: Suan Waree Temple, Khon Kaen*

Source: Authors.

Figure 6. *Sim C: Sra Thong Temple, Khon Kaen*

Source: Authors.

Figure 7. *Sim D: Kosol Matchimawas Temple, Nakhon Phanom*

Source: Authors.

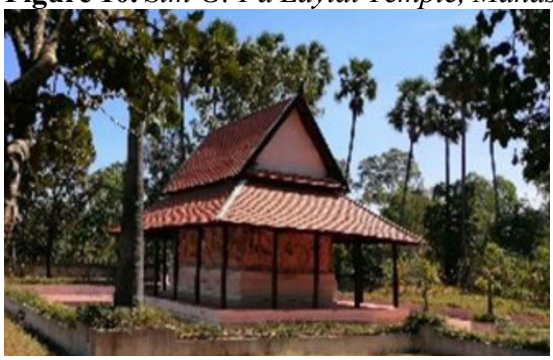
Figure 8. *Sim E: Burapharam Temple, Nakhon Phanom*

Source: Authors.

Figure 9. *Sim F: Phutthasima Temple, Nakhon Phanom*

Source: Authors.

Figure 10. *Sim G: Pa Laylai Temple, Mahasarakham*



Source: Authors.

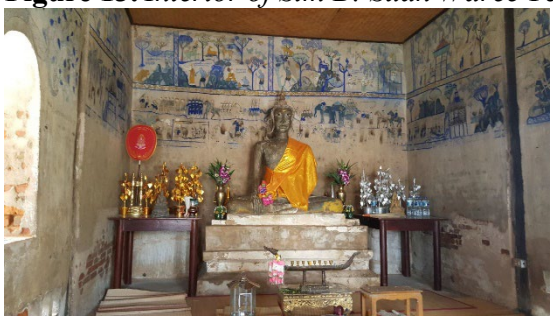
Figure 11. *Sim H: Photharam Temple, Mahasarakham*

Source: Authors.

Figure 12. *Interior of Sim A: Chai Sri Temple, Khon Kaen*

Source: Authors.

Figure 13. *Interior of Sim B: Suan Waree Temple, Khon Kaen*



Source: Authors.

Figure 14. *Interior of Sim C: Sra Thong Temple, Khon Kaen*

Source: Authors.

Figure 15. *Interior of Sim D: Kosol Matchimawas Temple, Nakhon Phanom*

Source: Authors.

Figure 16. *Interior of Sim E: Burapharam Temple, Nakhon Phanom*

Source: Authors.

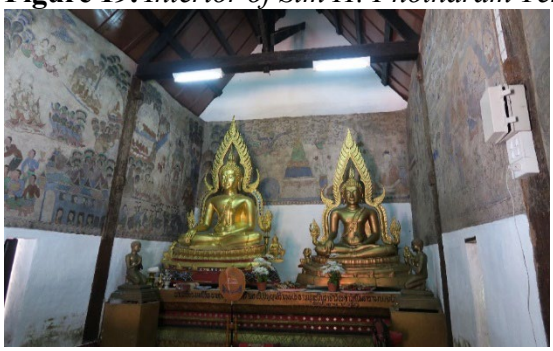
Figure 17. *Interior of Sim F: Phutthasima Temple, Nakhon Phanom*

Source: Authors.

Figure 18. *Interior of Sim G: Pa Laylai Temple, Mahasarakham*

Source: Authors.

Figure 19. *Interior of Sim H: Photharam Temple, Mahasarakham*



Source: Authors.

