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Solid Waste Management Plan for Ayubia National Park

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ABSTRACT

This study aims to evaluate the solid waste management scenario of Ayubia National Park and proposes a management plan. Due to lack of a proper mechanism for disposing of solid trash, all rubbish created is thrown away or publicly deposited in parks by visitors, residents, hotels, and restaurants. According to an evaluation 58.1% of the population disposes of their waste in the accessible public bins. Despite this, many people bemoan the lack of public bins in light of the large population. However, 32.6% of respondents said that there aren't enough public garbage cans in their area. Approximately 18.6% of the surveyed said they get rid of their solid waste in small spaces within their homes, 7% in public spaces, 7% areas close to national parks, and 2.3% in restroom lanes. During the solid waste characterization procedure in the field, it was found that some solid waste may be repurposed as an input into the cement industry. Here's an illustration of the circular economy in action. It is advised to establish an integrated solid waste management strategy for ANP based on information obtained from surveys and observations, which includes the 3Rs rule to protect the park, reduce the cost and benefit the environment.

Introduction

Solid waste refers to any substance that is worthless or worthless that comes from commercial, residential, or industrial sources, and they might serve as an important supplier of raw materials (Shafiul and Mansoor, 2003). Solid garbage has been produced from the beginning of human history. Solid waste management is a major challenge for urban areas on our globe (Zurbrugg, 2003; Ionescu et al., 2013). The people's cultural traditions reflect the ways in which their cultures dispose of waste.Because of the problems with public health and the environmentThe topics of solid waste collection, processing, transportation, and disposal are extremely important (Ali and

Hasan, 2011).Solid waste management is an international phenomenon (UN, 1998). In order to establish the most appropriate trash elimination options, statistics about waste production are crucial. Contamination may occur from improper disposal of waste materials. Humans and other living things are severely affected by pollution (Morra et al., 2009; Liu and Morton, 1998). Similarly, it can disrupt the earth's regular cycle and atmosphere, harming the biological system (Raga et al., 2001).

Rio de Janeiro hosted the UN Conference on Environment and Development in 1992 (UNCED), provided an excellent platform for worldwide discussion on waste management. This forum's outcome, which identified waste as a major issue to address in the pursuit of global sustainable development, has given structure to ecologically sound policy (UNCED, 1992; Barr, 2002). To preserve the quality of the planet's ecosystem and achieve sustainable development that is ecologically sound. Solid waste management emerges as a critical issue that requires attention (Grover, 2000). Ayubia, also referred to as Ayubia National Park, is a 8,184-acre (3,312-hectare) protected area (Khan and Ibrahim, 2010) situated in District Abbottabad, Khyber Pakhtunkhwa, Pakistan's Gallis Forest Division. The name "Ayubia National Park" was given to Ayubia in 1984 as a tribute to Pakistan's late, great president Muhammad Ayub Khan. Ayubia is a well-liked travel location in Pakistan that sees a lot of traffic.

The NWFP Wildlife Act of 1975 caused the park region to be drastically expanded to 3312 hectares in March 1998. Typically situated at an elevation of 2400 meters (8000 feet) above sea level, temperate coniferous, temperate broadleaf woodlands, and integrated timberland eco-area living areas. The four quiet villages of Khanspur, Ayubia, Nathiagali, and Thandiani, as well as seven major towns, encircle the park.

Currently, Khyber Pakhtunkhwa's government's Wildlife and Parks Department is in charge of overseeing it. The park is constrained by a dense population, with seven major towns made up of a greater number of interconnected communities. There are approximately 50,000 people living in and around the national park, and population growth is 2.1% annually, according to national data. Dispensaries, schools, roadways, water, and other amenities are all significantly below the national average, which is also below the South Asian average. One major obstacle to the growth of preservation mindfulness is the rapid rate of ignorance (Waseem et al., 2005).

The delicate ecosystem of Ayubia National Park is being threatened by a number of negative features of the tourism sector, including the pollution that visitors leave behind and the inappropriate disposal of solid waste by surrounding lodges and hotels. One of the main reasons the environment deteriorates is that visitors, neighboring networks, and line offices are ignorant of the best practices for solid waste management. Pakistan generates over 0.5 million tons of solid waste each day, according to statistics, and 70% of its people live in rural areas.

