Solid waste circulation in tourism: A close study of accommodation service establishments in Hoi An City, Vietnam

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Abstract: Tourism in Vietnam has become an important sector of the economy. Its environmental impacts include the quantity of waste generated. This study aims to assess the compositions of solid waste generated within diverse accommodation service establishments (ASEs) in Hoi An City to understand the differences across accommodation types and generating areas. The analysis indicated that most of the ASEs provided multiple services and waste components differed among generating areas. Initiatives for optimizing the recovered material flows from waste at the ASEs were proposed. A decentralized-centralized hybrid model was suggested as a suitable approach for waste circulation in the accommodation service sector. The training of staff in the ASEs and tourists, as well, is crucial. So is the participation of social entities in the city's waste management.

Keywords: hospitality; sustainability; sustainable tourism; waste circulation

1. Introduction

Tourism has become an important economic activity for countries in Southeast Asia [1]. As the sector flourishes, there is growing concern about the environmental impacts of the sector on the local environment [2]. In Vietnam, tourism contributed about 9.2% to the national GDP in 2019 [3] and many domestic destinations now attract tourists worldwide [4]. As of May 2023, Vietnam has five World Cultural Heritage sites recognized by UNESCO. Hoi An City - Quang Nam Province, with its 5 km^2 ancient town, is the only one that functions as a tourism service urban area rather than an isolated monument. The tourism sector in Hoi An City plays a leading role in the local economy. In 2023, Hoi An City welcomed about 4 million tourists, of which 3 million were international visitors [5]. At an estimated value of 8,563.6 billion Vietnamese dong (US$351.9 million), the tourism-service-trade sector makes up 73% of the production value of economic sectors in Hoi An City [6]. But, in addition to many economic benefits [7], tourism also leaves environmental impacts such as biodiversity loss, water pollution, and waste generation [8, 9]. Many recent studies have pointed out that tourism relies on overconsumption, making it a major producer of waste and pollution in cities [10, 11].

The Accommodation Service Establishments (ASEs) associated with the tourism sector generate business that enhances local livelihoods and socio-economic development [12]. Owing to the inadequate management of waste generated, there is, however, a major impact on the local

environment [11, 13]. Without better management approaches, this waste can overwhelm the system. Hoi An is facing adverse consequences for its status as a UNESCO site. In the context of achieving SDG12 (ensure sustainable consumption and production patterns) in a UNESCO city, efficient waste management in the tourism sector ought to be properly understood and prioritised. Such an understanding is essential as the tourism sector in Vietnam has grown in the post-COVID-19 era [14].

Context: Tourism in Hoi An City

The tourism sector in Vietnam is beginning to rebound as the restrictions implemented in response to the COVID-19 pandemic have been lifted. Before the COVID-19 pandemic, the average solid waste generation in Hoi An City was about 100 tonnes per day [15]. After the pandemic, when the tourism sector in Hoi An City had not fully recovered, the city's solid waste was 80 tonnes per day [16]. With the recovery of the tourism sector and projected significant growth, the quantity of solid waste generation is expected to be higher than in the pre-COVID-19 era. Yet, only a small amount of waste generated is processed on-site, and the rest is transported to another location within Quang Nam Province for treatment [6]. This is despite efforts by the local government and international organizations over many years in regard to waste sorting at the source, plastic reduction, reuse, and recycling of solid waste. The effectiveness and sustainability of technical solutions require an understanding of the characteristics of local solid waste.

In Vietnam, the ASEs provide overnight lodging for tourists. These are homestays, hotels, tourist villas, and resorts [17]. Accordingly, hotels range from establishments with 10 or more bedrooms, ensuring quality in terms of infrastructure, amenities, and necessary services for guests. Hotels include city hotels and resort hotels which are classified into five-star levels (1/ 2/ 3/ 4/ 5 stars). Guest houses are lodging facilities equipped with essential amenities to cater to tourists similar to hotels; but, they do not adhere to hotel rating standards. Homestays provide simple lodging rooms, often in a shared space with the host family. Tourist villas are equipped villas

intended for tourist rental, providing self-service during the stay. Resorts are designed as a complex comprising villas, apartments, or bungalows, with beautiful and modern landscapes, eco-friendly, and integrated with natural environments. As of the end of 2022, Hoi An City had 841 accommodation establishments serving both domestic and international tourists from countries like South Korea, Japan, China, various European nations, and the United States [18]. The city does not encourage expanding the number of accommodation establishments but focuses on improving quality, aiming for a tourism model that ensures green criteria [19].

Within Hoi An's accommodation establishments, homestays constitute the highest proportion (48.5%), and hotels with various star ratings constitute a modest percentage (19.6%). This predominance of homestays as against hotels is a distinctive feature of Hoi An, which aims to expand tourism beyond urban areas, conserve and promote cultural and natural values in suburban areas and develop sustainable tourism by improving the livelihoods of residents. Homestay and villa accommodations are regarded as appropriate to enhancing family income [19]. The types of accommodation establishments and the services provided by them significantly impact the generation rate and composition of solid waste in the respective units [20-22].

