The University of the South Pacific

Pacific Centre for Environment and Sustainable Development

Solid waste management and recycling in The Fiji Islands

Preliminary analysis of the situation in the Western region of Fiji and the handling of some difficult solid waste.

<u>Final report</u>
to

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EXECUTIVE SUMMARY

PURPOSE AND SCOPE OF THE STUDY

The major theme of this study is the management of solid waste in the Fiji Islands, a Small Island Developing State situated in the South Pacific region. In this study, the "management of solid waste (SW)" is approached with a holistic perspective: it not only refers to the collection and the disposal of SW in municipal councils, but it also deals with some necessary preventative strategies like SW prevention, re-use, recycling and recovery.

The Consulting Team approaches the study with two main focuses:

- A region-specific focus: current and foreseen practices in SW management in the Western region of Viti Levu, the main island of the Fiji Islands, are reported and analysed;
- A product-specific focus: the emerging problems caused by Waste Electric and Electronic Equipment (WEEE) in Fiji are assessed and analysed.

The ultimate objective of this study is to assist JICA and the Fiji Government in the identification of some future actions and further studies in the field of SW management in the country.

METHODS

Different methods have been adopted for both approaches.

Management of solid waste in the Western region of Viti Levu

For the first approach, a survey of the practices in six urban areas, in recycling industries and in some resorts was carried out during a one-week field trip in the Western region of Viti Levu. Data was collected through face-to-face interviews on the basis of a questionnaire specially developed for this purpose. Data collected includes facts (e.g. quantity and composition of SW) and subjective information (i.e. points of view of stakeholders on the limitation of the recycling activity). Some inspections of relevant sites (e.g. SW collection sites, rubbish dumps, recycling plants, resorts) were also carried out.

This collection of data was followed by a compilation and a homogenisation of data. Information was organised and prioritised so that recommendations could logically be formulated.

Production and management of Waste Electric and Electronic Equipment in Fiji

After a literature review of the WEEE issue in other countries, a consultation of the major stakeholders (i.e. Fiji Customs, retailers, institutional users, individual users, recyclers) was carried out. The consultation was carried out through face-to-face and telephone interviews on the basis of some questionnaires specifically developed.

Little collected information directly concerned WEEE, so information collected on EEE had to be treated. Also, as data was coming from different sources, it had to be compared and consolidated. On the basis of this data, some conclusions on the current end-of-life treatment practices of WEEE in Fiji were drawn. The collected data were then fed into a model to predict the quantities of WEEE that should arise in Fiji in the near future.

Obtained results were then compared to similar data available in other countries. On this basis, conclusions on the importance of the WEEE problem in Fiji and recommendations for better WEEE management were derived.

All questionnaires used to collect data included aspects extracted from the literature and requirements of JICA and the Fiji Department of Environment. The Consulting Team has produced several drafts of the report and the final report includes JICA comments and requirements.

REPORT

A general Introduction places SW management in the Fiji context, recalls the objectives of the study and gives an overview of the structure of the report.

Part I underlines the importance of better management of SW in Small Island Developing States (SIDS), SIDS of the Pacific region and in Fiji. In particular, the legislation concerning SW management in Fiji is reviewed and analysed.

Part II summarises the data collected in the Western region of Viti Levu concerning the SW collection and disposal in six urban areas, the activity of some recyclers and current practices of some large SW producers, the resorts. Some recommendations to improve the SW management in the Western region are formulated.

Part III concentrates on the problem of Waste Electric and Electronic Equipment (WEEE) in Fiji. In particular, it assesses the current and future generation rates of this type of waste and it attempts to understand the current end-of-life practices of some WEEE producers. Some recommendations aimed at better management of WEEE in Fiji in the future are finally given.

Some Concluding remarks briefly summarise the findings of the study and attempt to organise the main recommendations according to a possible time frame and their levels of preventativeness.

In the Appendix, 18 sections give additional information.

FINDINGS

The importance of better solid waste management in Fiji

It is widely recognised that SW management is a “critical issue” for SIDS and that the associated problems are currently drastically increasing. Worldwide in SIDS, there is a change of paradigm as stakeholders are currently switching from “dealing with waste” to “managing solid waste”.

In Fiji, despite the current structuring of better SW in the capital city Suva, SW is still poorly managed in the rest of the country.

Analysis of the legislative framework in Fiji shows that regulations are either clearly outdated or little enforced.

Management of solid waste in the Western region of Viti Levu

SW collection in six urban areas

Collection of SW is always contracted to local private firms. The trucks used for the collection vary widely and range from open trucks, to simple compactor trucks and to modern compactor trucks. The tax systems associated with SW collection and disposal vary between towns, cities and rural local authorities.

Data concerning quantity and composition of SW collected by municipalities are available for most of the municipalities from previous studies. After compiling this data, the study shows that this data has to be handled with care as procedures used vary widely.

For most of the municipalities, SW is collected only in urban areas. Uncontrolled dumping of SW in rural areas poses serious problems to human health and the environment. Therefore, the generalisation of the collection and disposal of SW from all the population is one of the most important challenges in the Western region.

SW disposal in six urban areas

SW collected from the six surveyed urban areas is disposed in five rubbish dumps. Depending on the location, the environmental impacts, the nuisance impacts and the management practices, the performances of these dumps can be rated from poor to very poor.

Backyard, roadside, coastal/river dumping and open fire burning are frequently observed in most of the surveyed municipalities.

SW minimisation in six urban areas

All municipalities understand that they have to embark voluntarily in Reduce / Re-use / Recycle activities, involving the main products / materials producers, SW producers (e.g. the population, industry, resorts) and the population. They should in particular develop some innovative composting schemes for green waste.

Main obstacles faced by municipalities towards improved practices

Municipalities acknowledge facing serious problems in trying to improve SW management, especially in trying to improve SW collection and disposal. These problems are, in order of importance: investment costs; costs of operation (in particular logistics cost and landfill proper management practices costs); legislative framework (enforcement of legislation); education; personnel constraints. The difficulty of finding a site available for a regional landfill seems also important.

If a regional landfill is to be constructed, municipalities differ in their views on the best way to manage it: some prefer a joint venture between municipalities, others prefer a joint venture involving municipalities and a foreign company.

The role of recyclers

A so-called “recyclable collection” activity exists in the Western region of Viti Levu: valuable materials (in particular non ferrous metals) are primarily collected from industries and a few individuals; other materials (ferrous metals, papers, plastics) are also collected but have less obvious economical viability. The recyclable

collectors do add little value on the collected materials by dismantling and manually sorting, and then do export them overseas for recycling. Only one recycler surveyed in the Western region transforms scrap metals into final products to be used by the industry.

Some beverage producers lead a take-back initiative of their beverage packaging (glass and PET bottles). However, those systems achieve mixed performances.

Although all recyclable collectors and recyclers foresee that they should have an important role to play in collecting recyclable waste from industries and individuals, the activity is still facing a lack of support of the main SW producers: in the near future, collectors and recyclers will need to be supported for them to promote their activity. Among other possible initiatives, subsidisation of activities (e.g. ferrous metals clean-up operations) should be considered in order to facilitate their development.

Practices of some important producers: the resorts

Great variation of practices in terms of SW management can be observed among the resorts surveyed. Resorts' practices range from good (the problem is being tackled, including some minimisation and recycling actions), average (SW is mainly sent to the public dump) to poor (SW is mainly either sent to the public dump or dumped on site). Interviews of other persons show that such a situation is usually observed in all tourist regions of Fiji. Remoteness of the islands is not always a limiting factor of appropriate management of SW; knowledge and know-how of resorts' management appears to be more crucial.

The survey shows also that SW management is a rising problem for the tourism industry and that improved practices in resorts could have some positive impacts on the SW management in surrounding communities.

Production and management of Waste Electric and Electronic Equipment in Fiji

Why focusing on Difficult Solid Waste? Why WEEE?

It is widely recognised that SIDS, considering their limited size and their remoteness, have limited capacity to deal with Difficult Solid Waste (DSW). Among DSW, Waste Electric and Electronic Equipment (WEEE) is of growing concern worldwide because of the potential hazards and the considerable increase in quantity to be handled. Consequently, worldwide, policies concerning WEEE are being developed and specific recycling systems are being set-up.

The impact of WEEE on the Fiji environment has not been clearly demonstrated. However, studies have shown evidence of increasing heavy metals concentrations from SW disposal facilities and it seems very likely that WEEE has contributed to it. The scarcity of final disposal sites in Fiji and the increase in use of Electric and Electronic Equipment in Fiji are such that the WEEE issue needs to be appropriately addressed.

WEEE generation rates and end-of-life practices of several users

A survey of three class of households in Suva shows that the higher the class, the greater the production of EEE. Also, the survey points out the existence of some "re-use loops" where obsolete equipment coming from a household can be re-used by a household with lower income. WEEE not given or sold for re-use is usually disposed.

A survey of six large organisations in Fiji shows that the quantity of WEEE produced is proportional to the number of users. However, a great disparity in the generation rate of WEEE per user can be observed among the organisations, as some

of them are still under-equipped. It can therefore be foreseen that the WEEE generation rate should drastically increase in these organisations in the next 10 to 15 years. Currently, WEEE is either sold to employees, given to schools, recycled internally, given to recyclable collectors or disposed.

Data communicated by the Fiji Customs and by some EEE retailers is fed as input of a recognised model to predict the quantity of WEEE to be produced in Fiji until 2020. Despite low consistency between input data, this approach gives some good insights of the range of importance of the production of WEEE in the future. The quantity of WEEE produced in Fiji is currently relatively low compared to other developed countries. However, it seems to be increasing at a higher pace. WEEE produced in Fiji make available an increasing quantity of recyclable materials like ferrous, non-ferrous and precious metals. Also, some increasing quantity of toxic and polluting substances (e.g. brominated plastics, batteries, lead-containing glass) is being generated from WEEE and needs to be handled properly.

CONCLUSIONS

SW management in the Western region of Viti Levu

The management of SW in the Western region of Viti Levu is still very poor and needs to be upgraded in the very near future. Considering that municipalities have very limited capacities to manage SW and that there is limited space available for landfill sites, any future plans will have to involve all stakeholders and will have to include some waste minimisation measures.

Management of WEEE in Fiji

Despite Electric and Electronic Equipment encompass quite new items in Fiji, it already seems to pose some threats to human health and the environment in the country. As a Small Island Developing State, Fiji does not yet have the full capacity to deal with WEEE. For these reasons, some innovative approaches (e.g. producer/importer responsibility, design for recyclability of products), which are being promoted in developed countries and regions like Japan and Europe, need to be transferred and adapted to the Fiji context.

RECOMMENDATIONS

SW management in the Western region of Viti Levu

A holistic approach to SW management needs to be developed for the management of SW in the Western region of Viti Levu and all stakeholders (government, municipalities, recyclers, industries, population, resorts) need to be involved.

The improvement of the SW disposal facilities and the generalisation of SW collection to the whole population are necessary measures that need to be taken in priority. Such actions imply further studies, policy-oriented and technical actions but also capacity-building in the municipalities and awareness-building among the population.

Also, some supporting measures, mainly aiming at developing a more preventative approach to SW management (i.e. reduction, re-use, recycling and recovery of SW), need to be initiated at the same time. Such measures imply some further studies, policy-oriented actions, training and awareness-building among the

population and large SW producers. Some pilot projects aiming at capacity-building on some specific and innovative aspects (e.g. composting, clean-up operations for ferrous metals, collection scheme for some packaging) should also be initiated.

Management of WEEE in Fiji

Product-specific approaches to SW management are currently being developed worldwide. They are still emerging and unfortunately no well-recognised process is already available. Therefore, the Consulting Team suggests a “road map” towards better management of WEEE. This road map should include WEEE-specific policy, further studies, pilot projects (e.g. take-back operations), awareness-building among EEE users (concerning end-of-life good practices, but also good environmental performances of products) and training of recyclers.

Articulating a regional approach and a product-specific approach

The Consulting Team believes that a regional approach to SW management is necessary and that it should be articulated with product-specific approaches: this should involve governmental bodies, the population, large producers, recyclers and, importantly, producers/importers of products that will eventually become waste in better SW management. This should develop into efficient integrated systems where each stakeholder assumes its part of responsibility.

LIST OF ABBREVIATIONS AND ACRONYMS

CC	City Council
DoE	Department of Environment
DoT	Department of Tourism
DSW	Difficult Solid Waste
EEE	Electric and Electronic Equipment
EGM	Emperor Gold Mining
EU	European Union
FIRCA	Fiji Island Revenue and Customs Authority
IAS	Institute of Applied Science
IT	Information Technology
JICA	Japan International Cooperation Agency
NGO	Non Governmental Organization
PC	Personal Computer
PET	Poly(ethylene terephthalate)
PACE-SD	Pacific Centre for Environment and Sustainable Development
RLA	Rural Local Authority
SIDS	Small Island Developing States
SPREP	South Pacific Regional Environment Programme
SW	Solid Waste
SWM	Solid Waste Management
TC	Town Council
UNEP	United Nations Environment Programme
USP	The University of the South Pacific
WEEE	Waste Electric and Electronic Equipment

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INTRODUCTION

BACKGROUND

Proper, appropriate and efficient practices for Solid Waste (SW) management are necessary for Small Island Developing States (SIDS) in the Pacific in order for them not to become "wasted islands" [1]. Rapid urbanisation and changing consumption patterns, limited land areas and vulnerable ecosystems add to the complexity of SW management and impose considerable burden on environmental (e.g. pollution), economic (e.g. management costs) and social (e.g. public health) aspects of island life.

Results from various national studies on SW show that the generation rate of solid waste is currently drastically increasing in the Pacific. Also, studies show that its composition is currently evolving quickly: there is indeed a shift in the solid waste stream from predominantly organic–based to more SW originating from imported and non-indigenous products [2]. It is foreseeable that better practices would have positive effects on the countries' environment, health, economy and employment [1, 3, 4].

In Fiji, as it is the most developed country of the region, waste disposal is a "burning" issue: waste disposal in the capital city, Suva and the surrounding towns is currently being reorganised through the Naboro landfill project. However, in the Western region of Fiji (Sigatoka, Nadi, Lautoka, Ba, Tavua and Rakiraki area), the waste collection and disposal system is still rudimentary and plans are in the pipeline to set up a regional landfill.

Considering the limited space available in landfills in the country, but also considering the loss of resources and of economic value associated with waste landfilling, it is necessary to focus not only on final disposal but also to promote more preventative approaches. In particular, waste recycling / recovery and waste minimisation should be encouraged in the country. Worldwide, especially in developed regions like European countries and Japan, due to failure of traditional approaches, there is a trend in adopting thematic strategies based on the prevention and recycling of waste (see e.g. [5]), that include producer-specific, region-specific and product-specific approaches. Similar and appropriate approaches need to be developed in Fiji.

This study is a holistic approach on solid waste management in Fiji. For this purpose, the study has been split into two main parts:

- A region-specific approach, that focuses on SW collection and disposal, the recycling industry and the production of SW by some important producers in the Western region of Viti Levu,
- A product specific approach, that focuses on the problems associated with the production of some Difficult Solid Waste (DSW) in Fiji, namely Waste Electric and Electronic Equipment.

OBJECTIVES OF THE STUDY

The present study is a preliminary analysis of SW management in the Western region of Viti Levu, Fiji, and on some DSW in Fiji. It aims at gathering relevant information on SW and DSW and drawing up some possible future studies or projects that could be carried out in these areas.

The particular aims of this study are:

For the management of waste in the Western region of Fiji:

- To gather information on the current collection and disposal of SW practices in the region, in six urban areas and some rural areas of the Western region of Viti Levu; this include some technical, economical and institutional information on the current practices and on trends;
- To identify current initiatives concerning SW recycling and recovery; current practices, trends and limiting factors of the recycling activity in the region are established;
- To survey the practices of some tourist accommodation places, ranging from up market to backpackers resorts, and those with different geographical conditions;
- To suggest further studies and actions to improve the management of SW in the Western region of Viti Levu on the basis of the above results.

For the management of Waste Electric and Electronic Equipment in Fiji:

- To gather and analyse data on the current and future production of WEEE in Fiji,
- To gather data on the current treatment of this type of waste,
- To suggest further studies and actions to improve the management of these DSW on the basis of the above results.

