



Sustainable Tourism Management Using Waste Minimization Approach: A Case Study of an Elephant Park in Chiang Mai

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Abstract

Elephant Park is one of the famous tourist destinations in many districts of Chiang Mai. The growth of tourism in elephant parks has a positive effect on national and local economies. However, tourist activities create solid waste, food waste, and elephant dung. Without proper waste management, environmental issues may arise. Therefore, this research aims to study the current solid waste situation in the elephant park, develop a solid waste management strategy using a waste minimization approach, and implement pilot activities. One of the elephant parks in Chiang Mai was used as a case study. Several methodological approaches have been used in this research, including surveying the elephant park, interviewing stakeholders, collecting solid waste, identifying waste characteristics and streams, improving compost quality from elephant dung, and developing waste separation points. Descriptive statistics and content analysis were used to analyze the data. Finally, all data will be used to construct a sustainable solid waste management strategy for the elephant park. The results showed that the elephant park produces an average waste of 10.84 kg per day from tourist activity. These wastes could be classified into four types, namely organic waste (27.16%), recyclable waste (15.36%), general waste (55.77%), and hazardous waste (1.71%), respectively. A person at the elephant park produces an average of waste at 0.03 kg/day. Waste minimization activities for the two major categories were proposed. It includes waste separation points for recyclables and improvement of compost quality from elephant dung. In addition, all people in the elephant park need to sort their waste correctly before disposal to make it easier to manage and help reduce the amount of waste that goes to landfill. In the future, the researcher recommends conducting follow-up assessments after implementing the management strategy.

Keywords : solid waste; elephant park; waste management; elephant dung

Introduction

Solid waste management is one of the challenging issues in many countries, particularly in developing countries. Developing economic systems, tourism, and urban community expansion in these countries have increased the amount of solid waste generated. The assessment of solid waste management in Thailand by the Pollution Control Department found that in 2023 [1], 26.95 million tons of solid waste were generated from various sources. Compared to 2022, solid waste

increased by 5 percent (25.70 million tons), with 27.7 percent of the total solid waste generated improperly eliminated. When considering Chiang Mai province, it was found that it produced up to 1,475 tons of solid waste daily in 2023. Improper waste management, specifically open dumps and burning, can lead to other environmental problems, such as wastewater and groundwater contamination. Even proper management technologies, like landfills, can increase the emission of greenhouse gases. Landfill management can produce landfill gases that include CH₄, CO₂, CO, H₂S, N₂, NH₃,

O₂, and water vapour [2], contributing to the global climate change problem. According to the United States Environmental Protection Agency (USEPA) [3], waste disposal methods by bulk and landfill contribute to the third-largest methane emissions of human-caused methane emissions. Methane gas has a Global Warming Potential (GWP) 28 times greater than carbon dioxide [4].

Thailand's tourism industry is experiencing high growth and is crucial to the country's economy and social system, serving as a significant source of income [5]. In 2023, the Ministry of Tourism and Sports reported that Thailand welcomed approximately 28 million international tourists, generating revenue of 1.2 trillion Bath, a figure expected to rise in the future. However, tourism also significantly contributes to waste generation [e.g., 6-7]. However, tourism is also a significant contributor to waste generation. Proper management of tourism-related waste can alleviate the burden on local government organizations tasked with waste management and contribute to more effective conservation of natural resources and the environment.

Chiang Mai boasts majestic mountains, lush forests, cascading waterfalls, and abundant natural resources. Its captivating blend of stunning scenery and unique art and culture continuously attracts both Thai and foreign tourists. Among its famous tourist attractions are the elephant parks scattered across many districts. These parks offer a variety of activities, including elephant shows, painting, bamboo rafting, ox-cart riding, and more. The growth of tourism in these elephant parks has positively impacted both national and local economies. A study by Kontogeorgopoulos (2009) [8] shows how wildlife tourism, particularly in elephant parks, contributes significantly to the local economy in northern Thailand. However, without proper environmental management, including the handling of solid waste, elephant dung, and other wastes, there is a risk of environmental degradation and related issues. Research by Salangam et al. (2019) [9] highlights the urgent need for effective waste management practices to mitigate environmental impacts in elephant parks, emphasizing the importance of implementing better practices to avoid long-term environmental harm.