In certain areas, a significant amount of garbage decomposes naturally. Statistics indicate that garbage generation in Pakistan varies daily between 0.283 and 0.613 kilogram per person, with waste generation per residence being between 1.9 and 4.3 kilogram per day (Waseem et al., 2005). Tourists generate 3.3 to 3.9 kg of solid garbage per capita every day at Ayubia National Park. That number is alarming because it is between 3.3 and 3.9 times more significant than the daily amount of solid garbage produced nationally per capita (Waseem et al., 2005). An increase in the volume of solid waste generated raises the hazards to the environment and the depletion of natural resources. The two primary methods for disposing of solid waste are open, unprotected dumping and sanitary landfills (Yvette et al., 2000).

Materials and methods

Study Area

This study was conducted at Ayubia National Park, Pakistan *(Fig. 1)*. According to study conducted previously, the Ayubia National Park is 3,312 hectares (8,184 acres) in size (Khan and Ibrahim, 2010). This park is located in the Abbottabad District, KP, Pakistan's Gallis Forest Division. The scope is 34o-1' to 34o-3.8' N, and the longitudes are 73o-22.8' to 73o-27.1'E (Waseem et al., 2005)

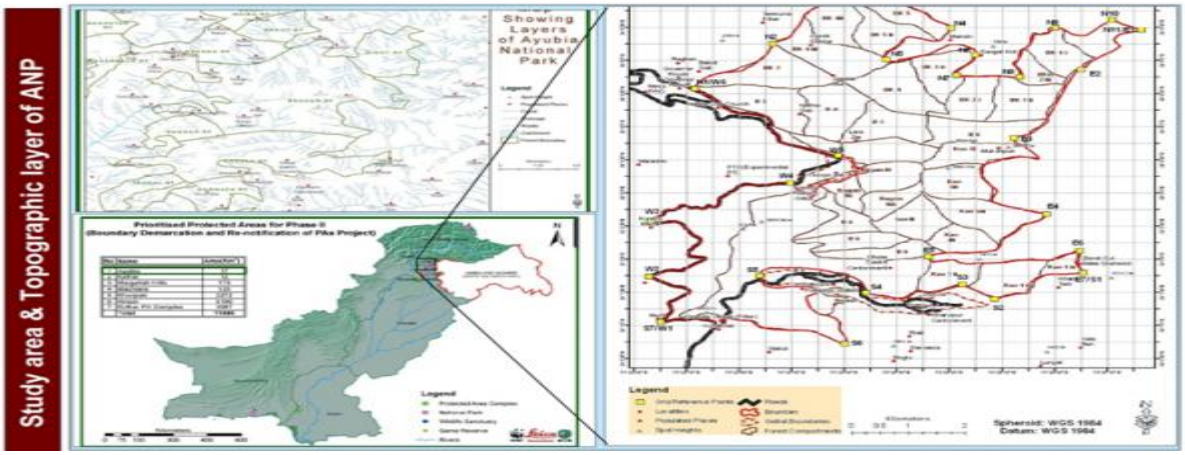


Fig 1. ***Study area map***

Solid Waste Quantification and Composition at ANP

There are an estimated 18097 people living in Ayubia. Based on the 0.2 kg of trash produced per capita per day, the average daily production of solid waste in ANP is projected to be 3875 kg, or 3.875 tons.

Mean Solid Waste Composition

The four samples that were gathered weighed a combined 25 kg. A thorough laboratory analysis was used to determine the average waste the solid waste's content over the four sampling locations. The data is displayed in *table 2* below.

Table 2. Average Solid Waste Content at ANP

Waste Components	Valid Percent	Cumulative Percent	Percent	Frequency
Food Waste	26.0	26.0	26.0	26
Paper	11.0	37.0	11.0	11
Plastics	21.0	58.0	21.0	21
Textiles	8.0	66.0	8.0	8
Garden Trimming	13.0	79.0	13.0	13
Rubber	4.0	83.0	4.0	4
Leather	5.0	88.0	5.0	5
Metals	12.0	100.0	12.0	12
Total	100.0		100.0	100

