To invest or not to invest in sustainability? Dilemma of a small hotel

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Abstract

It is no secret that hotels, while pursuing profitability, are largely responsible for many of our sustainability challenges today. The hotel industry consumes a huge amount of energy and resources in its relentless pursuit for customer's satisfaction. In turn, its operations often create many sustainability problems such as food waste, high energy and water usage and pollution. While many hotel owners understand their moral responsibility to direct its operations towards more sustainable practices and often through the adoption of green technologies, they are faced with a dilemma of choosing between profitability and sustainability. This is especially the case for small hotel owners. In this study, we examine closely a small hotel's courage and ingenuity in adopting and investing on green technologies from a system perspective. We model the intertwining relationships between the adoption and investment of green technologies and the hotel's profits and provide the evidence to shed light on how this delicate balance between profitability and sustainability can be achieved and sustained.

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Introduction

There is a mounting amount of evidence to indicate that human activities are one of the main causes of our sustainability challenges today (IPCC, 2007; Stern, 2007). Businesses around the globe have begun making sustainability as one of its key strategic priorities (McKinsey, 2009). Unfortunately, a huge number of business organizations are still struggling with implementing sustainability initiatives effectively (IBM, 2008). Successful organizations often find themselves in a constant state of struggle trying to fulfil its "*sense of obligation to contribute to environment sustainability*" (Elliot, 2011, pp. 219), while figuring out the significant uncertainties involved in estimating the impact of sustainability initiatives towards its financial bottom lines. This is especially so for small hotel owners.

In recent years, the hotel industry has experienced exponential growth, much of it due to the huge increase in tourism activities across the globe (Rodríguez-Antón, Alonso-Almeida, Celemín, & Rubio, 2012). Running a hotel business is a resource-intensive endeavour, consuming a large amount of energy, water, food and consumables in order to maintain or create new facilities to delight and keep its customers. At the same time, a hotel also generates a significant amount of wastes and carbon footprint as compared to buildings of similar size (Legrand, Sloan, & Chen, 2016). According to GreenHotelWorld (a non-profit organization that seeks to measure the CO2 emissions of the world hotel business), the international hotel industry is directly responsible in generating 1% of the global CO2 emissions which is equivalent to the total yearly emissions of the United Kingdom (GHW, 2017). Hence, it is

increasingly important for the hotel industry to adopt sound sustainable practices and green technologies to minimize its impacts to the environment.

Increasingly, major international hotel chains and small hotel's owners are becoming aware of the tangible and intangible benefits on being "*proactive in mitigating environmental impacts including real efficiency gains and improved corporate reputation*" (Legrand et al., 2016, Preface). An eco-friendly hotel is gradually becoming a key differentiator in the industry. In a study that investigates the moderating effects of environmental knowledge, environment concern, and the direct and indirect environmental behaviours of tourists, on the relationship between environmental practices of hotels and tourists' loyalty, Yusof, Rahman, & Iranmanesh (2016) found that a hotel's environmental practices can improve the tourists' loyalty towards it especially for those tourists who are environmentally conscious. However, understanding the benefits and being able to incorporate sound sustainable practices and green technologies are two different things. Hotel operations consists of many small work tasks that range from housekeeping, to banqueting, to restaurant's operations and to spas and activity management. While these operations individually contribute a relatively small amount of environmental pollution, they accumulate to significant amount when combined. For a small hotel's owner, it is difficult to find the time and resources to deal with the challenges of minimizing these environmental pollutions in all its operations, while earning sufficient profits to keep it afloat. More often than not, the obvious choice is to focus on profitability at the expense of sustainability.

In order to address this dilemma, the research and practitioner's community has suggested the adoption of the 'triple bottom lines' framework, which consists of economic sustainability, environmental sustainability and social sustainability by businesses in driving its strategy and operations (e.g. Adams, 2006; Elliot, 2011; Haugh & Talwar, 2010; Melville, 2010). By focusing on activities that reside at the intersection of the three dimensions, a hotel operator can fulfil its corporate social responsibility through the adoption of green practices and technologies (thus, reducing its carbon footprint) while generating financial and reputational benefits at the same time (Adams, 2006; Elliot, 2011). Conceptually, this makes a lot of sense for hotels. Unfortunately, in practice, finding this intersection is not easy. The constant bombardment of operational mandates often compelled hotel's operators to place more emphasis on economic sustainability (i.e. profitability) rather than the other two dimensions. Over time, the sustained emphasis on economic sustainability would be imbedded into the organization's culture and processes, obstructing them from seeing the value of achieving the balance among the three dimensions. The challenges faced by small hotel owners are so daunting that it has led to the rise of many NGOs across the globe with the mission of encouraging and helping these small hotel owners to adopt environmentally and socially responsible business practices. One good example of this NGO is the Green Leaf Foundation (GLF) in Thailand. Led by Professor Chirapol Sintunawa, the Green Leaf Environment Standard developed by the Foundation provides a framework to help Thailand's hotels (especially small hotel owners) to progressively transform its operations towards green practices (GLS, 2017).