STRUCTURE OF THE REPORT

The present report summarises the methodologies used and the findings of the study. It is organised as follows:

- Part I presents the context of SW management in the Fiji Islands; it includes:
    - A review of SW management in SIDS, in Pacific SIDS and in Fiji;
    - A review of the legislative framework concerning SW management in Fiji.
- Part II focuses on a holistic approach of SW management in the Western region of Viti Levu; in particular, it concerns:
    - SW collection and disposal organised by municipal councils in 6 urban areas;
    - The activity of the recycling industry;
    - The management of SW in some resorts.
- Part III focuses on the emerging problem associated to the management of Waste Electric and Electronic Equipment; the following are in particular analysed:
    - The consumption and end-of-life practices of EEE by institutional and individual users,
    - The activity of producers and retailers,
    - The activity of recyclers.
- Some concluding remarks are given.

The structure of the report is summarised in Fig.1.

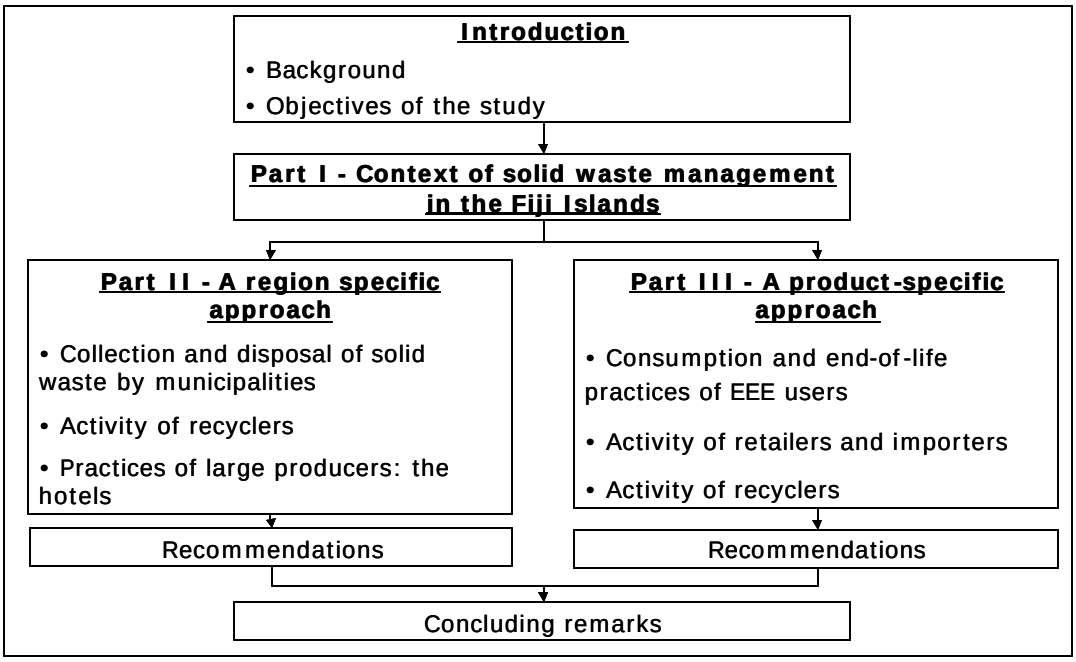

Figure 1. Schematic diagram of the organisation of the report.

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PART I

CONTEXT OF SOLID WASTE MANAGEMENT IN THE FIJI ISLANDS

I. INTRODUCTION

This part aims at reviewing the context of the management of solid waste in the Fiji Islands in order to prepare the foundation for the next two parts of the report.

The second section of this part is a literature review of problems, current practices and trends associated with solid waste management in Small Island Developing States (SIDS), in Pacific SIDS and in Fiji.

The third section aims at reviewing the legislation that governs solid waste management in Fiji.

II. MANAGEMENT OF SOLID WASTE IN SIDS, IN SIDS OF THE PACIFIC REGION, IN FIJI

II.1. Waste management in SIDS

II.1.1. Waste management and sustainable development of SIDS

The management of solid waste is recognised as “a critical issue for Small Island Developing States” [1]. The waste problem is increasing in SIDS due to [2, 3]:

- Increasing urbanisation,
- Increasing volume of waste,
- Changes of composition of waste (linked to changing consumption patterns), with more post-consumer products and hazardous waste,
- Increasing costs of technology,
- Limited land area for landfilling.

The need for more actions on Waste Management in SIDS has recently been reiterated in the so-called Nassau Declaration as most countries “have serious difficulties in terms of financial and technical capacity” [4].

II.1.2. Current practices

In many countries, a change of paradigm is being observed: all stakeholders are now switching from “dealing with garbage” to “managing solid waste” [3, 5]. This usually implies large increase in the costs of managing waste due to administration, collection and landfill management [6].

The first step adopted by countries for better waste management strategies usually aims at improving waste disposal by closing unofficial dumps and upgrading some into sanitary landfill [6].

II.1.3. Future trends

However, many argue that efforts should not only focus on palliative solutions and that solid waste should instead be seen as a possible resource [1, 3, 7]. This should include:

- Technological measures, with the development of demonstrative projects and appropriate technology for waste management and recycling,
- Financial measures, for example:
    - Developing efficient incentives (including subsidisation) and disincentives to promote the reduction, reuse and recycling of solid waste [5],
    - Developing and implementing mechanisms for generating sustainable funding for waste management [8],
    - Introducing levies on specific imported goods that could become a waste problem at the end-of-life [6].

II.2. Waste management in SIDS of the Pacific region

SIDS in the Pacific region have the same problems as all SIDS in terms of waste management. A number of initiatives in the region are currently ongoing and mainly aim at improving final disposal capacities. The following ongoing or future projects can be cited:

- The Asia Development Bank funded construction of a sanitary landfill in South Tarawa, Kiribati,
- The Australia-funded construction of a sanitary landfill in Nuku'alofa, Tonga,
- The European Union funded construction of a sanitary landfill for the Great Suva area in Fiji,
- The Japan-funded project aiming at upgrade the existing open dump to an acceptable level of sanitary landfill in Samoa [9],
- The Japanese assistance for a regional waste management strategy [10].

More integrated approaches focusing not only on final disposal, but also on reducing, re-using and recycling solid waste should however be developed [7]

II.3. Waste management in the Fiji Islands

Through the EU-funded Naboro landfill for the Great Suva area, the Fiji Islands will face tremendous change in solid waste management in the next few years. The management of solid waste in the capital city could include legislative and institutional changes, the involvement of foreign companies for the management of the landfill and some recycling initiatives. The approach is currently being developed by the Ministry of Local Government, Housing, Squatter Settlement & Environment.

In order to homogenise practices of solid waste management in the country, the Fiji Department of Environment is also currently promoting the concept for a regional landfill in the Western region of Viti Levu, as discussed in Part II.

III. REVIEW OF THE LEGISLATIVE FRAMEWORK CONCERNING SOLID WASTE IN THE FIJI ISLANDS

III.1. Introduction

This part aims at summarising the legislation that concerns solid waste management and disposal in the Fiji Islands. This legislation mainly comprises the Public Health Act, the Litter Decree and the future Sustainable Development Bill.

III.2. Public Health Act

The Public Health (Sanitary Services) Regulations [11] dates from 1944 and covers the responsibilities, powers, methods and penalties associated to the collection and the disposal of solid waste ("garbage") in Fiji. Its subsidiary legislation (or "by-laws") [12] covers the implementation of these regulations in each local authority of the country.

III.2.1. Administration and responsibilities

The local authority is in charge of implementing and enforcing the regulations.

It undertakes itself or sub-contract the removal, collection and disposal of garbage from houses and premises within its district.

It also collects and manages the fee charged to the owner of any house, building or other premises for garbage removal and disposal. This fee should not exceed F$24 per annum.

III.2.2. Method of collection and disposal

The garbage should be disposed of by incineration, controlled dumping or any other method approved by the Central Board of Health.

The garbage should be kept in standardised garbage pans (standards in size and shape) and should be collected at least twice a week.

No person other than an authorised officer of the local authority shall deposit garbage unless this person has written permission from the local authority.

III.2.3. Obstruction, offence and penalty

Any person committing a breach of the Regulations shall be subjected to conviction or a fine not exceeding F$10.

III.2.4. Limitation of the Public Health Act

According to most of the municipal councils, these 1944 Regulations need to be updated. In particular, the fact that only the owners of the premises (and not all the actual users of the service) are charged, this policy should be corrected. Also, there is no differentiation of the fees for households and commercial users. The amount of money charged for the penalty is too low to discourage any offender. These Regulations are also quite difficult to enforce at the local level, for example, for the use of standardised pans.

These regulations aim mainly at the prevention of solid-waste related health problems and still corresponds to the "dealing with garbage" paradigm. They do

incorporate very limited environmental aspects, e.g. method of disposal or reduce / re-use / recycle objectives.

III.3. The Litter Decree

The Litter Decree covers prevention, powers, procedures and penalties associated to the deposits and abandonment of any dangerous, offensive or conventional litter in Fiji.

III.3.1. Administration and responsibilities

Local authorities may appoint litter prevention officers to enforce the legislation.

III.3.2. Penalties

Penalties applied to offences under the Litter Decree are summarised in Table I.1.

Table I.1. Summary of penalties on offences to the litter decree.

Type of litter	Dangerous litter	Litter or offensive litter
Individual	6 month imprisonment or F$1000 fine	F$400
Corporate body	F$2000	F$1000

III.3.3. Limitation of the Litter Decree

Again, the enforcement of this legislation by local authority is difficult mainly because of lack of manpower. Therefore, litter is often seen in Fiji, as shown later on in Part II.

III.4. Future legislation: the Sustainable Development Bill

The future Sustainable Development Bill that is still under discussion should include some aspects on waste management, especially for commercial and industrial facilities.

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PART II

MANAGEMENT OF SOLID WASTE IN THE WESTERN REGION OF VITI LEVU, FIJI

I. INTRODUCTION: THE NEED FOR A HOLISTIC APPROACH FOR SOLID WASTE MANAGEMENT IN THE WESTERN REGION OF VITI LEVU

In the Western region of Fiji, the collection and disposal system of solid waste is still rudimentary and has some impacts on the environment, on public health and could hinder the development of tourism. It is time to develop some ambitious SW management plans that not only improve collection and disposal of SW but also encourage the development of more preventative approaches supported by all stakeholders.

For this review of current and foreseeable practices of SW management in the region, a holistic approach is adopted and practices from municipalities, recyclers and resorts are reported and analysed. The list and contacts of persons consulted for the study and who agreed to be cited is given in Appendix II.10.

Fig.II.1 presents a summary of the Part II of the report.

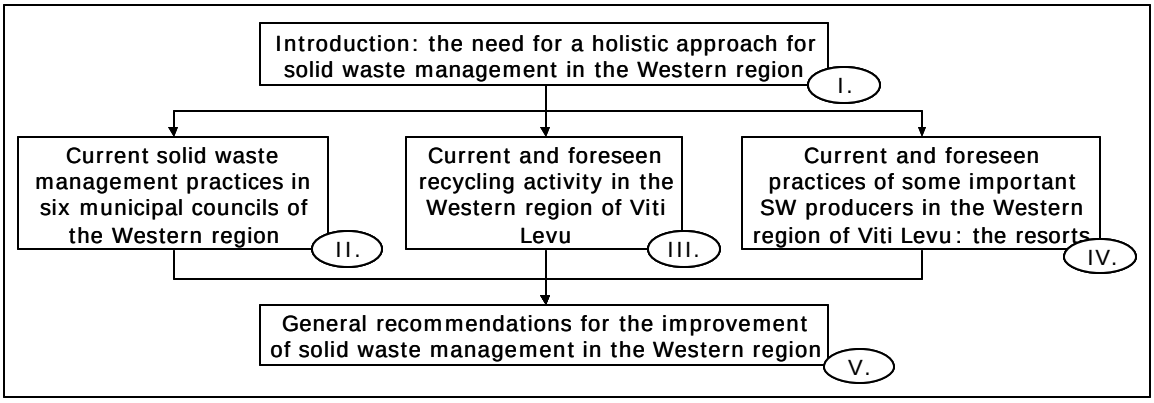


Figure II.1. Summary and organisation of the Part II of the report.

II. CURRENT SOLID WASTE MANAGEMENT PRACTICES IN SIX URBAN AREAS OF THE WESTERN REGION OF VITI LEVU

II.1. Objectives of the study

The aim of this study is to acquire knowledge on the current management of solid waste (mainly collection and disposal, but also waste minimisation and recycling) in six urban areas of the Western region of Viti Levu and to find out their perception of future plans for better management (i.e. mainly a regional landfill). The 6 surveyed municipal councils are Ba Town Council (TC), Lautoka City Council (CC), Nadi TC, Rakiraki Rural Local Authority (RLA), Sigatoka TC and Tavua TC. For the geographical location of these municipalities in Viti Levu refer to Fig.II.2.

Figure II.2. Geographical location of the 6 surveyed municipalities in the Western region of Viti Levu

This information should be a basis for further studies and actions.

II.2. Methodology of the study

Data collection was done through expert interviews with relevant Municipal Officers, contracted SW collection firms and the completion of a questionnaire (Appendix II.1). The questionnaire was prepared according to the format used in [1, 2] and supplemented with requirements from DoE and JICA. Visual inspection of the current rubbish dumps, urban and hinterland were also conducted. The questionnaire has been used as a basis for discussion and was organised according to four main areas:

- Waste collection and handling,

- Current disposal practices,
- Practices on waste minimisation and recycling,
- Towards improved practices of waste management.

Given the heterogeneous nature of the data collected (some figures were collected in tonnes, some in m^3, some in number of loads, etc.), the data has been homogenised to ensure comparability.

In this part, all relevant data collected is reported. As schematised in Fig.II.3, the data is organised as follows:

- Information common to all municipal councils on SW collection and disposal (Part III.3),
- Information on SW collection and disposal specific to each council (Part III.4 to III.9),
- Summary of actions concerning waste minimisation and recycling in municipalities (Part III.10),
- Views of municipal councils concerning improved practices (Part III.11).

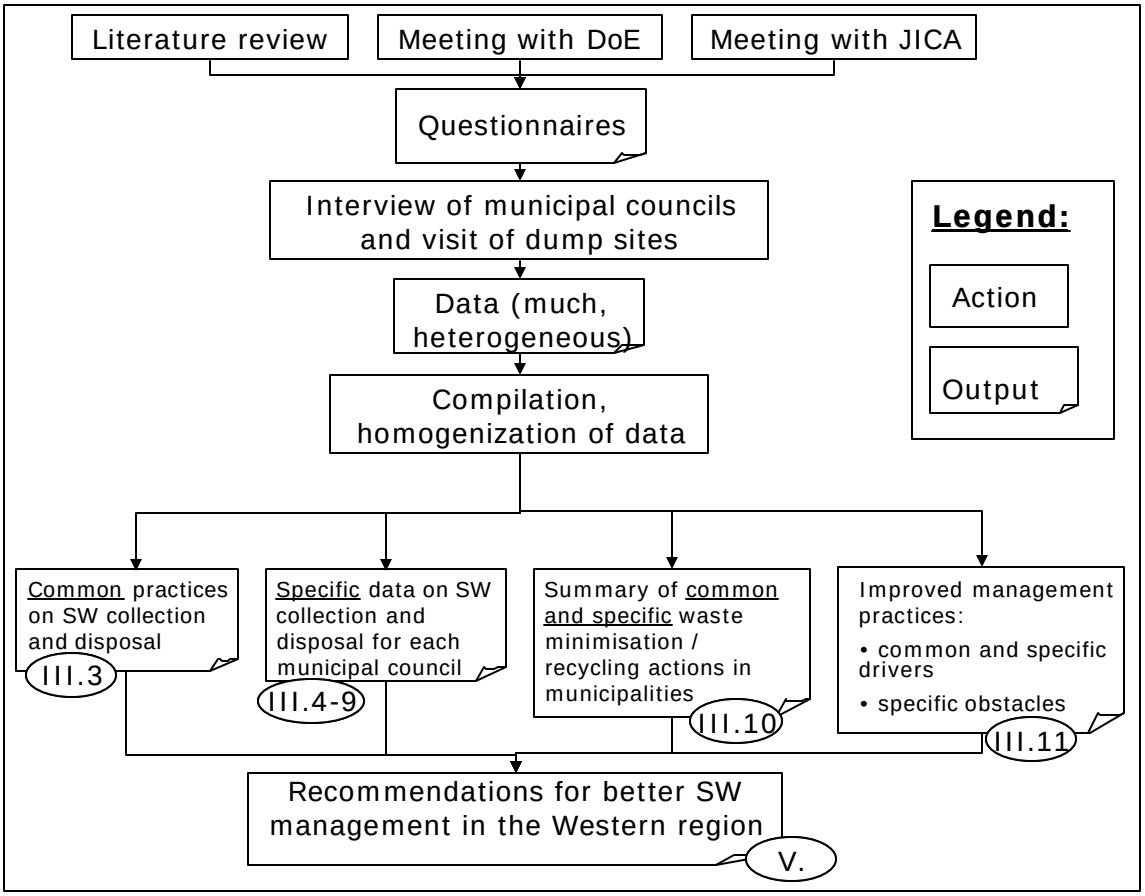


Figure II.3. Schematic representation of the methodology adopted for the study on solid waste management practices in urban areas of the Western region.