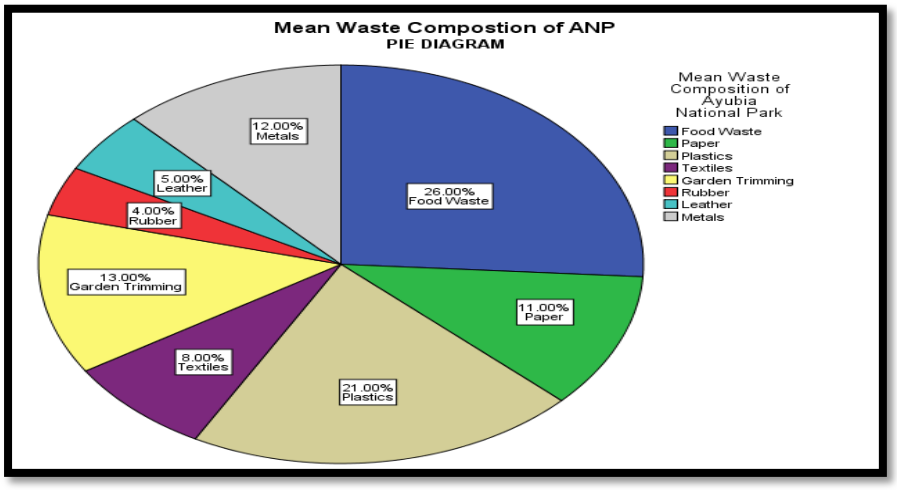


Fig 2. Mean Waste Composition of ANP

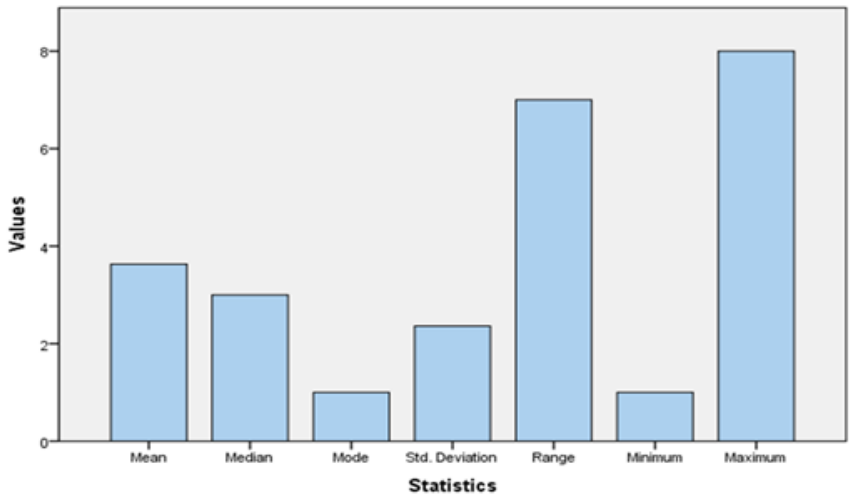


Fig 3. Statistics of Mean Waste Composition of ANP

Chemical/ Elements of Solid Waste: Chemical Content

The average chemical compositions of the solid waste components that were analyzed in a lab to determine the values of C, H, N, S, O, and Ash are listed in the *table 4.*

Table 4. Chemical Make-Up of Solid Wastes

Components	**Weight-based percentage (%) on a dry basis**					
	Hydrogen	**Carbon**	**Nitrogen**	**Oxygen**	**Ash**	**Sulfur**
Food wastes	6.0	42	2	35.2	2.1	0.2
Paper	3.8	28	0.2	32	2	0.1
Plastics(Mixed)	4.7	52	0.1	18.6	7.3	0.1
Textiles	2.4	15.7	0.9	13.6	2.2	0.2
Garden trimming	4. 2	22.6	1.6	24.0	3.2	<0.3
Rubber	4.6	35.0	0.1	0	1.0	0.9
Leather	3.9	32.4	8.3	10.7	6.5	0.3

All of the solid waste's average chemical composition was determined using SPSS analysis of the aforementioned data, the statistical results of which are provided below in *table 5*.

Table 5. Statistics of mean chemical composition

Mean Chemical Composition				
	Frequency	**Percentage**	**Valid Percent**	**Cumulative Percent**
Carbon	229	**50.7**	50.7	50.9
Hydrogen	32	**7.1**	7.1	58.0
Oxygen	138	**30.5**	30.5	88.5
Nitrogen	19	**4.2**	4.2	92.7
Sulfur	8	**1.8**	1.8	94.5
Ash	25	**5.5**	5.5	100.0
Total	452	**100.0**	100.0	