To address these challenges, adopting a waste minimization approach is imperative. This strategy focuses on reducing waste produced by individuals, businesses, and society rather than focusing solely on waste disposal or management after it's produced. The main principles of waste minimization are source reduction, reuse, recycling, composting and education and awareness. Waste minimization aims to shift society towards a more sustainable, resource-efficient approach to consumption and waste management, ultimately reducing the environmental impacts of waste generation and disposal.

Amidst this backdrop, the importance of adopting a waste minimization approach becomes evident. Hence, this research aims to investigate the current solid waste situation within the elephant park, develop a solid waste management strategy utilizing a waste minimization approach, and implement pilot activities in environmentally friendly tourist destinations by integrating the concept of minimizing waste into management in the study area. One of the Elephant Parks in Chiang Mai was used as a case study. The sustainable tourism management scheme aims to avoid environmental problems, especially the waste generated from the activities of the elephant park and tourists visiting. Furthermore, this research aligns with Thailand's 20-year National Strategy [10], which underscores the imperative of developing sustainable tourism practices and curbing greenhouse gas emissions.

Methodology

In this research, several methodological approaches have been employed to study the current solid waste situation at one of the elephant parks in Chiang Mai province. This park provides various tourist activities, including elephant shows, elephant rides, ox-cart rides, and bamboo rafting, as well as amenities such as parking, restaurants, and shops. The research aims to develop a solid waste management strategy using a waste minimization approach and to implement pilot activities. Data analysis was conducted using descriptive statistics and content analysis. The research process is outlined in the flow chart presented in Figure 1.

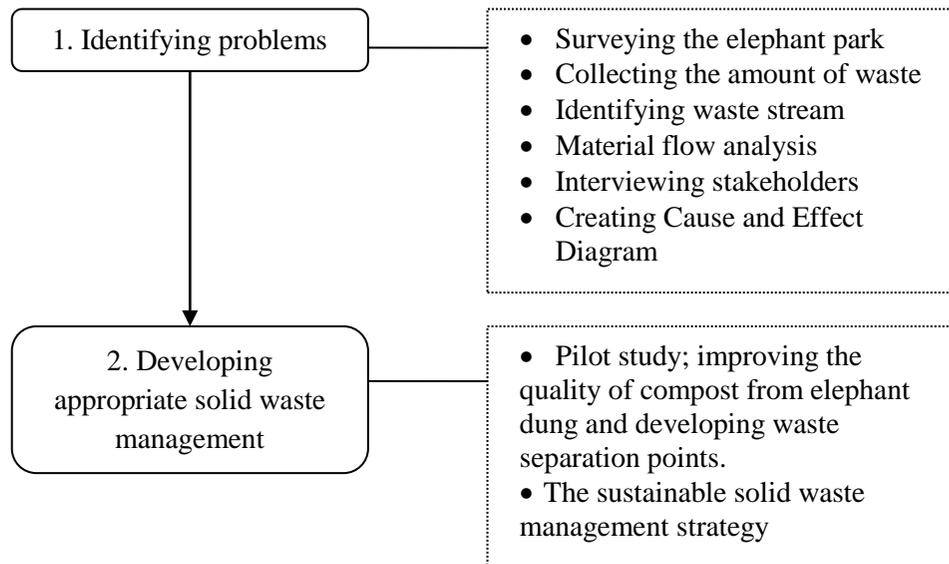


Figure 1 Research Framework

Identifying Problems

To identify the problems regarding solid waste management in the elephant park, the researchers conducted a site survey and interviewed the owner, manager, assistant manager and head cook to understand how they manage solid waste. After that, the researchers collected data on the amount and composition of waste generated from tourism activities at various locations within the elephant park, including an office, a restaurant, toilets, a shop, and all trash cans, for seven days in January 2023. This data was used to calculate the average waste weight per day (kg/day) and per person (kg/person). The average daily waste weight was calculated by dividing the total waste collected over seven days by the number of collection days. Additionally, the average waste generated per tourist was determined by dividing the total waste weight over the seven-day period by the total number of tourists during that time. Finally, all collected data were used to create a waste stream and cause-and-effect diagrams using STAN version 2.7.101."

