Analysis of Packaging Waste Generation Patterns and Waste Flows in Tourist Accommodations of North-eastern Thailand.

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ABSTRACT

Packaging waste produced by tourist accommodation significantly contributes to environmental impacts. Understanding packaging waste generation patterns and waste flows allows for the identification of major waste streams and the factors influencing their occurrence. This study aims to assess the patterns and flows of packaging waste generation in the tourist accommodations, focusing specifically on five provinces in North-East Thailand and five types of packaging materials. Investigating the geographical pattern, explore the complexities of consumer behavior and examine the dynamics of waste collection patterns. The questionnaire has been developed to collect data regarding packaging waste across 35 accommodations. The results indicate that plastic waste is the most predominant type, totaling around 300 kg per day, with plastic bottles for drinking water being the major component. However, the highest type of waste packaging is glass bottles, totaling approximately 266 kg per day. In geographical pattern, Loei generates the highest amount of packaging waste, averaging 0.41 kg per guest per day, while Udon Thani generates the least, an average of 0.15 kg per guest per day. The main reason is that Loei has more attractions, whereas Udon Thani offers a wider variety of restaurants, leading to more packaging waste generated outside of the accommodations. Consumer behavior patterns show that glass bottles and seasoning packets are the most commonly discarded waste items in kitchens, dining rooms and hospitality rooms, where much of the packaging waste is collected and sorted for recycling. A study of packaging waste flow revealed that the kitchen is the main source of packaging waste. Additionally, most packaging is sold or returned to the suppliers for recycling. Tourist accommodation should focus more on diverting packaging waste from landfills to promote sustainable waste management. This study provides guidelines for setting concrete targets to reduce packaging waste in tourist accommodation for tourist sustainability.

KEYWORDS Packaging, Waste flow, Recycling waste, Waste collection, Waste management

1. Introduction

Globally, climate change poses significant challenges to humanity, the environment, and the economy. Tourism, as a key driver of economic growth and has the growth of the global economy, which contributes to greenhouse gas emissions across multiple sectors, especially, transportation alone accounts for approximately 49% of the total carbon footprint of global tourism [1]. Another notable contributor is food and beverage consumption by tourists, representing around 10% of the tourism-related carbon footprint. After consumption, these food and beverage products are typically discarded in landfills, where the resulting waste generates additional environmental impacts. Stakeholders should ensure proper management of these wastes through good practices.

Thailand is regarded as a country where the tourism industry plays a crucial role in driving economic growth, and it is also considered one of the world's leading travel destinations. However, the continuous growth in the number of tourists has resulted in various environmental impacts, among which greenhouse gas emissions represent a significant global concern [2]. Greenhouse gas emissions are associated with all stages of the tourist journey from travel, hotel stays, and on-site consumption, through to post-consumption waste disposal. Waste production in tourist accommodations is another activity that contributes to environmental impacts. Packaging is one of the main components of all waste generated in tourist accommodations, and it significantly contributes to these impacts [3]. Moreover, waste management and recycling are integral components of sustainable tourism within the environmental dimension. The "Green Hotel" concept serves as a certification framework that acknowledges environmentally responsible practices, with waste management being one of the key criteria for certification [4]. Collectively, these practices not only enhance environmental performance in the hospitality sector but also contribute to advancing sustainable development, particularly in alignment with SDG 12 on responsible consumption and production [5].

In Thailand, waste generated from tourist accommodations is generally accumulated into municipal waste. Therefore, tourist accommodation should divert more packaging waste from landfills towards sustainable waste management to advance the circular economy and promote tourism sustainability. Packaging can be sorted before consumption. So, packaging waste should be collected before landfill. Studying waste patterns in tourist accommodations is important to be able to reduce waste to assess improvement [6]. However, in Thailand, this packaging waste patterns data of tourist accommodations do not exist.