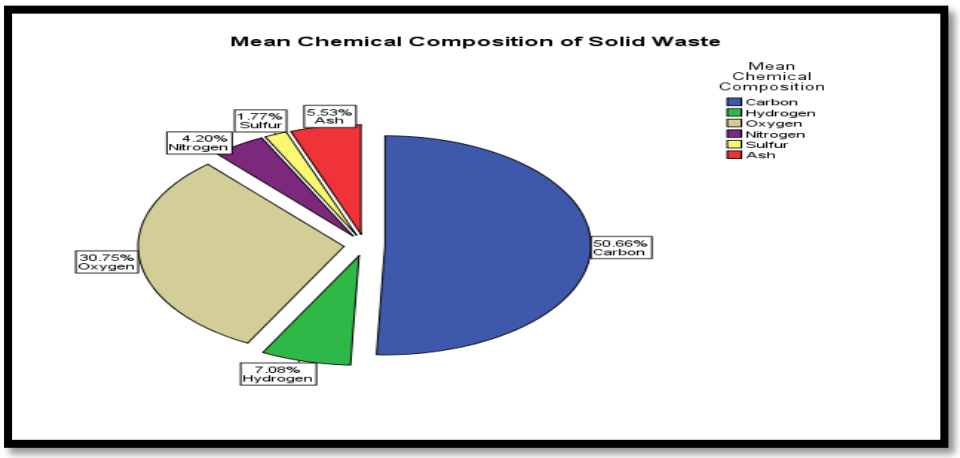


Fig 4. Mean chemical composition

Amount of humidity

The humidity amount is found through the % of the material's dry weight by using the following equation following equation;

$$\% \text{ MC in the solid waste} = \frac{w2-w3}{w2-w1} \times \frac{100}{1}$$

The solid waste's mass loss is expressed as w2-w3, while its original mass is expressed as w2-w1 (Rominiyi et al.2017). The outcomes for the various solid waste components are displayed in *Table 6.*

Table 6. Analysis of Solid Waste Contents' Humidity Level

% Moisture Content	**Dry Weight**	**Wet Weight**	**Components**
68.8	2.8	9	Food waste
6.9	24.2	26	Paper
9	9.1	10	Plastic
10	0.9	1	Textiles
58.3	10	24	Garden Trimming
0	0.7	0.7	Rubber
14.2	0.6	0.7	Leather

Movable Substance (VM)

Vapor produced during fuel heating is known as VM in solid waste. For the computation of volatile matter, the relevant ASTM standard E-872 was utilized The average percentage of volatile stuff for each component of the solid waste is as follows in *table 7.*

Table 7: volatile matter

%Volatile Matter	**Components**
75.69	Putrescible
82.87	LWTR [a]
93.95	Plastics
83.09	Paper
82.19	Total

[a] Leather, Wood, Textile, Rubber

Content of Ash

The analysis was carried out in compliance with ASTM E830 (ASTM 2004b) and (ASTM, D 2008) standards.

K-L / M x 100% = %Ash

where K is equal to the crucible's weight plus the cover plus the ash.

L= crucible's empty weight plus cover

M is the sample weight.

Table No. 8 shows the ash content for each of the solid waste's constituent parts, expressed as a percentage.

Table 8. Content of Ash

Content of Ash (%) by Weight	**Components**
2.1	Food wastes
2	Paper
7.3	Plastics(Mixed)
2.2	Textiles
3.2	Garden trimming
1.0	Rubber
6.5	Leather

