Application of solid waste assessment to the formulation of strategic solutions for solid waste management

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Introduction

It should be noted at the outset that despite the many efforts by government departments and non-governmental organizations to clean up Samoa, the problems of waste management keep coming up. That is because waste is an inevitable product of society[1]. Issues that are always at the fore when talking of waste management in Samoa could mirror those of developed countries. We will be best able to achieve intended outcomes and solutions when we consider these issues at the local level as it is there where the solutions could very well rest. The following are imminent solid waste management issues in Samoa:

- Indiscriminate disposal of wastes (solid and liquid) in places where they should not be directed.
- Poor municipal disposal mechanism due to lack of resources and low level of technology
- Lack of awareness and understanding
- Lack of data and information on specific types of waste
- Lack of systematic management systems.

Some positive effects have come out of departmental programmes in light of town cleaning services, municipal household solid waste collection, and awareness programmes. The continuation of initiatives to ensure all wastes are managed sustainably calls for integrated and more progressive actions.

The waste management hierarchy

In order to address these issues, waste management should take on a holistic approach. All stages and ingredients of Waste management must be integrated, and this can be achieved through a hierarchy of waste management options. These are as follows:

- Waste minimisation
- Waste reuse
- Materials recycling
- Energy recovery
- Incineration
- Landfilling

The first three stages are critical, and could prevent adverse environmental impacts of disposal options such as Incineration and landfilling. The more waste produced the more resources needed for disposal. It is equally critical to ensure the success of any activities undertaken to meet the requirements of the first three options, that public cooperation is secured. Waste minimization, Reuse, and Recycling need the support of the public and private sector in order to be successful.

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On the other hand, government should likewise fulfill its obligations within this hierarchy of waste management (despite the lack of resources). A draft policy is in its final stages of review and translation. This should be in force before the end of 2000 or by 2001 latest. The collection of data on wastes has been conducted. The level of awareness has also been assessed, and these findings we hope, will provide a good social and scientific basis upon which Samoa's national policies and strategies for addressing waste management problems, and are formulated.

When building an Integrated Solid Waste Management Strategy (ISWMS) for any defined area, it is essential as a first step to assess the current situation regarding solid waste. Like any problem that needs to be managed, one needs to know and understand what needs to be managed. Solid waste management is not different; it involves the management of different types of solid wastes. It also requires the management of people's behaviour, perceptions and attitudes towards solid wastes.

This paper intends to also contribute towards solving our country's solid waste management problems. Not in providing the solutions but in how to identify those solutions using the findings of a very commonly practiced methodology, the solid waste assessment process.

Solid waste management definitions

Defining solid waste management is possible through stating its main objectives such as to control, collect, process, utilise, and dispose of solid wastes in the most economical way consistent with the protection of public health and the wishes of those served by the solid waste management system[2]. But what is solid waste? Waste is an inevitable product of society[3].

Solid waste (sometimes called refuse) can be defined in general terms, as waste not transported through water, and has been rejected for further use. In the broadest of definitions, solid waste can include all discarded solid materials from municipal, industrial, and agricultural activities that have been rejected for further use. In many countries, solid waste is commonly referred to as municipal waste, so as to distinguish it from industrial, hazardous and special wastes. In more specific terms therefore, solid waste in its municipality sense refers to discarded materials and objects which originate from domestic, business and industrial sources, which are typically disposed of in landfills, but does not include industrial hazardous or special wastes.[4]

In Samoa, solid wastes are mainly non-hazardous materials from households and small businesses. Municipal solid waste in island states have several features that make them unique from municipal solid wastes found in larger industrialized nations. In Samoa, solid waste is mostly putrescibles such as food waste, combustible material such as textiles, paper and plastics, non-combustibles such as metals, glass etc. There are also bulky wastes such as old vehicles, gardening litter, construction debris, and old appliances.