Developing an Appropriate Solid Waste Management Strategy

Waste stream and Cause-and-Effect Diagrams were utilized for decision-making and to develop a sustainable solid waste management strategy, employing a waste

minimization approach and implementing pilot activities. These activities included enhancing compost quality from elephant dung and establishing waste separation points. In the elephant dung compost experiments, researchers mixed elephant dung with other waste materials, such as cattle dung and food waste, to improve compost quality. Compost quality will be analyzed using the following parameters: nitrogen, phosphorus, potassium, amount of organic matter, complete decomposition, carbon-to-nitrogen ratio, sodium, and pH by the Institute of Product Quality and Standardization, Maejo University. Additionally, three waste separation points were established within the elephant park. Waste bins of different colors were provided for proper segregation: red for hazardous waste, blue for general waste, green for food waste, and yellow for recyclables. Finally, recommendations will be provided to the park owner on the most effective solid waste management strategy.

Results and Discussion

The Current Solid Waste Situation

The cause-and-effect diagram in Figure 2, developed through surveys and interviews with stakeholders, identifies key waste management issues at the elephant park. The root causes of the problem can be divided into four main categories: management practices, types of waste

generated, lack of waste separation points, and human factors. Currently, waste management at the park lacks systematic organization. A significant volume of food scraps and elephant dung must be dealt with daily, and proper waste separation points are lacking. Additionally, the insufficient knowledge and understanding of waste separation among staff and visitors exacerbate the problem. This is further complicated by language barriers, as many employees do not speak Thai, and tourists come from diverse cultural backgrounds, making it challenging to educate individuals on proper waste management practices. These underlying causes contribute to the accumulation of mixed waste destined for landfills.

The identification of management practices, types of waste, lack of separation points, and human factors as root causes of waste management issues aligns with broader trends observed in ecotourism. Pham Phu et al. (2019) [11] similarly identified inefficient management practices as a major factor contributing to poor waste handling in ecotourism destinations. Nayono S. & Nayono S.E. (2021) [12] emphasized the need for structured waste management frameworks that address both infrastructural shortcomings and

the educational needs of staff and tourists. These findings reinforce the necessity of comprehensive strategies that integrate improved waste collection infrastructure with education and training programs, particularly in contexts like elephant parks, where large volumes of organic waste are generated.

According to the waste material flow shown in Figure 3, solid waste at the elephant park can be divided into two main categories: waste generated from human activities and waste generated by elephants. The total amount of solid waste that must be managed daily is 2,393.84 kg. The largest portion of this waste is elephant dung. As herbivores, elephants consume a diet primarily consisting of ripe bananas, leaves, bamboo, tree bark, and other fruits. They spend up to 18 hours a day eating and typically consume 100–200 kilograms of food daily. For example, a female elephant weighing 3,000 kg will eat around 168 kg/day, while a 4,000-kg bull will consume 192 kg/day. Given that elephants only digest about 40% of their food, they produce approximately 50–60 kg of dung daily [13]. With 47 elephants in the park, this amounts to around 2,350 kg of dung per day, making it the primary waste that the park must manage.

