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EVALUATION OF WASTE MANAGEMENT ACHIEVEMENT IN PADANGTEGAL PEKRAMAN VILLAGE, UBUD SUB DISTRICT, GIANYAR DISTRICT, BALI

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ABSTRACT

Aim: This study aims to evaluate the practice of waste management system conducted by community and business units in one traditional village in Bali and to discover the contributing factors to the success of the practice. **Methodology and Results:** A set of waste sampling method, observation, and interview were conducted to collect the basis data for the data calculation and analysis. The results show that the waste generation in Padangtegal Village currently reaches 38.18m3/day or 1,145.41 m^3/month, with the largest weight composition from leaves and twigs waste (39.87%), food waste (29.07%), and plastic (13.11%). With 100% of waste handling service, the processing of waste carried out in the area only reached 5.06% of 3R behavior (reduce, reuse, and recycle) at the source, and 1.10% composting at the composting house (Rumah Kompos). **Conclusion, significance and impact study:** Most of the processing carried out at Temesi Recycling is through composting (33.98%) and recovery of recycled material (33.68%), resulting in a residue (26.19%) which is transported to the Suwung Landfill. It could be concluded that organic waste processing through composting and recycling non-organic waste could reduce waste volume transported to the landfill about 67%.

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KEYWORDS

- Padangtegal village
- Waste management
- 3R behavior
- Waste composition
- Waste generation

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1. INTRODUCTION

Waste is the residual activity of human and natural process, especially in the solid form (National Law No.18/2008). Its presence often creates problems, in terms of place attractiveness, and for the health of people living in an environment. Therefore, the management of waste is needed by tourism areas such as Bali which is the main destination for both local and foreign tourists. Furthermore, with the increasing number of visitors and tourism activities, improper handling of waste generated has the possibility to cause problems in the tourism sector.

Based on the data obtained from the Ubud Village Government (2015), 75,081 tourists visited the area in 2008 and the number continues to increase every year. This, consequently, leads to increment in waste and makes the Temesi and Suwung Landfill in Bali become overfilled. It is, therefore, important to improve waste handling services in this area.

However, the Monkey Forest, which is one of the tourist destinations in Bali is located in the traditional village of Pekraman Padangtegal Ubud sub-district, requires effective waste management. This was, nevertheless, resolved through the establishment of a waste management and processing institution known as Rumah Kompos, especially for composting activities. This is currently quite good compared to other regions in Indonesia because the community and business people therein have succeeded in segregating wastes independently. This was conducted through 3R activities at sources and processing outside the area. Therefore, it is necessary to evaluate the waste management operations of Padangtegal in order to understand successful handling processes and ways to improve solid waste services in other areas.

2. RESEARCH METHODOLOGY

The methods used in this research are illustrated as a flow diagram as shown in Figure 1 as follows.

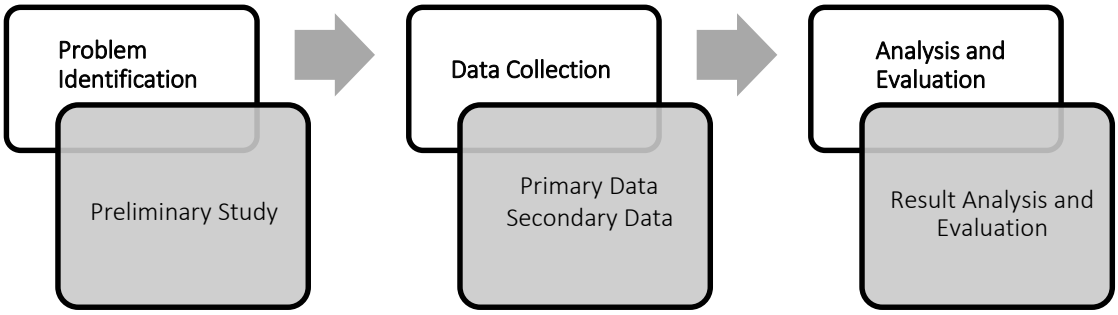

Figure 1 Flowchart methodology

2.1 Problem Identification

Problem identification was conducted through a preliminary study of the existing condition of waste management and general description of the study area.

2.2 Data Collection

Data collection was requisite of analysis and for the purpose of this study both primary and secondary data were utilized. The primary data were collected through observation, interview, waste sampling, and laboratory analysis while the secondary was obtained by examining literature, document analysis, and interview with stakeholders.