II.3. Issues common to all municipalities in solid waste collection and disposal

Practices of SW collection and disposal in each of the municipalities are summarised in Tables II.2 and II.5.

II.3.1. Common issues in solid waste collection systems

Organisation

In all the Municipalities, SW collection and disposal is contracted to private firms. The private firms use grill-fitted lorries, simple compactor trucks or modern compactor trucks (cf. Fig. II.4(a-c))

(a)

(b)

(c)

Figure II.4. Photographs of trucks used for the collection of SW in the Western region - (a) grill-fitted lorry in Rakiraki ; (b) simple compactor truck in Ba; (c) compactor truck in Lautoka.

Tax system collection

The collection of taxes associated to solid waste collection and disposal differs between cities/towns and rural local authorities.

In cities and towns, the tax is included in the General Rate collected from ratepayers and there is no visible line for solid waste management. Rural local authorities collect a special tax of F$24 per annum from the owner of any premises covered by the service. Only Lautoka City Council charges separately for the collection of green waste.

The tax systems in place in each city / town and rural authority are summarised in Table II.1.

Table II.1. Summary of the tax system for solid waste collection and disposal.

Municipality	Garbage collection and disposal	Bulk waste collection and disposal
Ba TC	Included in general rate	
Lautoka	Included in general rate	Charged to household
Nadi	Included in general rate	
Ra RLA	Local tax	
Sigatoka	Included in general rate	
Tavua TC	Included in general rate	

Solid waste generation rates

The data collected from our visits has been processed in order to turn it into homogeneous (in terms of unit) data for comparison. Original type of data collected from municipal councils and table of conversion of this data can be found in Appendix II.2.

Solid waste characterisation

Except Tavua TC, all municipalities have carried out waste characterisation analysis of their waste. For Lautoka CC and Nadi TC, it was done in 1999 by a foreign consultant [3]. For Ra RLA, Sigatoka TC and Ba TC, it was done by the municipalities, respectively in September 2003, October 2003 and March 2004.

The procedures followed for these characterisations vary much between the municipalities and none of them comply fully with the requirements given by the DoE in [4]. The procedures followed are summarised in Table II.3.

The compilation of the composition of SW (given in Table II.4) shows high heterogeneity and it is very difficult to draw conclusions on variations between councils. This might be linked to the different procedures used for the analysis. Therefore, data should be handled with care.

Urban and rural areas

In most of the municipalities, SW is only collected in urban areas.

Due to problems with land leases in the Western Region of Viti Levu, the population in rural and peri-urban areas around the municipalities of Ba, Lautoka, Nadi and Tavua is growing strongly. As SW is not collected in these areas, SW poses a serious problem for public health.

Use of rubbish bins

In all the municipalities, it was pointed out that few people use standard garbage bins (in terms of cylindrical shape, size and tight fitting) and plastic bags are very often collected. Only Lautoka CC gives very attractive prices for standard rubbish bins.

Table II.2. Summary of data on solid waste collection in municipalities of the Western Region.

Town - City - Rural Local Authority	Population covered	Quantity collected (in tons per year) [share of SW; share of bulk waste]	Share of		Average collection of SW (in kg/pers/day)	Number of truck used in the collection [capacity]	Number of workers	Frequency of collection [days]	Cost of the collection (in F$ per year)
			Domestic	Com-mercial					
Ba TC	16000	1,053 [75.4% SW; 24.6% bulk]	90%[1]	10%	0.18	1 simple compactor truck [4 ton] + 1 grilled lorry [2.5 ton]	7	3 times a week [Mo, We, Fr]	39000
Lautoka CC	45000	11,201 [79.6% SW; 20.4% bulk]	67%[1]	33%	0.68	3 compactor trucks [4 ton]	9	2 times a week	100,000
Nadi TC	20000	From 2,730 to 4,420 [from 53.1 to 64.7% SW; from 46.8 to 35.3% bulk]	80%[1]	20%	Between 0.37 and 0.61	2 compactor trucks [3 ton]	7	3 times a week	175,800 (127,800 SW; 48,000 for bulk)
Ra RLA	3255	1,188	80%[1]	20%	1.00	1 grilled lorry [15m^3]	2	2 times a week [Mo & Th]	8,400
Sigatoka TC	3500	1,872	52%[2]	48%	1.46	1 lorry truck + 1 compactor truck	6	6 times a week	33,500
Tavua TC	5000	933 [78.1% SW; 21.9% bulk]	80%[1]	20%	0.51	1 grilled lorry [20m^3]	4	3 times a week [Mo, We, Fr]	21,800 (16,800 SW; 5,000 bulk)

[1]: "expert" estimate by TC or CC staff;

[2]: calculation made using the number of bins.

Table II.3. Procedures followed to carry out solid waste characterisation in the municipalities of the Western Region.

Municipalities	Number of days	Number of premises	Volume of sample	Sampling at household	Sampling at truck	Type of waste	
						Household & commercial	Bulk
Ba TC	2	NR	3tons		✓	✓	✓
Lautoka CC & Nadi TC	4	NR	1-2m3		✓	✓	
Ra RLA	7	30	NR	✓		✓	
Sigatoka TC	4	NR	220kg		✓	✓	
Tavua TC	NA						

NA: not available; NR: Not relevant

II.3.2. Common issues in solid waste disposal practices

Locations of rubbish dumps

Location and cadastral maps of the rubbish dumps are presented in Appendix II.11.

Management practices

All rubbish dumps are managed with different procedures. The practices observed on each rubbish dump are summarised in Table II.5.

Assessment of the practices at the rubbish dump

Given the varied management regimes of each rubbish dump, the consulting team felt that an assessment of the performances of the five rubbish dumps would be useful. This assessment is based on a methodology that we suggested from the recommendations of [5]. The methodology and the results of this assessment are described in Appendix II.3. In Figure II.5, some views of rubbish dumps in the Western Region are shown.

Organisation and tariffs at the rubbish dump

Management types and tariffs systems vary for all rubbish dumps. Table II.6 offers a summary of their management and tariffs.

Unofficial dumping

The hinterland of the urban centres do not have any SW collection and disposal system in place and from discussions held with the municipal authorities, hinterland dwellers also use the rubbish dumps, although they do not contribute financially to the operations of the dumps. It was observed during the field visits (cf. Appendix II.4) that backyard, roadside, coastal/river dumping and open fire burning of SW were common in the Western Region. This could stem from the poor SW collection system and lack of awareness and goodwill on the part of those people concerned.

Table II.4. Summary of the waste classification results in municipalities of the Western region.

Primary waste classification	Secondary waste classification	Ba - Average weight percentage (%)		Lautoka & Nadi – Average weight percentage (%)	Sigatoka - Average weight percentage (%)			Rakiraki - Average weight percentage (%)
		Domestic	Bulk		Domestic	Commercial	Mixed	
Paper	Cardboard boxes	3.9	2.4	3.5	11.6	26.4	3.2	10
	Other (magazine, newspaper, office, packaging)	3.6		10.1			8.4	
	Sanitary			1.1			1	
Plastic	PET bottles	12	0.4	1.1	15.4	12.0	0.4	11
	Rigid HDPE			0.4			0.2	
	Flexible HDPE and other plastics			6.6			5.8	
Glass		1.8		2.7	4.3	4.6	2.3	1
Metals	Aluminium cans	3.4		0.3	5.4	5.8	0.3	3
	Other metals			2.9			2.2	
Biodegradable		70.5	97.2	67.8	57.2	37.2	73	13
Textiles		2.8		3.0	2.6	9.9	2.9	61
Potentially hazardous				0.2	0.7	1.0	0.2	
Construction & demolition waste				0.0	2.4	1.4	0.1	
Other		2		0.2	0.3	1.7	0.1	1
Total		100%	100%	100%	100%	100%	100%	
Source		[6]		[3]	Adapted from [7]			[8]

Table II.5. Summary of data and observed practices on waste disposal in the Western Region.

Rubbish dump name (Users)	Size (ha)	In operation since	Geographical situation	Number of workers	SW Compaction	Cover of waste [frequency]	Control of site access and use	Controlled burning of SW	Control of fire dissemination	Monitoring and record keeping	H&S training of staff	SW segregation	Machinery on the site	Scavengers [number]	Remaining life of the site (years)	Quantity of waste tipped (in t/year) [other users]
Mauruu (Ba TC)	3.2	1979	Hilly area in pine forest – surrounded by sugar cane plantations	1	×	(✓) [Once every 6 month]	×	×	×	(✓) (only 3 days a week)	✓	✓	(✓) (contracted when needed)	✓ [5-10]	NA	2,305 [commercial industrial facilities]
Naria (RA RLA)	0.4	1968	Mangrove area – Close to the road and to a school	2	×	(✓) [Once every 2 years]	✓	✓	×	×	×	×	×	×	25 to 30[1]	NA [Nananu-I-Ra hotels and residences]
Sandunes (Sigatoka TC)	0.4	1959	On a sandy area – beside Queen's Road and Sigatoka Sandunes – close to an commercial facility	1	×	×	(✓) (Gate but no fence)	✓	×	×	✓	×	×	✓	NA	NA [contracted companies (villages, industries), hotels, individuals]
Takoloa (Tavua TC)	8	Since 1997	Former open cutmine - Rocky area – Clay filters at the bottom	1	×	✓ [every week]	✓	×	×	✓	✓	×	✓	×	3 to 5[1]	5,934 [EGM households; EGM mining; commercial / industrial facilities]

Vunato (Lautoka CC, Nadi TC)	11	Since 1968	Mangrove area in urban boundaries – surrounded by settlements and industrial plants	2	×	✓ [once a month]	(✓) [Gate but no fence]	(✓) (only some paper)	✓	✓	✓	✓	✓	✓ [60]	20[1]	32,000 [Waste collectors, industries, individuals]

✓: yes;

(✓) partly;

×: no;

NA: not available;

[1]: "expert" estimate by TC or CC staff.

(a)

(b)

(c)

(d)

Figure II.5. General views of rubbish dumps of the Western region – (a) Maururu rubbish dump, Ba; (b) Naria rubbish dump, Ra; (c) Sandunes rubbish dump, Sigatoka; (d) Vunato Rubbish dump, Lautoka.

Table II.6. Summary of organisation and of tariffs applied at several rubbish dumps.

Dump (Users)	Type of SW	Managed by Town Council (TC) or contracted company (CC)	Tariffs	
			Inside town boundary	Outside town boundaries
EGM (Tavua TC)	All	CC	F$5280/year	NR[1]
Mauru (Ba TC)	Household	TC	Free of charge	NR
	Trade / Commercial		F$22.50/load (common trucks) F$44/load (big trucks)	
Vunato (Lautoka CC, Nadi TC)	Household	TC	F$3.30/load	F$5.50/load
	Trade / commercial		F$5.50/load	F$7.70/load
	Condemn food		F$16.50/load	F$22.00/load
	Hazardous		F$22.00/load	F$27.50/load
	William & Gosling		F$45.00/load	
Naria (Ra RLA)	Household	TC	Free of charge	F$40/year/user
Sigatoka	All	TC	Free of charge	

[1] NR: not relevant

II.4. Solid waste collection and disposal in Ba Town

II.4.1. Solid waste collection system

Area covered

The Ba Province has a population of 69,000, where only 16,000 urban residents are serviced through the SW collection system. It is very likely that the SW collection system will have to cater for 1,000 more people as a consequence of the extension of Ba town boundaries. The rest of the population have their small dumpsites within their locality and may also contribute to the illegal dumping evident on the roadsides, coastal areas and rivers. However, it is also worth noting that even in the urban centre, there is evidence of illegal dumping. Apart from the municipal SW collection system, two private companies (Waste Care Ltd. & Waste Management Ltd.) also collect SW from commercial and industrial facilities.

Collection machinery

A local contracted company carries out the collection using a simple compactor truck of around 4 tons capacity. A new tender has been recently called for the collection of SW in the next few years.

General remark on SW collection

Ba TC has pointed out that the amount of revenue generated is low and that it is hard to maintain the quality of the SW collection service. This issue is becoming more and more important considering that, the growth rate of the population of both urban and rural area in Ba is high, according to Ba TC.

II.4.2. Solid waste disposal

The rubbish dump

Ba rubbish dump is called Maururu. It is situated on a hilly area in a pine forest 7 km away from the town centre, outside the urban boundaries. Sugar cane plantations and farms surround the landfill. It has been used since 1979 but has been officially leased since 1984. It has recently been reverted to Native Land.

SW disposed at the dump

SW collected from Ba town is tipped at the dump. Moreover, SW from local commercial and industrial facilities is brought to Maururu landfill. This is charged F$44 per truck.

An analysis of the records for 2003 showed that around 1,309 tons of SW from Ba TC and around 996 tons of SW from other commercial facilities were disposed at the dump. However, it is quite likely that the quantity of SW from commercial and industrial facilities disposed at the dump may be higher (as much as two times the figure above, according to Ba TC) because access to the dump is not controlled on those days and times the municipal worker is not onsite.

Management of the dump

A worker from Ba TC is located at the landfill site three days a week (Monday, Wednesday, Friday) and, during his presence, he controls access and records the input of SW. When he is not at the landfill, anyone can use the rubbish dump free of charge, as the site is not locked.

No machinery is available on the site. Some machinery (bulldozer, excavator) is brought to the site when needed.

SW from the town is not segregated at the landfill site. However, there are some special locations for SW from industries and for end-of-life cars.

5 to 10 scavengers visit the dump daily. It was not possible to interview them. However, according to Ba TC staff, they are unemployed people who extract value from the landfill for their families' survival.

General remark on SW disposal

A former landfill site used before Maururu is situated in Ba. It was not possible to locate it.

In the future, access to the dump will need to be controlled, with a fence, gate and full-time onsite officer. The latter will depend on funding.

II.5. Solid waste collection and disposal in Lautoka City

II.5.1. Solid waste collection system

Area covered

The SW collection is organised for 45,000 people in the urban area. Large commercial and industrial premises, contract other waste collectors for the collection of their SW.

There is almost no collection for the 10,000 people living in the Rural Local Authority around Lautoka: the waste is only collected from households situated on the boundaries of Lautoka CC. In rural areas, SW is either buried in backyards, or burnt or dumped along the road, the river or in the ocean.

A collection of bulk waste is also organised and charged to the households.

Collection machinery

The collection is done by a local contracted company using 3 compactor trucks. The trucks were bought on the second-hand market in Japan.

SW collected: quantity and composition

According to the data collected, the quantity of SW collected in Lautoka CC boundaries reached 11,202 tons per year, corresponding to an average collection rate of 0.68kg/hab/day. This is much below the figure given in [3]. However, the latter figure included SW collected from industries.

II.5.2. Solid waste disposal

The rubbish dump

Vunato rubbish dump is situated on reclaimed land on a mangrove area inside the city boundaries. The landfill site is surrounded by some settlements and industrial plants. The land is the property of the government managed under license by Lautoka CC.

SW disposed at the dump

The dump serves Lautoka CC, Nadi TC, commercial and industrial facilities and individuals in the vicinity of the dump. Also, SW collected in other areas (e.g. Mamanucas group) by waste collectors is tipped at Vunato dump.

The use of the rubbish dump by users other than the City Council generates around F$96,000 per year.

Management of the dump

The landfill is managed by Lautoka CC and has an annual operating budget of F$100,000. The dump is sub-divided into sections that are separated by water canals. The canals serve as a safety measure against fire. A bulldozer and excavator are available on site. The entrance to the landfill has a gate, but it does not have a perimeter fence and many scavengers were observed in the landfill. From the SW data obtained in February 2004 and contingent data extrapolation, it is estimated that about 32,000 tons of SW is disposed at the landfill every year.

SW is partly segregated when tipped: there is a special area for green waste, for dangerous waste (e.g. broken glass, etc) and for end-of-life vehicles. Some commercial papers (from banks, Fiji Telecom, etc.) are burnt at the landfill on a specific location.