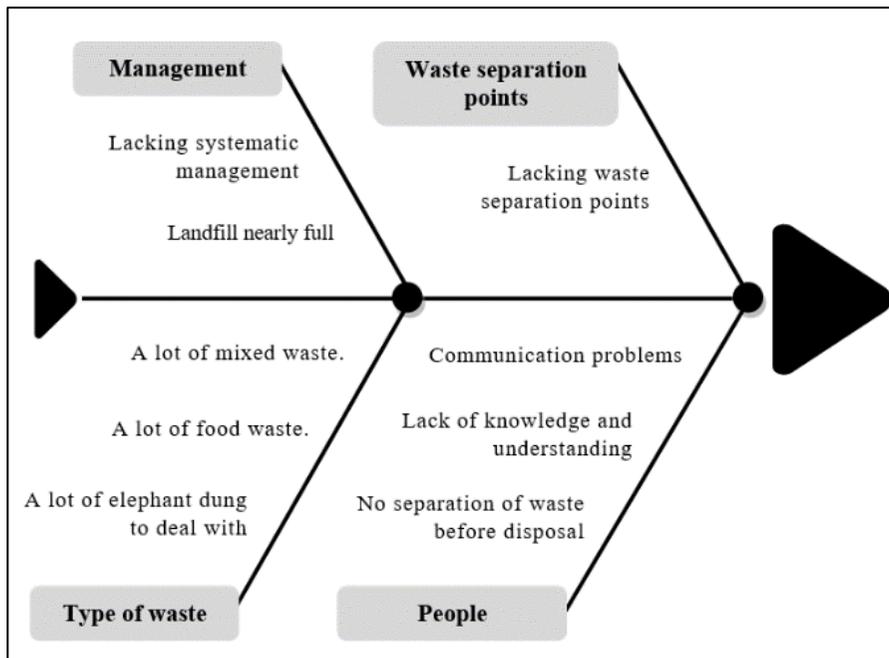


Figure 2 Cause and Effect Diagram of the Waste Management Problem in the Elephant Park