Other types of solid waste that are not normally included within the municipal solid waste definition above, but is also being disposed of at the landfill is sewage sludge from septic tanks, waste water from treatment plants, and medical waste which requires special arrangement for their disposal.

Therefore when developing an ISWMS for Apia or Samoa, the scoping of the solid waste problem must follow along the defined types of solid wastes present. Just looking at the

situation in Apia, a most appropriate solid waste definition should refer to a mixture of locally available materials that include mainly paper, plastics, metals, textiles, rubber, glass, garden waste, food scraps, household hazardous wastes such a batteries, household cleaning chemicals, construction and demolition wastes.

Solid waste assessment technology

From general observation, either at home or school or workplace or public areas etc, one can conclude that solid waste in Samoa is what is said above. But when putting together an ISWMS, there is more that needs to be known than just the types of solid waste. Of course it is important to have information about waste but it is often more difficult to manage waste without reliable and up to date information on specific parameters of waste management. So what kind of information is needed?

There are three basic parameters that need to be known to understand the solid waste stream.

- Generation Rate or Total amount of waste (expressed as kg/p/day)
- Component Composition (expressed in %)
- Bulk Density. (expressed as kg/litre)

Other parameters such as chemical qualities and energy content are also important, but only in technological evaluations. Given the level of technology for solid waste disposal found in Samoa, these latter two parameters might not be relevant yet.

Data on these parameters can be obtained from weighing garbage trucks at the landfill then contents are randomly sorted. This is normally the case in developed countries. The quickest way of getting such information is applying a weight factor to a type of carriage loading solid waste to the landfill. This may be easy and inexpensive but currently used weight factors (which have been determined mainly for developed countries) may not be applicable to local conditions.

The same data can also be derived from analysis of solid waste at source, or assessment of garbage bags from selected sources that are picked at random. The assessment of solid waste at source is mostly used in small developing island states and would be the most appropriate for Samoa to date.

Solid waste assessment in Samoa

The first ever recorded attempt was back in 1992 by the World Health Organisation (WHO) and Department of lands Surveys and Environment (DLSE). Estimates were calculated from observations of daily truckloads and came up with 66m^3 /day or 11.6 tonnes / day. Three solid waste assessment surveys have been conducted. The findings are compared in Table 1.

It should be noted that because these figures are derived from samples taken during a specific period of the year, they are indicative only of the situation on average per annum.
The composition of solid waste in its primary classification is presented in Table.2.

How should solid waste assessment results be used in Samoa?

The application of results of solid waste assessment as a planning tool is based on the variety of uses it was designed to meet. In Samoa the uses include planning for general waste management, designing waste minimization programme, setting goals and objectives, measuring progress, and monitoring the impact of this programmes. Results of waste analysis of different areas or small island states can also be compared to determine if there is

uniformity of their solid waste situations in relation to the size of their metropolitan centres and economies. For each particular use the data is analysed and interpreted according to the information needs and purposes for which the assessment was conducted[5].

Year	Generation type	Bulk density	Sewage sludge
1994	0.52 kg/person/day	350 kg/1	-
1998	0.45 kg/person/day	-	-
1999	0.99 kg/person/day	144kg/1	17.9kg/day

Table 1: Solid waste in Samoa

Type of Waste	Composition		
	1994	1998*	1999
Paper	13	2	7
Plastic	8	18	8
Metals	14	40	7
Organic/Biodegradable	59	20	68
Glass	2	13	2
Textiles	3	3	5
Hazardous	<1	<1	1
Construction	-	-	-
Others	<1	4	2

Table 2: Solid waste composition in Samoa. *Data collected from solid waste in Faasaleleaga which is a rural area

Waste management

To understand and be able to effectively manage the waste stream in an area, it is crucial as a first step to have knowledge of the material composition of the solid waste stream[6]. The results of the 1999 household solid waste and sewage sludge assessments provide for the per capita generation rate per day, bulk density, composition of the household waste stream, and estimate of sewage sludge being disposed at the landfill. These are summarised in Table 3.