Interviews with some scavengers present on the site revealed that some of them stay on the site from 6am until 6pm six days a week and collect PET bottles distributed by Coca-Cola Amatil (Coca-cola, Sprite, Fiji Water, etc.). Then, they sell the bottles to Coca-Cola Amatil and are able to earn up to F$25 per day. This represents more than 900 1000cl bottles collected per day. Some other scavengers collecting PET bottles on an irregular basis earn up to F$40 a week. They also collect some scrap metal.

Some of the scavengers, mainly women, collect on the site waste textiles produced by the garment industry. They bring it home and are able to sew mats that can be sold in the city. The scavengers did not seem to be concerned about the poor health and safety conditions of their activity.

General remark on SW disposal

According to Lautoka CC, the current rubbish dump, when closed, could be rehabilitated into a recreation area.

II.6. Solid waste collection and disposal in Nadi Town

II.6.1. Solid waste collection system

Area covered

Around 20,000 people are covered by the collection of SW managed by Nadi TC: this population includes 15,000 people living in the urban area and an estimated 5,000 people living in the hinterland who daily bring their SW into the town boundaries.

The population living around Nadi is estimated to 60,000 people. Apart from the estimated 5,000 people bringing their SW to Nadi, these people are not covered by any collection of SW.

Big commercial and industrial facilities are responsible for the collection of their SW and contract private collectors.

Waste Management Ltd. provides free of charge litterbins in Nadi's hinterland.

Collection machinery

Two compactor trucks of 3 tons capacity each do the collection.

SW collected: quantity and composition

The quantity of SW collected in Nadi urban area may vary between 1,770 tons/year (figure estimated by Lautoka City Council at the gate of the landfill site) and 2,860 tons/year (figure communicated by the contractor).

Nadi TC also organises free picking of green waste from household once every three month. 300 loads are collected every three months. This represents a weight of around 1,560 tons/year.

The composition of SW collected in Lautoka CC and Nadi TC established in [3] are presented in Table II.4.

General remark on SW collection

Nadi TC wishes to impose tax payments on users of the service that do not pay any fee, for example, people living in flats located in a block where only one ratepayer is identified.

II.6.2. Solid waste disposal

SW collected in Nadi TC is sent to Vunato Rubbish dump in Lautoka. Each compactor truck usually goes twice a day to the dump.

The green waste collected in Nadi is sent to a farm where t is used for land reclamation.

One rubbish dump situated outside the boundaries of Nadi TC was in use until 1991. Since then, it has been covered by soil and vegetation. Another dump (Wailoaloa Beach) situated inside Nadi TC boundaries was also used before to dump mainly green waste. Many small dumping sites can be found in regions where solid waste collection does not occur.

Nadi TC explored 23 sites in the last 12 years to establish its own landfill site [9] without success so far due to major obstacles, in particular: the availability of land, the security measures around the airport and more importantly the cost of purchasing land.

II.7. Solid waste collection and disposal in Ra Rural Area

For urban area, valuable information was extracted from Mr. Penioni Matadigo's report.

Mr. Penioni Matadigo is an Assistant Health Inspector at the Ra Rural Local Authority (Ra RLA), and as part of his studies at the Fiji School of Medicine [8], he investigated and did a project on SW management in the urban area of Ra RLA in 2003.

II.7.1. Solid waste collection system

Area covered

The Health Office organises the collection and the disposal of SW in the urban area of Ra RLA, more particularly in places called "Rakiraki", "Colasi", "Vaileka", "Katudrau" and "Penang". SW from residential, commercial and industrial premises is collected. Only a few supermarkets make their own arrangements and send their own SW to the Ba rubbish dump.

No collection of solid waste is provided to other settlements or villages in the Province. Outside the urban area, it is suspected that SW is either tipped in pits in backyards or is dumped along roads, rivers or in the ocean. Therefore, roadside, ocean and river dumping are seen very often in the Province.

Collection machinery

The collection is done by a local contractor using an open and grilled lorry, which has a capacity of about 15m^3. It is old and, according to Ra RLA, needs maintenance.

SW collected: quantity and composition

The data on quantity and composition of the SW collected was extracted from Mr. Matadigo's study. According to the study, 1,188 tons of SW are collected each year, which corresponds to a rate of 1kg collected per person and per day. This rate is very high. This can probably be explained by the fact that the characterisation study was carried out on a limited number of premises (30) that actually were not representative of the socio-economic reality of Rakiraki urban areas: it included 22 households, 3 commercial/industrial facilities and 2 government facilities. Also, the composition of the SW presented in Table II.4 shows a high share of textiles that probably come from garment industry premises.

II.7.2. Solid waste disposal

The rubbish dump

SW collected in Ra RLA is sent at the Naria rubbish dump. The site is situated on a mangrove area 5 km away from Rakiraki town centre. The site is owned and managed by Ra RLA.

SW disposed at the dump

It is believed that up to 80% of the textiles collected with the waste stream is usually extracted by the collector and do not reach the rubbish dump. The off-cut textiles are used by individuals to sew mats, these are then sold in the market. Subsequent adjustments, followed by relevant calculations, revealed that the quantity of SW collected in the urban area and actually reaching the dump (quantity collected – textiles extracted for re-use) should be around 561 tons.

Through a Memorandum of Understanding between the Ra RLA and the users of the Ellington wharf, the Naria landfill also receives the waste produced by hotels and private residences situated on the island of Nananu-I-Ra. This service is provided

against the payment of a levy of F$40 per year per user. Today, around 4 hotels (one upmarket hotel and 3 backpacker-type hotels) and around 30 private residences use this service.

Management of the dump

At Naria rubbish dump, SW is tipped, burnt under supervision and covered sometimes. The covering of waste with clay soil is only done when funding is available. It is usually done once every two years.

Since mid 2002, thanks to a government funding, the Naria disposal site has undergone important changes and management practices have improved. In particular, a fence and gate have been installed to prevent the unofficial use of the dump and scavengers from entering.

II.8. Solid waste collection and disposal in Sigatoka Town

II.8.1. Solid waste collection system

Area covered

SW collection is only carried out in Sigatoka town area, which has a population of 3,500 people. Domestic, commercial and bulk waste are mixed.

No collection of SW is organised for other people living in Sigatoka Province, that has a total population of 50,000. The Province is an important tourism area in Fiji. Most of the tourism establishments have their own SW collection system.

Collection machinery

The collection is done using one compactor truck and one lorry.

SW collected: quantity and composition

An analysis of the quantity and of the composition of SW collected in Sigatoka was carried out in 2003 by the Town Council [7]. The data was supplemented by those obtained by the consulting team from a private SW collection contractor.

There seem to be some anomalies in the information concerning the quantity of SW collected: the generation rate (around 1.46kg/pers of SW is collected every day) is indeed very high. Also, the results of the characterisation study sent to the Department of Environment are unclear (they correspond to commercial, household and mixed SW). Unfortunately, very limited additional information was obtained from Sigatoka TC for the refinement of these figures.

Other structured studies would probably be needed to obtain more accurate data on quantity and composition of SW collected by Sigatoka TC.

II.8.2. Solid waste disposal

The rubbish dump

The SW is sent to the Sandunes rubbish dump that is situated outside the town boundaries, beside the Queen's Road and the Sigatoka Sand Dunes, 7km away from Sigatoka town. It is situated close to a commercial facility. The dump is managed by the Town Council. The landfill site is owned by the government and is leased on a temporary basis to Sigatoka TC.

SW disposed at the dump

The landfill is used by companies collecting waste in villages, hotels, industries and individuals to dispose their SW. No fee is charged for its use.

Management of the dump

Due to the rising number of complaints about smoke in the neighbourhood and on the road, Sigatoka TC did some upgrading work at the landfill early 2004. Thanks to a new sandy road, the SW is now preferably tipped and burnt far away from the road (cf. Fig. II.5(c)).

General remark on SW disposal

Sigatoka TC is now thinking about closing the Sandunes dump and opening its own small rubbish dump. The new dump would be located in a hilly place called "Volevole", situated 6 km away from Sigatoka towards Lautoka, and 3km away from the highway. Sigatoka TC plan a budget of F$750,000 for two years including F$50,000 to acquire the land, F$600,000 to develop the dump and F$100,000 for the first year of operation.

Sigatoka TC is suggesting transporting the SW stored at the Sandunes dump to the future landfill. The Sandunes area would then be reclaimed.

II.9. Solid waste collection and disposal in Tavua Town

II.9.1. Solid waste collection system

Area covered

Tavua TC is in charge of the collection of SW produced by the 5,000 people living in the urban area. Commercial premises usually contract a local company for the collection of their SW (especially cardboards). Moreover, Emperor Gold Mining Co Ltd (EGM) organises the collection of SW for the 10,000 people living in their compound in Vatukoula.

However, no collection is organised for the 22,000 people living in villages and settlements of the Rural Local Authority around Tavua. Tavua being a local centre of activity for daily needs, many rural dwellers bring daily their SW to Tavua town. However, it is known that SW produced in rural villages and the Tavua hinterland is buried in pits, dumped in open areas, along the roadside and into the coastal area and rivers.

Due to increasing demand from ratepayers, it is foreseen that the collection could be increased to six times per week in the near future. This would greatly increase the costs associated with the SW collection.

Collection machinery

SW is collected in a grilled lorry with a capacity of around 20m^3.

SW collected: quantity and composition

Tavua TC was only able to communicate data on the volume of collected SW: the weekly collection of waste in Tavua Town Council (Tavua TC) reaches 60m^3. Basing our calculation on the ratio established in Appendix II.2, the estimate quantity of SW collected is 728 tons/year.

Moreover, once every two month, a bulk waste collection is organised and 200m^3 are collected. It adds around 204 tons of waste to the collection.

No study on the composition of SW was so far produced by Tavua TC.

II.9.2. Solid waste disposal

The rubbish dump

SW is tipped at the Tokoloa rubbish dump situated on EGM's industrial park. This landfill site is a 8ha former open cutmine site. The site is mainly rocky but the bottom of the site has been filled-in with clay filters. A local contracted company manages the site.

Tavua TC pays a fee of F$5,280 per year to EGM for the use of the landfill site.

SW disposed at the dump

SW collected by Tavua TC, by EGM (for mining activities and for Vatukoula households), by commercial outlets is sent to the landfill.

Management of the dump

SW is usually covered by clay soil once a week using a contracted bulldozer.

General remark on SW disposal

Some other rubbish dumps were used before the EGM site. All of them are now reclaimed lands that are usually situated on mangrove areas.

II.10. Waste minimisation and recycling actions in municipalities

II.10.1. Current re-use and recycling activities in municipalities

Some SW (e.g. glass, plastic bottles and textiles) is collected within municipal boundaries for re-use and recycling. Some are common to all municipalities (e.g. collection of beer bottles for re-use), and some are specific to some municipalities (e.g. re-use of textiles in Ra RLA). Other actors than waste collectors usually lead such activity.

Table II.7 below summarises the activity of re-use and recycling identified by municipal councils in their area. The actors leading the activity are mentioned. It was difficult to obtain any information about the scope and extent of re-use and recycling within the time of this project.

Table II.7. Summary of the re-use / recycle activities identified in the municipalities surveyed.

Municipality	Re-use [actors]		Recycle [actors]	
Ba TC	Beer bottles [companies]		Scrap Metals [Scrap metal collectors]	Scrap Metals [scavengers]
Lautoka CC				Scrap metals [scavengers] ; Coca-Cola PET bottles [scavengers]
Nadi TC				Green waste being stored for further composting at Denarau Island [companies]
Ra RLA		Textiles [individuals]		
Sigatoka TC				
Tavua TC				

Usually, SW collectors are rarely involved in re-use/recycling activities. This is explained by most of municipalities by:

- The lack know-how of the companies concerning SW segregation and recycling,
- The lack of time to carry out segregation activities,
- The lack of value of most of the SW collected.

II.10.2. Awareness campaign

It is widely acknowledged that minimisation and recycling initiatives can only be successful if they are accompanied by appropriate awareness campaigns. Here is a description of the actions led by municipalities in this field.

In schools

All municipalities lead some annual awareness campaigns in schools of the municipalities. Usually, litter and health problems associated to the management of SW are discussed with students.

Other awareness campaign

Lautoka CC and Nadi TC are about to begin an awareness campaign with a local radio station. This campaign will aim at discouraging littering and promoting individual composting.

II.10.3. Ideas and priorities for the future

During interviews, all municipalities highlighted some ideas and priorities to further develop waste minimisation and recycling. Although none of the ideas listed below are new, they show the maturity of most municipal councils in voluntarily embarking in Reduce / Re-use / Recycle as well as producer responsibility-type initiatives.

The ideas raised by municipalities are classified in 5 main categories:

Involving products / materials producers

Most of the municipalities highlight the necessity to technically and financially involve producers of products that will become waste at the end of their use. PET bottles have been often mentioned as one of the priorities.

Also, many municipalities raise the issue that it is currently very difficult to raise contributions from ratepayers, especially in rural local authorities and/or in poor areas. Some of them suggest asking financial contributions to big SW producers to cover increasing costs.

In particular, several of the municipalities would be ready to:

- Put pressure on PET bottles producers (Coca-Cola, Fiji Water, Punjas, etc) for them to develop innovative take-back and recycling schemes,
- Promote the setting-up of a deposit system on PET bottles that would be used for their take-back and recycling.

So far, municipalities alone did not have the capacity to ask for such contributions from large producers.

Involving waste producers (users)

Municipalities would like to develop “aggressive marketing”/ awareness campaigns to promote:

- Paper recycling in commercial premises,
- The preference of products with less packaging: for example, create competition between retailers in town to decrease the quantity of SW, or commercial initiatives where customers would be encouraged not to use plastic bags.

Developing solid waste prevention measures

Some of them suggest developing awareness campaign targeting:

- The limitation of the use of plastic bags, and the preference of durable/reusable bags or biodegradable bags,
- The limitation of the use of dangerous and non-recyclable products and materials.

Promoting and developing composting

Organic matter represents a very large share in the composition of SW in all the municipalities surveyed. All municipalities agree on the necessity to develop a composting scheme:

- At the municipal level: some suggest to acquire machinery (e.g. shredders) to compost their own green waste (mainly leaves, etc),
- And/or at the individual level: some suggest to lead large scale awareness campaign; and others suggest to target specific groups (e.g. women, farms)

Developing transfer & segregation stations

All municipalities highlighted the necessity of developing segregation stations, especially if the regional landfill concept is developed. Furthermore, the segregation stations will better serve those Town Councils that will be the furthest from the regional landfill.

II.11. Towards improved practices on solid waste management

II.11.1. Current status of the Regional landfill initiative

In August 2003, the Department of Environment and four Municipal Councils in the Western Region (Ba TC, Lautoka CC, Nadi TC and Sigatoka TC) had a meeting to consider the possibility of constructing a regional landfill for the region. In that meeting all parties reached a consensus that a regional landfill is needed. The meeting was organised on the basis of the Background paper for a regional landfill for the Western Division [10]. During the meeting, the following was achieved:

- A consensus on the need for a regional landfill,
- The agreement on the need for the councils full resolution,
- The agreement on the need of some solid waste characterisation studies for each municipal council (Lautoka CC and Nadi TC characterisation studies have been led in 1999 and are reported in [3]),
- The agreement on a step-wise approach for the initiative, as suggested in [10].

Since then,

- The full resolution and some fund commitments to acquire a land have been received from Lautoka CC and Nadi TC,
- Solid waste characterisation studies have been received from Ba TC and Sigatoka TC.

According to the Department of Environment, the involvement of other municipal councils (e.g. Tavua TC) could be studied.

II.11.2. Understanding of "improved practices" by the municipal councils

Since the full resolution concerning the Regional Landfill has not been fully adopted by municipalities surveyed, the study was conducted using the term "improved practices on solid waste management"

For four of the municipalities interviewed (Ba, Lautoka, Nadi, Sigatoka), the term "improved practices" is understood as all actions conducted around the regional landfill initiative.

Ra RLA and Tavua TC are so far not involved in the regional landfill initiative. Ra RLA was even not aware of it. However, the management of SW in Ra RLA and Tavua TC clearly needs some improvement. For these municipalities, "improved practices" is understood as all actions conducted to improve the current collection and disposal practices.

II.11.3. Drivers of improved practices

All municipalities agree that improvements are needed on their practices of solid waste collection and disposal.