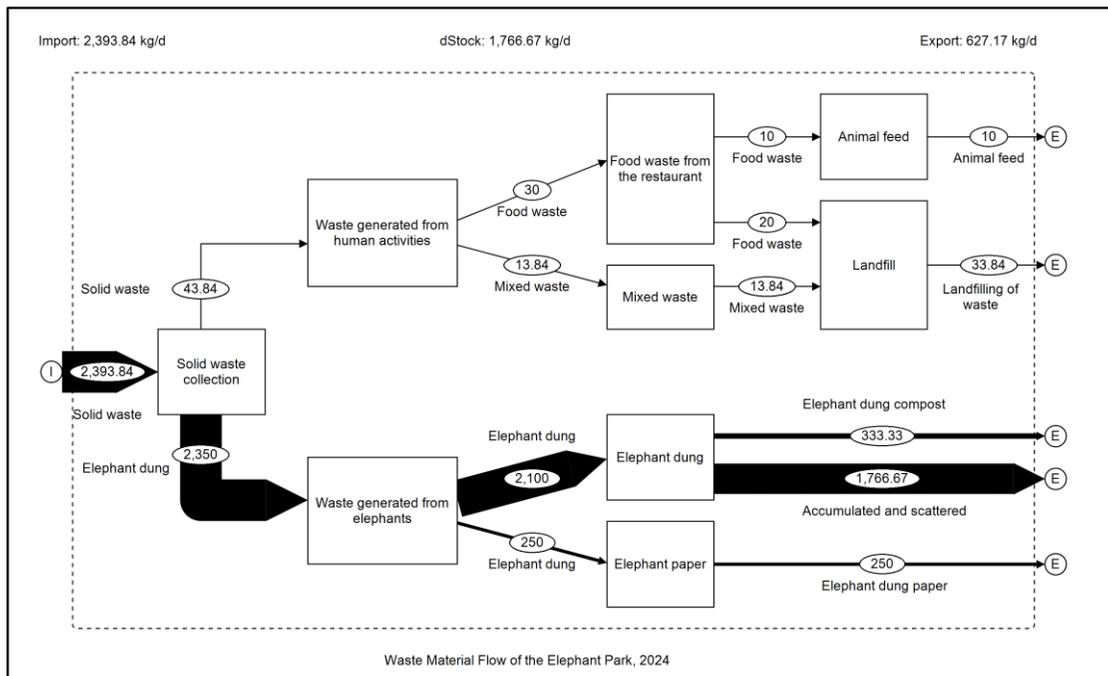


Figure 3 Waste Material Flow of the Elephant Park

In our initial survey and interview with the manager, it was revealed that approximately 250 kg of elephant dung per day is used to produce dung paper, while another 333.33 kg is utilized for composting, though this is done by dumping the dung in an open field without any treatment. Upon examination of the compost quality by the Institute of Product Quality and Standardization at Maejo University, it was found that many parameters, such as nitrogen, phosphorus, and organic matter, were below the standards set by the Department of Agriculture [14]. Thus, improvements are needed to enhance the quality of the compost and add value to the products derived from elephant dung. Details of these experiments are provided in Section 3, "Improving the Quality of Elephant Dung Compost."

The waste data indicate that tourism activities within the park generate an average of 10.84 kg of solid waste per day. This figure does not include the approximately 2,350 kg/day of elephant dung, 30 kg/day of food waste from the restaurant, or 3 kg/day of recyclable office waste. These findings are consistent with those of Pham Phu et al. (2019) [15], who found that ecotourism sites tend to generate a significant amount of waste, often exceeding regular household waste per capita due to the high concentration of

visitors in limited areas. Tourists in natural parks typically contribute a substantial amount of both organic and general waste, with a growing trend in plastic consumption and disposal.

The waste composition is classified into four categories: organic waste (27.16%), recycling waste (15.36%), general waste (55.77%), and hazardous waste (1.71%). Organic waste, which includes leaves and food waste, accounts for 27.16%. Recycling waste consists of glass (14.77%), aluminum (0.33%), and metal cans (0.26%). General waste, which makes up the largest portion, includes non-recyclable plastics (23.99%), paper (26.37%), and other materials (5.41%). Hazardous waste consists mainly of masks (1.45%) and batteries (0.26%). Similar patterns were observed by Nayono S. & Nayano S.E. (2021) [12], who found that rural tourism destinations often generate a high percentage of non-recyclable general waste, largely due to insufficient waste separation practices. Our study supports this argument but adds the layer of quantifying waste generation per person, which averages 0.03 kg/day. While this figure seems low, the cumulative effect over time is considerable, particularly during high tourist seasons, echoing Nayono's observations of waste accumulation.

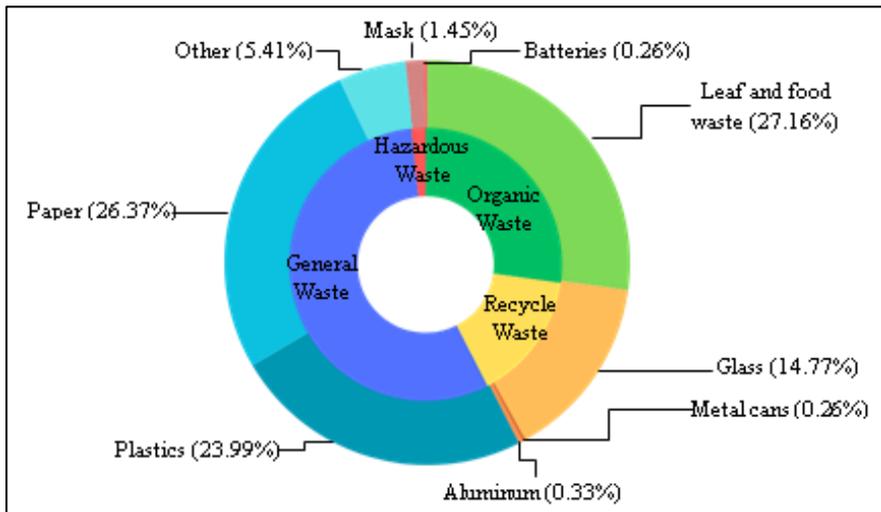


Figure 4 Waste Composition

One of the unique contributions of this study is its focus on elephant parks, a distinct context within waste management in ecotourism. Elephant parks have a different waste profile compared to typical tourism sites due to the large amount of organic waste, including elephant dung and plant matter, which make up 27.16% of the total waste. This highlights the need to design waste management strategies that are tailored to the specific requirements of such destinations. By focusing on waste issues in an elephant park, this study not only adds to the body of knowledge on waste management in ecotourism but also offers a specialized approach to addressing waste in wildlife tourism environments.