This challenge faced by small hotel's owners motivates our current study. In our study, we are concerned with just the balancing between environmental sustainability (for convenience, term it as sustainability) and economic sustainability (for convenience, term it as profitability). We have deliberately left out social sustainability in our study because in a context of small hotels,

getting to the state of balancing between sustainability and profitability is the first step before they can generate surpluses to contribute and fulfil its social sustainability mandate. By adopting a systems approach to analyse how a small hotel can balance the investment of green technology (i.e. sustainability) and profitability, our study strive to answer the following research questions: (1) *Should small hotel invest in green technology?* (2) *Will investment in green technology lead to higher business profitability?*

The remaining part of this paper is structured as follow. We will start by reviewing the existing literature in Systems Dynamics in the context of sustainable development. This is followed by a discussion on the methodology approach that we have adopted in our study. After which, we will present the model that we have developed based on the data from the case organization. A robust discussion and analysis of the model will be conducted after this. Finally, we will conclude our paper with a discussion of its potential contributions to both the literature and the practitioner's world.

Literature Review

Based on a very recent comprehensive literature review of 192 research papers written between 2000 and 2015 on the use of systems dynamics to examine sustainability issues, Moon (2017) has identified 18 research themes. The themes are listed as follows: (1) Agriculture, Aquaculture & Livestock; (2) Construction; (3) Ecosystem & Climate; (4) Energy; (5) Human Health; (6) Information Systems; (7) Land Use; (8) Manufacturing; (9) Mining; (10) Overview & Review; (11) Social Behaviour; (12) Supply Chain; (13) Sustainable Development; (14) Tourism; (15) Transportation; (16) Urban and Community Planning; (17) Waste, Recycling and Reuse; and (18) Water Resources. Together with our own reviews on systems dynamic modelling on sustainability, we generated a significant number of papers to identify the current state of the literature.

In order to review this large number of papers in a systematic way, we took the approach of creating a set of review criteria in order to narrow down the papers to those that are relevant to our study. The criteria that we have developed are: (1) Does the paper analyse its sustainability issue through modelling at firm level? (2) Does the paper examines its sustainability issue through modelling a small and medium enterprise? (3) Does the paper examines its sustainability issue in a hotel industry? (4) Does the paper use a model to explain how a company achieves the balance of sustainability and profitability? (5) Does the paper consists of models and variables that may be of interest to our study?

We read through the abstracts of all the research papers that we have identified and evaluated them using our review criteria. If we discovered papers that have more than three 'yes' or have a 'yes' for criteria (5), we will read the paper in more details to draw valuable insights to inform our model development. Based on this approach, we have identified the following papers that are relevant to our study and they are presented in Table 1. Analysing our extensive literature review on simulation for sustainability concluded with the following findings. First, there are only a few studies on using System Dynamics modelling to tackle sustainability challenges in the context of small and medium enterprises. The small and medium enterprises are the main engine behind most country's economy. They are also often the ones that are faced with complex challenges. Hence, we thought applying System modelling on these small and medium enterprises would provide many important insights that can help to grow the economy of the entire country. Yet, the literature in this area is limited and this gives us a more

compelling reason to conduct our study. Second, there are no studies that examine how a small hotel can balance between sustainability and profitability. Given our earlier assertion on the importance to examine this topic in an ever growing hotel industry, we believe that this is a missed opportunity. Hence, we have designed our study specifically to fit this gap in the literature.

Table 1: Relevant Research Papers from Moon (2017) and Our Own Review							
Category	**Reference**	**Description**	**Firm Level?**	**SME?**	**Hotel Industry?**	**Balance?**	**Of Interest to Study?**
Energy	Hollmann (2006)	The paper describes a new energy system that has a high potential of meeting ecological requirements and sustainability. A systems dynamic model is being constructed on one power supply unit and the effectiveness of the energy system is being analyzed	N	N	N	N	Y
Energy	Reddi, Weilin, Bochao, & Young (2013)	The paper examines the adoption of hybrid renewable energy system (HRES) and a combined heating and power generator into a SME manufacturing company. It uses a system dynamic model to identify components of HRES that creates a conflict between cost and environmental benefits which requires the company to make trade-off decisions	Y	Y	N	Y	Y
Overview & Review	Sterman (2014)	The paper describes a set of interactive web-based management flight simulators designed specifically to teach ideas in business, strategy, and sustainability.	N	N	N	N	Y
Sustainable Development	Duran-Encalada & Paucar-Caceres (2012)	The paper proposes a system dynamic model to explain the implementation and development of business sustainable policies of a decentralized government organization that is one of the largest oil producers in the world.	Y	N	N	N	Y
Sustainable Development	Nikolaou, Evangelinos, & Leal Filho (2015)	The paper describes a system dynamic model that is developed through six case studies of companies in agribusiness and ski sectors. The model explains the evolutionary trends of the relationships between climate change risks, financial performance and the operational processes of firms	Y	Y	N	Y	Y
Sustainable Development	Todorov & Marinova (2011)	The paper suggests a general classification of the models being developed in the area of sustainability and proposed that any sustainability model should be allowed for dynamic representation, including the co-evolution of the sustainability systems and human actors.	N	N	N	N	Y
Sustainable Development	Hsiao, Chuang, Kuo, & Yu (2014)	The paper establishes a set of attributes of an environmental management system (EMS) for the hotel industry in Taiwan using the Delphi method. It provides interesting variables that help us fine tune the variables used in our model especially when measuring the performance of the green technologies used in our case.	N	N	Y	N	Y
Tourism	Yusof et al (2016)	The paper proposes a study that investigates the moderating effects of environmental knowledge, environment concern, and the direct and indirect	N	N	Y	Y	Y