Indicator	Value
Average number of people in a household	7.6
Total population of Apia	36.120*
Total number of households in Apia	7.841
Bulk density of waste	0.143kg/litre
Waste generation rate per day (in Apia)	0.99kg/person/day
Household generation in one year (waste/household/year)	7.47kg/household/day
Amount of waste in Apia for one year:	2,726.6kg
Total volume	(13,051,962kg/143kg/m^3
Total volume of solid waste if compacted to half its volume	91,272.5m^3/year
Total volume of biodegradable refuse was composted (approx. 68%)	45,636m^3/year
If waste minimization and recycling programme are implemented to reduce remaining waste by at least 25%, the total refuse remaining for disposal would only be:	21,290m^3/year
Sewage sludge disposed in a day:	17.9kg
Total sewage sludge disposed at landfill at one year:	446.7kg

Table 3: Solid waste analysis and predictions. *Estimate from annual statistical abstract 1998. Department of Statistics, Government of Samoa.

A trend is noted when the results of this study are compared to previous work of this kind in Apia. There appears to have been an increase in the GR from 0.52kg/person/day as reported by Gangaya[7] to 0.99kg per person per day. The composition and bulk density also appear to have changed enormously as presented in Table 1. If the trend in generation rate continues into the future, then the management strategies would have to change its focus and direction to address the areas causing the increase. The waste composition will continue to be dominated by organic wastes if composting is not encouraged and practiced in an effective manner. Targeting the right components to be tackled first (such as green wastes) with composting will positively affect the composition of the household waste stream.

Waste management activities will therefore be able to be planned and structured in a way that this known amount of solid waste can be dealt with. As the data collated in the 1999 study concentrated on household wastes, its use should be collaborated with results from assessment of solid wastes from industrial and commercial sources. The amount of sewage sludge is now known from the estimate, which would be used in calculations from technology designed to address disposal needs for it.

Waste minimisation programmes

The identification of components of the waste stream that have the highest potential for reduction is possible through interpretation of the solid waste assessment results. This means that when waste minimisation programmes are limited for economic reasons, attention can then focus on just the priority component or sector of the waste stream that is economically viable. Knowledge about the composition and sources of solid wastes can also be used to define sectors of the community that waste reduction and awareness activities should target.

The results of the composition analysis show a very large component of organic and green wastes (68%) which can be used for design and prioritizing waste minimization and recycling programmes. Various scenarios can be applied that can reduce this large amount of organic wastes. For instance, the total volume of household waste estimated (refer Table 3) from the generation rate of 0.99 kg in a year is 91,272.5m^3. The need to dispose of that quantity of wastes would be avoided if all organic wastes (68%) were to be composted. This would reduce the total household waste volume to 21,290m^3 per year. De-watered sewage sludge can also be co-composted with the organics, reducing solid wastes even further. Composting could therefore be a priority activity to deal with organic wastes.

Goal setting and progress measurement

In particular the solid waste assessment provides data that can be used as baselines, against which goals of waste reduction programmes are measured. The data also creates opportunities for measuring and evaluating the effectiveness of the solid waste management strategy, policies and plans[8].

Use of data from a household waste assessment conducted for setting goals, and measuring progress, must acknowledge that the quantities and composition are only part of the total solid waste stream. Once waste assessments have been conducted for the remaining sectors, extrapolations to the population of Apia and the rest of Samoa would yield a measurable total volume and amount of waste that targets and goals can be set against. Targets could be set for a period of time whence by which the target should be achieved. For instance the ISWMS for Apia could set targets for solid waste reduction of perhaps 30% or 40% at a target rate of 10% per annum by the year 2004. One of the goals in addition to those addressing solid

wastes from other sources would be geared towards the reduction of the known household wastes (90638.6m^3) as appropriate to achieve the overall ISWMS targets.