To the question D(c) of the questionnaire (cf. Appendix II.1), all municipalities agreed on the fact that "Improving public health", "Providing a convenient and cost-effective service to the community", "Protecting the environment (for the quality of water, etc)" and "Protecting the environment for tourism purpose" were equally important in the perspective of improved SW management practices. However, a few local contexts were highlighted:

- In Ra RLA, many complaints about the visual impact of the dump have been recorded, especially on tourists;
- Sigatoka TC received a lot of complaints from tourist and hotels for the visual aspect of the current dump as well as the smoke coming from it.

II.11.4. Main obstacles towards improved practices

The main obstacles towards improved practices, as municipal councils perceive them, are classified in the Table II.8 below. The five first criteria were listed in the questionnaire; the last criterion (i.e. "Difficulty to find a site for a regional landfill") was cited by two municipalities.

Table II.8. Classification of obstacles to the setting-up of improved solid waste management practices.

	Educa-tion	Legislative framework	Costs of operation	Invest-ment costs	Manage-ment	Difficulty to find a site for a regional landfill
Ba TC	3	4	1*	1	5	
Lautoka CC	4	5	2	1	3	
Nadi TC	3	1	4	4	1	✓
Ra RLA	3	5	2	1	4	
Sigatoka TC	4	2	3	1	5	
Tavua TC	4	3	1	1	5	✓
TOTAL	21	20	13	9	23	

*: 1 is the higher priority; 5 is the lowest.

According to municipalities, obstacles towards improved solid waste management are in order of relevance:

1. Investment costs: acquisition of a land; construction of landfill; training of workers; pollution monitoring apparatus; purchasing/maintenance of collection trucks;
2. Costs of operation: logistic costs; cost of environmentally friendly operations and management; difficulty of increasing rate in some poor areas (e.g. Ba); too limited resources in RLA;
3. Legislative framework: enforcement of legislation (littering decree; use of proper garbage bins); collect of fee from all users of the service;
4. Education: need to educate children and rate payers;
5. Management: very limited resources; hands of Health Inspectors already full; difficult enforcement of legislation at local level.

Also, several municipalities mentioned the difficulty to find a site for a regional landfill as an important obstacle. They linked this obstacle to the difficult land issue in Fiji and to the NIMBY (Not In My Back Yard) syndrome. According to Lautoka CC, some sites have already been identified in the outskirts of Lautoka but, considering that they should be freehold for a regional landfill, these sites might be very expensive.

II.11.5. Preferences on the management of a regional landfill site

The answers of municipalities to the question D(b) of the questionnaire are presented in the Table II.9. As Ra RLA was not aware of the initiative, they did not answer this question.

Table II.9. Preferences of municipalities for the management of a regional landfill site.

	Managed by town/city councils	Partnership / joint venture with private companies
Ba TC		✓
Lautoka CC	✓	
Nadi TC	✓	
Sigatoka TC	✓	
Tavua TC		✓

The main arguments for a landfill managed by a joint-venture / partnership of municipalities were:

- The collection of SW in municipalities is a service that should not be conducted by profit-oriented organisations,
- There is a need to keep full control on the levy associated to SW collection and disposal in order to keep it as small as possible.

The main arguments for a landfill managed by a joint-venture / partnership between municipalities and private companies are:

- Municipalities are used to work with contracted private companies,
- Municipalities want efficiency,
- Limited resources to manage the site.

However, municipalities in favour of a landfill managed by a joint venture of municipalities highlighted that they did not have the technical capacity to operate a modern landfill. Therefore, they would need assistance of a foreign consultant at the beginning of the operation.

Some municipalities also highlighted the necessity to involve local recyclers in any partnership, since they have got the know-how of recyclable materials handling and its market.

III. CURRENT AND FORESEEN ACTIVITY OF THE RECYCLING INDUSTRY IN THE WESTERN REGION OF VITI LEVU

III.1. Objectives of the study

The study aims to better understand practices of the recycling industry in the Western region and to identify the factors that affect their development and, on this basis, provide reasonable recommendations to facilitate their expansion.

III.2. Methodology

Some companies involved in the recycling industry in the Western region of Viti Levu were interviewed and inspected. The questionnaires used as a basis for discussion are presented in the Appendix II.5. They are based on literature review and on the understanding of PACE-SD of the recycling activity.

The following companies were surveyed:

- The three most important (in term of size) recyclable collectors of Fiji: Recycler A, Recycler B, Recycler C. Recyclable collectors are companies that collect valuable materials, add value to them (through sorting, compacting, etc) and export them to markets abroad,
- A company situated in Ba, Recycler D, that, to our knowledge, is one of the few cases in the South Pacific region to actually recycle scrap metals into valuable and finished products. It is understood that another company actually recycles scrap metals in Fiji but this company did not accept to agree us;
- Two beverages producers (Carlton Brewery Ltd. and Coca Cola Amatil Ltd.) that lead take-back activity for the packaging of their products.

From the interviews and inspections carried out, conclusions were drawn on the future development of the collection and recycling industry in the Western Region of Viti Levu.

The methodology of the study and the structure of this part are presented in Fig. II.6 below.

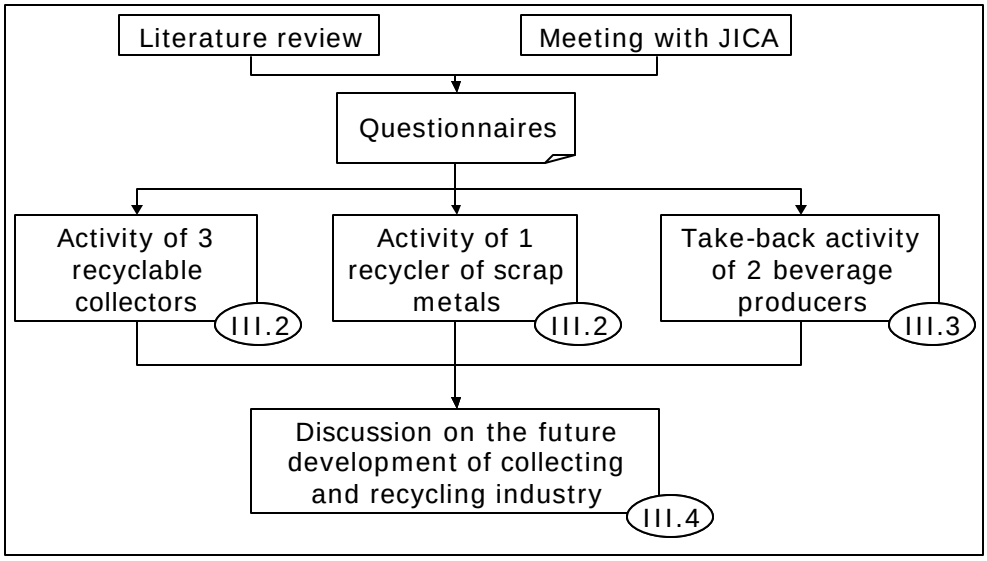


Figure II.6. Methodology and structure of the analysis of the activity of recyclable collectors and recyclers in the Western region of Viti Levu.

III.3. Description of the activity of recyclable collectors and recyclers in the Western Region of Viti Levu

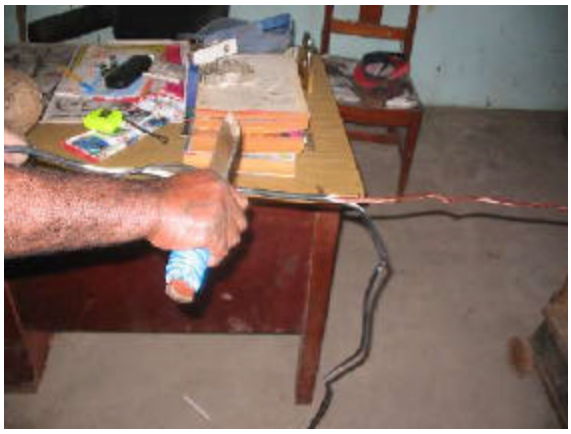
III.3.1. Activity of three recyclable collectors

The three most important "recyclable collectors" of the Western region of Viti Levu usually:

- Collect and buy recyclable materials from industries and individuals,
- Add value to the materials, mainly by manually sorting materials, and increasing density (by cutting, pressing, bailing) (see Fig. II.7(a-b)),
- Export valuable materials to external market (see Fig. II.7(c-d)).

Materials targeted by "recyclable collectors" are materials with value on international markets, mainly non-ferrous and ferrous metals, batteries, paper/cardboard, and some plastics and glass.

Among the three "recyclable collectors", one company operates a small-scale activity and is not foreseeing major developments in the future. It usually does not collect from customers: customers usually come to the company to sell their recyclables.



(a)

(b)

(c)

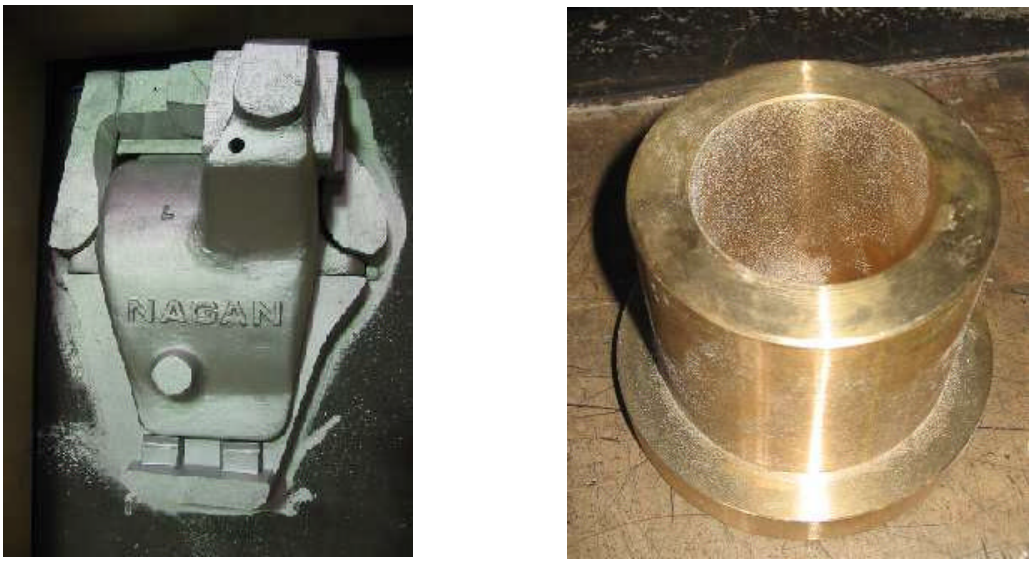
(d)

Figure II.7. Some photographs on the activity of recyclable collectors – (a) adding value to non-ferrous materials by manually extracting plastics; (b) adding value to non-ferrous metals by manually extracting ferrous metals; (c) ferrous metals ready to be exported; (d) bags of non-ferrous ready to be exported.

III.3.2. Activity of a scrap metals recycler

The activity of Recycler D includes:

- Collecting scrap metals from industries (e.g. Fletcher Steel, Emperor Gold Mining, etc.) and small garages,
- Melting and casting scrap metals them into finished products (see Fig. II.8(a-b)) to be used mainly by other industries (e.g. Fiji Sugar Corporation).



(a) (b)

Figure II.8. Some finished products produced by recycler D – (a) product made of ferrous metals; (b) product made of non-ferrous metals.

The main characteristics of the activities of these four companies are summarised in Table II.10. The criteria considered in the Table include: the targeted products and materials, the main processes applied to end-of-life materials, the market for the output of the activity, the size of the activity in Fiji and in the Western region of Viti Levu, the approximate share of industries and households that supply end-of-life materials, the machinery available on the site and the number of staff.

III.4. Collection of packaging in the Western region of Viti Levu supported by two beverage producers

Some initiatives of two beverage producers aim at organising a take-back of the beverage packaging in the whole country. This paragraph aims at briefly presenting the take-back activities of the two producers in the Western Region of Viti Levu

This paragraph is based on face-to-face and telephone interviews of the production managers of the companies, who are based in Suva.

III.4.1. Re-use of glass bottles at Carlton Brewery

After use, glass beer bottles are collected and returned to the beer producer Carlton Brewery for re-use in the Lautoka production plant. Empty bottles are collected from commercial outlets (e.g. restaurants, bars) by the distributors when they deliver new bottles. Bottles are collected from the public by private collectors who usually pay individuals. The price paid to individuals is usually of F$0.04 per 750ml bottle and F$0.02 per 375ml bottle.

Table II.10. Summary of the activity of three recyclable collectors and of one recycler of scrap metals in the Western region.

Recycler	Targeted products & materials	Main processes	Market for output	Size of activity in Fiji (ton/ year)	Size per material (ton/ year)	Size of activity in Western region (ton/ year)	Share of origin (%)		Machinery available	Staff
							Com-mercial	House-hold		
Recycler A	• Non-ferrous metals	• Reception • Sorting • Export	Australia	78	brass: 13; copper: 52; aluminium:13	NA	70	30	• Trucks: 3 (up to 1 ton)	5
Recycler B	• Non-ferrous metals • Ferrous metals	• Collection • Manual sorting • Density increase • Export • Little selling to local foundry	Australia, New Zealand, Asia	1174	non-ferrous: 520; ferrous: 460; batteries: 194	470	95	5	• Trucks: 4 (up to 5 tons) • Electro-cutter • Gas cutter • Can compactor	25

Recycler C	• Non-ferrous metals • Ferrous metals • Plastics • Paper / cardboard • Glass • Batteries	• Collection • Manual sorting • Density increase • Export	Australia, New Zealand, Asia	4415	non-ferrous: 64 cont.[1]; ferrous: 28 cont.; paper: 66 cont.; cardboard: 21 cont.; plastics: 67 cont.; glass: 38 cont.; batteries: 12 cont. ; tin plate: 5 cont.	903	99	1	• Trucks: 14 (up to 5 tons) • Baler (paper, plastics) • Compactor (metals) • Plastics shredder	60
Recycler D	• Ferrous metals • Non-Ferrous metals	• Collection • Melting • Casting • Selling of finished products	Mainly Fiji	250	Ferrous: 175 ton; non-ferrous: 75 ton	NA	100	0	• Truck: 1 (3.5 tons) • Melting and casting devices	35

[1]cont.: containers

During our interviews, exact figures on the collection of beer bottles in the Western region were not available. However, considering the low remaining share of beer bottles in the waste stream that reaches the landfills, it is believed that this take-back system works well and that a majority of the glass beer bottles put on the market are actually re-used by Carlton Brewery: the collection rate is estimated to around 90%.

III.4.2. Take-back of PET bottles by Coca-Cola Amatil

In 1998, Coca-Cola Amatil switched from glass to PET bottles for the packaging of its beverage. Since then, the company has been running its Mission Pacific Initiative that aims at taking back its own PET bottles after use. The company has between 60 and 70% of the market for soft drinks. At one collection centre in Lautoka (there is also one in Suva and one in Labasa), PET bottles are bought back from individuals for a price of F$0.68 per kilogram. This price corresponds to around F$0.02 per 600ml bottle. From there, bags full of PET bottles are brought back to the production plant in Suva by the company's trucks, where they are bailed and sent to Australia for recycling.

According to figures communicated by the company, 35 tons of post-consumer PET bottles are collected per month by the system and a take-back rate of 42% has been reached in 2003. The Lautoka collection centre represents 35% of the bottles taken back. Considering the amount of PET bottles still found in the waste stream being landfilled, these figures would need to be verified.

Coca-Cola Amatil argue that there is not enough volume of post-consumer PET bottles in Fiji to set-up a local recycling plant. In the future, the company aims at promoting the take-back system among individuals, schools, and resorts.

The financial incentive for the take-back of Coca-Cola Amatil's PET bottles is small. Consequently, in the Western region of Viti Levu, such a system seems to be working only in Lautoka where scavengers collect bottles and sell them to the company. In other municipalities and resorts in the Western Region (e.g. Rakiraki, Tavua), most people are even not aware of the initiative.

III.5. Discussion on the future developments of the recyclable collecting and recycling industry in the Western region of Viti Levu

Two of the main "recyclable collectors" revealed a steady state increase in their activity. One of them gave a figure for economic growth rate of around 2.5% per year.

However, all the collectors and recyclers pointed out the difficulty of expanding their activity and their financial weakness. This paragraph aims at presenting the limiting factors to their development, their foreseen developments, the technological needs of their activity, and the role the government or donors could play in their development.

III.5.1. Limiting factors

Limiting factors of any recycling activity

Recyclable collectors and recyclers can be defined as industries that purchase input (the recyclable waste), apply some processes on the input (e.g. sorting, shipping, etc) and sell outputs (the transformed materials), as presented in Fig. II.9.