The Solid Waste Management Strategy

The solid waste management strategy for the elephant park has been developed through a comprehensive process involving surveys, waste data analysis, interviews, and the utilization of waste flow and cause-and-effect diagrams. This strategy aims to effectively address the waste management challenges identified in the park. The following recommendations are proposed:

1. Constructing systematic management:
 - The cleaning staff will assume responsibility for daily waste collection, categorizing waste by type.
 - Food waste will be repurposed as animal feed and compost, while elephant dung will be used in paper production.

- Water and ice waste will be repurposed for watering plants.
2. Establishing appropriate waste separation points:
 - Five types of waste bins are proposed: general waste, recycling waste, food waste, water and ice waste, and hazardous waste.
 - The hazardous waste bin will be located at the Elephant Park office for proper disposal by municipal authorities.
 - Waste separation points should have clear signs indicating the type of waste to encourage people to segregate waste properly.
 3. Educating both employees and tourists about waste separation to enhance understanding and awareness:
 - Interesting projects will be implemented to educate employees and tourists about waste separation practices.
 - Media campaigns will be established to promote waste segregation among employees and tourists.
 4. Improving the quality of elephant dung compost:
 - Elephant dung will be used as raw material for compost processing, and the resulting products will be sold to mediators. However, efforts should be made to improve the quality of elephant dung composting and

shorten the fermentation time. This will help reduce the accumulated dung and ensure the production of products that meet market demand.

5. Converting the accumulated elephant dung to biogas:

- Due to the limitations of composting and the necessity of adding additional materials to improve quality, resulting in increased production costs, the authors suggest using accumulated elephant dung as raw material for biogas processing to convert dung to energy. This is an effective method for reducing the main organic waste in the elephant park.

Implementing proper waste separation will lead to increased recycling rates and a reduction

in general waste. Organic waste will be utilized as animal feed, compost, and for biogas production. Recyclable materials, including glass, paper, plastic, metal cans, and aluminum, will be sold to waste buyers, generating additional income for the park. Hazardous waste disposal will be managed appropriately by the subdistrict administrative organization.

The expected outcome of implementing this waste management strategy is a significant reduction in the amount of general waste sent to landfills, estimated at up to 33.25 kg/day (from 33.84 kg/day to 0.59 kg/day). Figure 5 illustrates the predicted waste volume when managed effectively, highlighting the potential for the elephant park to become a model ecotourism destination for waste reduction in the future.

