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APPLICABILITY OF LEED REQUIREMENTS TO ACHIEVE WATER EFFICIENCY IN SRI LANKAN HOTEL INDUSTRY

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ABSTRACT

LEED is an universally used green ranking system in the world. Among the six evaluation factors it specifically focuses on water use reduction, water efficient landscaping and innovative wastewater technologies. LEED provides a structure or collection of metrics to determine the water efficiency level that a building can achieve. Most of the hotels worldwide are inclined towards gaining LEED certification which is prompted by the higher volumes of water consumption in the facility. LEED is a US created rating system and the most categories of LEED certification are built according to the US aspects. Being an Asian country, Sri Lankan hoteliers also attempt to obtain LEED certification to their hotels with the motive of becoming in order to be more efficient. However, some of LEED requirements under the water efficiency category does not match the Sri Lankan hotel industry requirements. Therefore, the aim of the study to identify whether the LEED requirements under the water efficiency can be applied to Sri Lankan hotel industry. To accomplish the aim, literature synthesis was conducted to explore the water efficiency practices used by LEED certified hotels in other countries. A qualitative research methodology was subsequently adopted, directing semi-structured interviews with two LEED certified hotels in Sri Lanka to identify the LEED practices used in Sri Lankan hotel industry. Thematic analysis was conducted to analyse the collected data. Finally, a framework was developed to compare and contrast the water efficiency practices used in LEED certified hotels in other countries and Sri Lanka.

Keywords: *Green Building Rating System (GBRS); Leadership in Energy and Environment (LEED); Water efficiency.*

1. INTRODUCTION

Leadership in Energy and Environmental Design (LEED) is the most broadly adopted green building ranking system in the world, depending on the number of nations with more than 79,000 programs in more than 160 countries and regions (Doan, *et al.*, 2017). LEED system was established in 2000 by the U.S. Green Building Council (USGBC) for sustainable design practices (Xuan, 2012) and it is the worldwide known sign, which evaluates the building performance including water efficiency, sustainable sites, energy and atmosphere, materials and resources, indoor environmental quality, innovation in operations and regional bonus points (US Green Building Coulcil, 2021). LEED can be added to existing construction, existing buildings, industrial interiors, houses and

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facilities, residences, residential growth, school and retail building categories (Ahmed, *et al.,* 2019). Moreover, the authors declared that it has a point system that provides a score for green building design and construction. According to the earned points, there are four type of certification levels such as LEED Certified™ (40-49 points should be earned), LEED Silver® (50-59 points should earned), LEED Gold® (60-79 points should earn) and LEED Platinum® (80+ points should earn) (US Green Building Council, 2020).

According to Abeysekara (2015), Sri Lanka has 29 LEED certified buildings including 5 hotels and resorts such as Kandalama hotel, Cinnamon Bey hotel, Ulagalla Walawwa resort, Cape Weligama resort and Rainforest Eco lodge.To achieve LEED certification through water efficiency, there are several requirements needed to be full-filled by the buildings. According to US Green Building Council (2018), it is needed to reduce outdoor water usage, indoor water usage, building level water metering, cooling tower water usage, water efficient landscaping, innovative wastewater technologies, plumbing fixtures and fitting efficiency. According to the Green Building Market Report, Watson (2011) explained that a maximum of 1.2 trillion gallons (4.54 trillion litres) of water was saved by LEED certified projects. In addition to that Brown (2018), identified that LEED certified hotel building save 40% of water, 30% of energy, 35% of carbon emission and 70% of solid waste.

However, Rodrigo and Jayarathna (2012) pinpointed that complexity of the LEED requirements may cause an additional burden on anyone who attempts to follow LEED as certain people possess the perception that the documentation and certification procedures of LEED are costly and complex. Moreover, the authors explained that when applying LEED requirements in countries other than the United States for which it was originally developed, aspects such as compatibility, infrastructure, building policy, social needs, social and economic priorities may act as limitations. The above declaration therefore argues whether LEED certification is suitable to be used for achieving water efficiency in Sri Lankan hotel industry. In order to bridge the existing knowledge gap this paper intended to investigate the suitability of LEED certification to achieve the water efficiency in Sri Lankan hotel industry.