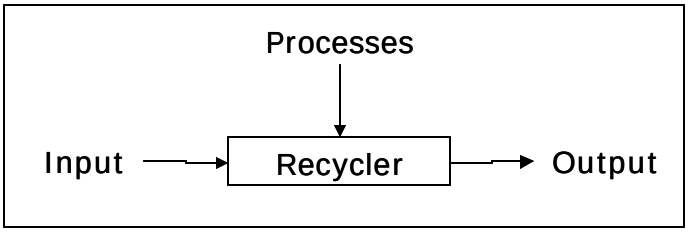


Figure II.9. Structure of the analysis of the activity of recyclable collectors and recyclers in the Western region of Viti Levu.

Like any recyclers in the world, in order to guarantee their survival, recyclers in the Western region should always try to satisfy the following condition [11]:

(1) Purchase_price (input) + Cost_processes (input) = Selling_price (output)

Therefore, the economic viability of any recycling activity always depends on:

- The costs of purchasing recyclable materials,
- The costs of the processes applied to the recyclable materials: this includes the wage of workers, the cost of operating and maintaining machinery and the cost of shipping to the outside market,
- The price of materials on international markets.

From this and as declared by the surveyed collectors and recyclers, limiting factors of the development of the recyclers' activity are the operating costs, the shipping costs and prices of materials on international markets.

According to expression (1), the limiting factors are in fact the relationships linking operation cost, shipping costs and price on the international market for each type of materials.

This situation is illustrated in the Western region as follows:

- Newspapers and phone books can easily be collected but the price of collection and processing (e.g. bailing, shipping) is actually not covered by the benefits made when the materials are sold on the international market;
- Steel-dominated products (e.g. end-of-life vehicles bodies, industrial rollers) are wanted in many countries to be recycled: however, for economical (the density of vehicles bodies should be increased so the shipping costs are not prohibitive) and technical (steel foundries have some technical requirements on the size of steel parts) reasons, the size of these parts should be reduced: unfortunately, the cost of reducing the size of steel parts (mainly done using gas-operated melting technique) would not be covered by the value of steel on the international markets.

Limiting factors of the recyclable collection activity in the Western region

The two "recyclable waste" collectors identified a number of limiting factors which are described below:

- A lack of knowledge and understanding of the "recyclable waste" collectors activity by local industries: either local industries do not know about the existence of collectors, or they do not understand that they could reduce their costs – or even make money- if they can better handle their waste;
- A similar lack of knowledge, understanding and care among the population;
- The low economic value of some important streams of waste produced in Fiji: for example, aluminium cans and cardboards boxes would be more economically valuable than PET bottles, tin cans or plastic bags from a collector perspective;
- The remoteness of some islands (e.g. Yasawas group), inconsistent transport and communication affects the promotion of their activity and the actual collection of recyclable waste.

Limiting factors of the recycling activity

According to Recycler D, the size of the market for its type of products is around 1,000 ton/year. The company is trying to expand its 250 ton/year market but is facing difficulties. This is due to the following reasons:

- A lack of support of local industries that prefer to be supplied by companies from overseas, e.g. China or Australia,
- A lack of economical competitiveness compared to large scale producers of similar parts, from China or Australia;
- The costs of some local scrap metal is too expensive to be bought locally, and are exported to external markets.

However, Recycler D points out that the remoteness of Fiji is actually an asset for its activity: the company is usually preferred by customers when long delays in the supply are not acceptable.

III.5.2. Foreseen developments

The main developments foreseen by surveyed recyclable collectors concern expanding their markets. Currently marketing is mainly through newspaper advertising but more direct promotion is planned through visits of salepeople to industry, supermarket and hotels.

For recycler D, the foreseen developments concern the expansion of its markets of final products. For this purpose, the company is trying to gain the confidence of industries that could use their products, insisting on the quality of the products. If its market could expand, the company would be able to absorb more local scrap metals.

III.5.3. Foreseen technological developments

As shown in Table II.10, recyclable collectors are usually well equipped in terms of machinery, e.g. trucks, baler, compactor, shredders. For the moment, technology does not seem to be a limiting factor of their activity. However, if there were a growth in the future years, they would need higher capacity balers and compactors. If some clean-up campaigns are organised for steel-dominated products (large quantities of steel-dominated products have been identified in the backyards of some industries, e.g. the FSC sugar mill in Ba), high-capacity shredders or compactors would obviously be needed.

In case of development of its market, Recycler D is thinking about acquiring a bigger electric furnace for the melting of scrap metal, this would bring melting

efficiency and reduce costs of the processes. The company is also thinking about acquiring its own quality control apparatus so it can better promote its products to customers.

III.5.4. Needed actions of governments / donors

The recyclable collectors and the recycler would be glad to receive support from the government or donors for the development of their activity on the following actions:

- To lead awareness campaigns to promote their activity among industrial / commercial bodies and individuals: apparently, the companies interviewed do not have the capacity to promote their activity to ensure a real development;
- Governmental and public agencies should show a good example by controlling and recycling their own solid waste; this should be done for example for office paper, for which the highest possible collection rate are currently not achieved, or for some pollutant waste (e.g. WEEE) for which it could be necessary to pay for its environmentally sound disposal;
- To subsidise some activities: this could be done on an irregular basis when for example subsidising the cost of the collection, compaction and the shipping of steel during some "steel-dominated products clean-up operations"; or on a more regular basis, when subsidising some operation costs (fuel, maintenance, etc);
- To consult recyclable collectors and recyclers more often when setting-up solid waste management plans.

Recycler D suggested that the government should protect its activity:

- Either by promoting locally-made products,
- Or by increasing tariffs on imported items that are competitors for local products,
- Or by regulating or restricting the export of non-ferrous metals so they could be bought more cheaply for local use.

III.5.5. Role in the Western region

Most of the surveyed recyclable collectors think that they should be involved in the setting-up of some solid waste management plans in the Western region of Viti Levu: these companies have the knowledge and expertise concerning the markets and the way to manage solid waste.

They envisage their role as either a recyclable collector at source from industries or hotels, and/or as a subcontracted company at the landfill site in charge of extracting and sorting some valuable materials.

IV. CURRENT AND FORESEEN PRACTICES OF SOME IMPORTANT PRODUCERS OF SOLID WASTE: THE RESORTS

"I enjoy recycling"

Genevieve, Canadian Tourist, Nananu-i-Ra Island, March 2004

IV.1. Introduction

The tourism industry is an important and growing economic activity in the Western region of Viti Levu. The reason for including resorts in this study is that future plans for better SW management in the Western region should take into account the current practices of the tourism industry. In particular, the following characteristics of resorts should be taken into account:

- The activity is growing, implying more guests,
- Considering that guests usually have peculiar consumption patterns, resorts produce a lot of SW and its composition might be different from the SW from Fijian cities and villages,
- Resorts can be situated in very remote and small islands with very limited transport facilities to the mainland.

IV.2. Methodology

The following methodology has been adopted for this study:

- Four resorts were identified in the Western region and their SW management practices were analysed during interviews and inspections (with questionnaires in Appendix II.6 as a basis for discussion); during interviews, innovative approaches on SW were identified;
- Some telephone interviews were carried out with an NGO, a member of staff of the Department of Tourism (DoT) and a member of staff of USP using the same questionnaire as a basis for discussion;
- From this information, current practices and further ideas for better SW management in the hotel industry were identified.

The methodology adopted for the study and the structure of this part is presented in Fig. II.10.

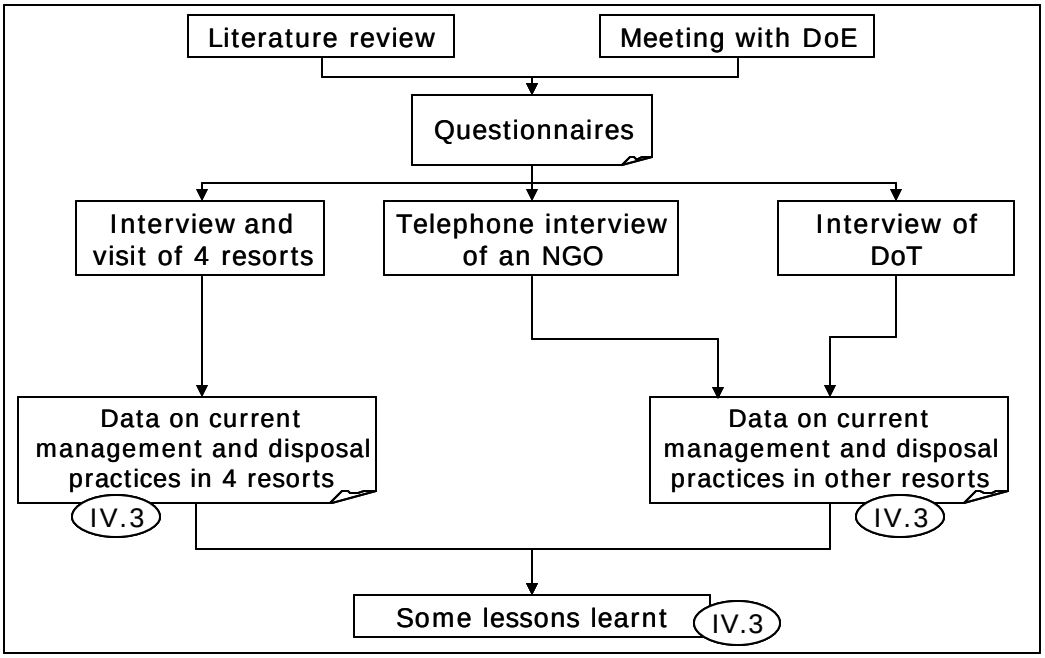


Figure II.10. Methodology adopted for the survey of current SW management practices in the tourism industry in the Western region of Viti Levu.

IV.3. Current management and disposal practices of solid waste in some resorts in the Western region of Viti Levu

IV.3.1. Methodology of the survey

For this analysis, the practices of four resorts in the Western region of Viti Levu were surveyed and analysed. These resorts ranged from "backpacker" to "upmarket" resorts, as defined by the Department of Tourism and described in the note of Table II.13. They are situated either on the mainland, or on remote islands (i.e. less than 30 minutes away from the mainland by boat) or on very remote islands (i.e. more than 30 minutes away from the mainland by boat).

Unfortunately, unlike municipals councils in the region, resorts do not have any accurate and quantitative information on their SW management. Thus, only qualitative information could be collected, that concerned the type of treatment received by each category of waste.

Due to time constraints, the survey was limited to only four resorts situated in three different areas of the Western region of Viti Levu: Nananu-I-Ra Island in the Ra Province, the Mamanuca Group and the Coral Coast. The type of sampling was a mix of expert and random sampling: the resorts that either declared having a problem with solid waste management (e.g. Resort C), or declared having developed some innovative practices (e.g. Resorts B and D), or that were on the way of our field trip (e.g. Resorts A) were surveyed. Willingness to cooperate was also an important factor in our choice of resorts. The type of sampling used for each resorts is presented in Table II.11.

The information was collected either by interviews, or by interviews complemented by visual inspection, as established for each resort in Table II.11.

Table II.11. Type of data collection for each resort.

Hotel	Resort A	Resort B	Resort C	Resort D
Type of sampling	Random	Expert		
Type of data collection	Interview only	Interview and visual inspection		

IV.3.2. Results of the survey

The information concerning the type of treatment received by each category of SW in each resort is compiled in Table II.13.

Very limited information concerning the quantity of solid waste actually sent to the dump was collected for some resorts. This information is presented in Table II.12. The daily generation rate of SW sent to the landfill for each of this resort is also presented.

Table II.12. Annual quantity and daily generation rate of SW sent to the public landfill by some resorts of the Western Region of Viti Levu.

	Resort A	Resort B	Resort C	Resort D
Annual quantity of SW sent to the landfill (ton/year)	NA	72	NA	949
Daily generation rate of SW sent to the landfill (kg/day/person)	NA	0.42	NA	3.1

NA: not available

At Resort C, the final destination of residual solid waste is a dump managed onsite: usually, ashes coming form the burning of some SW volume and other residual solid waste represent a volume of 30m^3 / year.

IV.3.3. Analysis of the practices of the four surveyed resorts

As the practices and geographical situation of the resorts vary greatly, it is very difficult to analyse the information compiled in Table II.13. Therefore, the consulting team suggested qualitatively analysing the performances of each resort, using an analysis grid produced by the team and presented in Appendix II.7.

Table II.13. Summary of the practices of solid waste management in four resorts of the Western region of Viti Levu.

Resort (location)		Resort A - (Nananu-I-Ra Island, Ra Province)	Resort B – (Mamanuca Group)	Resort C - (Nananu-I-Ra Island, Ra Province)	Resort D - (Sigatoka Province)
Type of accommodation[1]		Up market	Up market	Backpacker	Up market
Geographical sitiuation[2]		Remote	Very remote	Remote	Mainland
Average number of guests		40	170	54	350
Average number of staff		20	300 (with families)	9	500
Machinery available for solid waste management		-	Compactor for metal cans Small shredder for green waste	-	-
Management and disposal practices for each type of solid waste	**Paper / cardboard**	Burnt on site	Burnt on site	Burnt on site	Landfilled at Sandunes landfill
	Plastics (PET bottles)	A few re-used for flotation of boats Usually burnt on site	Collected for recycling	A few re-used for flotation of boats Usually burnt on site	A few re-used in villages Usually landfilled at Sandunes landfill
	Plastics (other)	Landfilled on the mainland	Landfilled on the mainland	Burnt on site	Landfilled at Sandunes landfill
	Glass (beer bottles)	Re-used by Carlton	Re-used by Carlton	Re-used by Carlton	Re-used by Carlton
	Glass (wine bottles)	Landfilled on the mainland	Landfilled on the mainland	Buried on site	Landfilled at Sandunes landfill
	Food scrap	Brought to the mainland for pigs	Composted (low quality)	Used as chicken feed	A few collected by staff for pigs feed Usually landfilled at Sandunes landfill
	Green waste	Burnt on site	Stored and eventually decomposed	Stored and eventually decomposed	Small quantity composted Usually landfilled at Sandunes landfill

	Metals (Aluminium and others)	Landfilled on the mainland	Mostly compacted and landfilled on the mainland Very Little collection and separation by staff for recycling	Buried on site	Landfilled at Sandunes landfill
	Construction & Demolition waste	Landfilled on the mainland	Wood: stored and re-used in site Concrete: re-used for sea walls	Buried on site	Small quantity re-used during guests activities Small quantity used for sea-wall Usually landfilled at Sandunes landfill
	Other				Sludge from water treatment plant: used as a fertiliser at the plants nursery

[1]: "backpacker": less than F$60/night; "middle market": between F$60 and F$150 / night; "upmarket": more than F$150/night

[2]: "mainland": situated on Viti Levu; "remote": situated on an island less than 30 minutes away from the mainland by boat; "very remote": situated on an island more than 30 minutes away from the mainland by boat

From this analysis, it is possible to categorise the four resorts qualitatively as:

- Group A: resorts with quite good practices (e.g. Resort B): the solid waste problem is being tackled including some minimisation and recycling practices; only the SW that cannot be easily recovered is sent to the public dump;
- Group B: resorts with average practices (e.g. resort D): few minimisation and recycling initiatives have been initiated and solid waste is mainly sent to the public dump;
- Group C: resorts with poor practices (e.g. resort A and C): few minimisation and recycling initiatives have been initiated, some solid waste is sent to the public dump and the onsite management of some solid waste could be harmful to health and the environment.

It should be noted that this analysis only considers the actual treatment received by each type of SW in each resorts and does not integrate the local context of each resort. It should be noted that:

- Resort D mainly uses the local public dump as it is situated close by and as its use is free,
- Resort A and B pay for the use of the local public dump that is situated on the mainland.

IV.3.4. Practices in other resorts

During our surveys, interviews and research, identification of some persons who have been leading some actions concerning SW management in resorts were made. Interviews of the persons were conducted; this led to a better understanding of the situation in some regions.

Management of SW in the Mamanuca Group

This information has been obtained during the telephone interview of Ms Diane Walker of the Mamanuca Environmental Society. This allowed a better understanding the situation in the resorts of the Mamanuca Group (mostly upmarket ones) and therefore to locate the situation at Resort B in this context.

According to Ms Walker, there are basically three types of resorts among the upmarket resorts of the Mamanuca group:

- Group 1: resorts that already adopted some routine practices where SW is minimised (through e.g. composting of green waste, controlled burning of paper) and segregated (recyclable are sorted) onsite and residual SW is sent to the mainland for landfilling or recycling; Resort B is part of this group;
- Group 2: resorts that are currently initiating some onsite minimisation and segregation practices;
- Group 3: resorts that send back all their SW to the mainland for landfilling.