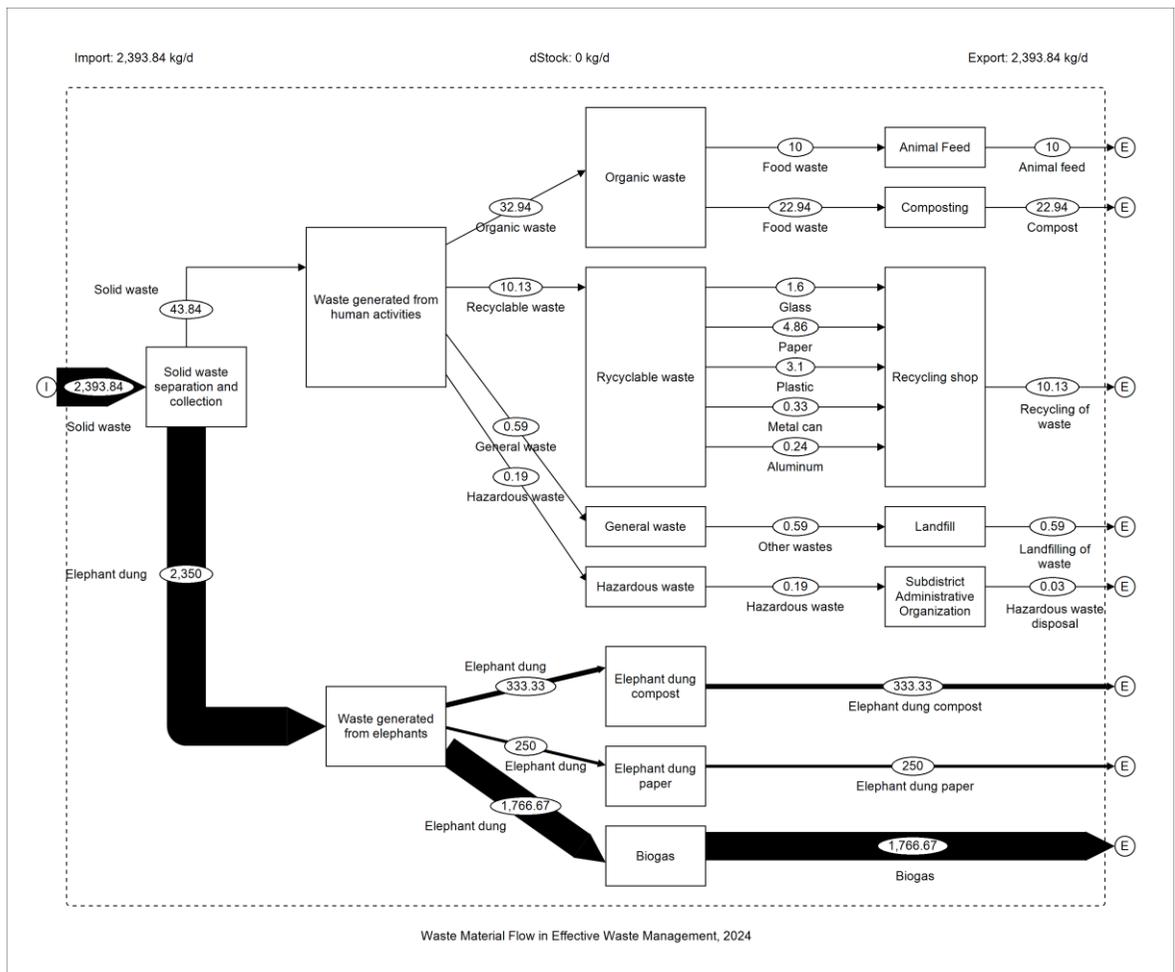


Figure 5 Waste Material Flow in Effective Waste Management in the Elephant Park

Improving the Quality of Elephant Dung Compost

This study aimed to improve the quality of elephant dung compost by incorporating organic waste from the elephant park, reducing the overall amount of organic waste generated in the elephant park. Elephant dung, cattle dung and food waste were used in this experiment in different ratios, as shown in Table 1. There are four treatments, namely the control (based on the quality inspection results of the elephant park), Formula 1, 2 and 3. Each treatment was replicated three times. In addition, phosphate rock and P.D.1 (microbial activators for composting produced by the Land Development Department) were added to all treatments. Compost piles were turned every week to enhance oxygen circulation within the pile. The composting process continued until the compost reached a dark brown or black colour, the internal temperature of the pile decreased, and it emitted a soil-like smell. Samples were sent to the Institute of Product Quality and Standardization, Maejo University, to assess the compost's quality. The experimental results are presented in Table 2.