		environmental behaviours of tourists, on the relationship between environmental practices of hotels and tourists' loyalty. The study provides to support that the more environmental practices incorporated by hotels, the higher their tourist's loyalty especially among tourists who are environmentally conscious.					
Tourism	Blersch & Kangas, (2013)	The paper uses an EXCEL worksheet to create a computer simulation model that is used to study the possible long-term patterns of ecotourism at the country scale for Belize, Central America. The paper highlighted the challenges involved in balancing sustainability and profitability as conversation efforts often will slow the income generated from ecotourists rendering it commercially not viable.	N	N	N	Y	Y
Waste, recycling & reuse	Antmann, Celik, Shi, & Dai (2012)	The paper proposes a simulation-based decision making and optimization framework for the analysis and development of effective solid waste management and recycling programmes under uncertainty which has been successfully demonstrated for the Miami-Dade County Solid Waste Management Systems in the State of Florida	N	N	N	N	Y

Methodology

The study adopts an iterative process in developing its system model through literature review, case study, system dynamic modelling and system validation and testing. This is shown in Figure 1.

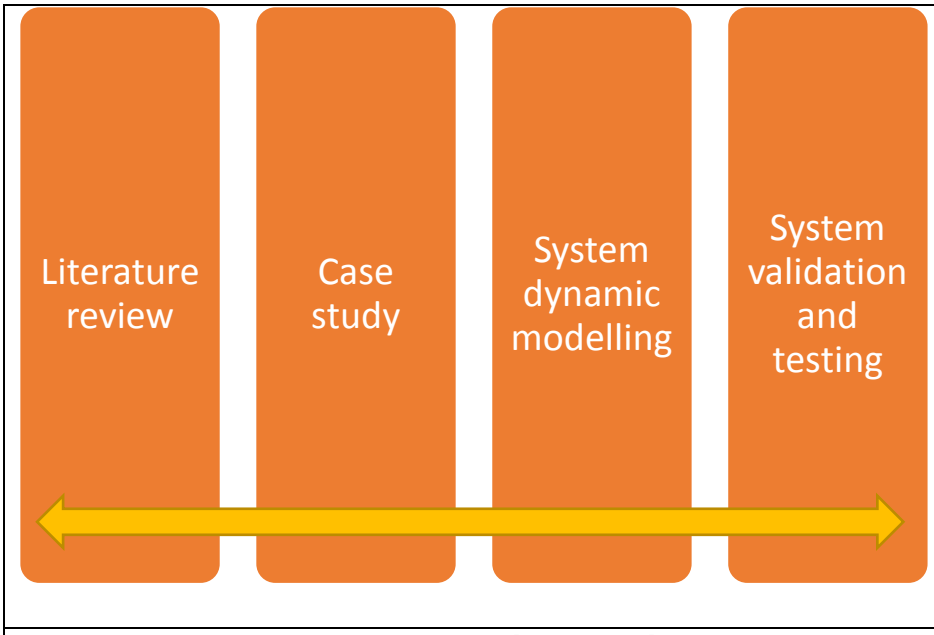

Figure 1: Research Approach

The case study and system modelling approaches are particularly suitable for this study because of two reasons. First, the investigation surrounding the investment and adoption of green technologies within a small hotel inevitably involve complex interactions between people, processes and technologies that are inseparable from its organization context (Pentland, 1999), this makes case study and systems modelling ideal research methods in uncovering and interpreting the shared mental model among key stakeholders (Klein & Myers, 1999). Second, according to the Moon (2017)'s comprehensive review of the literature on using systems modelling to address sustainability challenges, there is little research to date that look into developing insights about whether a small hotel should invest in green technology and if so, how will it contributes to its business profitability. A case method centred on developing a system model on this unexplored phenomenon through the collection of rich data in real world context is highly recommended (Eisenhardt & Graebner, 2007; Pan & Tan, 2011).

To select the appropriate small hotel to conduct our study, we adopted the following selection criteria. First, the hotel must be sufficiently small to be classified under the category of small and medium enterprise in Singapore. According to SPRING Singapore (2017) (a Singapore Statutory Board), the definition of small and medium enterprise follows these definitions:

1. Annual Sales turnover of not more than S$100 million OR
2. Employment size of not more than 200 workers

Second, the hotel must have sufficient evidences to prove that it has successfully achieved the balance between sustainability and profitability. Based on these two criteria, we scouted Singapore's hotel industry to find a matching hotel. After a series of shortlisting process, we

have narrowed down to the Siloso Beach Resort in Singapore as our case organization. One of the key reasons why Siloso Beach Resort was selected is because it was recently awarded the top regional Asia's Best Sustainability Report (SME) Award selected from a list of 68 companies from 14 countries nominated by members of an independent judging panel (CSRWorks, 2016). Thus, providing credible result to demonstrate that they have successfully balanced profitability and sustainability in its hotel's operations. Another reason is because its sustainability report is available online for us to review before the site visit. This allowed us to triangulate our observations and field notes during the site visit with what was being reported. Thus, improving the validity of our model.

Access to the case organization was granted through its Executive Director, Mr. Sylvain Ricker de Forges. Before the site visit, data were collected from secondary sources such as websites, and newspapers and literature to aid in the process of developing an interview protocol and strategy. The collected data were being used in the production of a set of potential variables and probable relationships among these variables that may be important to our systems model.