Of the 11 resorts that she has knowledge of in the Mamanuca Group, Ms Walker classified them into three groups as shown in Table II.14. A fourth group is created for hotels for which no information is available.

Table II.14. Classification of 11 resorts of the Mamanuca Group in three categories according to their SW management practices.

Category	Group 1	Group 2	Group 3	NA
Number	2	2	3	4
Share	18%	18%	27%	37%

NA: Not available

Management of SW in backpacker-type accommodation

This information has been collected during a face-to-face interview with Mr. Viliame Koyamaibole of the DoT in Suva.

Backpacker-type hotels usually start operation on their own initiative, without taking any advice from anyone. In particular, solid waste is generally poorly managed in such places (usually it is burnt and/or dumped on site) and some improvements are needed.

Since 2003, the DoT has been organising training sessions targeting these backpacker-type hotel in order to facilitate the development of good practices: several issues are addressed in these sessions, (e.g. finance, environment) solid waste management being one of them.

This training, funded internally by the Department of Tourism, targeted so far 22 backpacker-type hotels in the Yasawas, in Nadroga and in Tailevu area. In comparison, 24 backpacker-type hotels are currently in operation only in the Yasawas, and another 10 new ones should open by 2004.

The training program aims to promote:

- The onsite composting of all biodegradable waste (food scrap and green waste),
- The collection and shipment (usually with the hotels' boats) to Lautoka of all recyclable solid waste (glass beer bottles, metals, PET bottles) for selling to a local recycler (Recycler B),
- The onsite dumping of the other solid waste.

According to Mr. Koyamaibole, the training reached its objectives and the situation has improved in these resorts. Unfortunately, it was not possible to know how much the situation had improved.

Obviously, a limiting factor of such scheme would be the inconsistency and the price of the shipping. An option could be to gather funding (from the government or from donors) to collectively acquire a boat that would be in charge of:

- Bringing some supplies (e.g. water, food) to the islands,
- Bringing back solid waste to Lautoka for collection and recycling.

The hotels could financially contribute to the operation costs of the service.

Also, more funding would be needed to lead training in more resorts.

IV.3.5. Some lessons on the practices of resorts in the Western region of Viti Levu

Representativeness of the study

From the previous analysis, it is possible to draw some general lessons on the management of solid waste in resorts. However, it should be remembered that only tentative qualified conclusions may be drawn, bearing in mind the limitations of the study.

Why specific approaches should be developed for resorts?

Through our surveys, we have shown that specific approaches targeting the solid waste management of resorts should be taken because:

- SW is poorly to very poorly managed in some resorts; this appears to be especially true for backpacker-type accommodation; this is mainly due to a lack of know-how;
- Some resorts currently overburden the public dump of their area; the use of the dump is usually free or very cheap considering the quantity landfilled,
- Better practices of SW management in resorts could contribute to promoting good practices among surrounding communities.

Conclusions

The following lessons can be drawn:

- Solid waste management is a rising problem for the hotel industry because the frequentation of hotels increase and guests usually have highly waste productive consumption patterns;
- The practices of resorts are very heterogeneous, ranging from poorly to nicely managed;
- Poor solid waste management of surrounding communities can affect the hotels: for example, empty PET bottles thrown away by communities are often encountered on the shores of the resorts;
- Not all the resorts adopted some environmentally-sound practices for the management of their solid waste, mainly because of a lack of knowledge and know-how;
- Remoteness is not always a limiting factor for good management of SW: being situated on a fragile and very remote ecosystem, Resort B had to develop early, an innovative management of its waste, through onsite recycling and shipping of residual waste to the mainland; while Resort D, being situated only 10 minutes away by truck from a free landfill, has not tried to reduce the quantity of SW it is sending to the landfill;
- Involvement of management is a key aspect of good practices of SW: as shown in Resort B, the resort management should have a vision for SW reduction and disposal and should commit themselves to it.

During our survey and interviews, identification of a number of current and foreseen initiatives that should contribute to better management practices of solid waste in the tourism industry were made. They are presented in Appendix II.8.

V. RECOMMENDATIONS FOR BETTER SOLID WASTE MANAGEMENT IN THE WESTERN REGION OF VITI LEVU

V.1. Introduction

A holistic approach needs to be developed for the improvement of the management of SW in the Western region of Viti Levu. All stakeholders, i.e. the municipal councils, government, population, industries, recycling industries and big SW producers (in particular resorts) should be involved because they will all be affected by the construction of a new regional landfill.

This part summarises the recommendations of the consulting team. As represented in Fig.II.11, there are two levels of recommendations:

- First priority actions that should improve the disposal facilities and generalise the collection of SW in the Western region,
- Some supporting measures that should promote waste minimisation.

As schematised in Fig.II.11, the recommendations are organised in the following paragraphs in categories and are transversal to all stakeholders.

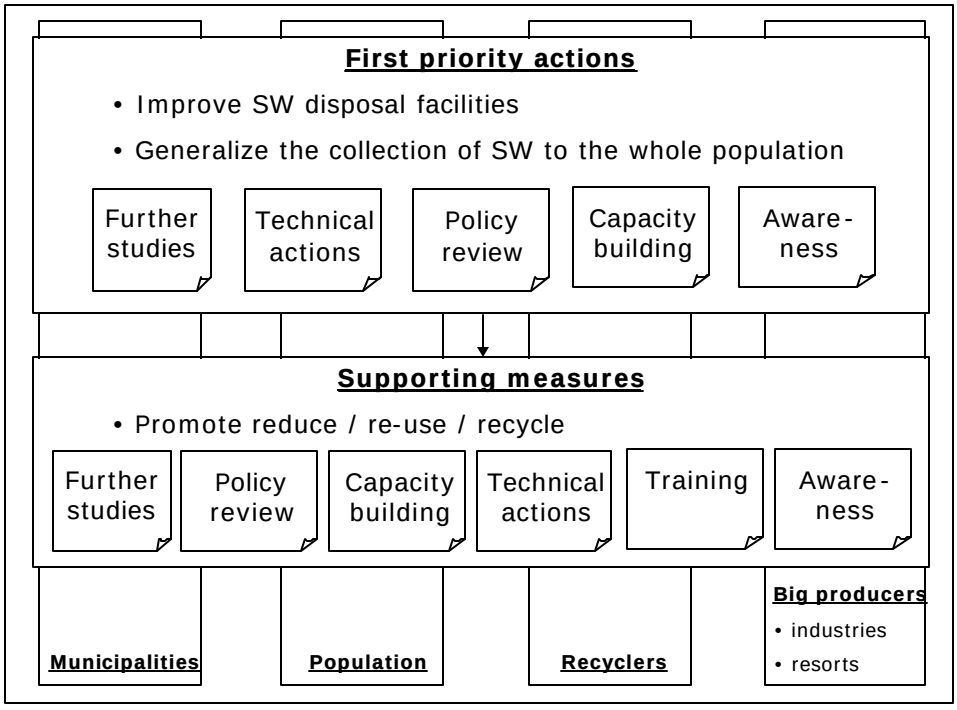


Figure II.11. Two levels of recommendations for the improvement of SW management in the Western region of Viti Levu – Recommendations are transversal to all stakeholders.

V.2. A starting point: improving SW disposal facilities and generalising SW collection to the whole population

Main objectives

The priority actions are:

- To improve the solid waste disposal facilities; this should include:
    - The construction of a regional sanitary landfill,
    - The closure and rehabilitation of the existing rubbish dumps,
    - The upgrading of the management of some existing rubbish dumps, if all municipalities are not involved in the regional landfill initiatives.
- To generalise the collection of solid waste to the whole population.

To realise such improvements, the actions below should be taken.

Further studies

The following studies should be carried out:

- Production of a waste characterisation study for Tavua TC and review of the waste characterisations studies of some municipalities (i.e. Rakiraki and Sigatoka): similar procedures should be used so that the data is comparable;
- Accurate determination of the quantity of SW being collected and disposed in all existing rubbish dumps;
- Cost-benefits analysis to determine which municipalities should be part of the regional landfill initiative: the costs of transporting waste from outlying municipalities but also the risk of having increased unofficial dumping if the sanitary landfill is far away from the towns should be considered;
- On this basis, determination of the ideal location for a regional sanitary landfill: the main criteria for an ideal location are: the cost of the land; the distance of the land from the towns; the ownership of the land; the geographical and geological attributes of the land;
- Assessment of the capacity of involved municipal councils to manage a regional sanitary landfill themselves.

Technical actions

The following technical actions should be taken:

- Construction of a regional sanitary landfill,
- Management of the regional sanitary landfill using high standards of practice, e.g. SW segregation, SW compaction, soil covering, leachate collection and treatment, methane collection and recovery,
- Construction of transfer stations in municipalities, where recyclables can be extracted and SW compacted before being sent to the landfill,

- Upgrading of the machinery used for the collection; high capacity compactor trucks could be used in the future to transfer SW from towns to the regional landfill,
- Acquisition of machinery (e.g. bulldozer) to manage the future sanitary landfill;
- Closure / rehabilitation or upgrading of the current rubbish dumps: the priority of rubbish dumps to be closed / upgraded could be determined using the Table of the Appendix II.3; in particular, rubbish dumps in Sigatoka and Ra should be considered as priorities.

Policy-oriented actions

The policies should be reviewed or enforced so that:

- All citizens are covered by the solid waste collection, not only in urban areas but also in rural and peri-urban areas,
- The tax system associated to the collection and disposal of SW is reviewed so that:
    - Every user of the service (e.g. individuals, industries, organisation, etc.) financially contributes to the collection, in particular rural dwellers and all tenants of premises;
    - The system generates more money for a better service;
    - The system is equitable, i.e. considering the ability to pay of the population and larger contribution of large SW producers (e.g. commercial premises and hotels);
- Some product-specific policies and approaches (e.g. for packaging, batteries, end-of-life vehicles, waste electric and electronic equipment) are developed.

Institutional strengthening of municipalities

Municipal officers' hands are already full and they still deal with solid waste only as a sanitary measure. The following actions should be taken:

- To increase the number of municipal officers dealing with solid waste; this should contribute to:
    - A better enforcement of existing regulations, e.g. controlling the accessibility of rubbish dumps, applying penalties for littering,
    - A better control and knowledge on the activity of SW collection and disposal in the councils,
- To train skilled people to the new issues associated with solid waste management, (waste characterisation procedures, recycling, composting, etc.)
- In-depth training of officers to manage the sanitary landfill, if a joint venture between municipal councils is chosen for the management of the regional landfill,

Awareness building among the population

Awareness campaigns should in particular focus on:

- Promoting the use of standard rubbish bins,
- Discouraging unofficial dumping.

V.3. Some supporting measures

The above priority actions should however be supported by other actions that should contribute to the improvement of the SW management in the long term. These actions should target municipalities, recyclers, the population, industries and big producers of waste (in particular resorts) and should mainly focus on reducing, re-using and recycling SW. Several categories of actions are described below:

Further studies

For recyclers:

Some further studies should determine:

- The extent to which collection of some SW (e.g. ferrous metals, pollutants, journal paper) should be subsidised; this could be done with a cost/benefit analysis;
- The amount of recyclable waste that is available for collection from industries.

For resorts:

To better understand the waste management of resorts in Fiji, it would be imperative:

- To lead a more exhaustive, quantitative and representative survey of the practices of the resorts: a more thorough and accurate classification of resorts according to their performances and their characteristics (size, location, type) could then be produced; the resorts that did cooperate with IAS for the JICA study on liquid waste could possibly be involved.

Policy-oriented actions:

Policy should be reviewed so that:

In general:

- Only “residual solid waste”, i.e. solid waste that cannot be further treated (reduction of its hazard, recovery of resources) according to the current technical and economical conditions, should be accepted in landfills: this should divert some recyclables from the landfill to the recycling industry.

For recyclers:

- Some subsidy mechanisms are established to support the recycling activity for products and materials for which recycling is either:
    - Not always economically viable: e.g. ferrous metals;
    - Or not economically viable, e.g. pollutants (batteries, Waste Electric and Electronic Equipment).

  Such subsidy could be:
    - Either regular,

  - Or irregular for some clean-up operations.

- Some innovative financing systems to fund the recycling activity are developed: these systems could be for example be based on the user-pay and/or the producer responsibility principles; in particular, the effectiveness of systems in place worldwide for different types of SW (e.g. packaging, WEEE, end-of-life vehicles) should be reviewed beforehand;
- Producers/importers of products (e.g. PET bottles, vehicles, EEE) are involved in the end-of-life collection and treatment of their products: this should include financial and/or technical contributions;
- If a local scrap metal recycling industry is to be encouraged, some mechanisms should be set-up so that the export of scrap metal to overseas market is limited.

Pilot projects

Some pilot projects should be developed to acquire knowledge on:

For municipalities:

- The recovery of green waste in municipalities: with appropriate technology and training, municipalities should be able to treat their own green waste and produce some compost for their own use; such an initiative could be led in conjunction with the composting experience being developed at Denarau Island;
- The separate collection and treatment of some difficult solid waste, e.g. waste oil, batteries, WEEE, end-of-life vehicles, chemicals, agro-chemicals.

For recyclers:

- Clean-up operations for ferrous metal products: machinery to increase the density of the shipment should be brought to Fiji; the results of the pilot project should determine whether such machinery should be regularly based in Fiji or not;

For resorts:

- Collection scheme for the collection and the recycling of PET bottles using a deposit system: such a pilot project could be developed in conjunction with the hotel industry. The island of Nananu-I-Ra could be a perfect location for this pilot operation: several hotels and residences are situated on remote islands; these islands are far away from the main collection centres; the management of some resorts are ready to take part in such a project. The technical and financial contribution of all producers/importers of PET bottles will be needed.

For industries or any other large organisation:

- An integrated and systematic management of all types of solid waste produced by a system (e.g. an industrial park or a large organisation): such a project would bring technical, economical and sociological information on the appropriate management of all types of waste in a limited area. It would be one of the first (if not the first) implementation of the principles of Industrial Ecology, which are gaining in interest worldwide (see e.g. [12, 13]). Such an approach could also be coupled with the implementation of an environmental management system. The Laucala Campus of the University of the South Pacific would be the ideal location for such a pilot project: USP is a leading organisation in the region, the size of the campus is limited, many people live and work on the campus and all kind of

SW are generated. Such an approach could be based on the discussion paper presented in Appendix II.8.

Technical support

For recyclers:

- If the recyclable collection activity is to increase, recyclable collectors should be supported to acquire more efficient machinery (e.g. balers and compactors).

Training

For recyclers:

Some trainings should be organised for recyclable collectors so that:

- They use the best available techniques and practices to handle waste, including dangerous waste,
- They fully comply with Health & Safety regulations and sound environmental practice.

Awareness building

For the population:

Awareness campaigns in schools should focus on:

- The litter problem and health problems associated with SW,
- And on waste minimisation and recycling.

The curriculum could also be modified to integrate these issues in their classrooms.

Awareness campaigns for individuals should focus on the promotion of:

- The Recycling of valuable materials (e.g. paper, non-ferrous metals),
- The composting of green waste at home.

For the promotion of the recycling activity:

- Promote the activity of recyclable collectors and recyclers by emphasising the associated economic benefits; this promotion should focus:
    - Primarily on commercial and industrial organisations;
    - Secondly on individuals.
- Promote local products made of scrap metals on the local market.

For resorts:

Awareness campaigns targeting hotels should:

- Promote the good practices of SW management for all resorts;

These practices should:

- Be adapted to the type and the location of accommodations, i.e. upmarket / backpacker,

- Adapted to the local context,
- Include not only SW collection and disposal aspects but also waste minimisation and recycling aspects.

They could integrate examples of best practices observed in resorts in Fiji (cf. Appendix II.9).

Such awareness campaigns could be based on:

- Existing guidelines, for e.g. the guide produced by the Integrated Coastal Management Project [14]; this guide should however be adapted to the local context of each area and be more focused on new or foreseen recycling initiatives;
- Existing training programs, like the one promoted by the Department of Tourism.

Miscellaneous

- Recyclable collectors and recyclers should be associated with the regional landfill initiative.

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PART III

PRODUCTION AND MANAGEMENT OF WEEE IN THE FIJI ISLANDS

I. INTRODUCTION

More and more post-consumer products and "Difficult Solid Waste" (mainly imported products with an important hazard potential) can be found in the waste stream in SIDS. Considering their increasing quantities and their potential hazards, they require specific approaches to be dealt with.

