An Assessment of Life Cycle Greenhouse Gas Emissions for day spa services in Eastern Thailand: A Case Study in Chonburi, Rayong, and Trad Provinces

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Abstract

Day spa services have become increasingly popular as people have become more interested in health and wellness due to a rapid increase in the older population, and also because the travel and tourism sectors are constantly offering these services. We conducted research to evaluate greenhouse gas (GHG) emissions of day spa services from twelve spas in three Eastern provinces in Thailand: Chonburi, Rayong, and Trad. The system boundary was from cradle to grave, starting from raw material acquisition, progressing to the spa service, and finishing with the waste disposal stage. The functional unit was one body spa package per person. The results showed that day spa services had GHG emissions of 5.76 kg CO_2 eq/person (ranging from 3.54 to 9.69 kg CO_2 eq/person). The net GHG emissions for each stage of the day spa services were as follows: service (84.70%), laundry (9.27%), waste disposal (5.82%) and transportation (0.22%). The service stage had the highest impact on overall GHG emissions, mostly due to electricity consumption from air conditioners and electrical equipment. Possible ways to reduce this service electricity usage included maintaining the air conditioners regularly, installing insulation in ceilings and walls, producing hot water either from solar or air conditioner sources, replacing incandescent bulbs with LED ones, and planting trees around the buildings. In addition, application of the 3R concept, (reduce, reuse and recycle), in the use of materials may not only help mitigate the emissions, but also minimize waste disposal, landfill, and the cost of excess resources used by day spa services.

Keywords: Life cycle assessment, Greenhouse gas emissions, Day spa, Spa service, Thailand

Introduction

Spas are one of the healthcare services that have become increasingly popular, because people, especially the increasing older population, are becoming more concerned regarding their health and wellness. Thai day spa services fit into a niche addressing these concerns. The numbers of tourists visiting Thailand increases each year (NSO, 2018), and annual growth in the demand for spa services (Chantaburee, 2016). According to the Department of Health Service Support, the number of registered spas passing certification from the Ministry of Public Health in 2013 was 2,032. The eastern part of Thailand had the highest increase in spas by 853.33% from 2012 to 2013, whereas the north, and south had 315.38% and 231.36%, respectively.

Day spas are a type of spa that offer a variety of services for the purpose of relaxation, and improving health and beauty (SMEs, 2006). The main feature of this type of spa is that it allows clients to enter for just an hour or for a whole day, offering either a single treatment or a combined package service. In Thailand, day spas are the most popular type, servicing 69% of the total amount of spa users (DTN, 2011). However, day spa services would create greenhouse gas (GHG) emissions from resources and energy usage along various pathways (Prasara-A, 2012).

Increases in GHG emissions from human activities cause an increase in the average surface temperature of the Earth, creating global climate change (IPCC, 2007) and resulting in an increase in severe weather conditions

(Hoegh-Guldberg et al., 2018). Accordingly, concern regarding the increase in climate change and its effects requires more research to find ways to reduce the GHG emissions. One method of doing so is by employing the life cycle assessment (LCA) method. This is an effective tool, and is widely used to evaluate the environmental impact of products and services during their entire life cycle, from raw material acquisition, processing, product manufacturing, product use, and their disposal (Curran, 2013).

A previous study on GHG emissions from spa services revealed some relevant results. Prasara-A (2012) studied the environmental impact assessment categories of human health, ecological system, and resource depletion. The results indicated that Thai spa services' greatest impact was on resource depletion, due to the use of fossil fuels and material production processes. In addition, this study showed that the body scrub process was the main contributor to resource depletion, human health, and the ecological system. Bath and laundry processes also had a significant impact on these aspect (Prasara-A, 2012).

The GHG emissions of universities as service provider have been studied by a number of researchers. They reported that universities in Thailand and other countries had GHG emissions in the ranges of 490-1,620 and 2,120-6340 kg CO_2 eq/person/annum, respectively. They concluded that electricity consumption was the largest contributor to GHG emissions (Maimun, Teekasap, Sareephattananon, & Rattanatai, 2018; Rippon, 2015; Usubharatana & Phungrussami, 2014).