The findings indicate that composts from all formulations (F1, F2, and F3) still show nitrogen, phosphorus, and organic matter levels below the standards set by the Department of Agriculture (as shown in Table 2). These results reflect common challenges faced in composting practices, particularly when handling large volumes of organic waste, such as elephant dung. Similar limitations in compost quality have been documented in studies, such as by Ayilara et al. (2020) [16], who found that nutrient imbalances, time constraints, and pathogen management often impede compost quality in agricultural settings. These factors are particularly problematic in systems dealing with high quantities of organic

waste, such as those generated by wildlife tourism facilities. In our study, the limitations in elephant dung composting can be attributed to the complex nature of the raw materials, which require careful management of moisture, aeration, and nutrient balance. These challenges are consistent with findings by Azim et al. (2017), who emphasized that achieving optimal composting results requires precise control over raw material ratios and environmental conditions [17]. Future improvements in the composting process could benefit from a more controlled environment and additional raw materials. Incorporating nutrient-rich materials, such as Napier Grass and bat guano, into the composting process could be a potential solution to improve nutrient content. Studies have shown that Napier Grass, due to its high nitrogen content, can significantly enhance compost quality when used in combination with other organic materials [18]. Similarly, bat guano has been widely recognized for its high phosphorus content, which not only accelerates the decomposition process but also enhances the overall nutrient profile of the compost [19]. These materials are therefore recommended for future studies aiming to optimize compost nutrient levels and shorten fermentation times. Our study contributes to the existing body of literature by applying these composting principles in the unique context of an elephant park, where organic waste is predominantly composed of elephant dung. This focus on wildlife tourism sites adds an important dimension to the current understanding of composting challenges in ecotourism destinations. By integrating locally available, high-nutrient materials into the composting process, we aim to provide a sustainable waste management solution for elephant parks, thus advancing the field of waste management in ecotourism.

Table 1 Proportion of Elephant Dung, Cattle Dung, and Food Waste in Each Treatment

Treatment	Proportion		
	Elephant dung	Cattle dung	Food waste
Control	Based on the results of the quality inspection of the Elephant Park		
Formula 1 (F1)	0.5	0.5	-
Formula 2 (F2)	0.8	0.1	0.1
Formula 3 (F3)	0.8	0.15	0.05

Table 2 The Quality of the Elephant Dung Compost by the Institute of Product Quality and Standardization, Maejo University

Parameters	Standard value	Unit	Mean ± SD			
			Control	F1	F2	F3
Total Nitrogen	≥1.0	% by weight	0.70	0.57±0.09	0.68±0.08	0.61±0.01
Phosphorus (P ₂ O ₅)	≥0.5	% by weight	0.06	0.31±0.03	0.24±0.05	0.23±0.06
Potassium (K ₂ O)	≥0.5	% by weight	0.81	1.42±0.47	0.95±0.20	0.79±0.18
Organic Matter	≥20	% by weight	14.47	17.14 ±0.41	15.75±0.68	17.76±3.12
Germination Index	>80	%	99.72	100.52±0.25	97.83±1.15	90.53±7.79
C/N Ratio	≤20:1	-	12.00	18.00±2.16	13.33±1.25	17.00±2.65
Sodium	≤1	% by weight	0.01	0.07±0.02	0.10±0.02	0.21±0.27
pH	5.5-8.5	-	6.58	6.66±0.15	7.42±0.02	7.54±0.04

Conclusions

This study devised a comprehensive solid waste management strategy for an elephant park in Chiang Mai by employing a waste minimization approach. Key findings indicate that the park generates significant waste, primarily from tourist activities and elephant dung. By implementing pilot activities, including composting elephant dung and establishing waste separation points, the research demonstrated practical methods to reduce the environmental impact of the park. The research identified challenges in current waste management practices, including the lack of systematic waste separation and the need for better education among staff and tourists. Composting experiments revealed that improving the quality of elephant dung compost is crucial for enhancing its usability, though further improvements in compost quality are necessary. Based on these findings, practical recommendations include continuing to improve compost quality, educating park employees and tourists on waste segregation, and exploring alternative uses for elephant dung, such as biogas production. Future research should focus on assessing the long-term impact of these strategies and collecting seasonal data to refine waste management practices. Implementing these recommendations could position the elephant park as a model for sustainable tourism and waste reduction.

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