Waste Recycling System for a Tourism City in Vietnam: 
Situation and Sustainable Strategy Approach – Case Study in 
Hoi An City, Vietnam

S T Pham Phu\textsuperscript{1,2}, T Fujiwara\textsuperscript{1}, P V Dinh\textsuperscript{1} and Hoa K T\textsuperscript{2}

1 Okayama University, 3-1-1 Tsushima, Kita Ward, Okayama 700-8530, Japan  
2 University of Technology and Education, The University of Danang, 48 Cao Thang, 
Danang, Vietnam  
E-mail: ppstoan@gmail.com

Abstract. Recycling waste brings many benefits for environment and society so that the 
establishment of sustainable recycling system is inevitable. This study aims to describe the 
situation of the recycling system in Hoi An City (HAC), through that establish sustainable 
recycling strategy for the future. The results show that HAC has a high potential for improving 
recycling. Whereby, recyclable waste accounts for three-fourths of total waste, and the rate of 
sorting waste is high. Besides, the proportion of recycling practice is slight high with 62% for 
residents, 39% for hotel sectors, and 56% for restaurants. However, the recycling system in 
HAC is simple with the rudimentary facility, in which informal sectors play important roles. 
Thus, the recycling effectiveness was low (24%), mainly papers, plastics, and metals. The 
concept of sustainable recycling strategy is established by the combination of the government, 
community, business sectors toward the balance between economic, environment and society.

1. Introduction
Recently, tourism has rapidly developed and become an essential industry in the world [1]. Also, the 
arrivals to Vietnam increased by 130% in the last ten years and has brought many benefits for society. 
However, the dark side of tourism development is the negative influences on the environment in which 
solid waste generation (SWG) is one of the most significant impacts [2, 3]. For developing countries, 
solid waste management (SWM) is still a big problem, and the green SWM for sustainable tourism 
development is a significant challenge.

Waste recycling and resource recovery bring many benefits to SWM, economy, environment, and 
society. In developing countries, both formal and informal sectors play significant roles in recycling 
system [4] but have several risks of conflict [5]. Thus, combining and promoting the roles of both 
sectors towards the establishment of sustainable recycling system (SRS) means significant challenges. 
Salau et al., reported that in developing countries (Lagos State, Nigeria) the informal recycling 
activities contribute to recycling rate more than the formal sectors [6]. Also, in Thailand (a case study 
of Phitsanulok City), informal sectors, which played a primary role in SRS were suggested to be 
supported technique, and finance for improvement [4]. Likewise, Wilson et al., revealed that informal 
recycling system brings many benefits to SWM in developing countries [5]. Furthermore, the 
establishment of new formal recovery system to substituted for the informal system is very expensive. 
Thus, strategy planning of sustainable SWM (SSWM) should be considered based on existing 
informal collection and recycling systems. Establishment of SRS inevitably approaches sustainability 
of SWM. Planning SRS strategy for a developing country should focus on three dimensions of
sustainability: waste collection and separation, municipal SWM plan, and local recycled-material market. Also, the SRS goes towards the balance between environmental impacts, economic benefits and social acceptance [7]. Recycling system in Vietnam was mentioned as an example in the publication of Troschinetz and Mihelcic with the recovery rate by 13-20%, are mainly paper, plastic, glass, and metal [7]. The situation and strategy of SRS have not studied more. Thus, this study aims to provide the current status of the recycling system in a tourism city, so that contributes to clarify a comprehensive view of the recycling system in Vietnam. Also, the strategy of SRS for this tourism city will be proposed as a specific case which should be considered to apply to other cities in Vietnam.

2. Study Sites

![Hoi An City, Vietnam.](image)

Hoi An City (HAC) is a famous tourism city located at the center of Vietnam (Figure 1) with the population of 94,331 people in 2016. Tourism is the primary industry in HAC. In the last decade, the growth rate of arrivals in HAC was 243% and reached 2,517,217 tourists in 2016, led the increase of a number of hotels and restaurants by 3.3 times. Notably, 446 accommodations with 7,795 rooms and 558 restaurants are mainly located in the center areas and tourism destinations [8]. On the other hand, the municipal solid waste (MSW) of HAC climbed from 19,282 tons in 2009 to 30,131 tons in 2016, while almost no difference in population from 2009 (93,808 people) to 2016 (94,331 people) [9]. Consequently, the tourism industry is a significant source of waste in HAC.