Tourism solid waste composition

Dileep [23] categorized tourism waste into three groups: biodegradable waste (food waste, fruits, vegetables), non-biodegradable organic waste (fruit seeds, fruit peels, paper, cloth), and non-biodegradable inorganic waste. Non-biodegradable inorganic waste was further classified into directly reusable (polythene, tin can lids, glass bottles), reused for decoration (eggshells, ceramics), and recyclable (plastics-nylon, rubber, metals). Biodegradable waste and recyclable waste were the two largest groups that are generated from tourism activities [20, 24, 25]. Solid waste from hotels and restaurants included non-hazardous components such as food waste, wood, paper, cardboard, plastics-nylon, metals, glass, fabric, household waste, and hazardous waste [20, 21]. According to a study by Hoang *et al.* [25], the proportion of biodegradable waste in hotels

and restaurants was 49.0% and 39.5%, respectively, higher than other components. The second-highest component in hotels (16.4%) was plastic (plastic bottles, PET bottles, plastic and nylon packaging), whereas, in restaurants, it was combustible waste (fabric, leather, carpets, mattresses, wood, bamboo, rubber, etc.), accounting for 15.3%. These studies did not clearly define the services provided by hotels or indicate whether the waste from restaurants inside the hotel premises was included.

The 2020 Law of Environmental Protection (72/2020/QH14) of Vietnam stipulates that domestic waste must be classified into 3 categories: (1) recyclable waste, (2) food waste, and (3) other waste. So far, it has not been documented which specific types of waste should be prioritized for recovery at sources to align with the solid waste management strategies. In theory, most types of plastic waste can be recycled, except for plastic types 3 (polyvinyl chloride - PVC) and 7 (other plastic materials, e.g., polycarbonate - PC) [26]. Plastics are not all equally viable to process in practice, considering their availability, economic efficiency, health concerns, and quality of recycled products [27, 28]. Although polyethylene terephthalate (PET), high-density polyethylene (HDPE), and polypropylene (PP) have recycling potential, only PET and HDPE are consistently recycled [27, 29, 30]. Similarly, not all food wastes are applicable for composting because of their inherent differences, leading to some technical challenges [31, 32]. Food residues that have poor porosity, fast degradable organic matter, and low Carbon/Nitrogen (C/N) ratio, could be reused as animal feed or for biogas production [23, 33].

The research investigates solid waste within diverse ASEs, examining waste categories concerning applicable technical remedies and disparities across accommodation types and waste-generating zones. Building upon this assessment, the study suggests tailored solutions to enhance waste management approaches for individual ASE categories. Strategies focusing on waste minimization and recycling at the community level serve as fundamental elements in fostering an accountable and enduring tourism sector at the regional level. Additionally, the findings illuminate the concept of circular tourism, seen through the lens of solid waste management.

2. Methods

2.1 Data collection

This study relied on data collected from tourism accommodation establishments (ASE) based on the fivefold classification of ASEs, viz., homestays, guesthouses, hotels, villas, and resorts (see **Table 1**). The data were collected by means of a questionnaire and sampling of solid waste at each establishment for component analysis. There were similar numbers for each type of ASE surveyed except for 4-5-star hotels and villas which are not numerous in the city.

The survey investigation at each ASE began with a questionnaire. This was used to collect information on the type and scale of ASEs, services, waste generation areas, and solid waste management at the source. Respondents to the questionnaires were either the ASE managers (for small-scale establishments) or personnel managing staff, room and kitchen managers, and restaurant managers (for large-scale establishments). All questionnaires were given in the morning so that the research team could explore the opportunity and time for waste sampling. Based on the survey data, the research team identified waste generation areas to conduct on-site waste measurements and collect waste samples for component analysis.

Following the questionnaire, solid waste was sampled from main generating areas including lodging rooms, kitchens, and restaurants (if any) for component analysis. This followed the approach by Zein *et al*. [21] which identified lodging, kitchens, restaurants, and bars as the areas generating a significant portion of solid waste. At each ASE, lodging room waste was collected randomly from 4 to 5 units during the check-out period, typically between 12 PM and 2 PM. Meanwhile, sampling kitchen and restaurant waste was either between 2 PM and 3 PM or from 8 PM to 9 PM, depending on the respondents' recommendation.