2.2.1 Waste Sampling

The measurement of waste generation units from the number of samples was determined proportionally at the source for 8 consecutive days (Damanhuri and Padmi, 2016). In Indonesia alone, this could be measured based on SNI 19-3964-1995 and the determination of sample conducted with specific reference to the socioeconomic level of the community concerned (Damanhuri and Padmi, 2016).

2.2.2 Laboratory Analysis

The wastes were analyzed for physical characteristics such as water, volatile, and ash contents, as well as chemical characteristics in the form of C-Organic, NTK, Phosphate, and Potassium contents. The samples were obtained from the same source as those used to measure waste generation and composition. They were preserved in a closed container at a controlled

temperature.

2.2.3 Observation

Observation is an active method of acquiring data and it was applied in the study by visually inspecting existing waste management conditions through systematic approach and recording.

2.2.4 Interview

Interviews were conducted to obtain primary data that has not been documented through face-to-face interaction with related parties such as the whole community, leaders, institutions, private sector, and other parties. A questionnaire was designed with a set of questions based on the list of data required.

2.3 Analysis and Evaluation

This was conducted through qualitative and quantitative assessment and the result was used as a basis for evaluation, by comparing the data obtained and the ideal system of waste management.

2.4 Basic Theory

Waste is defined as all solid forms of waste derived from human and animal activities discarded for their ineffectiveness or undesirable existence (Damanhuri and Padmi, 1993). In the Law of the Republic of Indonesia Number 18 Year 2008 as regards waste management, it is also defined as the solid remnant of the daily activities of human and/or natural processes.

2.4.1 Waste Source

In National Law No.18/2008, the source of waste is defined as the origin of its generation. It is, however, categorized into 3 types, which are:

1) Household Waste

   This comes from daily activities in the household, excluding feces and some specific wastes.

2) Waste Similar to those of household

This is similar to household waste but comes from commercial, industrial, and special areas as well as from social, public, and/or other facilities.

3) Specific Trash

Due to its nature, concentration and/or volume, this type requires special management.

2.4.2 Waste Composition

This was the most easily obtained data used to select and determine the operation of each equipment and other facilities, as well as to estimate the feasibility of using a waste handling facility. The composition and traits of waste describe the diversity of human activities. For example, in addition to the simple lifestyle of the people, more and more components of organic material would be found in the waste composition (Damanhuri and Padmi, 2016).

Every country has a way to group waste and according to the SNI 19-3964-1995 of Indonesia, it is classified into 9 types as follows:

a) food waste;
b) wood and garden waste;
c) paper and cardboard;
d) textiles and textile products;
e) rubber and leather;
f) plastic;
g) metal;
h) glass;
i) inert material, ash, etc.

In its implementation, hazardous waste is observed as the 10^{th} component (Damanhuri and Padmi, 2016).

2.4.3 Solid Waste Management

The federal and regional government are tasked with ensuring the implementation of good and environmentally sound waste management as stated in article 5 of 2008 National Law No. 18. The policy is further regulated in Presidential Law No. 81 of 2011 concerning Household Waste Management and Household-like Waste.

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In the 2008 law, waste management was defined as a systematic, comprehensive, and continuous activity including waste reduction and handling. These activities, as well as the operational techniques based on SNI-19-2454-2002, include the collection, transfer, transportation, processing and final processing of waste.

3. RESULTS AND DISCUSSION

Ubud is one of the 8 villages in Ubud sub-district and from the religious and customary aspects, it can be further divided into several Pakraman or traditional villages. However, based on Bali Provincial Regulation No. 3 of 2001, Pakraman Village is a customary law community unit in the Province. It has also been a unity of tradition and manners of association for Hindu for generations under a bond of Kahyangan Village and this makes it have its own territory, wealth, and the right to take care of its residents as well as a governance system and special regulations referred to as Awig-Awig. In Ubud, there are 6 Pakraman Villages which include:

1. Ubud
2. Bentuyung
3. Junjungan
4. Tegallantang
5. Taman Kaja
6. Padangtegal

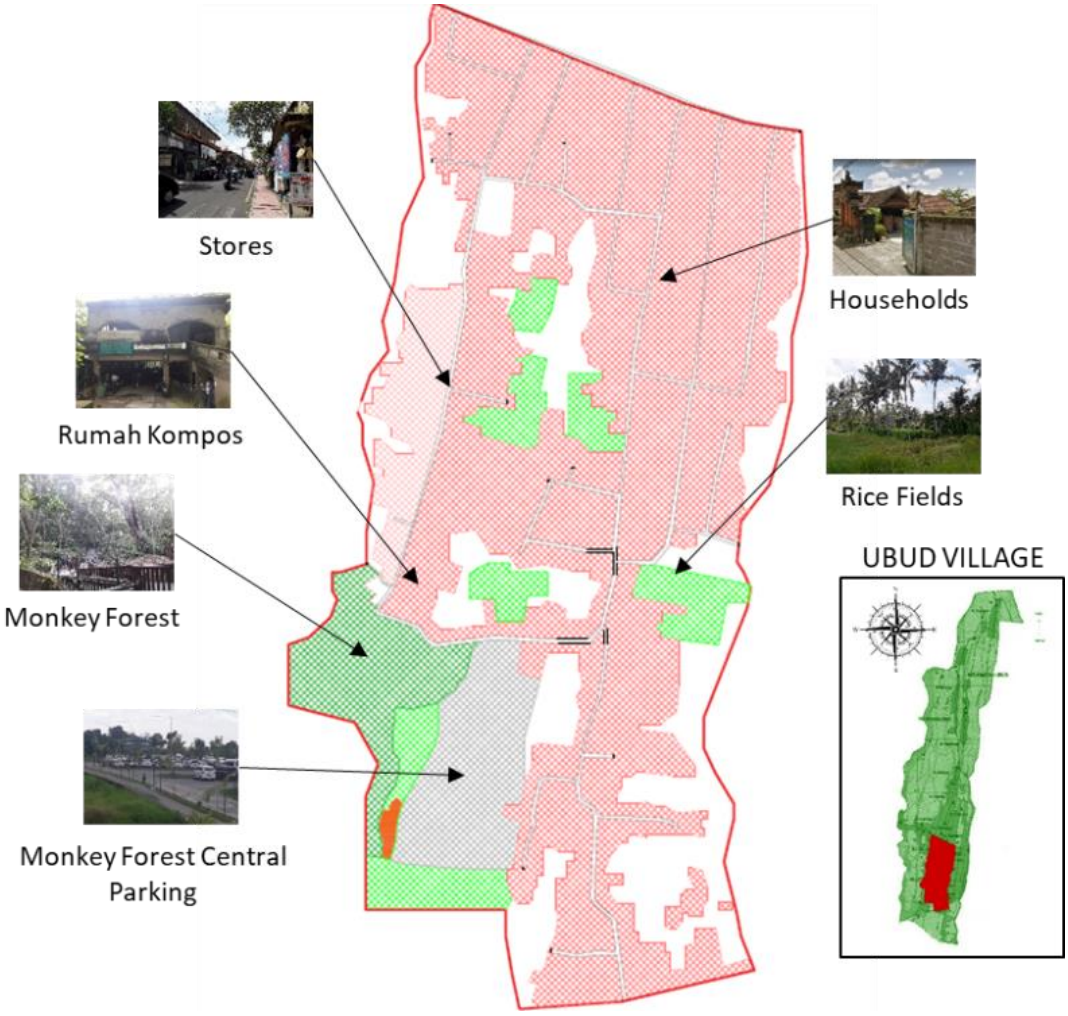

Figure 2 Map of Padangtegal Pakraman Village

Padangtegal is one of the traditional villages located in Ubud and it was chosen as the case study area for the research. It consists of 3 (three) Banjar/neighborhoods which are Kaja, Kelod, and Mekarsari as shown on the map in Figure 2. With an area of 134 hectares, it has a population of 2,644 people which is equivalent to 661 households (heads of households). Padangtegal has one of the main tourist destinations in Ubud Village, Monkey Forest, which makes it a strategic tourism area. In 2003, tourism arrivals reached approximately 47,000 and by 2009, there were 75,000 as shown in Figure 3. The numbers show there is an increase of 28,000 tourists which will certainly affect services and facility of the area.

