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Solid waste generation from the hotel industry in the coastal tourism cities of Vietnam

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Abstract:

While the tourism and hospitality sectors in Vietnam have been rapidly developing, the increasing consumption of natural resources and production of associated waste, especially in coastal and island sites, threaten these marine areas with pollution. This study provides data on solid waste from 10 hotels in three coastal provinces of Vietnam, namely, Hai Phong, Quang Nam and Phu Yen. The results indicated significant percentages and volumes of organic waste especially from large-scale hotels with in-house food services like restaurants and bars. The proportions of organic and recyclable solid waste from all three surveyed cities ranged between 35-84% and 10-27%, respectively. Plastic waste accounted for a relatively high proportion of solid waste ranging from 27 to 60% total solid waste by volume and from 7 to 30% by weight. In particular, PET plastic made up the highest proportion of solid waste in Cat Ba town (52.41%) and Tuy Hoa city (39.81%) while single-layer plastic accounted for the highest proportion (29.55%) in Hoi An city. Plastic waste from food packaging, related to the cultural habits of guests that bring instant food items during their stay, was identified as an important issue, which reflects a valuable but presently wasted potential resource. These quantities of hotel solid waste can be recovered and provide additional environmental and health benefits to the community by not being dumped, landfilled, or openly burned.

Keywords: **hotels, organic waste, plastic waste, tourism, Vietnam.**

Classification number: **5.3**

Introduction

According to the World Tourism Organization (UNWTO), the total worldwide tourism revenue in July 2019 reached 1,451 billion USD with the total number of international tourists reaching 1.4 billion [1]. While tourism is an important sector and the driving force for socio-economic development in many regions, inadequately managed tourism can also lead to negative impacts such as overconsumption of resources, habitat damage, and pollution emissions from transport in addition to the generation of a substantial amount of solid and liquid waste. According to United Nations Environment Programme (UNEP) estimates, each international tourist in Europe generates at least 1 kg of solid waste per day, and up to 2 kg/person/day in the United States [2]. Tourism cities and destinations face many challenges related to waste management due to the unique nature of the tourism sector such as seasonality and concentrated areas with high tourist-associated waste generation. Research also shows that the proportion of solid waste generated from tourism establishments and activities can account for the majority of solid waste generated in some tourist cities [3, 4]. According to the UNEP, 80% of tourism activities and destinations are in coastal cities. As such, coastal tourism cities face growing challenges to the management of solid waste from tourism and the associated environmental impacts of mismanaged waste [5]. The challenges are even more significant for tourism establishments on small islands [6]. According to International Union for Conservation of Nature (IUCN) reports, every year about 8 million tons of plastic waste leaks into the sea with 80% of that eventually being deposited on the sea bed [7]. It has been estimated that Vietnam discharges the fourth-largest amount of plastic waste into the sea, at 0.28-0.73 million tons/year, which is equivalent to 6% of the world's total plastic waste discharged into the sea [7]. Most of the plastic waste that enters the ocean each year comes from land-based activities. Plastics have a slow degradation rate, and in some cases emit toxic chemicals that pose

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serious physical, public health, and environmental threats to terrestrial, coastal, and marine ecosystems [8].

Vietnam has a fast-growing tourism sector that takes advantage of more than 3,260 km of coastline, an extensive archipelago of about 3,000 islands in large and small clusters, and 125 main beaches, all of which attract tens of millions of visitors each year. Indeed, tourism directly contributes 7.02% to total national budget revenue [9]. However, the lack of uniformity in solid waste management systems, weak infrastructure, inadequate incentives and enforcement, and the lack of awareness of many tourists, coastal communities, and industries including fisheries has caused coastal tourism destinations to face serious waste pollution that threatens the country's tourism potential. Thus, an overall solid waste management program for coastal tourism cities with focus on plastic waste in particular will foster the responsible development of the tourism sector, which includes effectively enhancing the environment and further increasing Vietnam's tourism potential. This study was conducted to contribute to the scientific basis towards the development goals of the tourism sector. Therefore, this work focused on three coastal tourism cities in three provinces in Vietnam to document quantities and compositions of solid and plastic waste generated from local hotels in comparison to other regions in Vietnam. In addition, the potential for recycling the solid waste is assessed on the basis of diverting waste from dumps, landfills, open burning, or incineration.