Because of the limited volume of lodging room waste, complete bags were sampled and analysed per individual room. Normally, solid waste from 4 – 5 lodging rooms did not exceed 25 kg. The waste from kitchens and restaurants at homestays, 1-star hotels/guesthouses, 2-3-star

hotels, and villas was sampled entirely for analysis. Depending on the type of ASEs, the amount of solid waste varied from tens to hundreds of kilograms, or in exceptional cases, up to 1-2 tonnes of solid waste. At 4-5-star hotels and resorts, the sorted kitchen and restaurant waste components were individually weighed. For unsorted waste, a thorough mixing process was carried out, and a sample size of 20 kg was collected for analysis. Large and sorted solid waste, intended for scrap sale, was weighed separately for each component. Waste sampling occurred once at each ASE.

In pursuit of enhancing recyclability, the sorting approach employed in this study aligns with the existing recycling practices, particularly for biodegradable and plastic waste. Accordingly, solid waste samples were sorted into 9 categories: food residues, food processing waste (discarded fruit and vegetables, egg shell), PET bottles, recyclable plastics (PP and HDPE), recyclable papers (cardboard, paper container, magazine, office paper, and other clean paper stuff), metal cans, remaining plastics (PVC, PS, plastic bag, and other plastics), remaining paper (toilet paper, tissues, dirty scraps, etc.), other remaining waste (glass, fabric, garden waste, rubber, foam, ceramics, coconut shell, animal bone, etc.). Each solid waste component in different areas was weighted, and percentages were calculated from the recorded data. All measurements were on the wet weight basis.

2.2 Data analysis

The information gathered from the questionnaires and the component analysis was processed and assessed using Excel (Microsoft 365®). The analysis delved into the services provided by various categories of ASEs, methods of handling waste and recyclables at the source, and the distribution of waste components among different ASE types and generating areas. Based on this analysis, tailored waste management strategies for the ASEs in Hoi An were formulated, considering both ASE types and their respective generating areas.

The initial step was to calculate the proportions of each waste component for each specific type, as well as for all ASEs that were surveyed (Eq. 1 - 3).

$$P_{i,k}(\%) = \frac{m_{i,k} \times 100}{M_k} \quad (1)$$

$$P_{i\_Ave}(\%) = \frac{\sum_{k=1}^{n} P_{i,k}(\%)}{n} \quad (2)$$

$$\sigma_{P_{i,k}}(\%) = \sqrt{\frac{\sum_{k=1}^{n}\left(P_{i\_Ave} - P_{i,k}\right)^2}{n-1}} \quad (3)$$

Where $P_{i,k}(\%)$, $m_{i,k}(kg.day^{-1})$, and $\sigma_{P_{i,k}}(\%)$ represent the percentage proportion, weight, and standard deviation, respectively, of the i^{th} waste component from all generating areas for the k^{th} ASE. $M_k(kg.day^{-1})$ denotes the total quantity of solid waste generated from the k^{th} ASE. $P_{i\_Ave}(\%)$ signifies the mean proportion values of the i^{th} waste component for each specific type and collectively for all ASEs, and n values denote the count of ASEs surveyed, either for each specific type or in total, as part of this study.

Subsequently, the proportions of each waste component at various generating areas were derived (Eq. 4 - 6).

$$P_{i,j,k}(\%) = \frac{m_{i,j,k} \times 100}{M_{j,k}} \quad (4)$$

$$P_{i,j\_Ave}(\%) = \frac{\sum_{k=1}^{n} P_{i,j,k}(\%)}{n} \quad (5)$$

$$\sigma_{P_{i,j,k}}(\%) = \sqrt{\frac{\sum_{k=1}^{n}\left(P_{i,j\_Ave} - P_{i,j,k}\right)^2}{n-1}} \quad (6)$$

Where $P_{i,j,k}(\%)$, $m_{i,j,k}(kg.day^{-1})$, and $\sigma_{P_{i,j,k}}(\%)$ represent the percentage proportion, weight, and standard deviation, respectively, of the i^{th} waste component from the j^{th} generating area for the k^{th} ASE. $M_{j,k}(kg.day^{-1})$ denotes the total quantity of solid waste from the j^{th} generating area for the k^{th} ASE. $P_{i,j\_Ave}(\%)$ signifies the mean proportion values of the i^{th} waste component from the j^{th} generating area for all ASEs, and n indicates the total number of ASEs that were surveyed.

3. Results and discussion

3.1 Current status of services provided at the ASEs

The survey results **(Figure 1)** indicated a low percentage of the homestay type (14.3%) and 1-star hotels/guesthouses (28.6%) providing only accommodation service. Most accommodation types offer "breakfast" to guests. Homestays, 1-star hotels/guesthouses, and villas shared a similar characteristic of providing "bar-café" as an extra service, with the respective percentages for each type being 71.4%, 42.9%, and 50%. Additionally, larger-scale homestays (with 35 guests or more) also had "restaurants" inside the units. Both 2-3 star hotels and villas had "bar-café" and "restaurants," with percentages of 57.1% and 50% respectively. In contrast, all 4-5 star hotels and resorts in Hoi An offer services including "bar-café," "restaurants," and "spa/beauty services."