Monitoring and comparisons

The state of the environment report for Samoa is to be updated every three years. Solid waste must be measured, recorded and assessed to present the state of the environment in relation to solid waste and its management.

The government may also consider regulating the amount of solid waste discharged by industries in the future. This data is not available from the studies conducted in Samoa to date, but once available will be able to be used as basis for monitoring the set levels of allowable solid waste volumes an amounts from industries. The measurable targets and goals that would be set for Apia's ISWMS, based on the annual amount of solid wastes from households, is checked by comparing to results of future bi-annual household assessments in Apia.

Solid waste assessment data from rural areas can be compared to results from surveys conducted in urban Apia. Any observed difference in generation rates and composition would indicate the need for a change in approach and scale of management options compatible to each setting. For instance the generation rate of household wastes in Apia in 1999 is 0.99kg per person per day, while for Faasaleleaga[9] which is a rural area has only 0.45 kg per person per day. While the amount may have increased in the period between the two studies, the differences are likely to remain significant. The waste composition data also show a marked difference in organic wastes dominant in Apia while metals are dominant in Faasaleleaga (refer Table 2).

Data on Samoa's solid waste can also be compared to data from neighbouring Pacific Island countries, or their total is averaged and used in designing regional goals and targets for solid waste reduction.

Designing strategic plans and actions

The first step in the development of the solid waste management strategy requires the preparation and distribution of information on solid and hazardous wastes. In the 1999 study sewage sludge is also included, as this is also disposed at the same landfill, hence would be addressed in the same landfill management plan. Issues and activities relating to these wastes within the Apia urban area should also be included. The results and findings of the waste quantity, and composition survey would be useful in this sense.

A strategy should have a vision and a goal. As mentioned earlier data and information from the waste assessment surveys enable the formulation of measurable indicators. Targets can be set on the basis of the baselines obtained, and proportions that would need to be addressed by the key principles of integrated solid waste management.

Integrated solid waste management systems tend to be developed with emphasis on source segregation, collection, composting, reuse, recycling and resource recovery as well as collection, transfer and disposal of solid wastes to landfill. Therefore, when planning for integrated management of solid wastes, information on the amount of waste and its composition at present as well as in the future is important.

Waste reduction and minimisation suggestions

Waste reduction activities are important to halt or slow down the increasing rate of waste generation per capita. Waste reduction has several aspects, all of which should be addressed. These include toxicity reduction and volume reduction as well as encouraging products that can be recycled more easily. For instance returnable glass beverage containers (52% of all glass wastes), green wastes (68%), PET plastics (19% of all plastics)[10]. There are many successful cases of reduction of wastes by individuals, commercial enterprises and agencies using their purchasing power, as well as governments and industries.

Waste reduction is therefore one of the most critical elements of a solid waste management strategy for Apia, and is a practical option for a Pacific Island country. That is because a large amount of waste types such as food wastes, green wastes, glass and metals are being reused locally. More of these kinds of wastes can be added or inserted into these practices to reduce the total solid waste further. Information from questionnaire surveys conducted in Apia indicated that a number of home-based recycling activities are taking place in Apia, and solid waste composition data has illustrated the impacts of these reduction activities[11]. There must be a major focus on waste reduction in Apia in the future.

Recycling and re-use options

There are two basic approaches to recycling. The first involves separating recyclable materials at source (by the waste generator) and separately collecting and transporting these materials to recycling markets. The second involves collecting mixed wastes and separating these at a central processing facility. The key factors in the success of pre-separation efforts are the cooperation and willingness of the waste generator to participate in the programme over the long term, and the additional collection and transport costs that may be required. Information on the willingness of the solid waste generators has been obtained and the majority of households could support a successful recycling and reuse programme. About 96% of respondents indicated their willingness to separate waste at home if there was a programme for it, and doing so together with separated collection and recycling. The successes of centralized recycling plants depend on the processing costs and the quality of the recyclable material produced[12].