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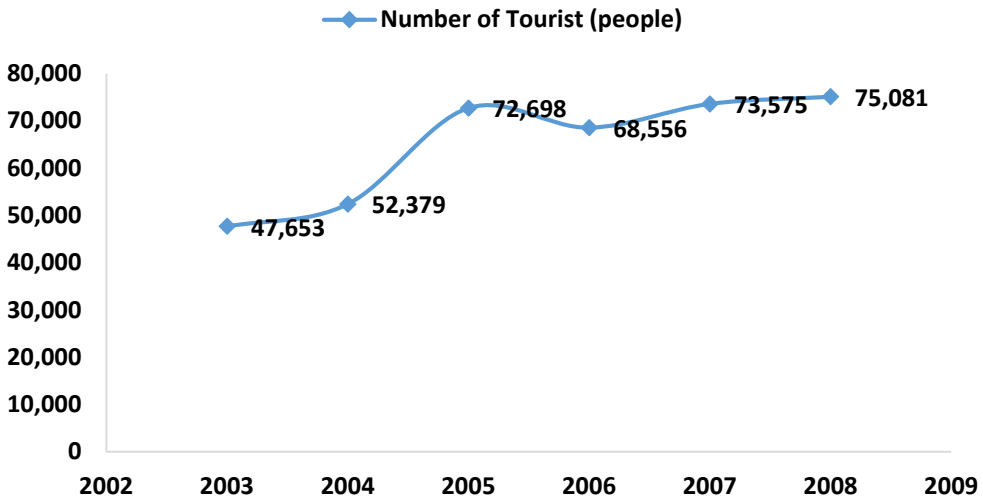

Figure 3 Ubud's tourist arrival (Government of Ubud Village, 2015)

The village manages its own waste by forming a solid waste management agency, Rumah Kompos-PadangTegal in 2012. The establishment was intended to serve as a center for solid waste management education as well as waste management institution in the area with the expectation to reduce the burden on government's finance, project the community in a positive image, and maintain a cleaner environment. The institution also makes it possible for the community to manage its waste independently without been bound by the Gianyar District's institution but rather by Village Regulations (PerDes) in the form of customary rules.

The number of residents benefiting from Rumah Kompos is currently 661 households and ±300 business units and the amount of waste transported reaches ± 40m³ per day (Rumah Kompos, 2017). The mechanism used in implementing waste handling in Padangtegal by the institution is illustrated in Figure 4 below:

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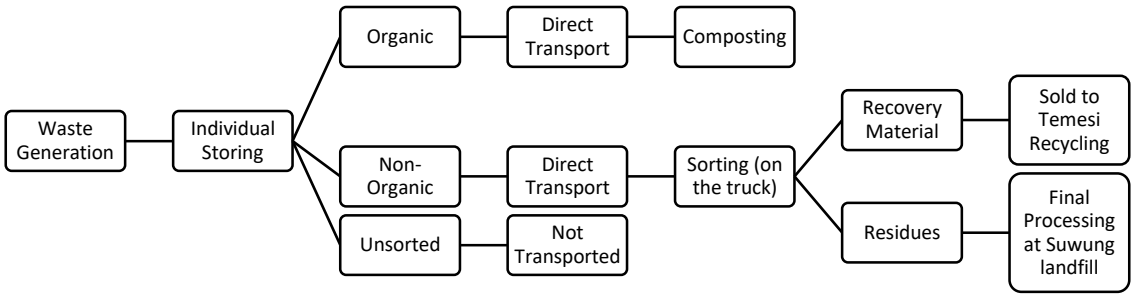

Figure 4 Mechanism of waste management in Padangtegal Village (Rumah Kompos, 2017)

3.1 Waste Storage and Sorting

Waste storage in Padangtegal is conducted individually and the organic and inorganic wastes are sorted by the population with trash bins provided by the Rumah Kompos. Therefore, the sorting of wastes is being conducted by both the residents and business units to date. This process started informally in 2009 and was formalized through the establishment of the institution in 2012.

Furthermore, Rumah Kompos has deployed several methods to familiarize sorting to the Padangtegal community, some of which include sorted waste container distribution, magazines and media info, Wayang (traditional puppet in Indonesia) performances with environmental themes, home, schools and government agencies visits, campaigns through Banjar meetings, dissemination of information through social media, and annual awards for the best sorting, as well as making separate truck collection for organic and non-organic wastes.