During the site visit, key stakeholders of the hotels were interviewed. Questions used in the interview protocol were open-ended questions designed to solicit or affirm the presence of important variables and/or relationships from the interviewees (Nikolaou et al., 2015). Detailed notes were being documented throughout the interview process. This was followed up with an onsite hotel's tour to help us understand how the green technologies were being invested and rolled out across the organization. A large amount of data ranging from websites, field notes, interview's records, photos and company's reports were collected.

Upon returning from the site visit, the collected data were reconciled and analysed to corroborate the interpretation of the key variables and its relationships to help us develop a system model to answer our research questions. The data analysis process were conducted in an iterative fashion oscillating among examining the large amount of data closely for theoretical insights, reviewing the existing literature for validation and developing and testing the model incrementally (Eisenhardt & Graebner, 2007; Locke, 2001; Sterman, 2000). A number of reference mode scenarios were also being developed to test the rigor of our model in its predication. This process is repeated until a stock and flow model comprising of the potential endogenous and exogenous variables and their relationships were derived and a state of model's confidence was achieved (i.e. confidence that the derived model can be used to explain most of the collected data especially in relation to the reference mode) (Sterman, 2000).

We made use of a variety of quantitative and qualitative data and techniques to help us validate our model. First, we compared the structure of our model against the structure of the real systems examined during our case study visit to ensure our model's technical correctness. This is similar in approach as adopted Reddi et al. (2013). Second, we made use of a simplified layman model along with flowchart and field notes to describe the important assumptions, variables and the relationships among variables to the key stakeholders to validate if we have understood and captured these important information correctly. Third, we ran our simulation and compared the model behaviour with the real system behaviour obtained from secondary sources, e.g. the case organization's corporate documents, government websites and published articles.

Case Organization Description

Siloso Beach Resort located in Sentosa Island of Singapore is a self-sustaining eco-resort that is dedicated to corporate social responsibility as well as environmental sustainability efforts (SBR). The resort is '*one of the few hotels which was purposely built, from its conception, to be an eco hotel and to apply best sustainable practices throughout all its operations*'(SBR-SR, 2015, pp 15).

Unlike traditional small and medium hotel, the resort operates based on a sustainability business model that strives to direct all its operations towards the intersection between sustainability and profitability right from the start. Not surprisingly, the resort has a rigorous set of key performance indicators to measure its progression towards the sustainability and profitability.

Given its relentless emphasis to become a top sustainability resort, the resort has implemented a suit of unique eco-innovations. These innovations had helped the resort balances between sustainability and profitability. One of such eco-innovations is its experimental worm composting system that is being managed onsite its resort. The system involves an innovative waste management technology that recycles food wastage for increased profitability. Worms, as shown in Figure 2, were fed with food waste generated through the hotel's dinning operations.

Figure 2: Wormery to decompose food waste into organic fertilizer

The worms helped to naturally compose these food wastes into organic fertilizers. These organic fertilizers were then being used to fertilize the organic vegetables produced in its in-

house rooftop garden (as shown in Figure 3). These organic vegetables were being used as raw cooking ingredients for its resort's dinning operations. In this way, instead of spending money to dispose the food waste, the resort was able to turn the food waste into useful fertilizers for its garden. This in turn allows the resort to cut its kitchen ingredient's cost. Thereby, further increasing the profit generated from its dinning operations.

Figure 3: Organic Vegetable Farm in Rooftop Garden

Apart from many similar eco-initiatives implemented in the resort, the hotel had also invested heavily on green technologies. For instance, the resort has been constantly upgrading its chiller system. According to Mr. Sylvain, the Director of Sustainability at Siloso Beach Resort, the chiller system in the resort has been through three upgrades within last 10 years. This is because they believe that it makes business sense to obtain better chiller technology to assure greater energy efficiency in its operations. Despite the high initial cost of investment, the resort believed that in the long run, such investment would inevitably generate positive returns.

Another example is the resort's heat recovery system which is specially designed to harness the heat generated from its air-conditioning units and channeling it to its hot water heater and resort's hot spa. Waters that were being used by the resort for washing floors, watering plants and trees and for swimming pools, were extracted from underground spring water after going through an advanced filtration system (see Figure 4). As a result, the resort has been able to successfully convert the energy/waste generated through its operations into tangible cost reduction implementations.