A major recycling impediment in the Pacific Islands is the question of continued viability and availability of secondary materials market. The key points are:

- Recycling only occurs when the separated material is incorporated into a product that can be sold
- Separation of materials does not constitute recycling – markets must be found first.
- Recycled products must be of a quality and price that compete in the marketplace.
- The difference in cost of disposal and recycling must be examined – i.e. The price received for the recycled material, the waste collection and disposal costs avoided, the cost of separation, the costs of collection and processing the separated materials.

'The remoteness, relatively small size of the country and high degree of dispersion pose severe difficulty in transportation and market fragmentation. As a result, procurement of solid waste management tools, equipment, machinery, spare parts and even fuel is not only expensive but in many cases, very difficult to obtain. Very often the procurement encounters excessive delay. This situation also creates many constraints in waste recycling and often renders many alternatives not feasible'[13].

In Apia almost all consumer goods are imported to sustain people's daily needs. This generates an excessive amount of packaging waste, which because of the limited local

recycling market has very little possibility of being recycled except for aluminum cans and beverage bottles. Waste minimization measures such as recycling of package waste practicable in other parts of the world are not necessarily easily applicable in Pacific Island countries[14]. This could be possible however with the trade in wastes. For instance, aluminum cans (7% of metals) can be crushed and packed into blocks of metals, while waste paper such as corrugated card boards, magazines and newspapers which are 28% and 25% consecutively of the waste paper category, can be baled for export.

The transportation of recyclable goods is one of the highest costs and can be higher than the return on the commodity carried. The opportunity to backload recyclable goods should be investigated in detail. The significant imbalance of imports to exports in Samoa means that there are significant opportunities to utilize empty ships leaving Apia. Negotiation of appropriate shipping rates will also be critical to the viability of recycling in Apia.

Recycling appears to have potential, given the amount of household solid waste that has been reused, and the interest expressed in the questionnaire results. For instance recyclable paper and metals compositions have been reduced from 13% to 7% and 14% to 7% consecutively in the waste stream, while plastics and glass remain unchanged at 8% and 2% each between 1993 and 1999 (refer Table 2).

However recycling is likely to be marginally viable in economical terms and may need to be subsidised by the community, government or another body wishing to dramatically reduce the amounts of material entering the landfill. The involvement of Government, community and business support will be critical to the success of recycling. For instance the glass beverage container recycling system by the Vailima Breweries in Samoa get a 70% return of used bottles[15]. The government of Samoa could also look at the State of Chuuk in Micronesia where local charges were placed on certain goods that are recyclable such as beer cans to pay for the aluminum recycling trade[16]. Paper and plastic wastes can be recycled also through the introduction of this type of levy to pay for their handling and transfer for recycling. Recycling of some materials might be feasible in Apia or even through regional networks or operations.

Composting (option)

Due to the quantity of biodegradable waste being produced in Apia it would be very likely that composting will be recommended as a viable implementation as a major part of Apia's waste management strategy. Composting produces a valuable product that can minimize the need to import expensive fertilizers. Composting is a well-known technique and there are numerous proven operations around the world.

The issues that need to be carefully considered before implementing a composting scheme in Apia are:

- · Whether it should be composting at community level or household level?
- ·Where the initial funding will be sourced?
- · What is the economic value of the product – can it be sold?
- · Private scheme or government operated scheme?

According to information gathered on awareness and understanding of composting, despite being practiced for years, locals are not very familiar with the modernized composting technologies, hence could run the risk of creating nuisances and vermin with home based

compost heaps that are not managed properly. This raises the need for more awareness and education for composting at the household level.

Composting at the national level or as a private commercial operation could find a large amount (79%) of biodegradable or organic materials that can be used. Hence the main material input into such an operation appears plentiful. However other factors that contributes equally to the success of such operation must also be understood and acknowledged.