Materials and methods

Study areas

This research was conducted in three coastal cities in Vietnam including Cat Ba town (Hai Phong city), Hoi An city (Quang Nam province) and Tuy Hoa city (Phu Yen province). The target cities are representative of the different urban levels and geographical regions of Vietnam. Each city has different economic and social characteristics, technical infrastructure, living standards, travel development, climate situation, consumption habits, and living habits. The locations of the study areas are shown in Fig. 1. These surveys were carried out in 2018 and 2019. Cat Ba is considered a class 4 urban area belonging to the Cat Hai island district in Hai Phong city in Northeast Vietnam. Cat Ba was recognized by UNESCO as a World Biosphere Reserve in 2004. Cat Ba has an area of 59.2 km² and a population of about 8,392 people (2019) with a population density of 141.8 people/km². According to the 2019 socio-economic report of the Cat Hai district, its total production value reached 7,973.5 billion VND in which the tourism sector accounted for 77.3%. In 2019, Cat Ba welcomed 2,180,000 visitors with an average annual growth rate of 10%. Total revenue from tourism

Fig. 1. Map of study areas.

and service activities in 2019 was 1,805 billion VND, which accounted for 77.3% of the total local budget revenue [10].

Hoi An city is a class 3 urban area and is considered the economic-political-cultural centre of Quang Nam province, which is in the central region of Vietnam. Hoi An was recognized by UNESCO as a World Cultural Heritage Site in 1999 and was also designated as part of the Cu Lao Cham - Hoi An Biosphere Reserve in 2009. The area of the city is 61.48 km² with a population of 94,579 people (2018), and a population growth rate of 0.59%/year from 2013-2017. According to the data reported in the Hoi An Waste White Book in 2018, the total production value of

the city was estimated at 10,073.7 billion VND, of which the trade-service-tourism sector accounted for 71.2%. In the tourism sector, the total visitors to Hoi An in 2018 were estimated at 4.992 million, up 31.7% over the same period (international visitors reached 3,755 million, up 90.94%). The total number of stays is 1.78 million and the average length of stay is 2.13 days [11].

Tuy Hoa city is a class 2 urban area and the political-economic centre of the Phu Yen province, which is located in the south-central region of Vietnam with an area of about 107.3 km^2 and a population of about 161,179 people in 2018. According to the 2019 socio-economic report of the Phu Yen province, revenue from accommodation services, catering services, travel, and tourism activities increased by 15.5% over the previous year reaching a total of 4,642.2 billion VND. From this revenue, accommodation services accounted for 232 billion VND, an increase of 20.2%, and accommodation facilities served 1,018,600 arrivals of which 15,000 were international visitors, which were up by 20.9 and 33.6%, respectively [12].

Survey method

A total of 10 hotels were sampled as described in Table 1. The surveys for Cat Ba, Hoi An, and Tuy Hoa were conducted from the 15th to the 21st of September 2018; from 1st to 7th, November 2019 and from 28th June to 4th July 2019, respectively. The surveys in each of the cities were conducted continuously and for a minimum of 7 days. Details of the sampling effort for the three study areas are also summarized in Table 1.

The sorting of hotel solid waste followed 19 sub-categories that are listed in Table 2. Each category is quantified by weight (kg) and volume (litres) and reported accordingly. The waste assessment method was adapted from the "Waste Assessment and Brand Audit (WABA)" methodology and toolkit developed by the Global Alliance for Incineration Alternatives (GAIA). This is a methodology of solid waste collection and analysis that determines the quantities and types of waste generated in a locality and identifies the brands responsible for producing this waste by calculating their contributions by percentage weight. The basic steps of the method are: (1) a waste assessment made at the source by collecting waste from each hotel and separating it into the 19 sub-categories identified in Table 2 and (2) waste auditing of 20-liter buckets for each sub-category of waste by arranging and proper labelling. Waste is sorted into the appropriate buckets and, when they are full, their weight and volume are recorded (volume is approximated based on the proportion of the bucket that is full).

Table 1. Surveyed hotels in these cities.