Pongsakornrungsilp (2017) studied tourism GHG emissions from marine and beach destinations at Koh Samui in Surat Thanee. They found that the total GHG emissions from tourism in Koh Samui was 1,163.37 kilotons CO_2 eq/year or 616.74 kg CO_2 eq/tourist, from which international travel was the major source of GHG intensity (61.15%), followed by accommodation businesses (37.10%), local transportation (11.95%), and waste disposal (10.92%).

A study by Pongchavalit's (2014) intended to determine ways to reduce GHG emissions from medium and small hotels in Thailand. They reported that medium and small hotels had average GHG emissions of 553 ton CO_2 eq in 2013. When taken into account by number of guestrooms, GHG emissions were 18.81 kg CO_2 eq/room-night and 11.65 kg CO_2 eq/guest. Electricity was the main GHG contributor accounting for 83.06% of emissions (from air conditioner 60.09%, water heater 17.64%, lighting 15.05% and other 7.22%).

Based on the literature review, the assessment of GHG emissions from spa services was limited. Therefore, this study evaluated GHG emissions of day spa services in Eastern Thailand. Twelve spas located in three provinces were studied: Chonburi (7 spas), Rayong (3 spas), and Trad (2 spas). The results from this study revealed not only the effect of day spa service activities on GHG emissions, but also identified the main stage and sources of GHG emissions. This study also provided guidance to reduce emissions in day spa service pathways.

Methods and Materials

1. Goal and scope

The goal of this study was to evaluate GHG emissions from day spa services in Eastern Thailand using LCA methodology. Twelve spas were studied, all located in three eastern Thai provinces: Chonburi (7 spas), Rayong (3 spas), and Trad (2 spas). Day spa services with a body spa package were selected as this package uses large amounts of materials and energy and also comprises more service processes than other spa packages (Prasara-A, 2012). The data on day spa services was collected from interviews with each spa owner.

2. System boundary and functional unit

The system boundary was from "cradle to grave", beginning with raw materials acquisition, transportation to the service stage, then the laundry stage, and finishing with the waste disposal stage, as seen in Figure 1. In this diagram, it should be noted that some spas did their own laundry in-house, while others paid an outside vendor to do it for them, thus involving additional transportation. The functional unit was one body spa package per person. The results of GHG emissions were reported in units of kg CO_2 equivalent per person (kg CO_2 eq/person). However, client transportation, offering drinks before and after treatments, the amount of water and washing agents used in cleaning utensils, equipment, and labor were excluded from this study.

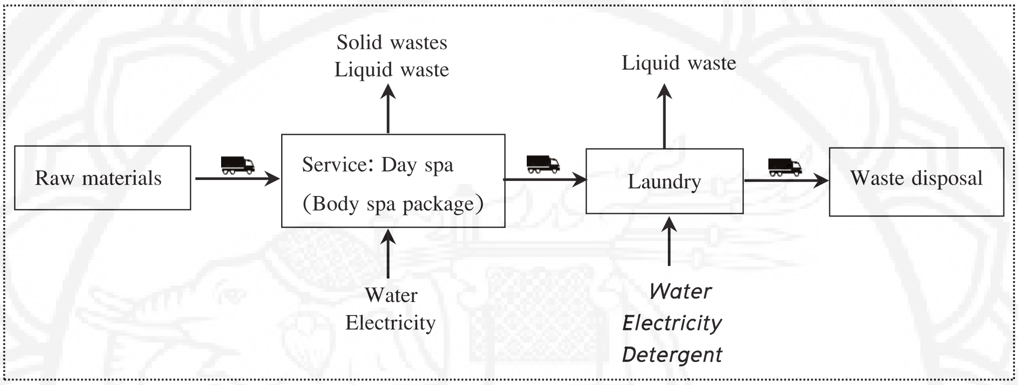

Figure 1 The system boundary of life cycle for day spa services

3. Life cycle inventory (LCI) analysis and assumptions

The data input for day spa services was mostly obtained from spa owners. Much potential data was not divulged by the owners as they regarded it as confidential. In addition, the amount of power used by the equipment to treat clients was often unknown to them. It was therefore necessary to collect data in other ways, such as from available literature and information on the equipment being used. These assumptions were based on information that was obtained from known spa treatments. The life cycle inventory database for raw materials, chemicals, and energy was acquired from the Thai national life cycle inventory database and the Ecoinvent database version 2.0 (TGO, 2016). The details of each stage and the assumptions are described below.