The process of sorting was strengthened in 2005 by the customary rules set out in the Regulation number 06/DPP/III/2015, Pawos Palet 5 Pawos 93-95. This reinforcement of the rules aids the successful achievement of community waste sorting in 2017 such that they would not be transported if unsorted. Moreover, organic and non-organic wastes were collected separately to avoid stigma in the community regarding the transported waste.

Customary rules providing sanctions for non-compliant residents are considered the method with the greatest impact on waste sorting efforts. Moreover, a high level of

inconvenience is seen among citizens when unsorted wastes are not collected and transported into final disposal and this is also considered a direct form of sanctions. Additionally, the wastes of Balinese people are usually dominated by organic wastes from the traditional ceremonies, and because of their components, they cause odors detrimental to the surrounding environment if not transported immediately. Besides that, Ubud has a strong custom belief therefore the existence of customary regulations gives a stronger effect on the community than administrative regulations.

3.2 Waste Collection and Transportation

Wastes are collected and transported through the use of the door-to-door system. This involves the collection and transportation directly from the source with schedules conducted 2 times each day in order to separate the transportation of organic and non-organic wastes. The non-organic ones were transported between 10:00 a.m. to 2:00 p.m. while organic was between 3:00 a.m. to 7:00 a.m. This was arranged to avoid any discomfort for visiting tourists, and not to hamper traffic considering the narrow width of the main road. However, the roads included in the waste collection are Wenara Wana Road (Monkey Forest), Pengosekan Road, Jalan Raya Ubud, Jalan Dewi Sartika, Jalan Hanoman, Jalan Sugriwa, and Jalan Jembawan.

3.3 Waste Reduction and Processing

As can be seen in Figure 4, some of the processing was conducted at Temesi Recycling which is about 16.7 km from the composting location (Rumah Kompos). From the observations made, few organic wastes are also processed in Rumah Kompos through the composting process but the quantity is very small. There are only 5 (five) composting basins, each measuring 2.5 m × 1 m × 0.75 m and assuming the composting time from half cooked to maturation to be 5 (five) weeks, only 0.27 m per day of organic wastes can be composted. However, the main reason most of the waste processes are conducted in Temesi Recycling rather than Rumah Kompos was because the institution was only intended as a media and place to educate people on waste processing. Besides, it is located on the side of a river that exposes the composting area to overflow of water and this alters effective conduct of composting activities just like other factors such as sufficient composting areas.

Therefore, based on the data from Table 1 (Rumah Kompos, 2017), the quantity of waste handled by the facility in each month reveals its limited capacity for processing.

Table 1 Types and amount of waste handled by Rumah Kompos (Rumah Kompos, 2017)

Type of Waste	Amount (m^3/ month)
Organic	240
Non Organic	600
- Paper	150
- Cardboard	240
- Plastics	60
- Glass/Bottles	30
- Metal	120
Residues	300
Total	1,140

3.4 Sampling Results

In assessing the achievement of waste handling, a sampling process was conducted to obtain data for waste generation and composition. With respect to SNI 19-3964-1995, waste generation can be sampled for 8 (eight) days with the location divided into 2 (two) main groups, which are household waste (RT) and non-household waste (NRT). From the process sampling, the following data were obtained.

3.4.1 Waste Generation

A sampling of waste generation was conducted by the method specified in SNI 19-3964-1995. The household sample was determined proportionally based on the community socio-economic level (Damanhuri and Padmi, 2016). This was further divided into three, including high income (HI), middle income (MI), and low income (LI). Data used were obtained from the District Statistics of Ubud (BPS Ubud, 2016). The results of household samples are shown in Table 2.

Table 2 Number of household samples

Group	Number of Family	Percentage	Number of Sample	Number of Sample Taken
Low Income (LI)	583	4%	1	2
Middle Income (MI)	1,154	7%	1	2
High Income (HI)	14,128	89%	6	6
	15,865	100%	8	10

The sampling process was conducted in accordance with the method provided by SNI 19-3964-1995 for 8 (eight) days. The results are shown in Tables 3 and 4 as follows.