Assuming a community or municipal scheme, there is at least 7000 tonnes per annum of organic matter available in Apia based on the current household waste generation figures. If a proposed commercial composting operation is able to capture 80% of that amount is captured for composting, with an average compression ratio of 20 to 1 from loose green matter to finished product then there is approximately 2,300 cubic meters per annum of compost as product available. It should be noted however that the value of the compost product in Apia would have to be determined.

Sewage sludge which has been determined also from this study, and can be added to this amount for co-composting. The chemical characteristics of the sludge should be determined first however for impurities that could affect the quality of the final product.

A system for collection and transfer of wastes

Data on the evaluation of the collection service could provide guidance as to the number of contractors needed to efficiently carry out the service, and how the service should be provided. The waste collection system in Apia is generally unsuccessful in terms of providing for the efficient, effective and economic removal of waste from source to point of disposal. This is proven by the information gathered in the questionnaire surveys where more respondents (40%) rated the service unsatisfactory compared to those (30%) that thought it was satisfactory. So how can it be improved? Findings of the same survey point to a number of options, which should be considered in light of current practice in neighboring or similar counties and cultures. These included improved training for the rubbish collectors, and strengthened monitoring of the collection contract by the DLSE.

The domestic collection system has not been fully privatized in Apia and the benefits of privatization have not been achieved. It is also provided free of charge.

Incineration and combustion

Incineration / combustion processes use the controlled combustion of solid waste for the purposes of reducing its volume. The advantages are destruction of hazardous waste, reduction of volume by up to 90%, and the possibility of energy recovery. In Denmark, Switzerland and Luxembourg over 75% of the municipal waste stream is treated by combustion with energy recovery. In Sweden it is over 60%, France 43% and USA 17%. Japan uses waste combustion to treat over 75% of the waste remaining after recycling.

The disadvantages of incineration are high capital expense, complex technology, complex operations, air emissions and management of ash residues. Incineration in Apia has not been very successful to date, as the management systems for dealing with hazardous waste are not adequate.

For a small island state, incineration is viable on a small scale for the disposal of hazardous wastes, if appropriate management systems are put in place. Detailed planning is needed prior to selecting a system, with investigations into waste composition, potential users, funding and operations and maintenance of the incinerator. Given the available data on the total amount of solid waste generated from households, there may be too little to warrant the commissioning of a large-scale incinerator. The composition indicates also that most (91% which is all types except metals and glass) is combustible. However, organic wastes would have be better off being composted which leaves just 23%. Paper, plastic, dewatered sewage sludge, textiles, woods and timber can be incinerated but for state of the art incineration technologies, packaging waste is the most preferred[17]. Even when the paper and plastic packaging are added together it will total to less than 20% of the total waste. Hence alternative fuel substitutes may be needed, which also have to be imported.

Implementation of composting and other recycling activities would mean that the total waste might even be less, eliminating the need for such expensive technology. Prioritising should therefore take place to decide whether to compost or incinerate. The first option seems to be supported by the quantity and composition assessment results, as well as responses from the public.

Sanitary landfills

The disposal of waste to landfills continues to be the predominant method used worldwide. The 1990 International Solid Waste Association report indicated that the percentage of waste disposed of by landfills ranged from 20% to over 90% for 15 countries tat were examined[18].

Landfilling of waste without adequate controls as occurs in Apia can result in serious public health and safety problems and severe adverse environmental impacts[19]. Modern sanitary landfills are equipped with leachate collection systems, liner systems, systems for control of landfill gas, groundwater monitoring, closure and post-closure care plans. The objective is to ensure that the landfilling activities are performed in a manner that greatly reduces the chance of release of contaminants to the environment and that any release is quickly detected and corrected. These need to be incorporated into the operation and management plan of Apia's landfill. Negotiations are continuing with the government of Japan to secure financial assistance towards the development of the landfill.

The amount of sewage sludge available for disposal has also been determined (17.9kg per day and 446 kg in a year), and all of it is currently dumped into unlined settlement ponds at the Tafaigata landfill[20]. Designing of alternative treatment facilities would require the total sewage for disposal, while co-composting technology would need its biological and chemical characteristics. This latter kind of information would require specialized scientific assessment methods. Their analysis and application is unfortunately beyond the scope of this research.