3.2 Current status of solid waste separation at the ASEs

The survey results from 31 ASEs showed that all units separated solid waste to recover valuable components for different purposes **(Figure 2)**. This is a positive indication for developing a circular economy model within the lodging service business sector. The primary motivations for waste categorization were selling (or giving for free) for recycling purposes, animal feed production, and in-house reuse. The two most common components being recovered were PET bottles (soft drink bottles) and metal cans (mainly beverage cans), presenting 92.5% of the ASEs. Clean paper like cardboard, office paper, and paper containers were also separated for sale in 80% of the ASEs. Food residues are the most prevalent waste type in these establishments, particularly abundant in facilities with buffet-style restaurants. Up to 84% of ASEs separated food residues to be transferred as donated animal feed for livestock and poultry.

The common waste type categorized and recovered for reuse in most ASEs (89.5%) was fabric items such as mattress covers, bedspreads, towels, napkins, and tablecloths. Items that have faded but were still in good condition were repurposed by the ASEs as pillow fillers, cleaning cloths, doormats, and household wipes. Cooking oil appeared as an exceptional component in solid

waste mixtures. Because of its liquid nature, cooking oil was typically contained in plastic packaging, such as plastic bags or bottles, and disposed of alongside other solid waste components. The disposal rate of cooking oil in solid waste mixtures or into drainage systems was as low as 12.5% for each route. Approximately 62.5% of the ASEs reused cooking oil (from frying foods like French fries, and spring rolls) for subsequent cooking (e.g., stir-frying rice). The remaining 12.5% incorporated it into food residues for feeding livestock and poultry.

3.3 Solid waste compositions at the ASEs

The primary component of the solid waste was biodegradable organic waste, with food residues averaging 42.8%, and waste from fruits and vegetables at 20.3%. The second-largest proportion (16.9%) comprised recyclable waste groups: recycled paper, recycled plastics, PET bottles, and metal cans. These findings align with the studies of Hoang *et al.* [25], Manomaivibool [24], and Pirani and Arafat [20] regarding the two largest waste categories in tourism solid waste. In Hoang *et al.'s* study [25], the rates of food waste and recyclable waste were 49.0% and 30.0%, respectively, whereas in Manomaivibool's study [24], these rates were 56% and 17%, respectively. Pirani and Arafat [20], through their review on waste management in the hospitality sector, found that food waste represented the largest proportion of waste generated by hotels, accounting for approximately 40% of their total waste.

The composition of solid waste varied depending on the type of ASEs **(Figure 3)**. The 4-5-star hotels and resorts exhibited the highest proportions of food residues and food processing waste, accounting for 50-52% and 31-24% of each waste type, respectively. Many of these luxury accommodations offered drinking water sourced from centralized filtration systems or bottled in glass, resulting in very low percentages of PET bottles, ranging from 0.8% to 1.9%. Additionally, the percentages of recycled paper and plastic found in the waste samples were also low, ranging from 2.5% to 2.8% and 2.4% to 3.5%, respectively.

In contrast, homestays and 1-star hotels/guesthouses showed significantly higher percentages of recycled paper and plastic, accounting for 10.3% to 10.7% and 5.6% to 6.1%, respectively, for each component. Particularly noteworthy was the high percentage of PET bottles, reaching 11.7% of the total solid waste sample in homestays. This could be explained by the diverse range of services offered by homestays and 1-star hotels/guesthouses, from "breakfast" to "bar-café," and even "restaurants," using bottled drinking water purchased from the market. Information regarding the mean proportion and standard deviation values of waste components has been included as a supplementary material – Table S1.

3.4 Solid waste components at different areas of ASEs

The predominant components of readily biodegradable solid waste in the kitchen and restaurant areas of the ASEs in Hoi An City were organic waste, with food residues accounting for 55.2% and 42.6%, and food processing waste at 27.4% and 31.6% respectively in these two areas (**Figure 4**). The results indicated similarities with the studies by Hoang *et al.* [25] and Pirani and Arafat [20], where food-related waste remained the main component, although the percentages in the ASEs in Hoi An are higher. Nonetheless, these components in the lodging rooms were minimal, representing only 11.2% of the total mass.

On the contrary, recyclable components from the lodging rooms constituted a higher proportion, with PET bottles at 16.9%, recycled paper at 13.8%, and recycled plastics at 8.4%. This could be explained by the fact that most ASEs, particularly homestays and small-scale hotels, provided bottled drinks for guests in PET bottles within the lodging rooms. The volume of paper waste arose from promotional materials and tourist activity guides for visitors, as well as packaging from souvenir items. Additionally, the remaining paper components (mainly tissues, small-sized scraps such as tickets) and other components (mostly food packaging, and cosmetics glass containers) also made up higher proportions in the lodging rooms compared to kitchens and

restaurants. The mean proportion and standard deviation values for waste components which support **Figure 4** have also been provided in the supplementary material Table S2.