The situation of SWM of HAC has analyzed in detail. Giang et al. identified solid waste composition and generation of MSW, and developed a model of SWG from households [10, 11]. Whereby, domestic solid waste was accounted for about 21% of total MSW. Hotel waste characterization and management practices were also analyzed clearly [9]. These studies presented that recyclable waste accounted 78.7% for domestic waste and 84.3% for the hospitality industry. However, the rate of recycling practice in HAC is low and justified by the weak driving force of residents, and many barriers against recycling practice for commercial sectors [9, 12]. Therefore, in this study, the situation of recycling system of HAC is clarified to design the SRS strategy for HAC.

A survey was conducted to collect data of recycling situation, and the face-to-face interviews were implemented to gather information of not only waste management but also recycling practice from recycling sectors. About 300 households, 120 hoteliers, 50 managers of restaurants and 17 owners, of recycling shops, were collected in this survey.

3. Results and discussions

3.1. The recycling paths in HAC

Figure 2 shows the path of recycling activity in HAC from generation to manufactures. In the structure of recycling system in HAC, waste segregation is the first step which plays an essential role in recycling strategy. Waste separation at source was implemented in HAC since 2012. Whereby, waste is sorted into the organic and inorganic waste, and collected separately by the public work company. Although no regulation of recycling waste classification, recyclable waste as mainly papers, metals
and plastics are also sorted by householders and commercial sectors (Figure 3-a). These recyclable materials are sold to itinerant buyers to get income. A part of recycling waste is picked out of trucks by collection crews. After transferring to disposal areas, mainly PET and metals are picked up again by scavengers. The collected recycling materials are sold to junk shops and moved to manufactures. The rest of recyclable waste goes to the land fill sites.

Figure 2. Waste recycling paths in Hoi An City.

The recycling system in HAC consists informal sectors and formal firms. The informal sectors, who are itinerant buyers, street picking, collection crews, scavengers and junk shops at treatment sites collect directly recycling material around the city. The formal sector is the public work company which operating waste collection and treatment in HAC. Until now, all of the recyclable materials were bought to recycling manufactures in Dien Ban industry zone and Danang cities.

3.1.1. Informal recycling waste collectors in HAC
An itinerant waste buyer is a recycling collector who buys sorted dry recyclable waste from householders and commercial sectors, and transfers to the junk shops for selling. In HAC, there are about 100 itinerant buyers. They buy recycling materials door to door by bicycles, tricycles or bikes (Figure 3). At the public points, the recyclable materials from the mixed waste in the garbage bins or on the street are collected by street waste pickers. Both itinerant buyers and street waste pickers are poor and marginalized social groups. Trading recyclable materials bring them the main income.

Figure 3. Itinerant waste buyers in HAC.
Figure 4. Recycling collection crews

Figure 5. Scavengers at treatment plants

For non-recycling practice at the source, the recyclable materials in the mixed waste are recovered by municipal waste collection crews when collecting by trucks or sweeping on the street (Figure 4). Sometimes, recycling waste is also given to collection crews by householders and commercial sectors for free. The rest of recyclable materials in the mixed waste is transferred to the treatment area. Here, around 20 scavengers (figure 5) pick recyclable waste again before treatment by composting, incinerator or dumping at the open landfill site.

3.1.2. Informal junk shops
Recyclable materials are sold to the junk shops which are informal commercial sectors. HAC has 17 informal junk shops, in which the recycling materials in 30% of shops are disassembled, separated and washed before compressing and packing for selling to manufactures (figure 6). Whereas, the rest of junk shops try to minimize the volume of recyclables by hand and pack in the form of sacks (figure 6-a).