The solid waste generation rates for industries and commercial establishments must also be determined. This was not possible through the solid waste assessment methodology employed for this research due to reasons mentioned earlier. Nevertheless, applying the estimate for total household wastes and its bulk density, the life span and operational requirements for landfill operation can be determined. This disposal options to be investigated and recommended for the strategy would also consider the types of waste needing disposal and their sources.

Public awareness and education

The data and information collected is firstly a statement of justification for the development of legislation and regulations. Secondly it would provide a baseline for measuring the effectiveness of the legal instruments pertaining to waste management. For instance, a mechanism for waste reduction is to examine the imports to a country and identify which materials will lead to significant quantities of wastes. Action by the Government to reduce the imports that create wastes, through legislation or tariffs could be part of the waste management strategy. This type of intervention may not be appropriate due to the following reasons:

- Reluctance to interfere with consumer choice
- Contravention of World Trade Organisation agreements
- Restricted sources of imported goods.

In Samoa the use of legislation or tariffs to influence the purchasing and distribution policies for imported goods is a waste management option that should be considered further. The introduction of the Beverage Container Deposit Act in American Samoa is an excellent example of the government using its legislative power to have a positive effect on solid waste management in a small island nation. Samoa has had taxes and now import duties on all imported drinks in cans, plastic and glass containers, where a portion of the duty is reimbursed if the importer re-exports the containers.

Information gathered from responses to the questionnaire survey, indicate a great urgency for legislative control over littering, and uncontrolled disposal of wastes. Options for the form in which these can be implemented have also been provided in the summation of responses as to the kinds of solutions for the solid waste problems in Samoa.

Government can also have influence on the success of waste minimisation schemes through tax structures. The exemption of taxes for the export of recyclable materials from Samoa or other tax incentives should be considered as part of the waste management strategy.

Public awareness and education

Information derived from the questionnaire on awareness issues provide insight into peoples' understanding of the issues that need to be addressed, and also their perception of what good waste management is. The level of awareness and public knowledge of waste management issues and safe disposal methods indicates the need for wider public awareness. For instance 28% of respondents either do not know or gave the wrong interpretation of what recycling is. Although more than half understood recycling and reuse, more than a quarter do not.

Programs targeted for unaware age groups can use the information from the survey to define its audiences. The same applies for designing the approach to deliver educational and public awareness programmes, where those considered useful by the respondents can be used. For instance it appeared that half (50%) of respondents saw or heard information on waste management through the media (TV, radio or newspaper). The rest varied between 2% and 14%, which showed that the media could be a very useful medium for imparting information to the public. The most common message or type of information heard or seen pertained to public notices and TV spots (64%) such as clean up campaigns, solid waste collection and disposal, litter control announcements that did not provide as much detail as those presented at workshops and seminars. Only 5 respondents attended such a seminar or workshop and it was apparent from their responses that their understanding of the waste management services and issues were high.

There appeared to be a reasonable proportion (24%) of respondents who do not understand industries and their processes, as they did not think industries generate solid wastes. The same number of respondents also had problems identifying the types of waste generated by industries. Therefore education and awareness information should include information on industrial wastes. Traditional methods of dealing with wastes would also help, and this can only be understood through consultation with the people. Traditional methods of dealing with wastes would also help, and this can only be understood through consultation with the people.

Conclusion

Knowledge of the sources, quantity and composition of Samoa's solid waste stream will allow realistic and achievable goals and targets to be set. Solid waste assessment surveys are important both for the planning of a national waste management strategy and policies, the facilities and services, as well as monitoring their impact and effectiveness.

Complimenting questionnaire surveys would provide insight into the public's understanding and awareness as well as perceptions and preferences for management systems that are compatible to their socio-cultural, economic and physical environment.

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