2. LITERATURE REVIEW

2.1 LEED

According to the U.S. Green Building Council (2017), LEED or Leadership in Energy and Environmental Design is the most universally used green ranking system in the world. Moreover, LEED offers a structure for the creation of safe, highly efficient and cost-effective green buildings and is a known global symbol of sustainability accomplishment.

Binh and Nguyen (2011), mention that the American LEED standard is comparatively ideal and one of the world's most sophisticated and practical green building certification scoring technologies. LEED certification system can be categorised as LEED-NC (applies to new buildings), LEED-CS (applies to owners and tenants to develop together), LEED-CI (applies to interior decoration of commercial buildings), LEED-ND (applies to community development), LEED-EB (applies to existing building operation management), LEED-FOR SCHOOLS and many other sub evaluation systems (Liu, et al., 2019). LEED certification system has a point system that provides a score for green building design and construction (Boston University, 2018). According to the earned

points, there are four types of certification levels such as LEED Certified™ (40-49 points should be earned), LEED Silver® (50-59 points should be earned), LEED Gold® (60-79 points should be earned) and LEED Platinum® (80+ points should be earned) (US Green Building Coulcil, 2021). Moreover, the authors emphasised that the LEED certification system evaluate six aspects when giving the certification for the buildings (refer Table 1).

Table 1: Requirements of LEED certification

Category	Description
Sustainable sites	Sustainable Sites (SS) strategies address effects by enhancing environmental choices around the construction and highlighting the essential interactions between structures, ecosystems and ecosystem services.
Water efficiency	Specialised applications and metering methods to reduce indoor use, outdoor use of water. It measures all building related water sources, including cooling towers, appliances, fittings, process water and irrigation.
Energy efficiency	Focusing on decreasing energy demand through energy use and efficiency instruction and then also give priority to use renewable energy sources, LEED increases the bar on energy and provides fresh alternatives to achieve objectives.
Material	This category is intended to take into account the entire building life cycle, from extraction and manufacturing to transport, operations and maintenance and ultimately the end of life.
Indoor Environment Quality	Provide strategies to maintain indoor air quality, thermal, visual, and acoustic comfort.
Innovations	New techniques are continuously implemented on the market and current scientific research affects the development of design strategies.

(Source: US Green Building Council, 2018)

2.2 DIFFERENT WATER EFFICIENCY REQUIREMENTS OF LEED CERTIFICATION

The water efficiency classification under the LEED certification focuses specifically on water use reduction, water efficient landscaping and innovative wastewater technologies (Gurgun, *et al.,* 2013). According to the US Green Building Council (2019), the requirements should be full filled to get the LEED certification can be described as follows.

2.2.1 Prerequisites

These requirements are necessary to end or to the carrying out of a function. Therefore, to get the LEED certification, the building should be achieved following requirements earlier (Janelle, 2018). It also adds value when calculating the credits under the LEED certification.

A. Outdoor Water Use Reduction

This requirement describes that how to build up the facility to reduce the future (operation Phase) outdoor water consumption. According to the US Green Building Council (2019),

the facility should be fulfilled the reduction of outdoor water usage through one of the following options.

- Option 1: No irrigation required

Beyond a fixed establishment duration of two years, the landscape does not require a permanent irrigation system.

- Option 2: Reduced irrigation

Landscape water use for peak irrigation at the site may be reduced by at least 30% from the baseline measurement. The reduction of water must be done by plant species and the effectiveness of the irrigation system. Two additional points can be earned by reducing the prerequisite water requirement. The point allocation for additional outdoor water conservation can be shown as given in Table 2.

Table 2: Points for reducing irrigation water

Percentage reduction from baseline	Points
50%	1
100%	2

B. Indoor Water Use Reduction

The aim of this prerequisite is reducing the indoor water consumption before the operation of the facility. All recently installed washrooms, urinals, private wash faucets and showerheads should be labelled with Sense water (SLOANE Global Holdings, 2016). The basic water consumption of fixtures and fittings is given in Table 3.

Table 3: Baseline water consumption of fixtures and fittings

Commercial Fixtures, Fittings, and Appliances	Current Baseline (SI units)
Water closets (toilets)	6 liters per flush (lpf)
Urinal	3.8 liters per Flush (lpf)
Public lavatory (restroom) faucet	1.9 liters per Minute (lpm) at 415 kPa, all others except private applications
Private lavatory faucet	8.3 lpm at 415 kPa
Kitchen faucet (excluding faucets used exclusively for filling operations)	8.3 lpm at 415 kPa
Showerhead	9.5 lpm at 550 kPa per shower stall

(Source: US Green Building Council, 2019)

Moreover, the US Green Building Council emphasised that water consuming appliances, equipment, and processes must meet the requirements listed in Table 4.