3.5 Waste management initiatives for the ASEs in Hoi An City

The current waste management guidelines are inadequate in detail to facilitate practical implementation at the ASEs. There is a need to consider prioritizing waste components for classification and setting recovery targets for specific types of ASEs. Simultaneously, to optimize waste management taking into account hygiene, aesthetics, and resource conservation issues, it is essential to prioritize waste components for classification at each distinct waste-generating area. Last but not least, the plan for resource recovery from solid waste should also ensure alignment with the socio-economic conditions and technical infrastructure for waste management at the local level.

Centralized or decentralized approach?

Centralization in solid waste management means concentrating authority and decision-making at a single or few central points, typically at the level of a central government or authority. It aims to achieve economies of scale and uniformity in waste management practices across a large area but may face challenges such as bureaucratic inefficiencies. On the contrary, decentralization distributes authority and decision-making to local or regional levels, empowering municipalities, communities, or private entities to manage waste within their own jurisdictions. This approach enhances responsiveness to local needs and promotes community participation but can lead to variations in service quality and standards across different areas [34].

Several useful guidelines for solid waste management have existed that could underpin waste circulation for the ASEs in Hoi An City. The organic waste management hierarchy proposed by Schüch *et al.* [35] considers the centralized/ decentralized problem. Accordingly, measures for waste reduction at source, such as backyard or home composting, are preferred before

decentralized composting, followed by centralized composting and/or anaerobic digestion. To practise backyard or home composting, the ASEs must have adequate outside area. Among the various types of ASEs, villas and resorts, accounting for 29% of the total, have gardens alongside other amenities. Therefore, the conversion of readily biodegradable organic waste into compost can be achieved for these two types of ASEs. Food processing waste, such as discarded fruit and vegetables, egg shell, best fits backyard composting since it has low protein content and consequently avoids nuisance from pests.

Located in peri-urban areas of Hoi An City, vegetable cooperatives and the social enterprise named Green Youth Collective (**Figure 5**), which practise organic farming with compost and serve as education hubs for the public and tourists, could play roles in decentralized composting [36-38]. From 2015 to 2023, Green Youth Collective, the social enterprise, has formulated partnerships with > 10 hospitality businesses, trained hundreds of families and women in Hoi An on zero waste lifestyle, waste segregation and composting, and processed over 40 tonnes of organic waste into compost for local agriculture [37]. Decentralized composting hubs will not only bring about community participation but also promote waste circulation as well as sustainable tourism in Hoi An [39].

On the other hand, the Washington Department of Ecology [40] complements the organic waste management hierarchy by highlighting *the role of waste minimization at the source*. Various measures can count including educational programs for waste reduction, followed by feeding people and feeding animals before on-site and off-site management. This approach completely fits with the existing behaviours of donating food residues for livestock feeding in Hoi An.

Hoi An is also home to many handicraft workshops that make lanterns and artistic paper masks (**Figure 6)**, forming a unique cultural and local economic feature of this city. Lanterns are made from bamboo and silk fabric, and paper masks are made from notebook paper and newspaper. Establishing information channels for material exchange between the ASEs and

handicraft workshops could promote recycling activities for certain types of fabric and paper. This would form a green supply chain for handicraft products while also facilitating waste circulation for the ASEs.

The responsibility for managing the city's remaining waste should lie with centralized recycling systems. Since homestays and hotels generally lack extensive garden spaces, it is practically feasible to carry out organic waste recycling in the city's centralized composting facilities rather than on-site. For plastic and paper recycling, centralized facilities are recommended because they are effective in emission control and overall management [41].

The analysis depicted can be a decentralized-centralized hybrid waste recycling model for Hoi An, represented in **Figure 7**.

Guidelines for placing waste bins at the ASEs

Optimizing waste bin placement is assisted by the analysis of service provision, the current situation of waste separation, and the compositions of waste of different ASE types at different generating areas (summarized in **Table 2**). The three main spaces in the ASEs include public space (e.g., reception, lounge, lobby), kitchen and restaurant, lodging room and corridor. Types of waste bins should be sufficient and appropriate in order to maximize recovering resources from waste. In public spaces, it is necessary to place four types of waste bins for PET bottles, metal cans, recyclable paper, and non-recyclable waste (non-recyclable plastic and paper, and remaining waste) Because of the predominant waste components (non-recyclable types, as shown in **Figure 4**) and aesthetic considerations in lodging rooms, only bins for non-recyclable waste are feasible inside the rooms. Bins for recyclable materials (such as PET, metal, and paper) should be placed in the corridors, subject to the avoidance of fire risk and the provision of clear space for normal passage and emergency purposes. The placement of waste bins in public spaces and lodging rooms is not necessarily different among the ASEs.