Figure 6. Junk shops

3.1.3. Formal firms – waste treatment plants
In HAC, The Public Work Join Stock Company, which is the formal firm response for collecting and treating municipal waste. Composting and incineration are two main treatment methods. However, compost product has low quality with many impurities of plastic, metals, and glass, so farmers do not use that. Whereas, the new open incinerator is working with a capacity of 30 tons per day (30% of design capacity) so that it cannot handle the daily waste of the city. The rest of waste is dumped at the open landfill sites. HAC has not any recycling factory for recovering recyclable materials.

3.2. Recycling material flows

3.2.1. Proportion of recyclable waste of municipal solid waste
Table 1. The proportions of recyclable waste of MSW in HAC [9, 10].

| Recyclables          | Household | Hotels | Restaurants | Street |
|----------------------|-----------|--------|-------------|--------|
| Biodegradable waste (%) | 57        | 58.5   | 45.9        | 40.8   |
| Plastics (%)         | 14        | 13.7   | 8.4         | 13.8   |
| Papers (%)           | 6         | 8.9    | 11.5        | 7.7    |
| Metals (%)           | 0.7       | 1.2    | 2.2         | 0.4    |
| Glass (%)            | 1         | 2      | 9.4         | 4.5    |

In HAC, plastics, paper, metals, nylon bags, biodegradable waste and glass are the raw materials which are considered to recover. However, the minority of the plastics, papers, and metals are sorted at the source for recycling by households and commercial sectors. The rest are usually mixed into the garbage. Table 1 presents the SWG rate and the proportion of recyclable materials from household waste, hospitality waste, and street waste in HAC. In general, recycled waste accounted for more than three-fourths of total municipal waste, in which the inorganic recycling materials was about 25% of total waste. Whereas, the rate of dry recycled waste of the hotels and restaurants are higher than such of households with 33.4% and 31.5%, respectively. Furthermore, solid waste from commercial sectors accounted for 76% of the total waste. Therefore, the tourism industry is a significant source of recyclable materials in HAC.

3.2.2. The flows of recycling material in HAC

Figure 7 shows that the paths of sorted dry recycling materials from sources to manufactures. It is quite simple by commercial transactions through intermediaries as recycling collectors and shops. Also, the price of recyclable materials increases follows the trading flow. Whereby, the value of plastics, papers, and metals increase to 7 times for plastics and two times for papers and metals from waste sources to manufactures. Whereas, the government must pay for separation glass and treatment cost ($ US 267/ton). Hence, the financial benefit of glass in value flow from generation sources to manufactures is negative. Besides, the negative economic value of unsorted waste is also one of the burdens of the government by the fee of transportation, segregation, and treatment.

![Figure 7. The recycling waste flow in HAC.](image-url)
3.3. Separation and recycling practice at source in HAC
This study conducted surveys of separation at source and recycling practices on two main waste sources of HAC: households and hospitality sectors. Waste separation at source has been implemented since 2012 and strictly checked by the government. Thus, waste segregation rate was high. However, the majority of low scale hotels (LSH), homestay (HOM), and restaurants (RES) have not sorted waste. This is the weakness of recycling system of HAC which should be improved. Recycling practice depends on many factors, in which economic motivation and condition of storing space are the main influencing factors. Figure 8 shows that waste segregation at source was homologous, recycling practice in various areas in HAC was significantly different. Especially, the rate of recycling practice in commercial sectors was lower than such of residents. Waste from commercial sectors accounted for two-thirds of total municipal waste. Therefore, recycling practice of commercial sectors plays a significant role in recycling system of HAC.

Figure 8. Waste separation rate at source and recycling practices in HAC.

3.4. Recycling practice rate and the recovery effectiveness in HAC
The recovery rate of recycled waste in shown in Figure 9. In general, about 17.5 tons of dry recyclable waste (accounted for 25%) were generated per day, in which 24% of recyclable waste was recovered by junk shops (17%) and scavengers (1%). Glass was collected one ton/day which accounted for 6% of total recyclable waste. 76% of recycling waste was mixed into the garbage and have not recovered.

Figure 9. The recovery rate of recycled waste in HAC.