Findings

General

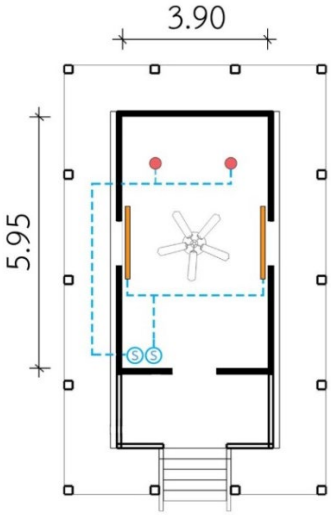
According to local records and anecdotal evidence, the eight examined Sims were originally constructed between 1865-1953. It was found that all (100%) of the Sims had been renovated over time. Observed interventions included at the sites included: 1) interior ceiling and wall repairs; 2) roof repair; 3) repairs to original interior mural paintings; 4) renovations to the volumes of Sims (i.e. raising of roofs);

4) repainting of room interiors in modern colors; 5) lighting and electrical modifications. Refer to Figures 4-19 for color photographs of the Sim sites and interiors.

Lighting

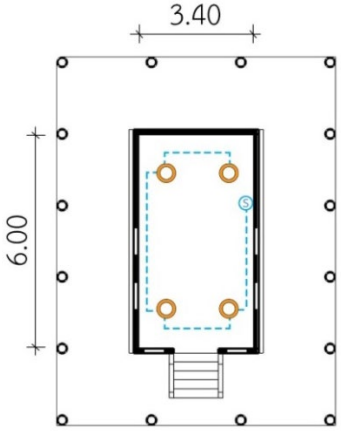
Anecdotal and some visual accretion evidence (candlewax) informed the researchers that the original illumination of the Sims had been via natural light & candlelight. More recently, artificial sources, including fluorescent and Light Emitting Diode (LED)s and associated wiring and controls (i.e., light switches), had been installed. It was found that the newer interior lighting was often mounted towards the center of Sim ceilings. Dimensioned in meters, the reflected ceiling and lighting plans of the Sim temples, showing the location of existing lighting fixtures and associated wiring observed in the current study, were developed. Refer to Figure 20-27 for the eight reflected ceiling plans. Refer to Table 1 for the Sim reflected ceiling and lighting plan legend.

Figure 20. *Reflected Ceiling Plan of Sim A: Chai Sri Temple, Khon Kaen*



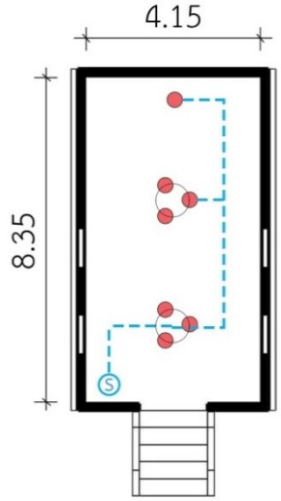
Source: Authors.

Figure 21. *Reflected Ceiling Plan of Sim B: Suan Waree Temple, Khon Kaen*



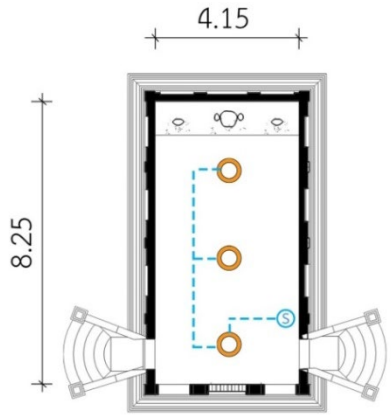
Source: Authors.

Figure 22. *Reflected Ceiling Plan of Sim C: Sra Thong Temple, Khon Kaen*



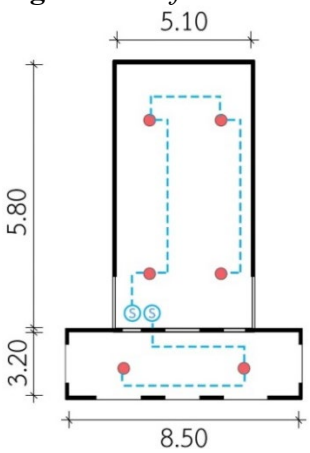
Source: Authors.