3.1 Service

Day spa services with a body spa package, typically consisted of a shower first, then sauna, scrub, mask, hydrotherapy, oil massage, and another shower after the treatment, although the service order and times varied from spa to spa. In this study, raw material acquisition input was included in the service stage. The electricity consumption associated with air conditioners and lights used in each process was accounted into the GHG inventory, because spa services in Thailand generally use both to accommodate their clients. The average data input for each process of the service stage and assumptions are shown in Table 1.

Table 1 Inventory input for each process of the service stage (per person)

Resources	Amount	Assumptions
Sauna		
Electricity (kWh)	0.71	For sauna heaters or herbal steamers, air conditioners, and lights: The average power consumption of a sauna heater, herbal steamer, and lights were 3000*, 1000*, and 60* watts, respectively. The average capacity of an air conditioner was around 12000* BTU, set at 25°C (TGO, 2015b)
Herbs (g)	67.50	Herb ingredients consisted of kaffir lime leaves, lemongrass, and shallots (Prasara-A, 2012) in equal proportions.
Water (L)	1.71	
Scrub		
Electricity (kWh)	0.96	For air conditioners and lights.
Scrub (g)	126.67	Scrub ingredients consisted of salt, honey, milk, marl and coconut oil (Angwara, 2003; Kongsuk, 2000) in equal proportions.
Disposable underwear (g)	14.67	Disposable underwear (used once and disposed of) (Prasara-A, 2012) had a weight of 16* g.
Mask		
Electricity (kWh)	0.82	For air conditioners and lights.
Mask (g)	92.92	Scrub ingredients consisted of salt, honey, milk, marl, and coconut oil (Angwara, 2003; Kongsuk, 2000) in equal proportions.
Mud (g)	43.33	Mud was obtained from Kaolin (Subtang, n.d.).
Plastic film (g)	13.14	Polypropylene film was used and had a weight of 18* g.
Disposable underwear (g)	8.00	
Hydrotherapy		
Electricity (kWh)	1.38	For a water heater, air conditioners, and lights. The power consumption of a water heater was about 2000* watts (DPT, 2008) and the flow rate of the water was 14* L/min (TGO, 2015b).
Water (L)	358.33	The capacity of the square and round-shaped bathtubs were 150* and 650* L, respectively.
Milk (L)	0.36	The average density of milk was 1.03 g/cm^3 (Nave, 2017).
Mineral water (ml)	35.83	
Coconut oil (ml)	15.83	The average coconut oil density of 0.93 g/cm^3 (Dorfman, 2000) was used.
Oil massage		
Electricity (kWh)	1.49	For air conditioners and lights.
Coconut oil (ml)	67.50	Coconut oil was used (Prasara-A, 2012).
Disposable underwear (g)	12.00	
Shower (before and after service)		
Electricity (kWh)	0.19	For an air conditioner and lights. The power consumption of a fluorescent light was 9* watts.
Shampoo (ml)	20	10 ml of shampoo (Prasara-A, 2012), with a density of 1.020 g/cm^3, (Gallant, 2012) was used each time.
Soap (ml)	20	10 ml of soap (Prasara-A, 2012), with a density of 0.932 g/cm^3 (Allard, 2005), was used each time.
Water (L)	50	25 L of water was used for each shower (Prasara-A, 2012).

* approximate value

3.2 Laundry

After the service, used clothes (i.e., towels and clothes) from each service process were laundered. It was assumed that the laundry was washed in a washing machine using a full load of 7 kg with 155 L of water, and 50 g of detergent powder for each wash (TGO, 2015a). The data on the number and type of laundry used at each service stage was obtained from the spa owners. The average data input for the laundry stage and assumptions are shown in Table 2.