Nevertheless, the amount of waste from kitchens and restaurants in homestays, 1-star hotels/guesthouses, and 2-3-star hotels is much smaller than that of 4-5-star hotels, villas, and resorts owing to their scale. Therefore, in *the former* ASEs, bins for food waste should be introduced in kitchens and restaurants along with other bins, where all kinds of food waste can be combined. Serving numerous guests, kitchens and restaurants of *the latter* ASEs create a significant volume of food waste. To manage this waste effectively, it is advisable to segregate it into two categories: food processing waste for decentralized composting and food residues for livestock feeding.

4. Conclusion

The main objectives of the study are to determine the solid waste components from the ASEs in Hoi An City, distinguishing between types and waste-generating areas, and to propose solutions for recirculating this waste. The analysis reveals that the majority of ASEs offer multiple services such as “breakfast”, “restaurant”, "bar-café", resulting in complexities regarding waste segregation at the source. The purpose is to make a circular economy in terms of waste generated by ASEs. Opportunities exist for enhancing resource recovery, building upon the current waste reuse activities. A decentralized-centralized hybrid model aligns suitably with the city's landscape and holds the potential to accomplish the twin objectives of fostering sustainable tourism and preserving cultural heritage. Emphasis is placed on ASEs ensuring the provision of adequate waste bins along with comprehensive guidelines for both their staff and guests. The significance of social entities, such as information centres and recycling facilities, is underscored. The active participation of social and private entities, such as vegetable cooperatives, the Green Youth Collective, resorts, and villas, is highly recommended for decentralized recycling of food processing waste. The total amount of waste from this decentralized approach can be recorded by registering with the Department of Natural Resources and Environment of Hoi An City.

The study makes a substantial contribution by enhancing the understanding of solid waste recycling potentials within the ASEs of Hoi An City. These establishments play a crucial role as core actors in a tourism-based economy. Mass tourism does not necessarily lead to wasteful extravagance. A circular economy can incorporate recycling of discarded materials with profit.

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Tables

Table 1. Characteristics of the ASEs in this study

Type of ASEs	Sample size (unit)	Percentage (%)	Number of lodging rooms available	Number of guests accommodated
Homestay	7	22.6	4 - 21	8 - 63
1-star hotel/guesthouse	6	19.4	8 - 24	28 - 86
2-3-star hotel	7	22.6	16 - 60	32 - 120
4-5-star hotel	2	6.5	68 - 100	190 - 280
Villa	4	12.9	5 - 25	16 - 50
Resort	5	16.1	83 - 220	200 - 440
Total	**31**	100.0		

Table 2. Guidelines for placing waste bins at ASEs

<table>
<tr><td rowspan="2">Types of ASEs</td><td colspan="3">Waste generating areas</td></tr>
<tr><td>Public space</td><td>Kitchen, restaurant</td><td>Lodging room</td></tr>
<tr><td>Homestay
1-star hotel/ guesthouse
2-3-star hotel</td><td rowspan="2">☑ PET bottle
☑ Metal can
☑ Recyclable paper
☑ Non-recyclable waste</td><td>☑ Food waste
☑ PET bottle
☑ Metal can
☑ Recyclable paper
☑ Non-recyclable waste</td><td rowspan="2">Inside lodging room:
☑ Non-recyclable waste

Outside and shared by clusters of lodging rooms:
☑ PET bottle
☑ Metal can
☑ Recyclable paper
☑ Non-recyclable waste</td></tr>
<tr><td>4-5-star hotel
Villa
Resort</td><td>☑ Food residues
☑ Food processing
☑ PET bottle
☑ Metal can
☑ Recyclable paper
☑ Non-recyclable waste</td></tr>
</table>