City/Town	Star Rating[a] (Hotels)			Total registered hotels[b]	Number of hotels sampled	Number of guests during the audit period (person)	Total weight audited (kg)
	5 and 4	*3 and 2*	*1 and 0*				
Cat Ba	0	2	1	135	3	84	62.44
Hoi An	1	1	1	120	3	1,964	876.66
Tuy Hoa	2	2	0	56	4	14,786	7,476.27
Total	3	5	2	311	10	16,834	8,363.55

Notes: star ratings for hotels are based on TVCN 4391-2015: hotel - classification; registered hotels: total number of hotels were obtained from the local tourism department for registered hotels in the 2017-2018 period.

Table 2. List of solid waste sub - categories.

No	Sub-Categories	Description	Note
1	Plastic bag	All kinds of plastic bags	Non-recyclable
2	Multi-layer plastic packaging	Package has multiple layers	Non-recyclable
3	Single-layer plastic packaging	Package has only one layer	Non-recyclable
4	Polystyrene	Polystyrene container	Non-recyclable
5	Hard Plastic	HDPE, LDPE and PP plastic	Recyclable
6	PET Plastic	PET bottles	Recyclable
7	PVC Plastic	Water pipe	Non-recyclable
8	Straws	Plastic straws	Non-recyclable
9	Diapers & Tissue	Diapers and toilet paper	Non-recyclable
10	Metal	All kinds (copper, lead, iron…)	Recyclable
11	Glass	All kinds of glass	Recyclable
12	Paper and Cardboard	Paper documents, newspaper.	Recyclable
13	Organic Waste	Leftover food, food scraps, leaves, flowers	Recyclable
14	Textiles	Tablecloths, clothes	Non-recyclable
15	Ceramics	Ceramic, minerals	Non-recyclable
16	Hazardous Waste	Paint, oils, pesticide, fertilizer.	Non-recyclable
17	Medical Waste	All medical purpose waste	Non-recyclable
18	Footwear	Shoes, flip-flops (sandals)	Non-recyclable
19	Other	Unable to categorize	Non-recyclable

Note: HDPE: High density polyethylene; LDPE: Low density polyethylene; PET: Polyethylene terephthalate; PP: Polypropylene; PVC: Polyvinyl chloride.

Results and discussion

Solid waste generation rate

The results of the solid waste generated for each type of hotel in the study area are presented in Table 3 including comparisons with other hotel audit studies in Vietnam.

Table 3. Daily solid waste generation rate.

City	Method (*n-number of surveyed hotel, methodology and surveyed time*)	Solid waste generation rate (kg/guest/day)					Ref.
		5 star	*4 star*	*3 star*	*2 star*	*1 star*	
Ha Long	n=3 Sampling (collect - separate - audit), 7 consecutive days in June 2004.	-	0.38-0.98	0.3-0.58	0.34-0.74	-	[13]
Hue	n=45 Sampling (collect - separate - audit), 10 consecutive days in June 2012.	6.57	2.32	1.71	0.48	0.60	[14]
Hoi An	n=120 Sampling (collect - separate - audit) and questionnaire, 7 consecutive days in December 2016.	0.6-2.28					[15]
Hoi An	n=9 Sampling (collect - separate - audit), 14 consecutive days August 2015.	0.8-3.33					[16]
Cat Ba	n=3 Sampling (collect - separate - audit), 7 consecutive days in September 2018.	-		0.13		0.03	This study
Hoi An	n=3 Sampling (collect - separate - audit), 7 consecutive days in November 2019	0.46		0.35		0.93	This study
Tuy Hoa	n=4 Sampling (collect - separate - audit), 7 consecutive days in June 2019	0.67		0.43		-	This study

Notes: "-" indicates no data collected in the cited reference; the solid waste generation (SWG) rate is calculated by dividing the total amount of waste generated per day in the hotel by the number of guests in the hotels on the day sampled.