C. Building Level Water Metering

As a precondition for receiving water efficiency points, LEED has introduced a building level water metering standard (Harbour, 2016). According to the US Green Building Council (2019), permanent water meter installation will calculate the maximum use of the building's potable water and associated grounds. Monthly or annual meter readings must be collected manually or automatically. It is also noted that this

commitment will continue for a period of five years or until the building changes ownership or the lessor.

Table 4: Standards for appliances

Appliance	Type	Requirement (SI units)
Dishwasher	Under counter	≤ 6.0 liters/rack
	Stationary, single tank, door	≤ 5.3 liters/rack
	Single tank, conveyor	≤ 3.8 liters/rack
	Multiple tank, conveyor	≤ 3.4liters/rack
	Flight machine	≤ 680 liters/hour
Food steamer	Batch	≤ 23 liters/hour/pan
	Cook-to-order	≤ 38 liters/hour/pan
Combination oven	Countertop or stand	≤ 13 liters/hour/pan
	Roll-in	≤ 13 liters/hour/pan

(Source: US Green Building Council, 2019)

2.2.2 Additional Requisites

Once the facility has fulfilled all the preconditions, there are four places where additional LEED credit points can be received by the facility.

A. Outdoor Water Usage

Eliminating the need for an outdoor irrigation system fully or increasing the need for landscape water by at least 50 % will receive up to 2 points (SLOANE Global Holdings, 2016).

The 50 % reduction of water can be accomplished from the approximate base point for the site's peak irrigation month by selecting plant species and active irrigation systems (US Green Building Council, 2019). In addition, the article highlighted that any combination of capacity, alternative water sources and intelligent scheduling technologies could achieve additional reductions above 30%.

B. Indoor Water Usage

A building can gain up to six points for LEED certification by using high-efficiency components and alternative water resources to go beyond the precondition (Southerland, 2015). In addition, the author clarified that water recycling supports the pilot credit for sustainable wastewater management, which aims to reduce waste water use by 50% from a baseline. As stated in US Green Building Council (2019), required water reduction percentages and its credit allocation are given in Table 5.

C. Cooling Tower Water Use

The main aim is to maintain the water requirement of the cooling tower while regulating bacteria, oxidation and scale in the condenser water system (US Green Building Council, 2019). Evaporative condensers that are more energy efficient than traditional condensing systems due to evaporative systems can reduce air temperature more quickly and do not lose air humidity (Western Cooling Efficiency Center of the University of California Davis, 2011). Completing this sort of evaporative condenser would allow up to two points for a project (Southerland, 2015). For cooling towers and evaporative condensers, one-

time potable water study can be undertaken to optimise cooling tower cycles. The points are allocated according to the number of cooling tower cycles and Table 6 describes that credit allocation.

Table 5: Points for reducing water use

Percentage reduction	Points (CI Hospitality Industry)
25%	2
30%	4
35%	6
40%	8
45%	10
50%	11

(Source: US Green Building Council, 2019)

Table 6: Points for cooling tower cycles

Cooling tower cycles	Points
Maximum number of cycles reached without reaching any rate of filtration or affecting condenser water system operation (up to maximum of 10 cycles)	1
Achieve a minimum of 10 cycles by increasing the level of treatment in condenser or make-up water or achieve the number of cycles for 1 point and use a minimum 20% recycled non potable water	2

(Source: US Green Building Council, 2019)

D. Water Metering

Water metering is a new LEED version 4 credit that mainly focuses on water sub metering in the building (Western Cooling Efficiency Center of the University of California Davis, 2011). As stated in US Green Building Council (2019), two or more sub-systems such as irrigation, indoor plumbing and fittings, hot water, boilers, waste water or other process water should be installed in the sub-metering system.

3. METHODOLOGY

In order to fulfil the research gap, firstly it is needed to identify the LEED requirements needed to achieve under the LEED water efficiency category. A comprehensive review of literature was carried out to explore water efficiency requirements under the LEED certification by referring journals, web sites, books, dissertations, conference papers and other publications.