Table 2 Inventory input of the laundry stage (per person)

Inputs	Amount	Assumptions
Electricity (kWh)	1.21	For washing machine and dryer. The power consumption of a washing machine and dryer was 0.14* (TGO, 2015a) and 1.45* (PEA, 2016) kWh, respectively.
Detergent powder (g)	0.02	
Clothes (kg)	3.29	The average weight of a towel and the clothes were 287* and 400* g, respectively.
Water (L)	72.94	

* approximate value

3.3 Transportation

Transportation for spa services consisted of three pathways: 1) transportation of raw materials from a store or market to the spa, 2) transportation of laundry from the spa to the cleaning service (if required), and 3) assumed transportation of waste from the spa to a municipal waste disposal site. This data was acquired from the spa owners, and Google maps was used to measure the distances traveled. The average data for transportation is not shown here due to the excessive quantity of available information.

3.4 Waste disposal

For the disposal stage, it was assumed that solid waste from the services was taken for landfill disposal. In addition, raw materials used for the scrub and mask treatments were assumed not to be disposed of in landfill as they were soluble in water. Moreover, liquid waste was collected and treated through the waste treatment system. The average data for the waste disposal stage is shown in Table 3.

Table 3 Inventory inputs for the waste disposal stage (per person)

Resources	Amount	Assumptions
Herb residues (g)	67.50	
Disposable underwear (g)	34.67	
Plastic film (g)	13.14	
Liquid waste (L)	483.43	From the service (including milk, mineral water, coconut oil, shampoo, and soap) and the laundry stages

Results and discussion

The life cycle GHG emissions for each stage of the day spa services are presented in Figure 2, it should be noted that raw material acquisition input was considered and included in the service stage. The average result for GHG emissions from day spa services was 5.76 kg CO_2 eq/person (ranging from 3.54 to 9.69 kg CO_2 eq/person). The service stage resulted in the highest source of GHG emissions, accounting for 84.70% of total emissions. The laundry, waste disposal, and transportation stages had GHG emissions of 9.27%, 5.82%, and 0.22%, respectively.

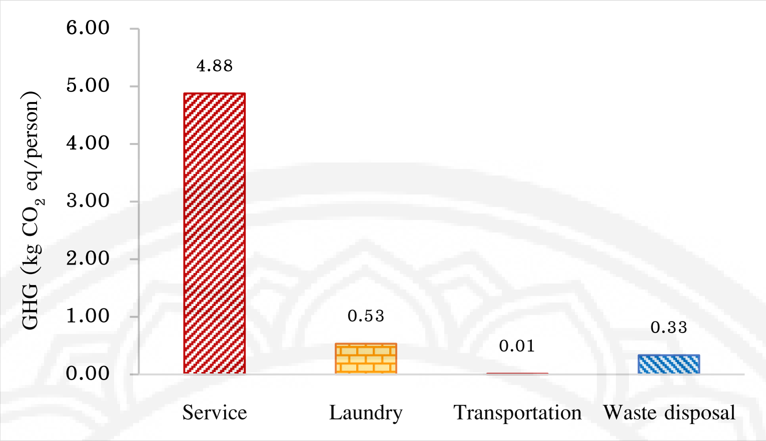

Figure 2 GHG emissions of day spa services

The service stage provided the largest source of GHG emissions at 4.88 kg CO_2 eq/person or 84.70% of the total GHG emissions. However, when considering each process in the service stage as seen in Figure 3, the GHG emissions were divided into 4 groups as follows: materials (e.g., herbs, masks, and plastic film etc), equipment (e.g., sauna heater, and water heater etc), air conditioners, and lights. The GHG intensity from the service stage was mostly attributed to electricity consumption at 65.93%, which was used for air conditioning at 41.70%, equipment at 16.82% (water heaters produced 10.19%), and light bulbs at 7.41%. In addition, emissions from materials accounted for 34.07% (milk produced 21.16%). Moreover, it was found that hydrotherapy was the largest process contributor to GHG intensity at 37.61%, where the main sources of GHG emissions were from milk and water heaters. The GHG emissions from oil massage, scrub, and a mask process were 19.85%, 15.24%, and 12.97%, respectively, where the emissions were mostly from air conditioners. The oil massage process has the highest electricity consumption, due to the required service time being greater than the other processes. The emissions associated with the sauna and shower processes accounted for 9.81% and 4.52%, respectively.