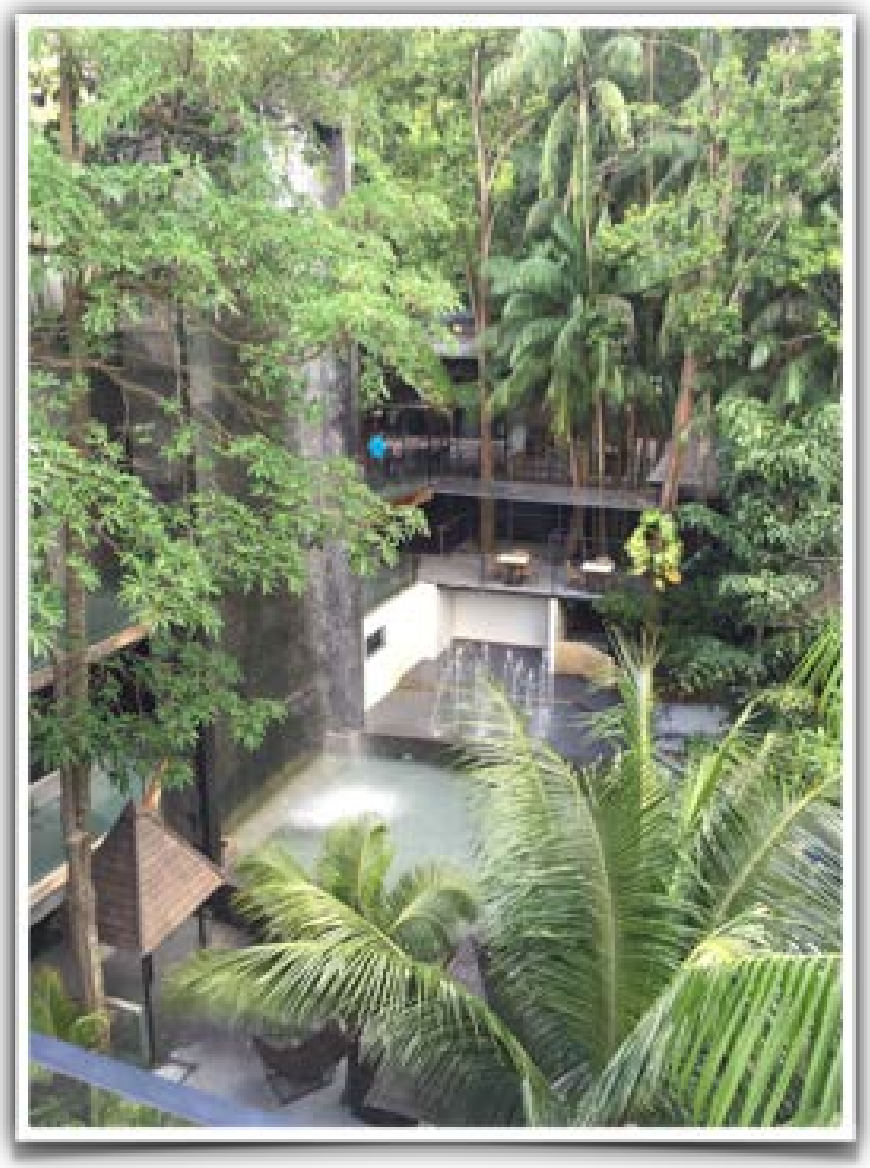

Figure 4: Water used to create waterfall comes from underground spring water with advanced filtration system

Model Discussion

Using data collected from our case organization, we developed a stock and flow diagram to analyse how investment in green technology is able to contribute to the profits of a small hotel through saving from operational costs. Our system dynamic model is shown in Figure 5.