Waste management in tourist accommodations is often studied primarily in relation to food waste. However, the amount of food and beverage packaging is closely related to food waste generation [7] The increase in food and beverage packaging is part of tourists' food consumption in accommodations, such as kitchens, guest rooms, and dining areas. Moreover, most studies on waste management focus on waste generation from large hotels located in both tourist destinations and major cities. For example, A study of 578 large hotels in Thailand reported that waste management was the second-largest source of GHG emissions in hotels, following energy consumption. GHG of waste around 84,155 tCO2eq from 81,011 tons based on appropriate disposal method [8]. However, relatively little work has focused on packaging waste in tourist accommodations.

Material flow analysis (MFA) is widely used for identifying major material streams. Packaging is one of the materials in (MFA) that is studied with waste management after post-consumer. For example, in Netherland, the result of MFA of beverage carton indicates factors limiting the net recycling yield which consist of the low degree of separate collection, the relatively low mechanical recovery yield from MSW and the shootout from the recovery and sorting process due to contamination. The benefit of that study can aid in making policy decisions by providing a visualization of a complex system in order to minimum environmental impact or achieving maximum efficiency [9]. In the Republic of Korea, MFA of single-use plastics (SUPs) and packaging materials which focus on their short lifespans and significant contributions to plastic waste, is studied [10]. While Thailand is facing the challenge of increasing waste generation, especially plastic waste and is during a significant plastic waste crisis [11]. So, plastic is often studied in material flow analysis in Thailand which analyzed and show the flow of plastic materials through production, consumption and waste management [12][13]. However, material flow analysis in Thailand is not studied in other materials such as paper, glass and metal.

Assessing packaging waste generation patterns and flows in tourist accommodations supports more effective waste management in the tourist accommodations. Understanding the quantity and types of waste generated allows for the identification of major waste streams and the factors influencing their occurrence. This study aims to assess packaging waste generation patterns and flows in tourist accommodations, focusing specifically on five provinces such as Nakhon Ratchasima, Khon Kaen, Ubon Ratchathani, Udon Thani, and Loei in Northeastern Thailand and on five packaging material types: plastic, paper, glass, aluminum, and foam. A questionnaire was designed to survey and collect data on packaging waste from 35 hotels across the five provinces.

This study provides the basis for formulating tangible actions to reduce packaging waste in tourist accommodations and enhance tourism sustainability, through the identification of major waste streams and the factors influencing their occurrence.

2. Materials & Method

2.1 Scope of this study

North-East Thailand comprises 20 provinces. In this study, the questionnaire has been developed to collect data regarding packaging waste across seven hotels in each province, totaling 35 hotels across five provinces: Nakhon Ratchasima, Khon Kaen, Ubon Ratchathani, Udon Thani, and Loei. These provinces were selected based on the rank among the top provinces of the maximum number of hotels, the maximum number of guest rooms and maximum tourist arrivals refer to Accommodation and tourist statistics by National Statistical Office, Ministry of Economic and Social Development in 2020 [14]. The selected five provinces are shown in Fig. 1.

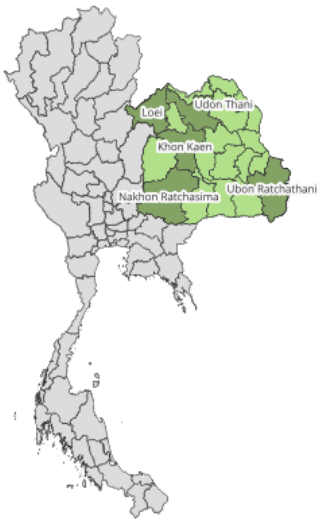


Fig. 1 Five selected provinces in North-East Thailand

2.2 Questionnaire design

This study utilized a survey method to gather data, employing interviews through questionnaires as the primary tool. The respondents included owners or staff from tourist accommodation. The questionnaire comprised into two main sections: general information and packaging waste information. General information included name, address, number of guests rooms, guest per room, occupancy rate and facility. Facilities were categorized into four areas such as guest room, dining room, hospitality room and legally authorized establishments. Another, packaging waste information collected waste type, amount of waste and method of collecting waste, for different material types. Material types are considered plastic, paper, metal, glass and foam. Amount of waste is sorted from four sources including guest room, dining room, hospitality room and kitchen. Method of collecting waste considered return, reuse, recycling, landfill and open burning.