The amount of solid waste generated at hotels in Cat Ba ranges from 0.03 to 0.13 kg/guest/day, which is significantly lower than that of similar hotels in Hoi An and Tuy Hoa. This is because the time of the survey in Cat Ba was September 2018, which is a time of absence of tourists as the high season ranges from May to August. Similarly, the time of the survey (November 2019) in Hoi An, was also the low season of the city, and the amount of generated solid waste ranged from 0.35-0.93 kg/guest/day. This value is quite similar to the obtained results of S.T.P. Phu, et al. (2008) [17] where the sampling process was conducted over 7 consecutive days from 120 hotels. Indeed, the results showed that the average amount of solid waste released from those hotels was 2.28 kg/person/day in the rainy season and 0.6 kg/person/day in the dry season (from February to September 2018). In contrast, the amount of solid waste generated from the hotels in Phu Yen was quite high and ranged from 0.43 to 0.67 kg/guest/day. This value can be explained as the survey was conducted in Tuy Hoa in June 2019, which is the high tourist season of the city. These results are similar to the solid waste audit results reported by P. Byer et al. from 3 hotels in Ha Long with 4-star, 3-star, and 2-star hotel waste ranging from 0.38-0.98, 0.33-0.58, and 0.34-0.74 kg/guest/day, respectively [13]. However, this result is significantly lower compared to the published result of L. Son, et al. (2018) [14], which were conducted under the same conditions in June 2012 in Hue city. The amount of solid waste generated for different types of hotels from 5-star, 4-star, 3-star, 2-star, 1-star, and guest house has the average value of 6.57; 2.32; 1.71; 0.48; and 0.60 kg/guest/day, respectively. Meanwhile, the study of D.N. Trung, et al. (2005) [18] estimated the waste generation rate of 50 hotels in Vietnam. The results showed that 2-, 3-, and 4-stars hotels generated 0.7-5.6; 8.2-17.9 and 13.5-32.3 kg/person/day, respectively, of daily solid waste. Their results are significantly larger than the other published studies, and this is explained by their method of study being a questionnaire survey.

The results show that the amount of solid waste generated in hotels is mainly from tourism activities, which depend on factors related to the hotels, e.g., their size and characteristics such as the number of rooms, quality, and range of services and facilities such as food service, presence of garden or green areas, and seasonality factors like the time of year and whether it is the high or low tourist season. Besides, high standard hotels produce significantly higher quantities of solid waste than lower standard hotels, which is not dependent on the geographic area. This is explained by the many accompanying services these high-quality hotels often have to serve exceptional tourist demands such as food, spas and gyms, and expansive green spaces.

Solid waste composition and recycling potential

In terms of composition by weight, the percentage of organic waste in hotels from the three sampled areas was higher compared to inorganic waste (Fig. 2). The organic waste percentage was approximately 35, 58 and 84%, meanwhile the inorganic waste percentage was approximately 38, 25 and 6% for Cat Ba, Hoi An and Tuy Hoa, respectively. The percentage of organic waste from the hotels in Tuy Hoa were the highest with more than 80% while Cat Ba is the lowest with 35% of the total waste. In Hoi An, the percentage of organic waste was approximately 58.3%, which is similar to the result of Hoang, et al. (2017) of 56.2%, although the percentage of recyclable waste in Hoi An was 16.9%, which is significantly different from 30.4% in Ref. [16].

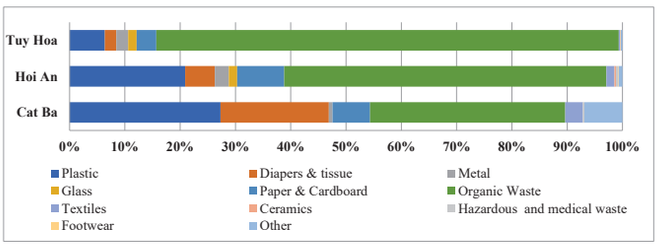

Fig. 2. Solid waste composition by weight in hotels from the 3 cities.

The 2020 law of environmental protection (law No72/2020/QH14) stipulates that domestic waste has to be classified into 3 categories: (1) recyclable waste, (2) food waste and (3) other waste. Food waste is considered as any food or inedible parts of food that is removed from the food supply chain to be recovered or disposed. In the organic waste generated from accommodation facilities, the organic component from fruits and food scraps often accounts for the largest proportion. They can be used for composting or food for animals. In our study, the percentage of food waste in hotels in the three sampled areas was higher compared to other waste items (30.5% for Cat Ba, 44.6% for Hoi An and 70.1% for Tuy Hoa). The high percentage of food waste from hotels in Tuy Hoa can be linked to the hotel type; all were larger hotels (upper 3-star) with large restaurants and bars for food services, while the Cat Ba hotels that were audited were mainly without food services.