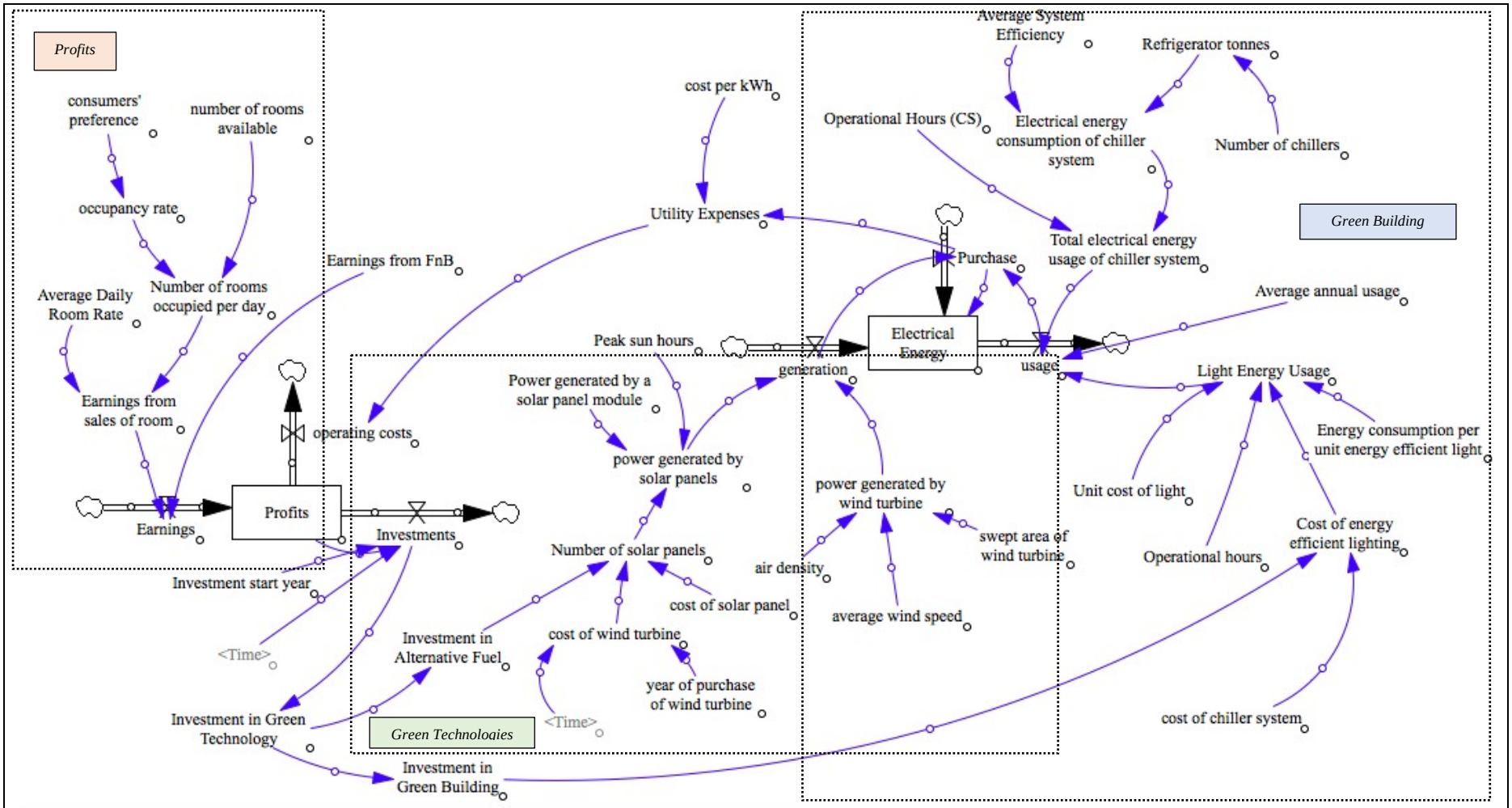

Figure 5: System Dynamic Model on Small Hotel Using Our Case Study

There are three main sections in our stock and flow diagram and they are explained in details below:

1. **Profits** – this section on profit focuses on modelling the dynamism that generates profit through the product and services of our case organization. The source of the company's earning largely comes from the sales of room and from food and beverages.
2. **Green technologies** – this section describes the dynamism involved in the adoption and implementation of green technologies in our case organization. The management of the resort has decided to only invest in a wind turbine. Hence, the number of solar panels that the resort invested in is computed using this formula: ("Investment in Alternative Fuel" – "Cost of Wind Turbine")/"Cost of Solar Panel". The energy generated through alternative fuels from solar and wind becomes an inflow into the "Electrical Energy" stock.
3. **Green Building** - this section models the dynamism surrounding all the key infrastructure green technologies used in our case organization. It includes more energy efficient lightings and chiller systems. These infrastructures consume electrical energy and hence serve as an outflow to the "Electrical Energy" stock.

When the amount of electrical energy generated by the green technologies is insufficient to meet the energy demand required to maintain the hotel, the case organization would make a purchase from the power company to cover the shortfall and this is represented through the inflow "Purchase". The inflow "Purchase" is unlike any typical inflow. It's value during simulation is based on the current value of the "Electrical Energy" stock. If the stock is less than or equal to zero, the same amount of inflow from "Purchase" will be added to the stock (simulating that the shortfall in energy is covered by the power grid). If the stock is less than zero, the amount of inflow from "Purchase" will also be zero.

However, if the electrical energy generated by the green technologies exceed its energy demand, the surplus electrical energy generated by green technologies will be wasted since it cannot be channel back to the power grid.

The adoption of green technologies in solar and wind and green building will over time reduce the overall operating costs in maintaining the resort. This means that the hotel will generate more profits, which in turns will increase the amount of money being invested into the green technologies. A reinforcing cycle is formed. Figure 6 shows the behaviour over time graph generated for the stock 'Profits'. The profit over time increases and maintains at a steady state from around 20^{th} years onwards. This implies that the profitability (denoted by the earning section) and sustainability (denoted by the green technologies and green building sections) within the model has reached dynamic equilibrium. Providing evidence to support that balancing between profitability and sustainability is a real possibility for a small hotel. The drop in the stock 'Profit' is the initial capital cost that is being used to purchase the green technologies. We can see from the Figure that this cost is being recovered in around 5 years time.

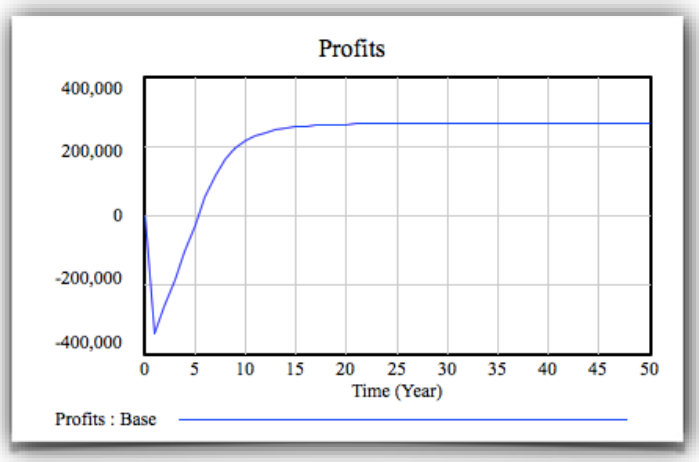

Figure 6: Behaviour over time of Profit

To mimic the real-world situation, we have made the following assumptions:

1. Since the investment of alternative fuel is often a large amount of one-time capital cost, we made an assumption that the resort does not make any investment in green technologies in the first five years of its initial operation. This will help the resort save up sufficient amount of its profits to finance the capital investment.
2. We further assume that a constant 20% of the case organization's profits is being invested into green technologies after the first five years of operation. This amount is justified by testing the model with varying percentage to look for situation when the drop in profit is not too drastic and the return of investment is the shortest.
3. We assume that lighting and chiller system infrastructure is already in place. The green building investment is used to replace the existing lighting and chiller system with more energy efficient one.
4. We also made an assumption that the existing lighting and chiller system do not add to the 'Electrical Energy' stock as the cost of financing the purchase and maintenance of them is covered by the other 80% of the profit.

The definition of each of the variables used in our model is provided in Table 2. Within this table, we have also included sources that we have used to derive the formula and/or data for the variables in our system.