2.3 Waste flow analysis

This study calculated the waste flows associated with the waste management of different packaging from different sources by Excel for calculation and SankeyMATIC for visualization. Waste flow analysis in this study considers waste streams for different waste types from source of waste generation and then material of waste type to waste collection.

3. Results & Discussion

3.1 Packaging waste generation

The total amount of packaging waste generation from five province consists of Nakhon Ratchasima, Khon Kaen, Ubon Ratchathani, Udon Thani, and Loei in Northeastern Thailand is illustrated in this part.

The result of collection data from 35 tourist accommodations in five selected provinces in North-Eastern Thailand. Therefore, the result of collection data shows 35 tourist accommodations contributed to 19 hotels, 10 resorts and 5 homestays. In addition, total packaging waste is 891.53 kg per day.

As shown in Fig. 2, packaging waste generation per day by tourist accommodation separate into three types of tourist accommodation such as hotel, resort and homestay. This indicates a number of guests is not affected to waste generation. Waste generation often various activities in tourist accommodation, specialty hotel. A large hotel is located for weddings, meetings, conferences in which these activities can generate a lot of waste packaging.

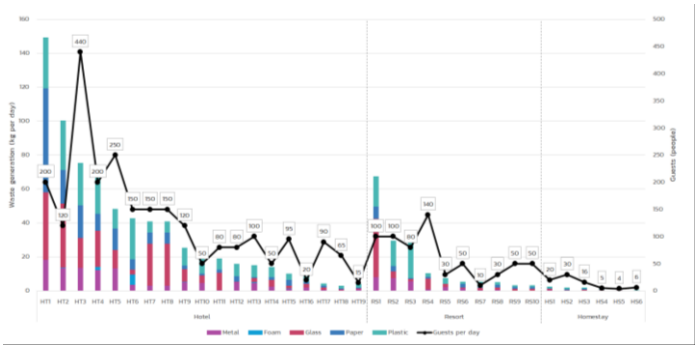


Fig. 2 Packaging waste generation per day by tourist accommodation

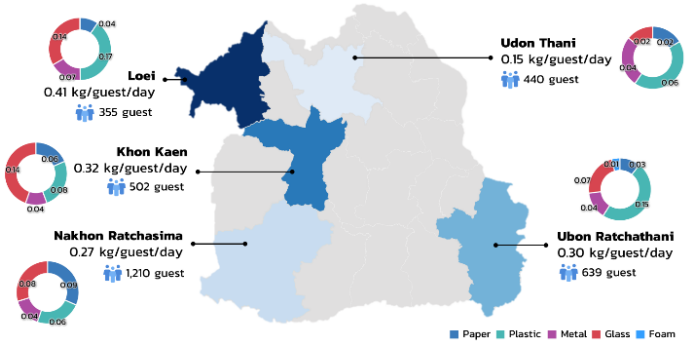


Fig. 3 Packaging waste generation per guest per day for five provinces

Packaging waste generation per guest per day is determined in this part. As shown in Fig. 3, Loei generates the highest amount of packaging waste, averaging 0.41 kg per guest per day, while Udon Thani generates the lowest, an average of 0.15 kg per guest per day. The main reason is that Loei has more natural attractions and tourist accommodations located in natural settings, which encourage tourists to spend more time and engage in activities within the accommodations. In contrast, most tourist accommodations in Udon Thani are situated in urban areas. So, Udon Thani offers a wider variety of restaurants, leading to more packaging waste generated outside of the accommodations. Similarly, Khon Kaen and Ubon Ratchathani exhibit comparable levels of packaging waste generation per guest per day. Nevertheless, due to the higher volume of tourist arrivals in these provinces compared to Udon Thani, the average packaging waste generated per guest per day is relatively lower than that observed in Udon Thani.

As shown in Fig. 4, based on the types of tourist accommodations, the amount of packaging waste generated per guest per day is relatively comparable between hotels and resorts, while homestays generate considerably less. Regarding the composition of waste types, plastic packaging accounts for nearly half of the total waste generated in homestays.