The mean ash content was examined by SPSS, which is given below in *fig 5.*

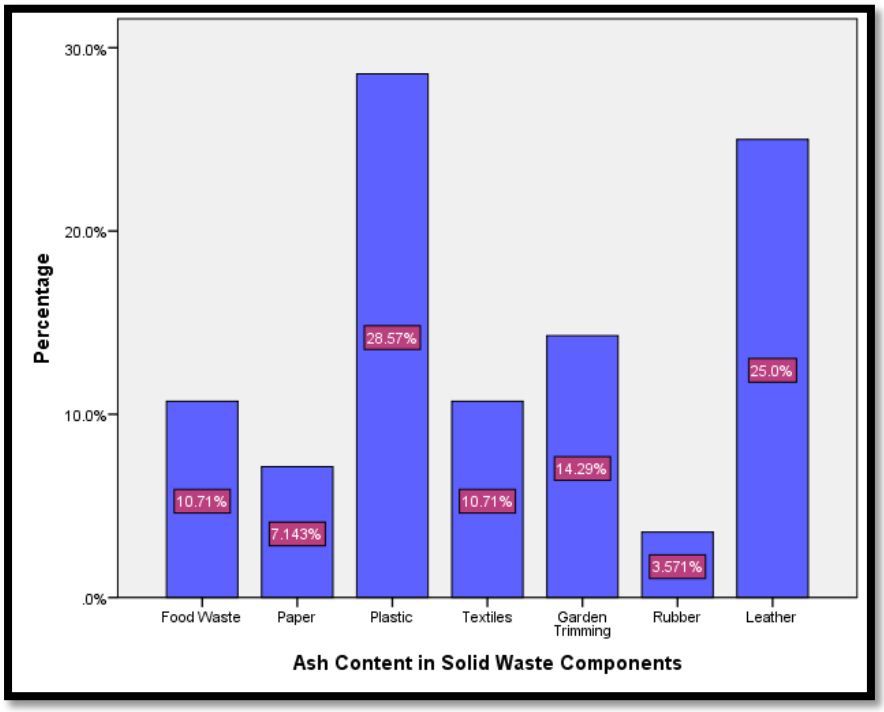


Fig 5. Ash content

Table 9. Statistics of Ash content

Statistics		
Ash Content		
N	Valid	28
	Missing	0
4.21		Mean
4.00		Median
2.043		Std. Deviation
6		Range
1		Minimum
7		Maximum

Table 10. Ash contents of waste components

Ash Content of Solid Waste Components					
		Percent	**Frequency**	**Cumulative Percent**	**Valid Percent**
	Food Waste	10.7	3	10.7	10.7
	Paper	7.1	2	17.9	7.1
	Plastic	28.6	8	46.4	28.6
	Textiles	10.7	3	57.1	10.7
	Garden Trimming	14.3	4	71.4	14.3
	Rubber	3.6	1	75.0	3.6
	Leather	25.0	7	100.0	25.0
	Total	100.0	28		100.0

Assessment of Existing Services and Facilities

A questionnaire survey was used throughout the research region to evaluate the solid waste management services and facilities that are currently in place. Three different kinds of questionnaires were created for the stakeholders, which included visitors, locals, and hotel operators. Using SPSS software, the questionnaire was examined, and intriguing findings were found that are shown here in *table 11*.

Table 11: Category

CATEGORY					
		Percent	**Frequency**	**Cumulative Percent**	**Valid Percent**
Valid	Hotel Owner	30.2	13	30.2	30.2
	Tourist	25.6	11	55.8	25.6
	Household Resident	44.2	19	100.0	44.2
	Total	100.0	43		100.0

Out of the three categories, 43 questionnaires were filled out. The questionnaire asked about general information such as age and gender, as well as the respondents' awareness of solid waste management practices that were coming to an end and their methods for disposing of waste. The responders are between the ages of 15 and 70. It was discovered that the proportion of men was 44.2% and that of women was 55.8%.

The gender frequency is displayed in detail in the following *table 12*, which was generated using SPSS.

Table 12: Stats on Gender Variance

Gender					
		Percent	**Frequency**	**Cumulative Percent**	**Valid Percent**
Valid	Male	44.2	19	44.2	44.2
	Female	55.8	24	100.0	55.8
	Total	100.0	43		100.0

Table 13: Gender and Age Statistics

Gender and Age Statistics			
		Gender	**Age**
N	Valid	43	43
	Missing	0	0
Mean		1.56	27.02
Median		2.00	25.00
Mode		2	16
Std. Deviation		.502	12.787
Range		1	55
Minimum		1	15
Maximum		2	70
Sum		67	1162

After the ages of the participants were examined, it was discovered that those in the 15–16 age range made up a greater proportion of the sample than those in other age groups, with 21.9% of the sample being 16 years old and 11.6% being 15 years old. The age ratio is displayed in the *table 14.*

Table14. Age Statistics

Age of Respondents					
		Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Valid	15	5	11.6	11.6	11.6
	16	9	20.9	20.9	32.6
	17	3	7.0	7.0	39.5
	18	1	2.3	2.3	41.9
	21	1	2.3	2.3	44.2
	24	2	4.7	4.7	48.8
	25	3	7.0	7.0	55.8
	26	1	2.3	2.3	58.1
	30	2	4.7	4.7	62.8
	31	1	2.3	2.3	65.1
	32	3	7.0	7.0	72.1
	33	1	2.3	2.3	74.4
	35	2	4.7	4.7	79.1
	36	2	4.7	4.7	83.7
	40	3	7.0	7.0	90.7
	44	1	2.3	2.3	93.0
	48	1	2.3	2.3	95.3
	60	1	2.3	2.3	97.7
	70	1	2.3	2.3	100.0
	Total	43	100.0	100.0	