Figure 23. *Reflected Ceiling Plan of Sim D: Kosol Matchimawas Temple, Nakhon Phanom*



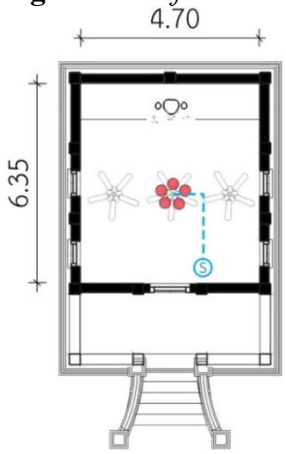
Source: Authors.

Figure 24. *Reflected Ceiling Plan of Sim E: Burapharam Temple, Nakhon Phanom*



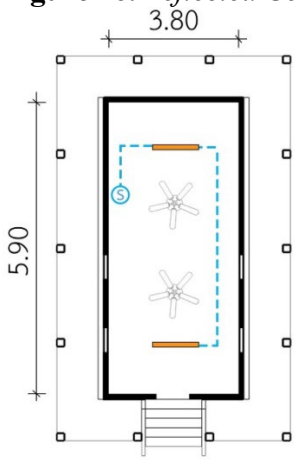
Source: Authors.

Figure 25. *Reflected Ceiling Plan of Sim F: Phutthasima Temple, Nakhon Phanom*



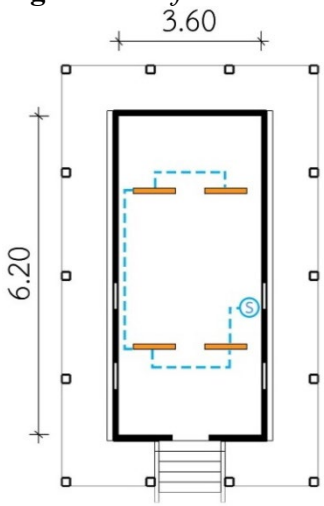
Source: Authors.

Figure 26. *Reflected Ceiling Plan of Sim G: Pa Laylai Temple, Mahasarakham*



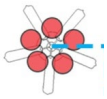
Source: Authors.

Figure 27. *Reflected Ceiling Plan of Sim H: Photharam Temple, Mahasarakham*



Source: Authors.

Table 1. *Sim Reflected Ceiling and Lighting Plan Legend*

Symbol	Description
	Fluorescent open can luminaire
	Fluorescent surface mounted luminaire
	Fluorescent bare strip luminaire
	Fluorescent pendant mounted luminaire
	Ceiling fan
	Ceiling Fan with fluorescent light kit
	Light switch

Note: Light Emitting Diode (LED) battery-operated candles had been temporarily installed at Sim D. Refer to Figure 28. These were mounted approximately one m. AFF but since they were not ceiling mounted and not electric, they were not shown in Table 1.
Source: Authors.

The researchers found that all of the newer, building-mounted, hard-wired, interior lighting consisted of fluorescent sources. Some of the fluorescents were the linear type and some were the compact type. Refer to Table 1 for the reflected ceiling and lighting plan legend which denotes light sources and mounting locations. Additionally, temporary, battery-operated, light emitting diode (LED) candles had been installed in Sim D. Refer to Figure 28 for photograph of the LED candles in Sim D.

Figure 28. *Illuminated Interior of Sim D with Temporarily Installed LED Candles*

Source: Authors.

Researchers identified the associated compositional lighting techniques, utilizing Smith and Bertolone's (1986) quality of light classifications as a guide. They determined that a total of (N=5) lighting techniques were represented within the Sims: Highlighting (n=0); Wallwashing (n=2, Sim A & C); Beam Play (n=0), Shadow Play (n=0); Silhouetting (n=0), Backlighting (n=0); Structural lighting (n=2, Sim G & H); Downlighting (n=2, Sim A & E); Grazing (n=0); Uplighting (n=0); Sparkle (n=1, Sim D); Light as Art (n=1, Sim C). Generally, there was a dearth of representation of the aforementioned compositional techniques in the examined Sims. Less than one-half (n=5, 41.6%) of the twelve compositional lighting techniques (Smith and Bertolone 1986) were found by the current researchers in the eight Sims. The illumination in the Sims was generally ambient and lacked hierarchy. Refer to Table 2 for the Compositional lighting techniques observed.