3.5. Sustainable recycling strategy for HAC
The informal recycling system that is the common feature of recycling activity in developing countries. There are many factors influencing a recycling system such as environmental education, waste management collection and separation, government finances and policy, and waste management planning as well [7]. Furthermore, Salau et al., reported that in developing countries the informal sectors play a more important role in recycling system than the formal sectors [6]. Also, the establishment of new formal recovery systems to replace the informal one is very expensive [5]. Thus, sustainable recycling strategy for HAC should be established a base on the gradual improvement the
role of informal sectors combines with enhancing waste management practice, government regulation, and supports of stakeholders (figure 10). The core value of sustainable development is the balance between environment (ENV), economy (ECO) and society (SOC) [13]. Figure 10 presents the concept of a sustainable recycling system for HAC. Whereby, the government (GOV), business sectors (BUS) and communities (COM) are the three main subjects that directly perform this strategy. The BUS is as hotels, restaurants, tourism commercial sectors which produce a significant amount of waste of the city. Whereas, COM is the important factor influencing the effectiveness of recycling system of the city [7]. Furthermore, GOV plays a necessary role in making a decision, promulgating regulations, calling for support from stakeholders (STA), managing and investing recovery facility for SRS. Three of them should cooperate, monitor and manage with each other to gradually implement sustainable recycling strategy.

Moreover, the implement process approach SRS is described in figure 10. Whereby, three primary factors as solid waste practices (SWPs) at source, socialization of recycling system and supports of GOV and STA are the foundations to establish SRS. Troschinetz and Mihelcic proved that waste collection and segregation is one of three most significant barriers to recycling [7]. Furthermore, Loan et al., reported that residents in HAC did not sort waste unless they understand its positive effect [12]. Hence, to enhance SWPs, waste separation at source should be improved by a combination of regulation and training. Also, composting should be considered to deploy at the big hotels and the rural areas after segregation. The better practices of SWM is, the less SWG is, the smaller cost of transportation and disposal, the higher economic benefit of sectors and society as well as the higher effectiveness of SRS.

Additionally, socialization in recycling system should be considered to expand and develop. From 2010 to 2012, a socialized model of SWM in HAC conducted by Women’s Union of HAC and funded by Global Environment Facility Investing in our planet. This project contributed to enhancing the effectiveness of waste recycling, improving awareness of local people and developing the number of itinerant buyers [14]. However, the stability of the project is not maintained due to lack of organization and management of the government. Moreover, socialization in recycling system should be synchronous. Whereby, collection system, recycling shops, and manufacturers should be encouraged to invest in private sectors. The economic benefit from recycling may be higher if recycling materials are purer. In term of recycling management, the role of government is irreplaceable. The recycling training guideline and regulation should be promulgated, supports and funds should be provided, and the coherence between SRS and STA should be enhanced by the GOV. All in all, the synchronized implementation of three factors above will gradually establish and develop SRS for HAC.

4. Conclusion
Sustainable recycling system is the necessity toward sustainability of the municipal SWM in Vietnam. This study contributes to an issue on current concerns of waste management in Vietnam, especially in tourism cities. The situation of the recycling system in HAC is provided as below.

(1) Solid waste characterizations were the favorable condition for developing recycling activities in HAC. Whereby, the recyclable waste was 78.7% for household waste, 84.3% for hotel waste, 77.4% for restaurant waste and 67.2% for street waste. In which, organic waste accounted for two-thirds.
(2) Recycling practice in HAC achieved some initial successes. Notably, the sorting rate was about 88% for residents, 76% for hoteliers, and 32% for restaurants. Also, the recycling rate was 62% for residents, 39% for hotel sectors, and 56% for restaurants.

(3) The recycling system in HAC was simple with rudimentary facilities, which mainly consists separation and collection of recyclable materials by informal sectors, who played a significant role in the recycling system.

(4) Recovery effectiveness of recyclable waste in HAC was 24%, mainly metals, plastics, and papers. While recycling of plastics, metals, and papers bring positive financial benefits for informal sectors, recycling glass has negative economic value.

(5) The sustainable recycling strategy for HAC was suggested by combining the role of government and the collaboration of business sectors and communities based on the balance of social acceptance, economic benefit, and environmental impact. Besides, the implementing process of sustainable recycling strategy was suggested by improving waste management practice, the socialization in recycling activities, supports of the NGOs, and the management of the government.

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