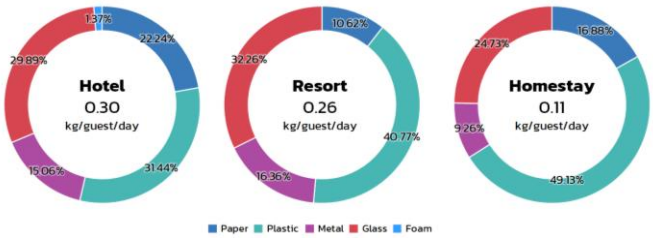


Fig. 4 Packaging waste generation per guest per day for type of tourist accommodations

3.2 Consumer behaviour pattern

The total amount of packaging waste generated was analyzed in relation to its sources, which were identified as facility service rooms within tourist accommodations. Facility service rooms consisted of kitchen, hospitality room, guest room and dining room.

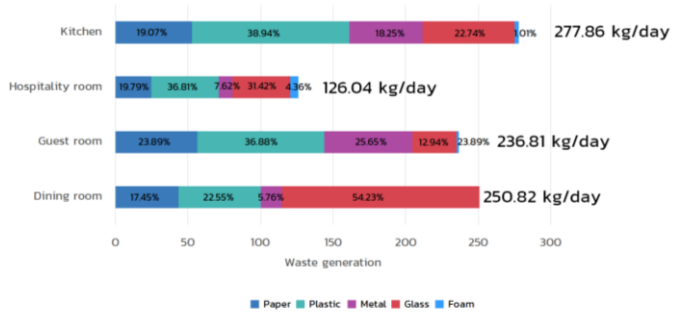


Fig. 5 Generation of waste by activity

Considering the sources of waste generation, the largest amount of packaging waste is generated from kitchen around 277.86 kg per day (31.17%). Plastic packaging waste is the most generated in the kitchen, hospitality and guest room, whereas glass packaging waste is the most frequently discarded in the dining room (see Fig. 5). In particular, glass bottles or seasoning packets are the most discarded items across the kitchen, dining room and hospitality room.

Fig. 6 present generation of waste by usage. Plastic waste is the most predominant type, totaling around 300 kg per day (33.48%), with plastic bottles for drinking water around 136.44 kg per day (15.30%) being the major component. Glass bottles and seasoning packets are the most discarded waste items around 266.15 kg per day (29.85%). Plastic and glass packaging waste in the form of bottles is generated in significant amounts. Most plastic bottles are collected from guest rooms because of drinking water consumption from tourists. In addition, the majority of glass bottles and seasoning packets are collected from the dining room, which can be attributed to the fact that water consumption and food preparation occur mainly in this area, with dining services in some tourist accommodation operating on a full-day basis.