Qualitative research approach was selected since the research problem is exploring how LEED requirements are applicable for Sri Lankan hotel industry. Semi-structured interviews were used as data collection method to identify the applicability of the identified LEED requirements to achieve water efficiency in Sri Lankan hotels with reference to a case study strategy. Two case studies were done in two LEED certified hotels located in Kandalama and Beruwala. and through the 6 number of respondents, it was identified that how they use LEED requirements to their hotels in order to achieve the water efficiency.

Based on the data and findings collected, a comprehensive analysis was conducted by using thematic analysis method to identify the applicability of LEED requirements to achieve water efficiency in Sri Lankan hotel industry. According to Clarke and Braun (2013), the thematic form of analysis is a dynamic data analysis strategy that can be used to evaluate case studies, phenomenology and general qualitative and narrative investigations. Finally, the results of the study were used to achieve the final objective of the research, which was establishing the benefits of LEED certification system in terms of water consumption for the hotel industry.

4. RESEARCH FINDINGS AND ANALYSIS

4.1 WATER EFFICIENCY SYSTEM IN SRI LANKAN HOTEL INDUSTRY

This Section describes the water efficiency practices, which were used by the LEED certified hotels in Sri Lanka. As per empirical data gathered and analysis, discussion can be carried out by comparing the practices used by Sri Lankan hotels and the requirements which has mentioned under the water efficiency category in LEED. Table 7 summarised the existing water efficiency practices used in selected LEED certified hotels in Sri Lanka.

Table 7: Existing water efficiency practices used in LEED certified hotels in Sri Lanka

Existing Water Efficiency Practices	Hotel 1	Hotel 2
Use alternative water resources	x	x
Awareness Programme	x	x
Water aerators	x	
Sensor taps	x	
Dual flushing system	x	
Sewerage water treatment plant		x
Sub-metering	x	x
Sprinkler system for irrigation	x	
Sustainability team	x	
Rainwater harvesting system	x	
Use dishwashing machine	x	x
Use native plants	x	
Training programmes	x	
Water management plan	x	
Foreign visits	x	
BMS for monitoring	x	
Air cool chillers	x	x
7R principal	x	
Water management policies	x	
Knowledge sharing sessions	x	x
New management		x
Set targets		x
Innovative technologies	x	

Existing Water Efficiency Practices	Hotel 1	Hotel 2
Induction programmes	x	
Reuse of condensed steam water	x	x
Use atomizer for boilers to reduce the hardness of the water	x	

As per Table 7, it was summarised the water efficiency practices used in selected LEED certified hotels in Sri Lanka and it can be divided to two aspects such as water efficient fixtures and equipment and water efficiency mechanisms and technologies. Accordingly, it can be summarised as shown in Figure 1.