Table 3 Padangtegal's household waste generation based on socio-economic level (kg/person/day)

Cluster	Waste Generation (kg / day / person)								Stocking of average (kg/person/day)
	day 1	day 2	day 3	day 4	day 5	day 6	day 7	day 8	
HI	0.35	0.29	0.39	0.33	0.44	0.25	0.36	0.45	0 .55
MI	0.27	0.12	0.47	0.67	0.40	0.00	0.81	1.04	0.54
LI	0.26	0.09	0.40	0.00	0.49	0.73	0.29	0.71	0.42

Table 4 Padangtegal's household waste generation based on socio-economic level (L/person/day)

Cluster	Accumulation of Waste (L / day / person)								Average (L/person day)
	day 1	day 2	day 3	day 4	day 5	day 6	day 7	day 8	
HI	5.88	3.92	6.96	5.09	7.49	4.95	5.53	7.20	5.88
MI	6.13	3.47	8.80	8.00	7.73	7.47	7.47	7.01	7.01
LI	6.33	1.53	6.98	3.93	5.89	5.45	7.20	5.33	5.33

According to Damanhuri and Padmi (2016), one of the factors influencing the quantity of waste generated is the level of the economy such that a higher economy results in greater wastes. As shown in Table 3, high-income population (HI) produced the largest solid waste of 0.55 kg/person/day while the smallest figure of 0.42 kg/person/day was from the low-income population (LI). However, Table 4 shows waste generated by the middle-income population (MI) to be greater with 7.01 L/person/day while high-income population (LI) was smaller with 5.88 L/person/day. This is due to the differences in treatment of waste conducted by sampled family members. It is estimated that in high-income homes, a lot of compaction is conducted on

wastes which reduce the volume and increases the density. The knowledge of the proportion of each economic level (cluster) was used to determine the average quantity of waste generated as shown in Equition (1). Therefore, the value was found to be 0.55 kg/person/day or 5.94 L/person/day as shown in Table 5.

$$Average\ Waste\ Generation = \sum(\%\ Cluster\ x\ Cluster\ Average\ \ Waste\ Generation) \quad (1)$$

Table 5 Padangtegal Village average waste generation

Cluster	Persentage[a]	Average Waste Generation (L/person/day)	Average Waste Generation (L/person/day)	Waste Generation (L/person/day)	Waste Generation (L/person/day)
HI	89%	0.55	5.88	0.49	5.23
MI	7%	0.54	7.01	0.04	0.51
LI	4%	0.42	5.33	0.02	0.20
Total				0.55	5.94

(BPS) of Ubud District (2017),
Ubud District in Figures 2017

This quantity of household waste generated in Padangtegal is larger compared to the solid waste generated at 0.322 kg/person/day or 2.047 L/person/day in Gianyar Regency with a difference of ±0.228 kg/person/day and ±3.893 L/person/day (Bali Provincial PSPLP Work Unit, 2016). Furthermore, when compared with the solid waste generation based on the classification of cities in SNI 19-3983-1995, The quantity from high-, middle-, and low-income groups, is 2.5 L/person/day and more than 0.4 kg/person/day, which is greater than those generated from permanent house waste. An underlying reason could be due to the presence of the Monkey Forest, one of the main tourist attractions in the village. As a result, the tourism sector has grown rapidly in the community. Simultaneously, this causes rapid economic growth and development which correlates with the statement of Damanhuri and Padmi (2016) regarding factors affecting solid waste generation: the higher the level of economy and development, the higher the amount of waste generated.

Non-household samples taken were adjusted to the number and presence of existing facilities in Padangtegal such as clinic, places of worship (Pura), schools, street, store, hotels/homestays, restaurants, offices, and tourist attractions. The results are presented in Table 6 and from calculations conducted the total waste generated in Padangtegal is estimated to be 38.18 m3.

Table 6 Padangtegal Village waste generation

Source	Unit	Waste Generation (kg/unit/day)	Waste Generation (L/unit/day)	Total Unit	Waste Generation (kg/day)	Waste Generation (m^3/day)
Household	Person	0.55	5.94	3,107	1,702.63	18.45
Clinics	Bed	1.28	15.90	2	2.57	0.03
Pura	m^2	0.01	0.08	5,850	31.97	0.50
Schools	Student	0.02	0.26	423	7.58	0.11
Street	m^2	0.02	0.17	3,750	68.02	0.65
Store	Employee	0.48	5.33	1,680	801.50	8.95
Hotel	Bed	0.12	1.40	5,925	738.69	8.32
Restaurant	Chair	0.27	1.35	736	196.77	0.99
Office	Employee	0.06	0.86	55	3.15	0.05
Tourist Attraction	m^2	0.00009	0.00057	207,000	18.05	0.12
Total					3,570.91	38.18

The percentage of waste generated by non-household was 52%, while household activities reached 48%. This is in accordance with the existing condition of the region where the development of non-household activities is growing rapidly in conjunction with the growth of the tourism sector. It was also observed that the ratio household compared to non-household waste generated was 5.2 : 4.8.