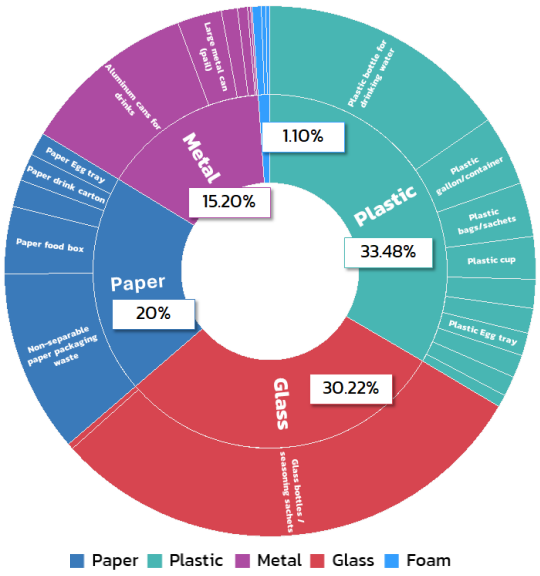


Fig. 6 Generation of material waste by usage

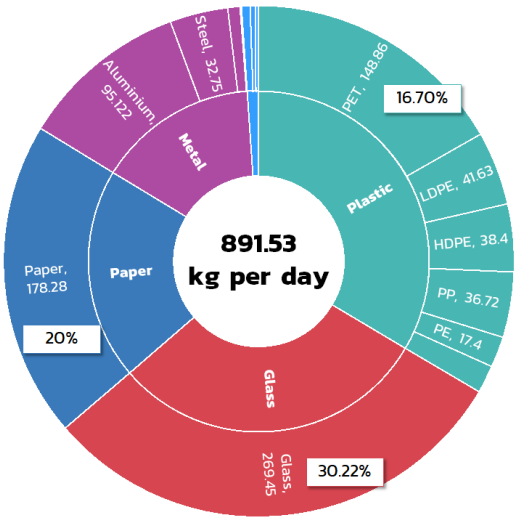


Fig. 7 Generation of waste by material type

Fig. 7 present packaging generation of waste by material type. Glass packaging waste is the most common material, totalling around 269.45 kg per day (30.22%) followed by paper, which is close to PET around 178.28 (20%) and 148.86 (16.70%), respectively.

3.3 Waste collection

The total amount of packaging waste generated was analyzed based on waste collection. The survey revealed that tourist accommodation was involved, and six

waste management methods were identified: recycling, reuse, return, landfill, open burning, and unknown destinations.

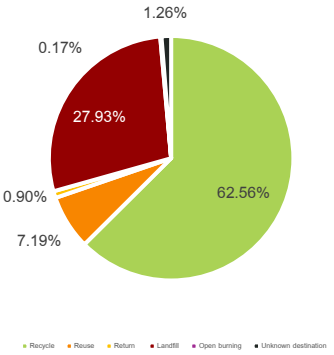


Fig. 8 Ratio of Waste collection

Fig. 8 illustrates the overall waste collection from tourist accommodations. The majority of waste is sorted for recycling, accounting for approximately 557.71 kg per day (62.56%). This is followed by waste directed to landfill at around 249.01 kg per day (27.93%). In terms of circular management, about 64.06 kg per day (7.19%) is reused. The remaining portion includes waste returned to suppliers, open burning, and other unknown destinations.

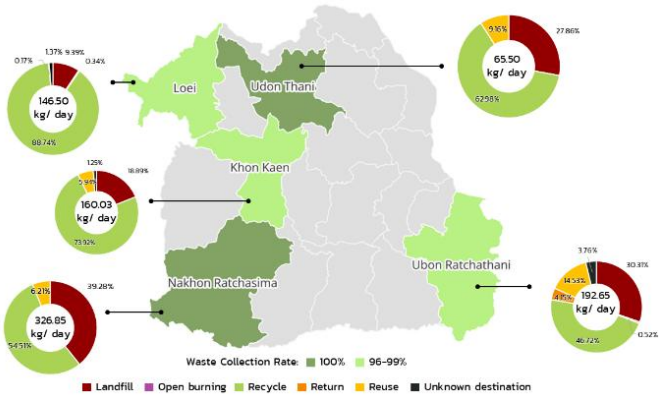


Fig. 9 Waste collection for five provinces

An analysis of the waste collection rate by province indicates that nearly all provinces achieve a high level of waste collection, with most of the generated waste being successfully collected as shown in Fig. 9. In terms of recycling ratio, Loei recorded the highest proportion. Considering recycling, reuse, and return as pathways to a circular economy, Loei also demonstrates the highest overall circular ratio.