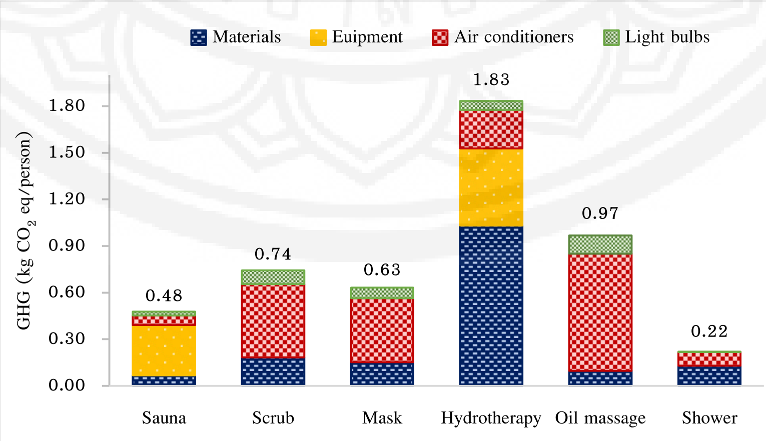

Figure 3 GHG emissions for each process of the service stage

The GHG emissions from the laundry stage were 0.53 kg CO_2 eq/person or 9.27% of the total day spa service (see Figure 2). Electricity was the main GHG contributor, which was used for clothes dryers and washing machines. Waste disposal emissions were 0.33 kg CO_2 eq/person, which were mostly from herb residues and disposable underwear, and the transportation stage showed the lowest level of emissions, at 0.01 kg CO_2 eq/person, due to the use of diesel fuel.

The GHG intensity from this study, at 5.76 kg CO_2 eq/person, was lower than Prasara-A (2012) (16.16 kg CO_2 eq/person, using calculations based on their data). This was mostly due to differences in electricity consumption and materials. When considering the main resources used for the services (based on one person), the amount of electricity, water, and milk in our study were 6.76 kWh, 410.04 L, and 0.36 L, respectively. This was in contrast to the amount of electricity, water, and milk from Prasara-A (2012) at 10.37 kWh, 819.55 L, and 0.97L, respectively. Accordingly, the GHG results from our study were lower than those obtained by Prasara-A (2012).

Conclusion and Suggestions

This study evaluated the life cycle GHG emissions of day spa services from twelve spas in three Eastern provinces of Thailand: Chonburi, Rayong, and Trad. The system boundary was from cradle to grave and the functional unit was one body spa package per person. From the results, spa services had average GHG emissions of 5.76 kg CO_2 eq/person, ranging from 3.54 to 9.69 kg CO_2 eq/person. The service stage had the highest impact on overall GHG emissions at 84.70% of total emissions, followed by the laundry at 9.27%, waste disposal at 5.82%, and transportation at 0.22%.

To reduce GHG emissions, it is therefore essential to focus mainly on the service stage. For the service stage, electricity consumption associated with air conditioners and electrical equipment was the main factor contributing to GHG emissions. Suggested possible ways to reduce the GHG emissions from electricity usage for the service stage include regularly maintaining the air conditioners to increase their efficiency, installing insulation in ceilings and walls, installing air conditioner coils in shady areas to receive less sunlight, replacing incandescent bulbs with LED ones, producing hot water either from solar or air conditioning heaters, and planting trees around buildings to reduce surrounding air temperatures. Furthermore, the 3R concept (reduce, reuse and recycle) should be adopted for the use of materials, since this strategy may help mitigate emissions, minimizes waste disposal and landfill area, and also reduces the cost of excess resources used in the spa service.

However, our study had limitations. The ingredients of raw materials, the weight of materials, and the specifications of electrical equipment were assumed due to limitations in time and effort required for data collection. Future study may be able to improve this data with accurate measurements to address these limitations and uncertainties. Further research on the carbon footprint for organization (CFO) of spa businesses is recommended. The results from this study show how service activities in day spas effect GHG emissions and also identify the main stage and sources of GHG emissions. It also suggests ways to reduce emissions from day spa service pathways. This data can be used as a baseline to support decision making policy for improving environmentally sustainable service delivery in Thai spa services.

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