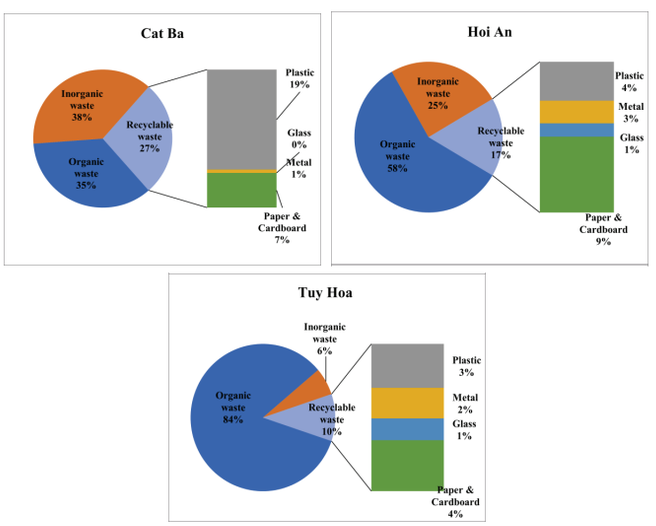

Fig. 3. Composition of waste from hotels in 3 cities.

The highest amount of recyclable waste was recorded in Cat Ba with 27% total solid waste. Meanwhile, this value was only approximately 10% in Tuy Hoa City. For the recyclable waste composition, plastic and paper accounted for the highest proportion (19 and 7% for Cat Ba, 4 and 9% for Hoi An and 3 and 4% for Tuy Hoa, respectively). The proportion of recyclable waste such as paperboard, metal, and plastic accounted for quite a large proportion ranging from 10-30%, and these materials can be generally recycled and reused for other purposes.

The total amount of waste that can be recycled and reused (including food waste and recyclable waste) accounts for up to 50-80%. This waste is presently delivered to dumps, landfills, open burning sites, or incineration facilities and is currently being lost as a significant and valuable resource from hotel waste. If source segregation can be implemented with a collection and treatment system connected to the type of waste sorted, this can redirect up to 80% of the waste to become new, usable, and potentially valuable economic resources.

The results of the solid waste composition of this study in comparison to some coastal tourism cities in Vietnam are shown in table 4. For Da Nang city, the average amount of solid waste generated at hotels was 89.72 kg/hotel/day or 0.95 kg/room/day that includes 62.8% organic, 13.5% inorganic and 23.7% recyclable waste [19]. The percentage of organic, inorganic and recyclable waste in Ha Long and Hue city were 64.33; 30.07; 5.6 and 45.2%; 21.20; 33.6%, respectively. The difference in the solid waste composition among the hotels can be explained by the different types of hotels, the survey time (high or low season), the methodology of the survey, and the characteristics of the studied city. In addition, since the volume and composition of solid waste generated by the hotel industry in Vietnam are still quite limited, this comparison will be more accurate when these data are complete and detailed.

Table 4. Comparison of solid waste composition in coastal Vietnamese hotels.

City (*n -number of the surveyed hotel)*	Average composition (%)			References
	Organic	*Inorganic*	*Recyclable*	
Da Nang (n=10)	62.8	13.5	23.7	[19]
Ha Long (n=3)	64.3	30.1	5.6	[13]
Hue (n=45)	45.2	21.2	33.6	[14]
Hoi An (n=9)	56.2	10.4	33.4	[16]
Cat Ba (n=3)	35.3	37.7	27.0	This study
Hoi An (n=3)	58.3	24.8	16.9	This study
Tuy Hoa (n=4)	83.6	6.1	10.3	This study

Plastic waste from the hotel

The plastic waste generation rate from hotels in Hoi An is the highest (0.09 kg/guest/day), while in Tuy Hoa and Cat Ba they are the same (0.03 kg/guest/day). Recyclable plastic waste included PET plastic and hard plastics such as HDPE, LDPE, and PP plastic. Non-recyclable plastic waste consisted of plastic bags, PVC,

polystyrene plastic, single and multi-layer plastic bags, and straws. The proportion of plastic waste by weight and volume in the total waste generated from the studied hotels is shown in Figs. 4 and 5. The plastic waste from the hotels by weight and volume accounts for a relatively high proportion ranging from 27 to 60% total solid waste by volume, and from 7 to 30% by weight. The high proportion of plastic waste by volume suggests handling and management challenges in utilizing plastic waste for storage or transport facilities for each city.