Table 2: Variables, its definition and sources

Variables	**Definition**	**Source**
Profit	The main stock of the model. Taken to be the Earnings - (Operating costs + Investments).	Siloso Beach Resort: http://silosobeachresort.com/

Table 2: Variables, its definition and sources

Variables	**Definition**	**Source**
Earnings	The total of Earnings from Sale of Rooms + Earnings from FnB	
Earnings from Sale of Rooms	The sum of Average daily room rate * Number of rooms occupied per day.	
- Average daily room rate	Calculated estimate of 258.1 SGD per room.	Referenced the average room rate reported in the hotel statistics produced by Singapore Tourism Board as well as Siloso Beach Resort's and similar scaled hotels under the Far East Organisation. Singapore Tourism Board Hotel Statistics: https://www.stb.gov.sg/statistics-and-market-insights/marketstatistics/2014hs(updated%2007apr15).pdf Far East Organisation: http://www.fareast.com.sg/en/hospitality Siloso Beach Resort: http://silosobeachresort.com/ Interview data and field notes
- No. of rooms occupied per day	The product of Occupancy rate and the Number of rooms available.	
- Number of rooms available	Set parameters : 200 rooms The number is set to mimic the average resort/commercial type hotels in Singapore.	Based on research on number of rooms available in Singapore's resort/commercial type hotels. Far East Organisation: http://www.fareast.com.sg/en/hospitality Siloso Beach Resort: http://silosobeachresort.com/
- Occupancy rate	Affected and dependent on Consumers' Preference. Taken an estimate of 74.95% (the average of Siloso Beach Resort and the average reported on Singapore Tourism Board	Based on an interview conducted at Siloso Beach Resort Singapore Tourism Board Hotel Statistics: https://www.stb.gov.sg/statistics-and-market-insights/marketstatistics/2014hs(updated%2007apr15).pdf

Table 2: Variables, its definition and sources

Variables	**Definition**	**Source**
- Consumers' Preference	Adjustable variable in the model that serves to experiment with the correlation between consumers' preference and the sustainability actions of a company. Built on the assumption that with growing consciousness of need to be sustainable, consumers' are leaning towards eco-friendly consumptions.	'What motivates consumers to make ethically conscious decisions?' (12 August 2011): https://www.theguardian.com/sustainable-business/motivates-consumers-environmental-ethical-decisions 'Global consumers are willing to put their money where their heart is when it comes to goods and services from companies committed to social responsibility' (17 June 2014): http://www.nielsen.com/us/en/press-room/2014/global-consumers-are-willing-to-put-their-money-where-their-heart-is.html Do customers care: http://www.greenhotelier.org/our-themes/community-communication-engagement/do-customers-care/
Earnings from FnB	Profit company earns from offering food and beverage services.	Singapore Hotel Industry Survey 2012 (Financial Year 2011)
Operating Cost		
Utility Expenses	The product of Cost per kWh and total amount of Electrical Energy Purchased.	
- Cost per kWh	Taken as 22.1 cents per kWh as recorded in the first half of 2015.	Singapore Powers: https://www.spgroup.com.sg/home Energy Market Authority: https://www.ema.gov.sg/cmsmedia/Publications_and_Statistics/Publications/ses/2015/energy-prices/index.html
Electrical Energy	The balance of energy generated and energy used - (Generation - Usage)+Purchase. If generation is more than usage, no electrical energy is purchased.	
- Generation	The total of Power Generated by Solar Panels and Power Generated by Wind Turbines.	
- Usage	The total of Light Energy Usage and Total Energy Usage of Chiller System.	

Table 2: Variables, its definition and sources

Variables	Definition	Source
- Purchase	Amount of Energy purchased is the difference of usage-generation when usage >generation.	
Investments	The main flow of the model. Investments are placed in Investment in Green Technology.	
- Investment start year	Set at 5. Investment to start at the five years mark taking into account that it is in the interest of the company to invest with accumulated interest.	
Investment in Green Technology	Investment in Green Technology is placed in Investment in Alternative Fuel as well as Investment in Green Building.	
- Investment in Alternative Fuel	Investment in Alternative Fuel is used to fund the purchase of inventory for solar panels and wind turbines.	
Power Generated by Solar Panels	Determined as the product of Power Generated by a Solar Panel, the Number of Solar Panels and, Peak Sun Hours.	
- Number of Solar panels	Is calculated to be the remainder of Investment in Alternative Fuel, after subtracting Cost of Wind Turbine, over the cost of solar panel.	
- Cost of a Solar Panel	Estimated as 1500SGD per solar panel.	Solar panels yet to shine: https://www.ema.gov.sg/reply_to_forum_letter.aspx?news_sid=20140626AxqskVnyaR3k Feasibility of Renewable Energy in Singapore: http://www.diva-portal.org/smash/get/diva2:444754/FULLTEXT01.pdf
- Power Generated by a Solar Panel	Taken estimated value: 0.1 kWh	A Study of Solar Installation in Singapore: http://www.schneider-electric.com.sg/documents/company/event/fm_seminar/a_study_of_solar_installation_in_singapore.pdf