Figures

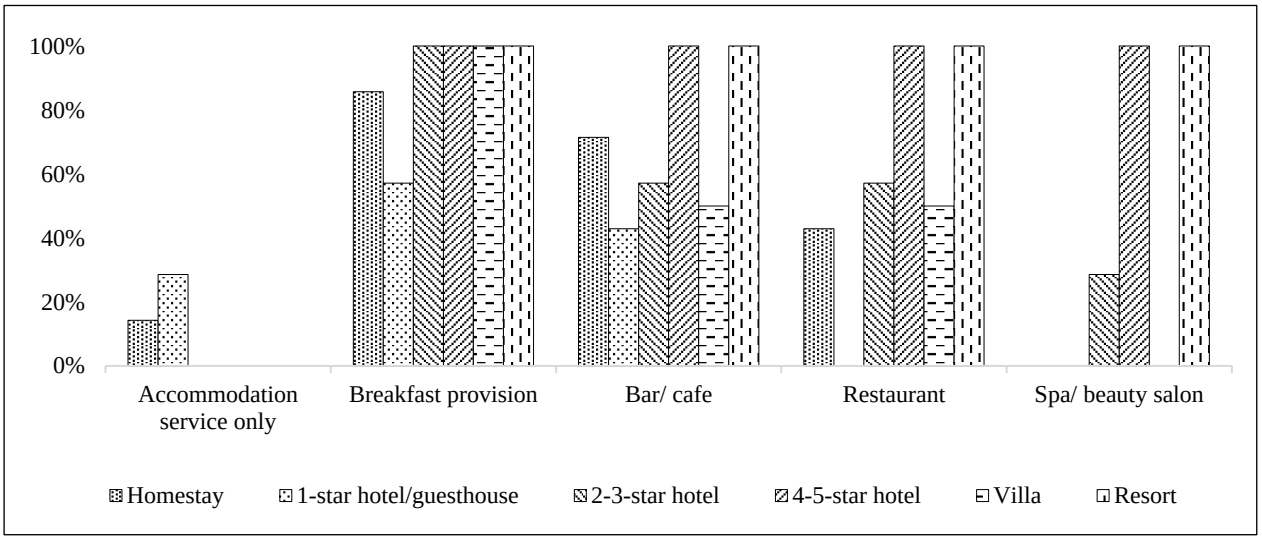

Figure 1. Services provided by the ASEs in the survey.

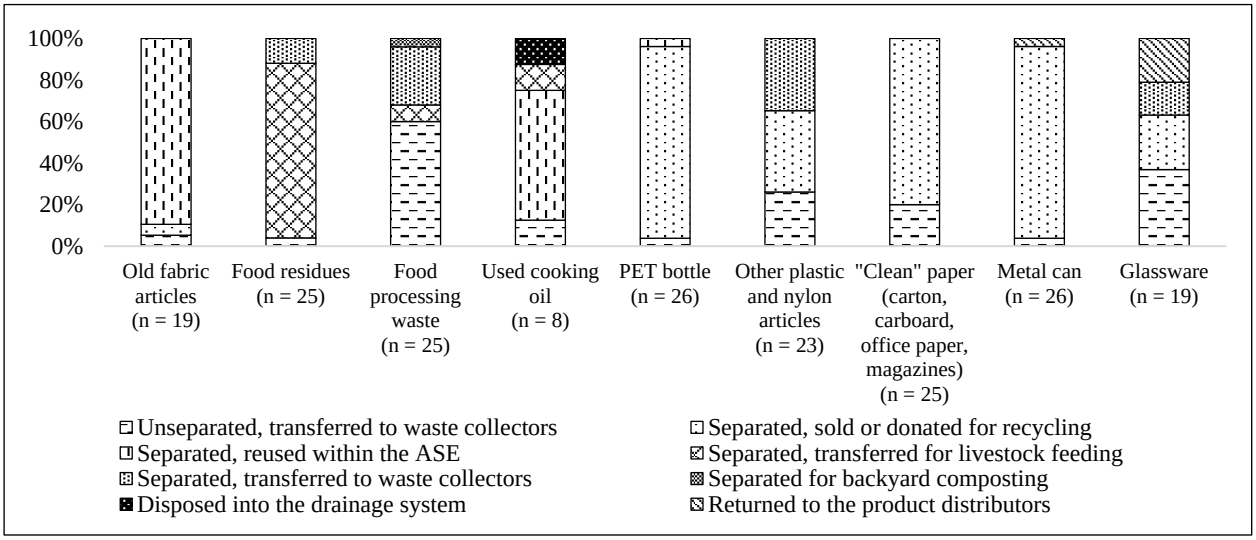

Figure 2. Percentages of the ASEs separating solid waste and the purposes of separation.