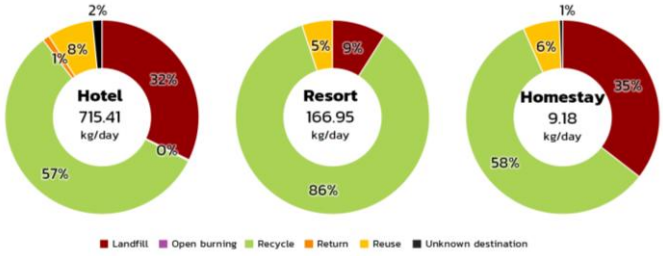


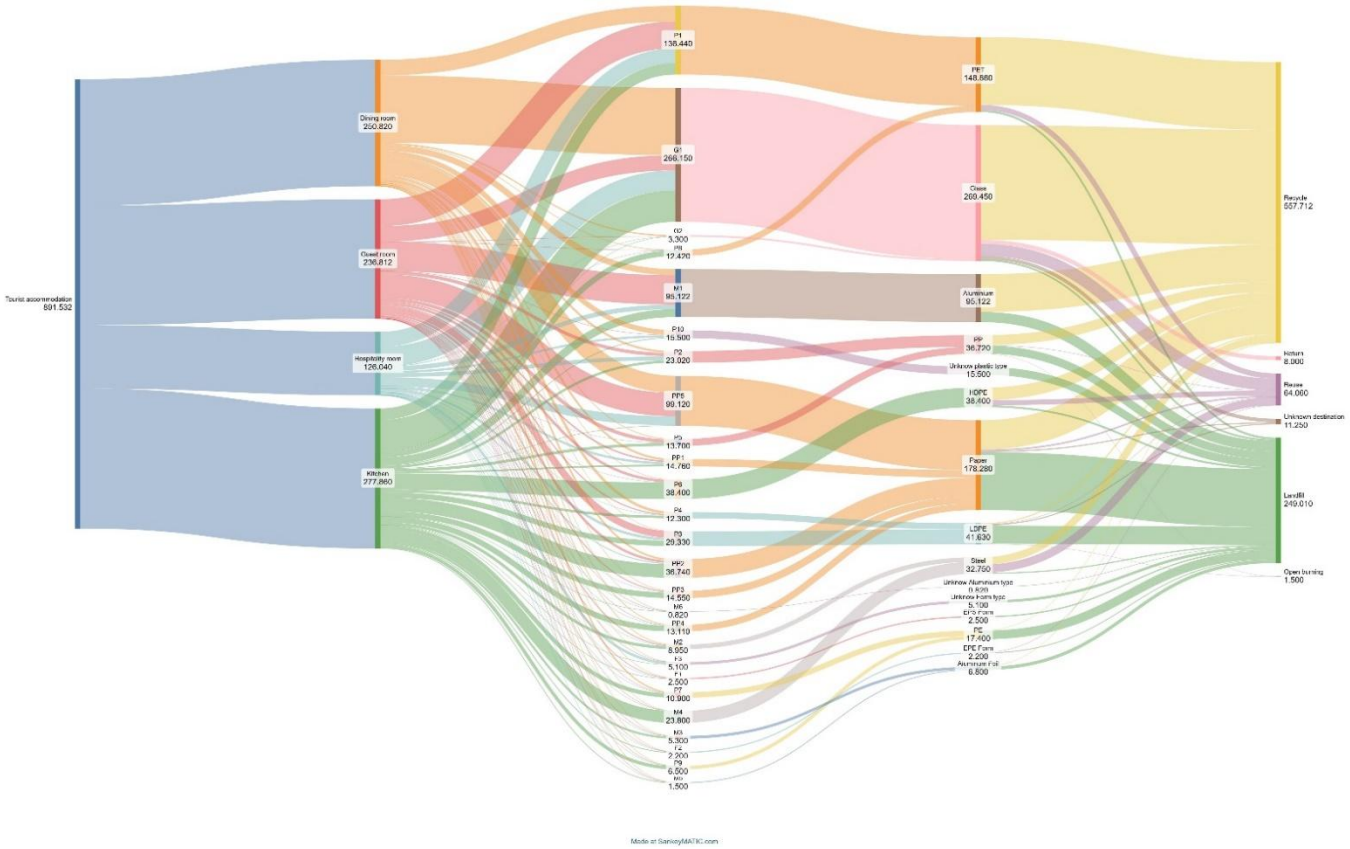
Fig. 10 Waste collection for types of tourist accommodations

Fig. 10 show waste collection for types of tourist accommodation. Recycling ratios of resort is more than hotels and homestay. In addition, all types of tourist accommodation can implement waste management practices aligned with the circular economy.