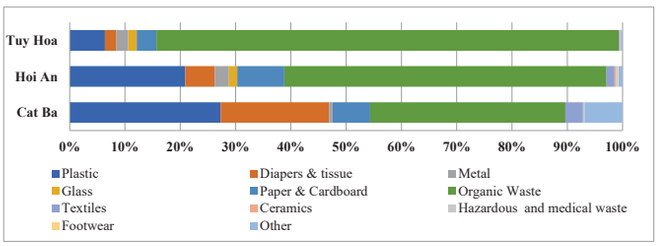

Fig. 4 Proportion of plastic waste from the hotels in 3 cities by weight.

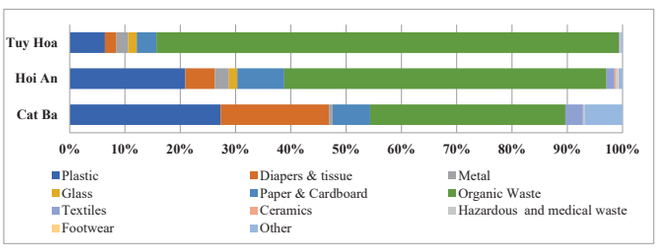

Fig. 5 Proportion of plastic waste from the hotels in 3 cities by volume.

This study also evaluated the composition of plastic waste in each studied city and the results are shown in Fig. 6. Among the types of plastic waste, PET plastic accounts for the highest proportion in Cat Ba (52.41%) and Tuy Hoa (39.81%), meanwhile, single-layer plastic accounts for the highest proportion (29.55%) in Hoi An. The generation rate of the multi-layer plastic packaging per guest day in Hoi An (0.0153 kg/guest) is approximately five times higher than in Tuy Hoa (0.0028 kg/guest) and eight times higher than in Cat Ba (0.0019 kg/guest). Survey interviews suggest that this may be related to cultural factors as most hotel visitors during the survey period were Korean, with a reported habit of bringing ready-to-eat food packages for their stay. Further, the amount of plastic waste (multi-layer plastic packaging) related to food packaging with the label origin from Korea is very high. This result suggests that the characteristics of waste, in general, and plastic waste, in particular, depend on the characteristics and consumption habits of the guests.

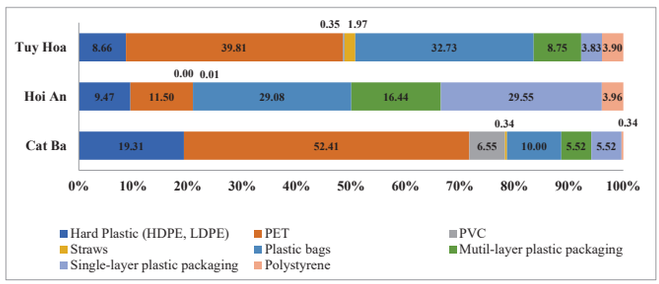

Fig. 6. Composition of plastic waste by weight from the hotels in 3 cities.

The percentage of recyclable plastic waste by weight was highest in Cat Ba (more than 71%), followed by Tuy Hoa is 48.47%, and Hoi An's recyclable plastic waste was the lowest in both weight and volume (21 and 23%, respectively). Comparing across large and small hotels, although the total waste generation rate is higher in larger hotels due to greater quantities of food waste (leftovers), there was no significant difference in plastic waste composition between the two hotel types. Thus, the rate of non-recyclable plastic waste from hotels in the study cities are still at a high level, especially in Hoi An. It is these significant challenges to the management of plastic waste in coastal cities. Audit results also show the need to address non-recyclable plastic in hotels. For example, the number of used plastic straws found was quite large, up to 0.8 kg of plastic straws/day (hundreds per day) from a 5-star hotel in Tuy Hoa city. However, most of these hotels are willing to stop providing plastic straws and convert to other types like bamboo, almond grass, or paper. Indeed, changes like these will require coordination with suppliers, the adoption of technically accurate advice, and awareness-raising with guests for modification or replacement, including the use of authentic biodegradable products. This should extend to other plastic items available for guests e.g., brushes, combs, and other toiletries, including their packaging.