The respondents' degree of awareness concerning solid waste management was higher than average; when asked if they had any ideas or information about the topic, 81.4% of respondents indicated they did, and just 18.6% stated they did not. About the solid waste management education offered by the local council, GDA, and WWF, 58.1% of respondents agreed that they had received it from these organizations, while 41.9% disagreed, claiming they had not received any instruction at all. Ninety-three percent of those surveyed knew that the main issue currently harming the ANP's natural environment is solid waste.

The 3Rs principle was unknown to 48.8% of respondents, whereas 51.2% of respondents were aware of it. In this location, the disposal of waste is viewed as a concern by 94.0 percent of the respondents.

Table 15: The Problem of Waste Disposal

Waste disposal is a problem in this area?					
		Percent	**Frequency**	**Cumulative Percent**	**Valid Percent**
Valid	Yes	93.0	40	93.0	93.0
	No	7.0	3	100.0	7.0
	Total	100.0	43		100.0

The responder was asked about waste collection and disposal methods as well as whether or not there were any solid waste management techniques in place at the time in order to learn about the present practices in the area. Twenty-nine percent of the respondents said that solid waste management techniques are available nearby, while seventy-nine percent said that there isn't a solid waste management practice in their region at the moment. Those who throw away trash without gathering it include 9.3% of the population; those who do so in waste baskets (60.1%), plastic bags (14%), repurposed baskets (7), and cartons (9.3%).

Table 16. Waste Accumulation

Where do you gather your trash?					
		Percent	**Frequency**	**Cumulative Percent**	**Valid Percent**
Valid	in carton	9.3	4	9.3	9.3
	in Waste Basket	60.5	26	69.8	60.5
	Old Basket	7.0	3	76.7	7.0
	Plastic bags	14.0	6	90.7	14.0
	Throw away outside	9.3	4	100.0	9.3
	Total	100.0	43		100.0

When interrogated about how they disposed of the rubbish they gathered, the respondents listed a number of locations. While 58.1% of respondents stated they dispose of their waste in the designated public bins, they also voiced dissatisfaction with the bin's little quantity given the size of the population. Thirty-six percent of respondents claimed there are no public trash cans in their neighborhood, while 67.4% claimed there are, but they are very tiny and limited in number. According to the survey, 18.6% of participants dispose of their solid trash in a confined space inside their homes, 7% do so in an open location, 7% do so near a national park, and 4.7% do so near a valley and 2.3% dispose it in the sanitation lanes.