3.4 Packaging waste flow

Waste flow from survey collection data is analyzed to identify major waste streams in this part. This study shows end-of life of waste generation though Sankey diagram. The Sankey diagram illustrates the flow of packaging waste generated in tourist accommodations across the five studied provinces (see Fig. 11). The analysis shows that the total packaging waste amounted to 891.522 kg/day. Kitchen is the large source of waste generation around 277.86 kg per day. In addition, Glass 269.45 kg per day and represent the dominant waste streams. Smaller fractions were attributed to foam such as EPS foam, EPE foam and others. A significant proportion of paper waste was directed to landfills (approximately 64.38%), despite their high recyclability. Only 90.45% of PET plastic and 84.43% of glass were recovered through recycling channels, indicating inefficiencies in waste segregation and collection systems at the accommodation level. Foam waste was almost entirely disposed of in landfills due to limited recycling options.

This section compares packaging waste generation with findings from previous studies. Existing study analyzed waste pattern of hotel which demonstrate waste generation from hotels in Slovenia. In part of packaging, packaging waste provided mixed packaging, paper and cardboard packaging, glass packaging and plastic packaging estimated 1%, 3%, 2% and less than 1% of all waste generation from hotels, respectively (Juvan, E., et.al., 2023). Another previous study in large hotels in Thailand found that plastic, paper, glass and metal around 37.73%, 21.83%, 0.90% and 1.26%, respectively [15]. Besides, hotels in Gammarth and Hammamet in Tunisian generated solid waste that contributed plastic 12%, paper 10%, glass 8% and metal 6% of all solid waste [16].



P1: Plastic bottle for drinking water
P2: Plastic cup
P3: Plastic bags/sachets
P4: Plastic pouch for oil/vacuum pack
P5: Plastic plates/trays/boxes/cups
P6: Plastic gallon/container
P7: Plastic food wrap film
P8: Plastic Egg tray
P9: Plastic mesh for fruits
P10: Non-separable plastic packaging waste

G1: Glass bottles / seasoning sachets
G2: Non-separable glass packaging waste
M1: Aluminum cans for drinks
M2: Tin cans for food
M3: Aluminum foil for food
M4: Large metal can (pail)
M5: Cooler bag
M6: Non-separable aluminium packaging waste

PP1: Paper plates/trays/boxes/cups
PP2: Paper food box
PP3: Paper drink carton
PP4: Paper Egg tray
PP5: Non-separable paper packaging waste
F1: Form plates/trays/boxes/cups
F2: Form mesh for fruits
F3: Non-separable form packaging waste

Fig. 11 Packaging waste flow

Similarly, packaging waste generation in this study allowed plastic waste to be the largest proportion, which is as same as the previous studies in large hotels in Thailand and Tunisian. In contrast, only a small amount of plastic waste is generated by hotels in Slovenia, as the country is an EU Member State that enforces strict legislation on packaging and plastic waste [17]. Whereas, Thailand have Thailand's Roadmap on Plastic Waste Management 2018 – 2030 to address the packaging waste problem [18]. However, this plan has not been fully effective in reducing or eliminating the use of single-use plastics. As a result, Thailand contributes great deal of plastic waste.

4. Conclusion

This study revealed that tourist accommodations in Northeastern Thailand generate approximately 891.53 kg/day of packaging waste, with kitchens and glass packaging as the dominant sources. Recycling was the primary waste management pathway, though significant recyclable materials, particularly paper, were still landfilled. The findings highlight inefficiencies in waste segregation and emphasize the need for improved circular waste management to reduce environmental impact, especially from landfilled foam. Another one, unknown type should be known in order to sort waste collection.

For limitation, waste generation data from surveys in tourist accommodation should be interpreted with caution, particularly for packaging waste, because staff estimates are self-reported. Consequently, the collected data may not accurately reflect the actual waste generation in these accommodations.

Tourist accommodation should focus more on diverting packaging waste from landfills to promote sustainable waste management. This study provides guidelines for setting concrete targets to reduce packaging waste in tourist accommodation for tourist sustainability.

Acknowledgements

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