3.4.2 Waste Composition

In addition to the measurement of solid waste generation, data was also provided on waste composition. The unit used in this study was the percentage of wet weight (% wet weight) because the weight unit was not affected by changes in density. The composition sampling process sorted waste into 9 (nine) main types and they include food waste, leaves/twigs,

plastics, paper and cardboard, metals, rubber and leather, textiles, glasses, hazardous and toxic materials, and residues (others) in accordance with SNI 19-3964-1995. Therefore, Figure 5 shows the largest composition of waste comes from leaf and twig waste, which is 39.87% wet weight, followed by food waste with 29.07%. This means the major part of the waste is derived from organic waste with a total of 68.94%. This can be associated with the Balinese habits of giving offerings in the form of flowers, leaves, or food in their daily worship rituals.

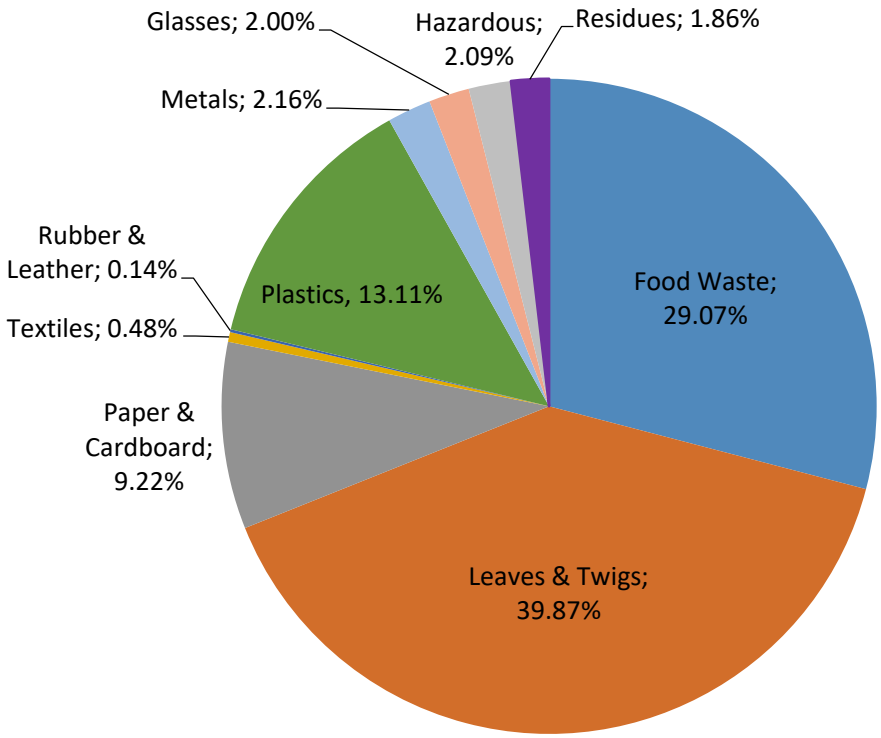

Figure 5 Composition of waste in Padangtegal Village

3.4.3 Waste Characteristics

In this study, laboratory tests were conducted to determine water content, volatile content, heating value, C-Organic, and NTK (Nitrogen Total Kjeldahl) and the result are listed in Table 7.

Table 7 Padangtegal Village waste generation

Parameter	Unit	Organic	Non-Organic	Average
Water Content	% Wet Weight	79.76 %	44.14%	61.95%
Volatile	% Dry Weight	88.94%	90.43%	89.69%
Calorific Value	Kal/gr Dry Weight	3,439.54	7,515.51	5,477.53
C-Organic	% Dry Weight	53.19%	49.84%	51.52%
NTK	% Dry Weight	1.98%	0.58%	1.28%

3.4.4 Waste Material Flow Analysis

The sampling results and analysis showed waste generated to be 38.18 m^3/day or 1,145.41 m^3/month. Based on this calculation, the difference between the generation of waste in the source per month with the data on the amount of waste handled by Rumah Kompos aligns with the 3R behavior (reduce, reuse, and recycle). This is also consistent with results of observations and questionnaire surveys where most of the communities have already done 3R activities in their homes.