Table 17. Frequency of Waste Disposal

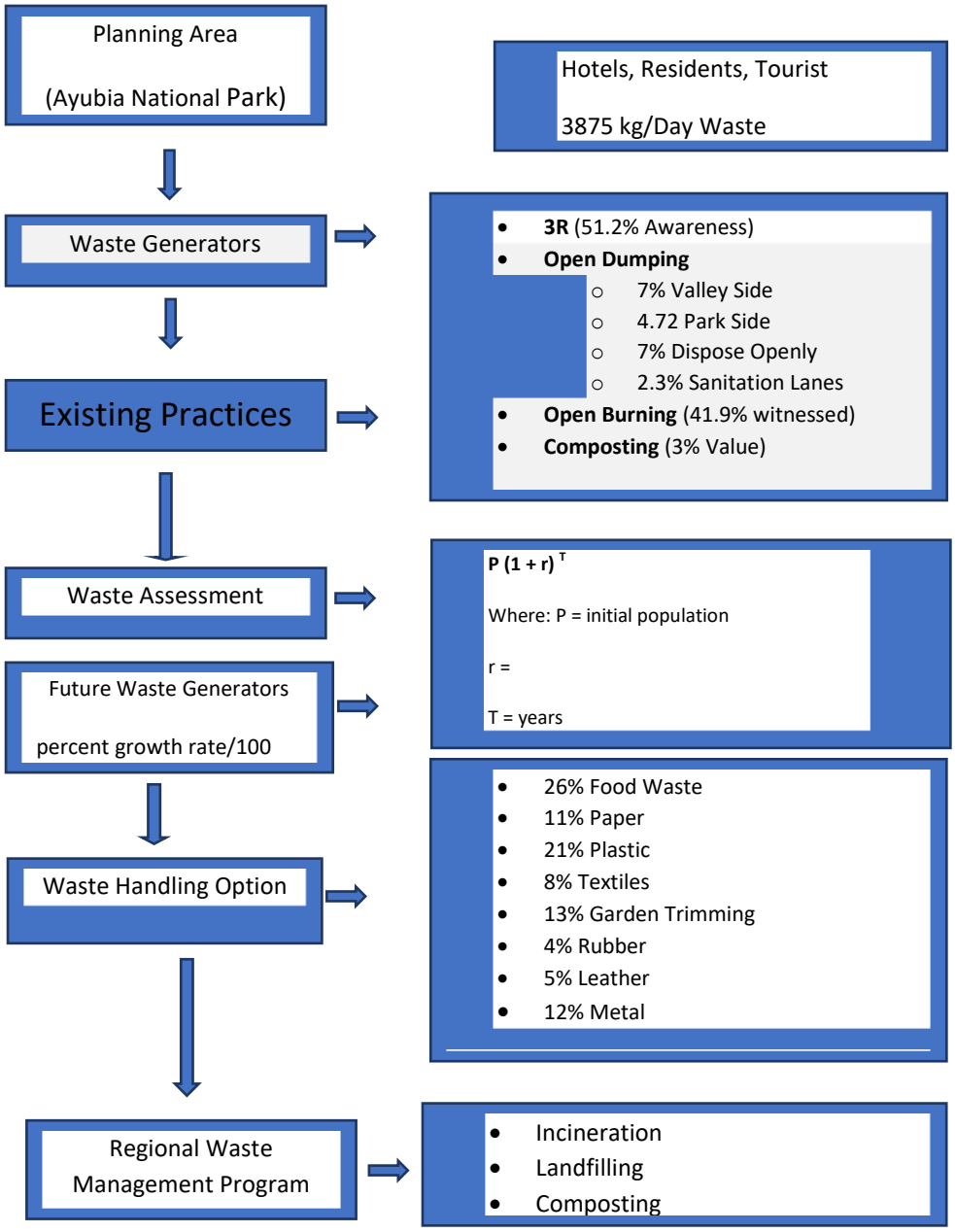
Where do you get rid of the trash you've collected?					
		Percent	**Frequency**	**Cumulative Percent**	**Valid Percent**
Valid	Public Bin	58.1	25	58.1	58.1
	By the valley side	4.7	2	62.8	4.7
	National Park Side	7.0	3	69.8	7.0
	Sanitation Lane	2.3	1	72.1	2.3
	in open area	7.0	3	79.1	7.0
	at a confined place in home	18.6	8	97.7	18.6
	Other	2.3	1	100.0	2.3
	Total	100.0	43		100.0

In response to questions concerning the types of waste generated at their locations, the respondents revealed that food waste accounted for 34.9% of the rubbish created, followed by plastic waste (32.6%), paper and cardboard waste (25.6%), fiber waste (7%), and other waste types. The data analyzed with the SPSS software is shown in the *table 18* below.

Table 1. *Nature of waste generated*

What type of waste is produced by you?					
		Percent	**Frequency**	**Cumulative Percent**	**Valid Percent**
Valid	paper & cardboard	25.6	11	5.6	25.62
	Plastics	32.6	14	58.1	32.6
	Food	34.9	15	93.0	34.9
	Fibers	7.0	3	100.0	7.0
	Total	100.0	43		100.0

Plan for Solid Waste Management



Conclusion and Recommendations

It is discovered that the main factors contributing to the production of solid waste in the ANP are tourists, accommodation facilities, restaurants, and residents, in addition to the poor and ineffective SWM system. To protect ANP from hazardous solid waste circumstances or concerns, solid waste management methods must be strictly adhered to, as per the study's conclusions. The proper implementation of rubbish disposal techniques and the enhancement of the park area's waste collection system are vital. The primary issue undermining the park's aesthetic appeal is the open dumping and trash.

It is advised that in order to reduce the amount of solid waste produced, public education regarding the proper disposal and littering of solid waste should take precedence. Wastes of all kinds, including hazardous and organic ones, need to be handled and processed correctly. Reducing, reusing, and recycling are also very beneficial and can be cost-effective for the area.

Conflict of Interest: None.

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