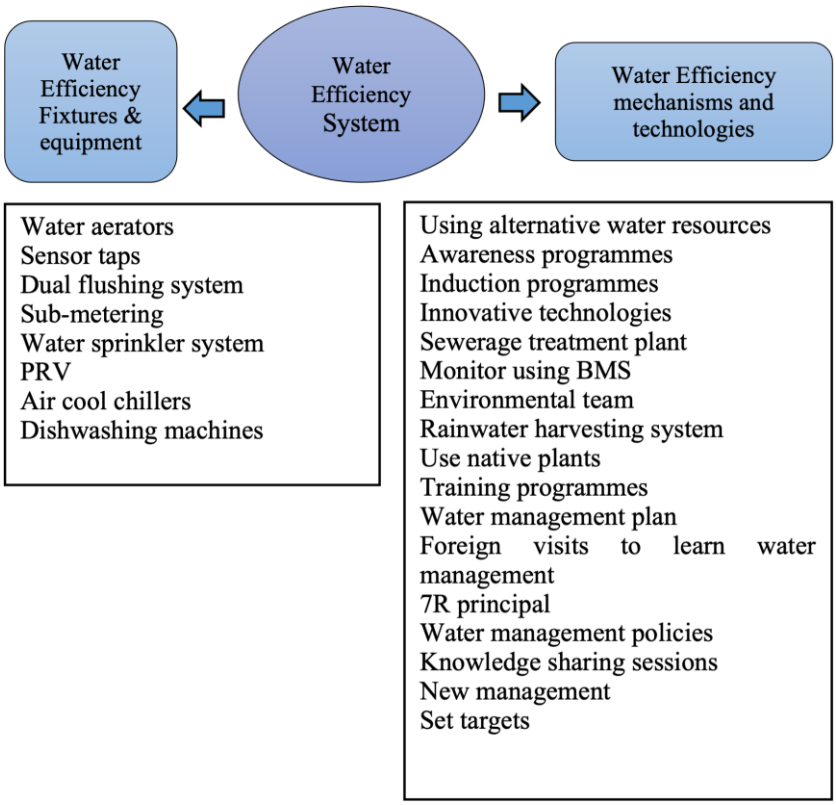

Figure 1: Water efficiency practices

As per the above analysis, most of the LEED hotels has focussed to reduce outdoor water usage, indoor water usage through the water efficiency mechanisms and technologies. Furthermore, they have tended to use innovative water management technologies such as 7R principal, water management policies, knowledge sharing session organizing with other hoteliers, water management plan, water saving method training, native plants used to reduce outdoor water consumption and they have used air cool chillers instead of using water cool chillers.

Table 8 shows the water efficiency practices used in Sri Lankan hotels as per the categories under the LEED certification. The empirical findings demonstrated that Sri Lankan LEED certified hotels are also following the water efficiency mechanisms similar to other countries. Sri Lankan hoteliers also use outdoor water reduction methods, indoor water reduction methods, cooling tower water reduction methods and water metering with new innovative technologies. Furthermore, they have use alternative water resources like tube well water, treated wastewater and harvested rain water in order to fulfil the water

requirement. In addition to that, they have used native plants which is suited for the Sri Lankan environment, since those plants do not require watering.

Table 8: Water efficiency practices

LEED Requirement	Water Efficiency Practices
Outdoor Water Use Reduction	Use native plants
	Reduced the artificial irrigation systems
	100% rainwater and treated waste water used for irrigation
	Use water sprinklers to spray water
	Use low water consuming plants
Indoor Water Use Reduction	Sensor taps
	Dual flushing systems
	Aerators
	PRV
	Dishwashing machines
	Low flow shower heads
Cooling Tower Water Usage Reduction	Use air cool chillers instead of using water cool chillers
Water Metering	Sub-metering the all the Section
	Install BMS to monitor the system

When it comes to indoor water use reduction, Sri Lankan LEED hotels have used sensor taps, dual flushing system, water aerators, pressure reducing valves, dishwashing machines and low flow shower heads as water efficient fixtures.

In order to reduce the cooling tower water usage, they have used air cool chillers instead of using water cool chillers. Further, they have always encouraged their staff and guests to use natural ventilation methods instead of using air conditioners. They have arranged several knowledge sharing sessions, leaflets, meetings for their guests and staff.

Moreover, all LEED certified hoteliers have installed sub meters and BMS to identify the water consumption and water wastages. By installing BMS to the water distribution system, they can check water consumption, daily water usage any time and they can get clear idea about water usage pattern and it helps to identify any wastages easily.

5. DISCUSSION

LEED certification was developed by the US, but using worldwide and the requirements under the LEED are environmentally compatible even in the Sri Lankan context (Rodrigo and Jayarathna, 2012). It also emphasised that Sri Lanka has knowledge skills and equipment to fulfil LEED certification credit requirements. As stated by Jayasinghe and De Silva (2011), most of the credit under LEED certification can be achieved without incurring significant initial incremental costs. Green Building Information Gateway (2019) stated that 51 buildings are achieved the LEED certification and there are only 2 hotels and 5 resorts in Sri Lanka.

As per the literature review, there are four requirements such as outdoor water usage reduction, indoor water usage reduction, cooling tower water usage reduction and water metering needed to be fulfilled by under the water efficiency category. According to the data analysis which was done by using the collected information in Sri Lankan LEED certified hotels, it proved that they have also following the water efficiency practices as per the LEED requirements.