Therefore, the achievement of waste management can be illustrated through material flow analysis diagram in Figure 6.

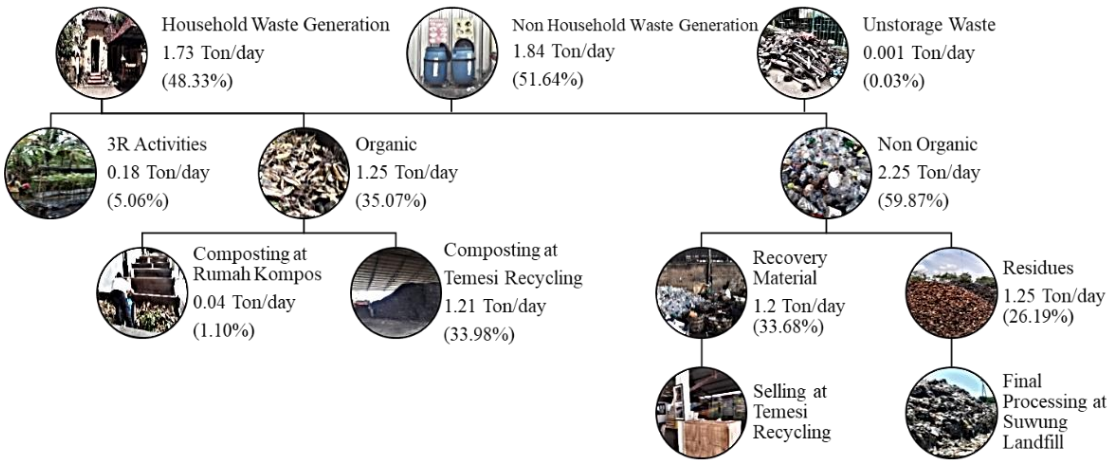

Figure 6 Flow chart of Padangtegal village waste material

The Figure shows the waste handling at source to be minimum, at 5.06% of 3R behavior (reduce, reuse, and recycle), and 1.10% composting at Rumah Kompos. Most of the processing

conducted at Temesi Recycling was through composting (33.98%) and recovery of recycled materials 33.68%. The resulting residue of 26.19% was transported to the Suwung landfill which has already reached an overcapacity stage and is being planned for closure. Therefore, to increase the level of waste services, processing facilities are needed to support waste reduction activities.

4. CONCLUSION

Padangtegal is one of the traditional villages in Ubud, Ubud Sub-District, Gianyar District, whose main attraction center is the Monkey Forest. As a strategic tourism area, the village manages its own waste by forming a solid waste management institution known as the Rumah Kompos and the effort inputted has been considered to be good enough. One of the success factors has been found to be the waste segregation activities conducted by the whole community and businesses units. This was evident in the waste sorting practices established through community education since 2009 as well as the provision of sanctions for non-compliant residents through customary rules. Furthermore, the inconvenience experienced by the people due to unsorted waste is also observed to be another form of sanction. Moreover, Ubud is an area in Bali with strong custom traditions directly related to beliefs, therefore, the implementation of customary regulations gives a stronger effect on the community than administrative regulations. In addition, this success was also supported by technical adjustments to waste management conducted, among others, by procuring disaggregated waste containers and other collection methods implemented.

The results showed the total waste generated in Padangtegal to be 38.18 m^3/day or 1,145.41 m^3/month, with the largest weight composition comprising of leaves and twigs waste at 39.87%, food waste at 29.07%, and plastic at 13.11%. It was also observed that 1,141 m^3/month was handled by the Rumah Kompos, with the major contributing factor being the 3R behavior of the community. The waste processing activities were found to be at the minimum, with 5.06% of 3R behavior (reduce, reuse, and recycle) at the source, and 1.10% composting at home. Furthermore, most of the processing activities conducted at the Temesi Recycling was through composting, 33.98%, and recovery of recycled materials 33.68% resulting in a residue of 26.19% which was transported to the Suwung landfill.

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