Proposing the solutions in solid waste management from the hotel industry

Along with the study on generated solid waste, this work also conducted surveys of the current status of solid waste collection, its classification, and transportation from the hotels in the study areas. The results show that all hotels have contracted the collection and transportation of waste with a collection company, with a frequency of two times per day (morning and afternoon)

to ensure that all of generated wastes are collected the same day. For large-scale hotels, especially those with restaurants and bars, the daily amount of waste is very large. Some of the hotels sorted food waste and then sold or gifted it to livestock facilities, which has significantly reduced the amount of waste that has to be transported to landfills. The recyclable wastes are collected and sold to informal collection systems by the hotel's staff, and profits are transferred to the union fund of the hotel. However, most single-use plastics such as plastic bags, spoons, combs, toothbrushes, and straws can not be sold to a junk buyer due to low profit, thus, it transported to landfills. In addition, hotels in coastal areas often contain seafood shells in their waste composition that are heavy, fast-degrading, and smelly, along with coconut shells that are heavy and bulky. These types of waste are still being collected and treated through the municipal waste without being reused or recycled, and these conditions are placing even more pressure on landfills.

Based on the experimental data and survey results, our study proposes several solutions to effectively manage solid waste arising from the hotel systems including:

Internal communication within the enterprise to all employees and tourists to bring awareness and understanding to the meaning of waste management.

Most hotel management units want to change because they have a good understanding and awareness of environmental responsibility, however, there are still hotels that say they only change solid waste management activities upon request from local authorities. Some hotels are willing to change solid waste management practices such as reducing single-use plastics (water bottles, toiletries) or practicing plastic reduction activities, but are still afraid of the reaction of customers. The results show that communication programs to update knowledge and behaviour are very necessary for the tourism industry. Besides, tourists are an extremely important factor, so they will play a role in guiding the changing trends of hotels. If they are fully informed, after the change, they will become supporters and continue spreading the change to the community.

Development of a set of guiding criteria for waste management, waste classification, criteria for green hotels in the field of waste reduction, and honouring typical elements such as green labelling and corporate image promotion. The local agencies of tourism and environmental management need to issue specific guidelines and routes to the hotels. In addition, it is necessary to cooperate with solid waste collection and treatment entities, the media, NGOs, etc.

Synchronizing the classification, collection and treatment system in the city. Waste segregation and waste minimization activities at hotels are only really effective when there is synchronization of the stages of solid waste management system such as classification at the source, collection, transportation, recycling, and treatment. This needs consensus from central and local management agencies and each citizen.

Conclusions

This study focused on the solid waste generation and composition of the hotel industry from three coastal cities in Vietnam. The results showed that the percentage of organic waste in hotels from lowest to highest was 35% for Cat Ba, 58% for Hoi An and 84% for Tuy Hoa. The percentage of food waste is similar with 30.5, 44.6, and 70.1% for Cat Ba, Hoi An, and Tuy Hoa, respectively. For large-scale hotels with in-house restaurants and bars, more attention must be paid to food waste separation, which can be linked to supporting the development of an associated value chain of using food scraps for livestock as well as compost. Presently, these hotels have initiated bio-product development from organic waste, e.g., by using fruit peels to develop organic detergents, thus, reducing some direct waste and improving the image of hotels as environmentally-friendly businesses. However, many other bio-products can also be developed from organic food waste from hotels and hospitality [20] and should be commercially explored. The percentage of recyclable plastic waste by weight is highest in Cat Ba (more than 71%), while, by volume, Tuy Hoa has the highest (52%). Hoi An's recyclable plastic waste is the lowest in both weight and volume (21 and 23%, respectively). To reduce plastic waste, the hotels also need to obtain technical guidance and work with their suppliers to request authentic environmentally-friendly packaging modifications or replacements based on the life cycle and other analyses.

At the waste collection level, it is necessary to both promote and connect the informal waste collection chain to hotel waste management systems and work with hotel

management to conduct training and increase awareness of the hotel staff so they too understand the benefits and importance of waste recovery. Organic and plastic waste recovery can not only increase income but also improve the local environment on which their tourism businesses depend. This study contributes to raising awareness of the potential of waste recovery to guide waste management in coastal tourist cities in Vietnam. This work can also be used as a basis to encourage tourism service establishments to limit single-use plastic products and, in particular, actively classify, reuse, and recycle waste, as well as increase the use of environmentally-friendly hotel products.

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COMPETING INTERESTS

The authors declare that there is no conflict of interest regarding the publication of this article.

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