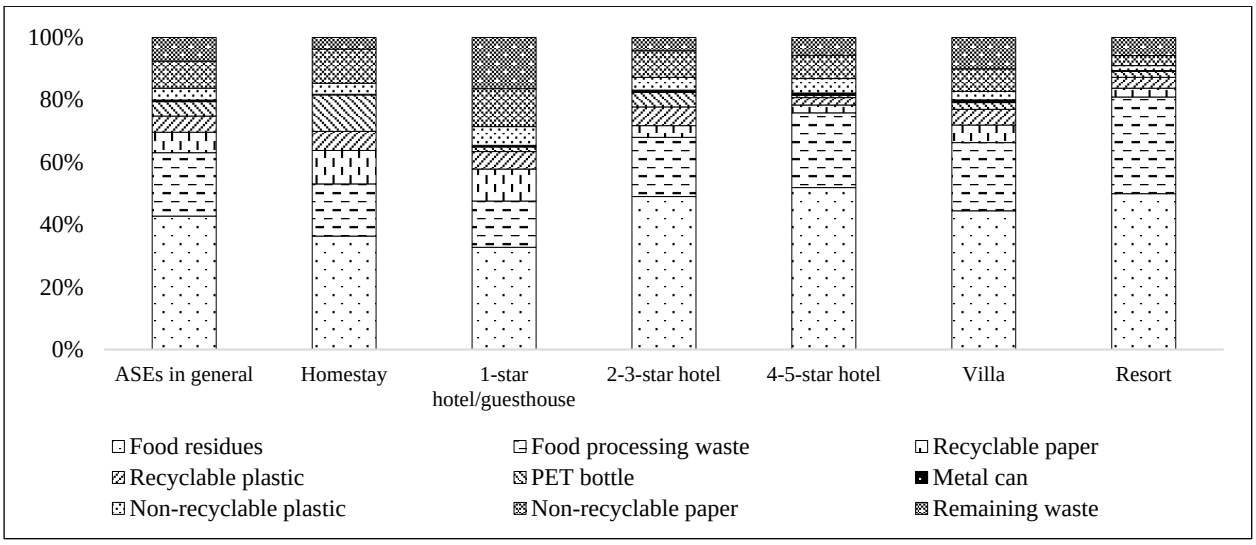

Figure 3. Solid waste compositions at each type of ASEs.

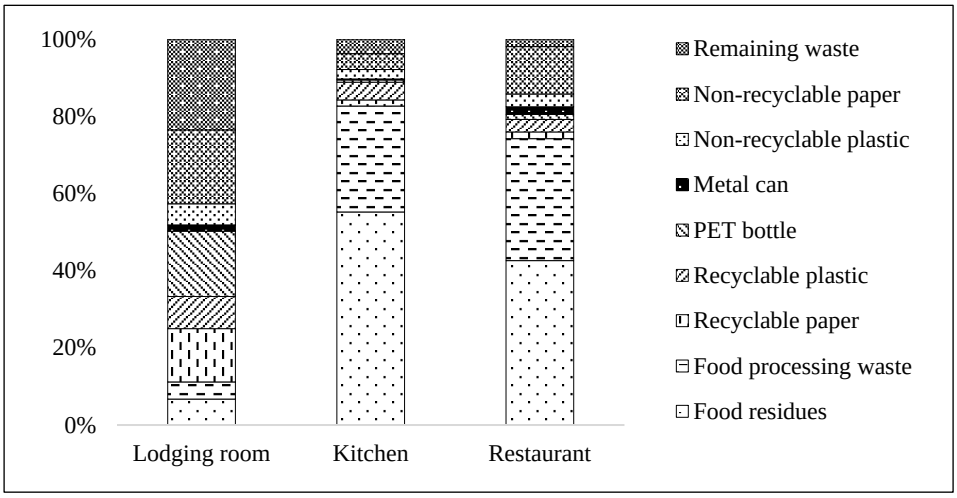

Figure 4. Solid waste components in different areas of ASEs.

Figure 5. Green Youth Collective composting station [42].

Figure 6. Paper mask workshop [43].

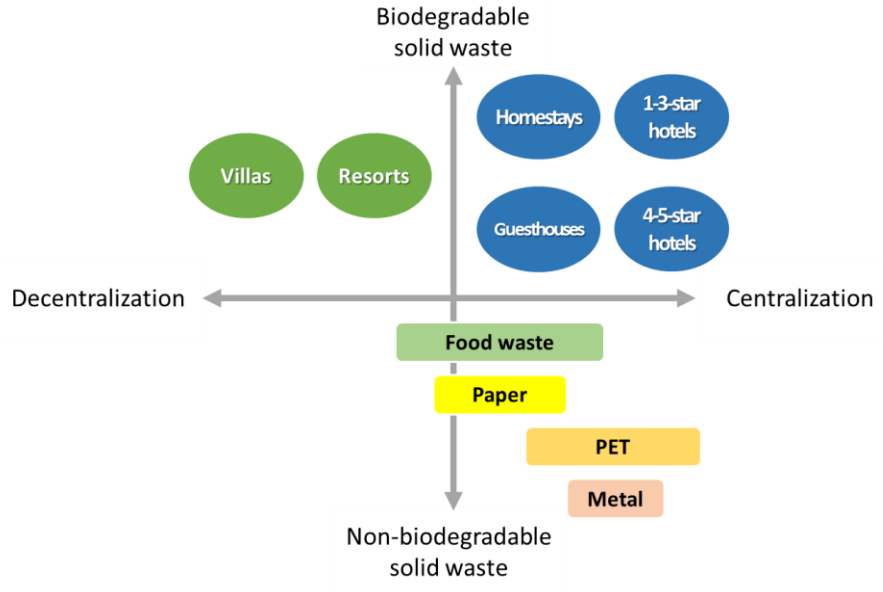

Figure 7. Scenario for ASE's waste management in Hoi An.