ITC Grand Chola Hotel in Chennai is a LEED platinum rated hotel and it is the world's largest LEED Platinum rated Green Hotel (Tuppen, 2012). As stated in the article, the hotel is adapting several water conservation methods such as water harvesting structures using to collect storm water, using water efficient fixtures, fittings and appliances, it can be reduced water usage by 35% compared with conventional usage, choose plants that consume low water, while trees plant to reduce the loss of evaporation and thus reduce water consumption, use drip irrigation and timer-based controls to operate the irrigation valves and prevent wastage of water, the water from the last wash is used in the laundry to pre-wash the second cycle and the use of environmentally friendly low acidic washing fluids helps to reduce running time and saves water. The Hyatt hotel, which has become the first LEED-certified hotel in Seattle by receiving the LEED Silver certification, achieved a 32% reduction in water use by installing low-flow showerheads, washstands and water closets, along with dual-flow toilets and other water-saving innovations (Chikushi, 2009).

According to the case study results, all Sri Lankan LEED-certified hotels have same practices with regard to water efficiency practices in other countries. The majority of respondents in both LEED and non-LEED certified hotels highlighted the importance of water efficiency to reduce water consumption costs, align with company environmental policies, long term conservation, avoid unbalanced water distribution throughout the year and is used as a marketing tool, increase consumer satisfaction and maintain certifications. As per the case study findings, LEED-certified hotels and non-LEED-certified hotels have similar water saving practices, while there are several differences such as; no air-cooled chillers, appropriate meters, BMS systems to monitor water usage, and local plants to reduce outdoor water use, training programs to understand employees, water management plans, 7R principles, water management policies, knowledge sharing sessions. According to the above findings the framework given in Figure 2 has been developed to show how LEED requirements are suited for Sri Lankan hotel industry.

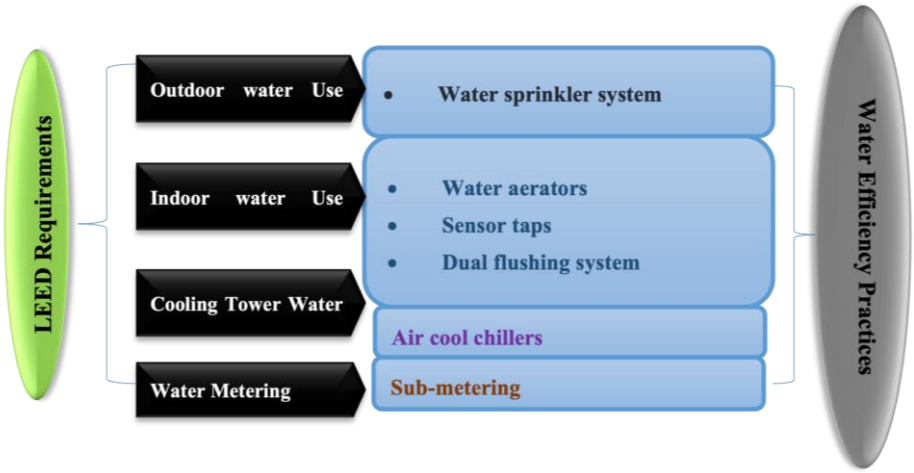

Figure 2: Framework

As per the framework, which is shown in Figure 2, black colour boxes show the water efficiency requirements under the LEED certification and blue colour boxes shows the water efficiency practices used by Sri Lankan LEED certified hotels as per the LEED requirement. This framework is useful to hotel industry people and students, who are following research regarding the water efficiency practices.

6. CONCLUSIONS

As outlined in introduction section, this review investigated the applicability of LEED certification requirements under water efficiency category in terms of achieving water efficiency in the hotel industry in Sri Lanka. At the very first, it was the identified the water efficiency requirements under the LEED certification system, which was achieved through a literature review of the study. According to the literature findings, in order to achieve the water efficiency hoteliers, need to reduce outdoor water consumption, indoor water consumption, cooling tower water consumption and sub metering with innovative water efficient technologies. Secondly, it was focused to identify the water efficiency practices used by Sri Lankan hotels through semi-structured interviews carried out during the case study exploratory process. According to that, they have used water efficiency practices as per the LEED requirements. Through these findings research aim was achieved and finally, it can be deduced that water efficiency practices under the LEDD certification are suitable to Sri Lankan hoteliers and they can easily achieve water efficiency by following LEED certification. In the case study and literature review, the final goal of identifying the applicability of LEED water efficiency practices in Sri Lankan hotel industry is achieved through the data analysis. The results of this research will be provided benefits to hotel industry professionals to identify and improve the water efficiency in Sri Lankan hotel industry.

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