Table 2. *Compositional Lighting Techniques Observed*

	Sim Site							
	A	B	C	D	E	F	G	H
Compositional Lighting Techniques								
Highlighting								
Wallwashing	X		X					
Beam Play								
Shadow Play								
Silhouetting								
Backlighting								
Structural Lighting							X	X
Downlighting	X				X			
Grazing								
Uplighting								
Sparkle				X				
Light as Art			X					

Source: Authors.

Researchers utilized descriptive statistics to determine the mean measured illuminance levels in the eight Sims. A total of 21 mean light levels were reported. Refer to Table 3 for average illuminance levels in Sims, by task.

Table 3. *Average Illumination Levels (in lux (lx)) Measured at Specified Heights in Sims where Visual Tasks Occurred (i.e. Walking, Reading, Viewing) in Meters (m) Above Finished Floor (AFF)*

Sim		Visual Task and Height of Task AFF								
		Walking at 0. m.			Reading at 0.50 m.			Viewing Wall Mural at 1.5 m.		
		Horizontal Orientation of Task & Light Meter			Horizontal Orientation of Task & Light Meter			Vertical Orientation of Task & Light Meter		
		Average Measured Light Level (Lux)	Standards Recommendations		Average Measured Light Level (Lux)	Standards Recommendations		Average Measured Light Level (Lux)	Standards Recommendations	
			TIEA/ IES/ CIE	CIBSE		TIEA/ IES/ CIE	CIBSE		TIEA/ IES/ CIE	CIBSE
A	Chai Sri Temple, Khon Kaen	**75**** ***	100	100	**88**** ***	300	150	**138**** ***	300	150
B	Suan Waree Temple, Khon Kaen	187			**229****			**252****		
C	Sra Thong Temple, Khon Kaen	261			**205****			*		
D	Kosol Matchimawas Temple, Nakhon Phanom	615			489			*		
E	Burapharam Temple, Nakhon Phanom	369			386			*		
F	Phutthasima Temple, Nakhon Phanom	253			**219****			422		
G	Pa Laylai Temple, Mahasarakham	**36**** ***			**41**** ***			**69**** ***		
H	Photharam Temple, Mahasarakham	**59**** ***			**59**** ***			**79**** ***		

Notes:
1) *No murals exist in this Sim.
2) Bolded values indicate measured light level was too low to comply with one or more standard:
TIEA/IES/CIE **
CIBSE ***
Source: Authors.

The measured interior lighting levels appeared to exhibit variability within and across the Sim temples. Average measured illuminance ranged from a low of 41 lx in Sim G to a high of 615 lx in Sim D. Some illuminance measurements did not comply with current industry standards. Refer to Table 3 for the light level measurements as compared to industry standards.

The results were compared with four standards. It was found that three of the standards (TIEA, IES and CIE) utilized the same recommended average light level for all of the visual tasks studied (walking, reading and viewing mural) and that one standard (CIBSE) was different from TIEA, IES and CIE for both of the visual tasks of *reading* and *viewing murals*. Refer to Table 3 for average measured light levels and a comparison of the measured illumination levels to the recommendations put forth in the four standards.

For the visual task of *walking* in the Sims (N=8 average measured illuminance in each of the eight Sims), it was determined that over one-third (n=3, 37.5%) of the Sims (A, G and H) did not comply with either the TIEA/IES/CIE or CIBSE standards.

For the visual task of *reading* in the Sims (N=8), it was found that almost two-thirds (n=5, 62.5%) of the average illumination levels measured in the Sims (A, B, C, F, G & H) did not comply with the TIEA/IES/CIE standards and over one-third (n=3, 37.5%) of the average illumination level in the Sims (A, G & H) did not comply with the CIBSE standard.