Table 2: Variables, its definition and sources

Variables	**Definition**	**Source**
- Peak Sun Hour per day	Defined as the number of hours per day when solar irradiance = 1000w/m^2. Estimated to be 4.5 hours per day in Singapore.	A Study of Solar Installation in Singapore: http://www.schneider-electric.com.sg/documents/company/event/fm_seminar/a_study_of_solar_installation_in_singapore.pdf
- Cost of Wind Turbine	Taken to be 15000SGD for installation of urban wind turbine.	Feasibility of Renewable Energy in Singapore: http://www.diva-portal.org/smash/get/diva2:444754/FULLTEXT01.pdf
Power Generated by Wind Turbines	Power Generated by Wind Turbines is taken to be the product of air density, swept area of turbine, and average wind speed. P= 1/2 * Air Density * Swept Area of Turbine * Avg Wind Speed **3	Feasibility of Renewable Energy in Singapore: http://www.diva-portal.org/smash/get/diva2:444754/FULLTEXT01.pdf
Year of Purchase of Wind Turbine	Set at 5. Investment to start at the five years mark.	
- Air Density	Estimated 1.164 kg/m^3	Feasibility of Renewable Energy in Singapore: http://www.diva-portal.org/smash/get/diva2:444754/FULLTEXT01.pdf
- Swept Area of Turbine	8 m^2	Feasibility of Renewable Energy in Singapore: http://www.diva-portal.org/smash/get/diva2:444754/FULLTEXT01.pdf
- Average Wind Speed	2 m/s	National Climate Change Secretariat Strategy Group, Prime Minister's Office: https://www.nccs.gov.sg/climate-change-and-singapore/national-circumstances/singapores-approach-alternative-energy
- Investment in Green Building	Investment in Green Building is channeled to the use of Energy Efficient Lighting as well as to the chiller system.	
Light Energy Usage	The multiplication of Energy Efficient Lighting with Unit Cost of Light and Energy Efficient Lighting	

Table 2: Variables, its definition and sources

Variables	**Definition**	**Source**
- Operational hours	24 hours Assuming that areas in the hotel such as the front desk, main lobby, lift lobbies, corridor, and wash room areas are to remain lighted throughout for the safety of guests and for operation purposes.	
- Unit Cost of Light	Taken to be 43 SGD	National Climate Change Secretariat Strategy Group, Prime Minister's Office: https://www.nccs.gov.sg/news/straits-times-light-bulbs-filament-fading-out
- Cost of total Energy Efficient Lighting	Investment in Green Building minus the Cost of Chiller System	
- Energy Consumption per unit Energy Efficient Light	10W	The Simple Dollar: http://www.thesimpledollar.com/the-light-bulb-showdown-leds-vs-cfls-vs-incandescent-bulbs-whats-the-best-deal-now-and-in-the-future/
- Cost of Chiller System	Taken an estimate of 500,000SGD	Interview conducted at Siloso Beach Resort
Electrical Energy Consumption of Chiller System	The product of Average System Efficiency and Refrigerator Tonnes of the chiller system.	
- Refrigerator tonnes per Chiller	650 tonnes	Eco-Business: http://www.eco-business.com/news/W-hotel-singapore-combining-sustainability-comfort/ Hotel-Online: http://www.hotel-online.com/News/PR2003_4th/Oct03_ChillerReplacement.html
- Number of Chillers	Adjustable variable	
- Average System Efficiency	0.6 kWh/ ton	Energy Design Resources: https://energydesignresources.com/media/1681/edr_designbriefs_chillerplant.pdf?tracked=true
- Operational Hours (CS)	24 hours	
- Average Annual Usage	2170000 kWh Average of annual energy consumption of Siloso Beach Resort from years 2009-2013.	Siloso Beach Resort: http://silosobeachresort.com/

Potential Contributions and Conclusion

Fuelled by the rapid growth of tourism across the world, the hotel industry has been growing exponentially in recent years. In order to meet these needs, more small hotels are springing up across the globe. Consequently, the hotel industry faces not just the issue of increased business competition but also a greater competition for scarce resources (such as energy, food and water) to maintain its operations. It seems certain to us that hotels should consider leveraging upon green technology to maintain this delicate balance between sustainability and profitability as they grow.

Our research questions were 'should a small hotel invest in green technologies?' and 'will investment in green technology lead to higher business profitability?'. Based on our case study of Siloso Beach Resort and the system dynamic model that we have generated, we have provided evidence to support that small hotel should invest in green technologies and that investing in them will lead to higher business profitability.

In so doing, we believe our model provides a clear roadmap for many other small hotel owners on what they can do to achieve the balance between sustainability and profitability. This is particularly important as it helps to alleviate the current sustainability and resource challenges in the hotel industry. Furthermore, we believe the insights drawn from our case study and model can also be extended to other small and medium enterprises from other industries.

From the research point of view, as far as we know, our study is the only study that helps to fit the existing literature gap by providing a system dynamic model that describes the dynamism in a small hotel when it strives to pursue sustainability and profitability at the same time. We believe our study will spur interesting discourse in this area among the research community.

No research is without limitations and we feel it is important for us to discuss some of the key ones here. First, the model is based on a unique case that has already successfully achieved the balance between sustainability and profitability and has the advantages of embedding the culture of sustainability throughout its organization since its inception. These two factors are not simple to achieve for existing 'profitability'-driven small hotels that have been in operations for some time. Further study can look into modelling how an existing 'profitability'-driven small hotel can effectively transform to a 'profitability-sustainability' balance one. Second, many of the variables within our model are context specific and some of its values built on assumptions. This means that it will not be wise to generalize our model to any small hotels. However, our model does serve as a starting point where other researchers can build upon. Future study on this topic can draw insights from our work and consider developing a system model that is potentially generalizable across all small hotels.

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