For the visual task of *viewing murals* (N=5), it was determined that a majority (n=4, 80%) of the average illumination levels did not comply with the TIEA/IES/CIE standard and over one-half (n=3, 60%) did not comply with the CIBSE standard. Note that there were only five averages for the task of viewing murals because no murals existed in Sims C, D or E.

Refer to Table 3 for standards compliance.

Discussion

Researchers speculated that some of the noted renovations and interior alterations were probably made for practical reasons: (i.e., using electric light in lieu of candles to reduce fires); to reflect newer styles (i.e. changes in height and volume of temples apparently to comply with new standards, over time. The researchers speculated that originally in Sims, candlelight probably produced some variance as candle flames could be influenced by variables, (i.e. drafts and other movement within the Sims; impurities in the candle wax; moisture, wick trimming, etc.). Candlelight may flicker irregularly, presumably creating an air of mystery. Compositional technique that might be associated with candlelight include: Sparkle, Uplighting, Shadow play, Silhouette, and Highlighting. It should also be noted that historically, daylighting in Sims may have created different patterns and light levels based on time of day and changing seasons. With building alterations, some fenestration, and presumably associated daylight effects, were changed.

Generally, there was a dearth of representation of the aforementioned compositional techniques in the examined Sims. Less than one-half (n=5, 41.6%) of the twelve compositional lighting techniques, originally identified by Smith and

Bertolone (1986), were found by the current researchers in the eight Sims. The researchers perceived that the newer electric lighting in the renovated Sims was somewhat glaring, monotonous, and mostly mounted overhead in the central of the ceilings in the Sims. Unfortunately, these newer lighting installations produced relatively even illumination with no highlighting or hierarchy of light for important and sacred artifacts (i.e., mural, statue of Buddha).

Also, it should be noted that all of the examined lighting standards are relatively new and came into effect long after the Sims were originally built and potentially even after some of the Sims were renovated. The current lighting standards are based on commercially available, artificially-created, electric lighting sources (i.e., fluorescent and LED). The lighting standards generally address the needs of end-users in modern buildings within urban contexts. However, the studied Sim buildings were constructed within local contexts and originally utilized natural light and flame sources (i.e., candles) exclusively. The newer lighting standards may not take religious rituals and the intended sacred nature of the Sim interiors into account when recommending light levels for tasks such as reading. Light levels recommended for reading in an institutional setting, such as a library, and intended for longer periods of time, may need to be of higher lux than shorter readings in a temple, which may also be meant to evoke feelings of deep meaning and mystery. The applicability of the current lighting standards to this religious building type located in the rural areas of Thailand should be studied further.

Conclusions

The researchers perceived that, unfortunately, the observed building renovations appeared to not be respectful of Sims' original building typology, former ritualistic nature, and associated sacred tasks. Measured light levels varied at the examined Sims and they did not all meet the four consulted industry standards.

This research fills a gap in the literature regarding the illumination of Sim temples in Thailand and the documentation of Sims. Although only eight temples were visited, this study lays the groundwork and methodology for future Sim lighting research in Thailand and beyond.

Implications

Sims do not evoke the same spirituality with their current modifications as did the original Sims. Sims are no longer as authentic as they once were with their current modifications. The studied Sims may no longer fully support the traditional Buddhist rituals or create the same ambience as those experienced in previous times. Older end-users, including Buddhist monks, villagers, visitors and tourists, may have difficulty with some visual tasks within the Sims due to light levels and associated glare. Further, some measured light levels were far in excess of some standards' recommended light levels which could indicate an unnecessary waste of electricity.

Recommendations

Sims should be returned to original design with regards to building configurations, height and interior decoration; murals should be conserved and return to original designs; existing lighting should be replaced with the lighting better reflecting that which was originally installed with regards to: light sources, light levels, luminaire installation locations and compositional lighting techniques.

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