There is today a global trend for product-specific approaches: after focusing on packaging and end-of-life vehicles, Europe and Japan have more recently focused on Waste Electric and Electronic Equipment.

This study is a preliminary analysis of the problems associated with Waste Electric and Electronic Equipment in Fiji

The summary of this part is presented in Fig.III.1.

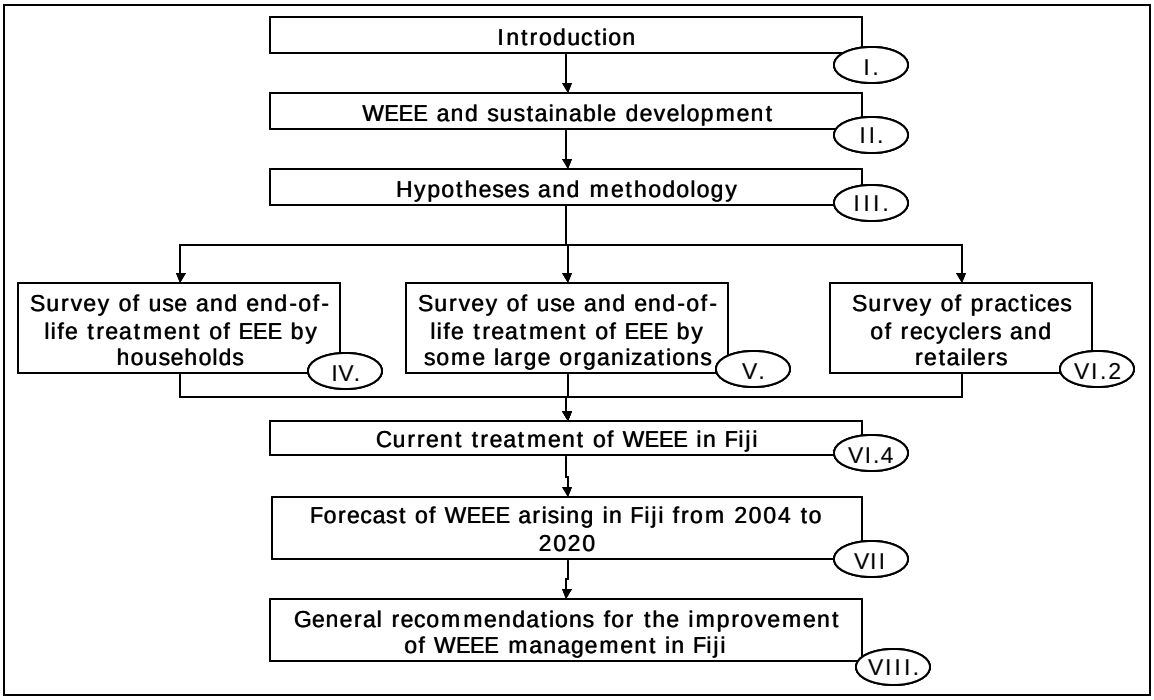

Figure III.1. Summary and organisation of the Part III of the report.

II. WASTE ELECTRIC AND ELECTRONIC EQUIPMENT AND SUSTAINABLE DEVELOPMENT

II.1. Relevance of the WEEE problem

Recently, the problem associated with Waste Electric and Electronic Equipment (WEEE) has been gaining interest among government, NGOs and customers. This type of waste is now targeted by numerous environmental policies worldwide: the national legislations of the Netherlands [1] and of Japan [2] and the European Directive on WEEE [3] in particular can be cited. The WEEE stream is under much scrutiny as it is a complex mixture of materials and components and because [4]:

- It is rapidly growing: in 1998, 6 million tons of waste electrical and electronic equipment were generated in Europe and represented 4% of the municipal waste stream; the volume of WEEE is expected to increase by at least 3-5% per annum; the growth of WEEE is about three times higher than the growth of the average municipal waste;
- It contain a large share of hazardous substances, and it can cause major environmental problems during the waste management phase if not properly pre-treated; as more than 90% of WEEE is landfilled, incinerated or recovered without any pre-treatment, it is widely acknowledged that a large proportion of various pollutants found in the municipal waste stream comes from WEEE;
- The environmental burden due to the production of electrical and electronic products by far exceeds the environmental burden due to the production of materials constituting the other sub-streams of the municipal waste stream. Consequently, enhanced recycling of WEEE should be a major factor in preserving resources, in particular energy.

II.2. Policies on WEEE in other countries

As stated above, a number of policies concerning WEEE are being developed worldwide. As it is often considered that Europe is a leader in policies concerning WEEE (see e.g. [5]), its recent legislation is described in this section.

The purpose of the EU legislation concerning WEEE [3] is, as a first priority, the prevention of WEEE and secondly its re-use, recycling and recovery. The main features of the legislation are:

- Separate collection systems should be set-up for private households and other EEE users; in particular, some collection targets (on average 4kg/inhabitant/year) should be reached by 2007;
- Some recycling systems using the best available treatment, recovery and recycling techniques should be set-up;
- Some specific recovery activities should be applied to WEEE: it includes the extraction and special treatment of hazardous components (e.g. batteries, printed circuit boards, cathode ray tubes) and some recovery targets per weight: for example, 75% of the weight of IT or consumer equipment should be either re-used, recycled or energetically recovered;

- Some specific financing arrangements should be set-up for WEEE coming from households and WEEE coming from commercial / industrial bodies;
- Producers/importers should make sure that equipment is designed in order for it to be easily dismantlable and recyclable.

As stated for example in [6] and [7], legislations on WEEE in Europe and Japan are expected to not only have environmental benefits: they should also have some positive impacts on the economic (facilitating the development of a dynamic secondary materials economy, a "recycling-based society") and social (creating an important number of jobs) spheres.

The WEEE legislation was passed in December 2003 and is currently brought into force by all member states. The WEEE legislation is a good example of an Extended Producer Responsibility approach, where producers/importers are partly responsible for the treatment of the end-of-life products. Other countries are planning to adopt similar legislation in the near future, in particular Australia [8].

II.3. Effects of WEEE on health and the environment

II.3.1. Review of literature available in the world

Many recent publications show the negative impacts of WEEE on the environment and on human health. According to [4], treatments applied to WEEE contribute to a number of health and environmental impacts. Some of them are summed-up in Table III.1 for each treatment option.

Table III.1. Summary on health and environmental impacts of several treatments applied to WEEE.

Treatment	Impact
Incineration	• WEEE contributes significantly to the emissions of heavy metals (Mercury, Cadmium) by incinerators; • Incineration of some substances contained in WEEE (e.g. brominated flame retardant) may lead to the generation of extremely toxic polybrominated dibenzo dioxins (PBDDs) and polybrominated dibenzo furans (PBDFs); • Incineration of WEEE has a negative energy balance; • After incineration, a great quantity of heavy metals is found in the residues.
Landfilling	• A number of substances contained in WEEE (e.g. brominated substances, heavy metals like cadmium or lead) can be found in the leachates after their landfilling; • In case of uncontrolled fire arising at the landfill, both metals and other chemical substances (e.g. extremely toxic dioxins and furans including tetrachloro-dibenzo-dioxin (TCDD) and polychlorinated and polybrominated dioxins and furans (PCDDs, PBDDs and PCDFs)) may be emitted.
Recycling	• Both dioxin and furans can be emitted during the recycling of WEEE.

II.3.2. In Fiji

A number of publications, for example [9], points out that "special waste" like Nickel-Cadmium and Lithium batteries contributes to heavy metal burdens in leachates in SIDS of the Pacific. Also, The Institute of Marine Resources highlights in a study the role of Lami Dump and other urban rubbish dumps on the concentration of heavy metals in Fiji ecosystems [10]. Some field studies carried out mainly by the University of the South Pacific have demonstrated the impact of rubbish dumps on the quality of the surrounding environment, especially on the concentrations of heavy metals. In particular:

- S. Chandra shows that the concentration of heavy metals in some areas of the Lami Dump exceed the so-called Dutch Standards and the land should therefore be considered as a "polluted area" [11];
- P. Gangaiya et al. show that high concentrations of heavy metals in the Lami foreshore actually comes from land sources, in particular from the Lami Dump [12].

Obviously, at the moment it is impossible to demonstrate the link between the concentrations of heavy metals in Fiji and the presence of WEEE in rubbish dumps. However, considering scientific work elsewhere in the world, it can be concluded that WEEE has some influence on the concentration of heavy metals around some rubbish dumps in Fiji.

II.4. WEEE treatment and social issues

Some recent reports (e.g. [13]) have shown that a great quantity of WEEE collected in developed countries is exported to Asia (mainly China, India and Pakistan) for treatment and recycling: "50 to 80 percent of the WEEE collected for recycling in the USA is not recycled domestically, but very quickly placed on container ships bound for destinations like China" [13]. This is linked to cheaper labour and to lack of environmental and occupational standards in Asia. In Asia, WEEE "are dismantled and treated using very poor practices: this includes open burning of plastic waste, exposure to toxic solders, river dumping of acids, and widespread general dumping. Such practices expose the men, women, and children of Asia's poorer people to poison" [13].

Therefore, great care should be taken when setting up a collection and recycling system for WEEE.

II.5. Relevance of a study on WEEE in Fiji

Considering:

- The scarcity of final disposal sites in Fiji and their very limited standards of operation,
- The recognised impacts of WEEE on health and the environment described in the literature,
- The suspected increase of the use of EEE in Fiji,

Waste Electric and Electronic Equipment have to be seriously considered in Fiji.

Also, like elsewhere in the world, the collection and recycling of WEEE could have some positive impacts on the economy and the society in Fiji. The contribution to

the development of secondary materials results in an economy that could increase employment opportunities.

III. HYPOTHESES AND METHODOLOGY

III.1. Targeted products

For this study, the definition of Waste Electric and Electronic Equipment as it is defined in the European legislation [3] is adopted. This definition is widely recognised and used, for example in Australia [8].

According to EU definition, “waste electrical and electronic equipment means electrical or electronic equipment which is a waste; waste electrical and electronic equipment includes all components, sub-assemblies and consumables, which are part of the product at the time of discarding” [3].

The EU legislation includes an exhaustive list of equipment (in Annex 1B of WEEE Directive). However, due to the short duration of the study, and considering that Fiji is a developing country (many products, e.g. toys, medical equipment, covered by WEEE EU-Directive and Japanese legislation are not very common here), it was decided to consider a smaller number of relevant items. So, for the present study, WEEE include:

- Large household appliances: cooling appliances (e.g. fridge), washing machines, stove, micro-waves, dish-washers, air conditioning appliances,
- Small Household Appliances: irons, blenders, toasters,
- IT and Telecommunications equipment: computers, printers, facsimiles, telephones, cellular phones, copiers,
- Consumer equipment: radio sets, TV-sets, video/DVD player, Hi-Fi equipment.

According to some studies that include some collection trial (e.g. in Ireland [14]), these four categories of products cover up to 94% of the weight of the WEEE stream.

III.2. Targeting different sources of information for the study

III.2.1. Sources of information

At the beginning of the project, very limited information concerning WEEE in Fiji was available. This project being a preliminary analysis of the WEEE problem, the consulting team decided to collect information from all possible stakeholders, in particular FIRCA, retailers and importers, institutional users, individual users and recyclers.

For such an approach, several questionnaires were developed and data was collected. Most of the data collected concerned EEE and not WEEE, thus it had to be treated in order to produce valuable information regarding WEEE in Fiji.

The Fig. III.2 below sums-up the steps taken for the study.

The list and contacts of persons consulted for this study and who accepted to be cited is given in Appendix III.8.

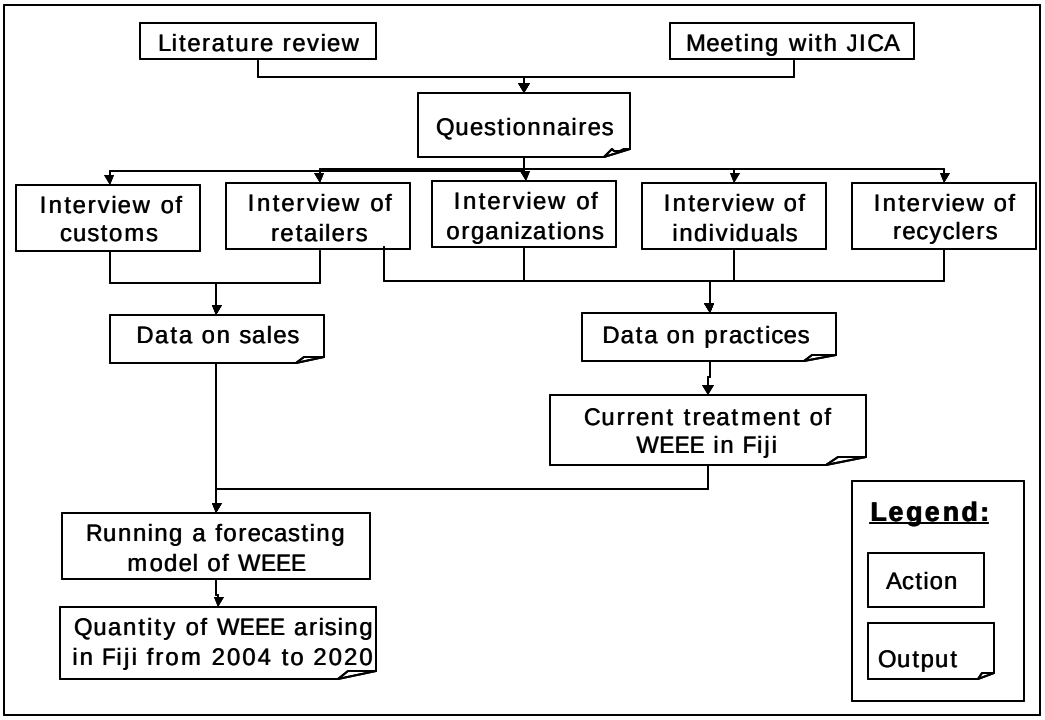

Figure III.2. Graphical representation of the methodology adopted for this study.

III.2.2. Implication on the representativeness of the results

Considering that the surveys led among individual users, institutional users and retailers:

- Were mainly based on “random sampling” with a low social representativeness,
- Were mostly led in the capital city Suva,

the results obtained can hardly be considered as fully representative of the situation in the Fiji Islands and have therefore to be handled with care.

IV. USE OF EEE USE BY HOUSEHOLDS AND CURRENT END-OF-LIFE TREATMENT

IV.1. Methodology

For our study, some quantitative and qualitative data concerning the use of EEE by households was needed. It was thus decided to lead a survey on the use and the end-of-life treatment of EEE in households in Fiji using the questionnaire presented in Appendix III.1. Twenty questionnaires were filled-in by individuals of three classes of households: lower, middle and upper class.

The survey was led in February and March 2004 by a project officer visiting houses in different areas of Suva: the classification of data among "lower" and "upper" class was done according to the officer's knowledge of the surveyed areas and to the external appearance of the households. For the middle class, data was collected on USP Laucala Bay Campus when surveying some students: after checking that the surveyed student was actually from middle class (when asking where he/she was living), the questionnaire was completed. The places of data collection were:

- For lower class: Nabua, Raiwai, Raiwaqa, Toorak, Vatuwaqa;
- For middle class: USP Laucala Bay Campus, with answers from people living in Caubati, Cunningham, Nausori, Samabula;
- For upper class: Bay View Heights, Domain, Fletcher Road, Muanikau, Nadera and Namadi Heights.

The sampling can therefore be qualified as "random sampling".

IV.2. Results

Results of the survey are presented in Table III.2 below.

Table III.2. Summary of the results concerning the use and the end-of-life treatment of EEE by households.

		Lower class	Middle class	Upper class
Weight of equipment in use (kg/person)		25	30	63
Weight of equipment discarded annually (kg/person/year)		1.3	2.3	2.5
Disposal behaviour (% of numbers of items)	**Share of equipment given for re-use**	28	32	42
	Share of equipment given for recycling	0	0	0
	Share of equipment given for disposal	72	68	58
Average duration of storage in backyard (years)		2		

IV.3. Discussion on the results

The results presented in Table III.2 give some good insight of the practices of households. Some collected quantitative data (e.g. share of re-use, duration of storage) will be used later in the study.

The main comments that can be drawn from the data collection are as follows:

- The higher the class, the greater the consumption of EEE: it varies from 25kg of EEE in use per person for the lower class to 63 kg of EEE in use per person for the upper class;
- The higher the class, the greater the rate of buying new equipment;
- The higher the class, the greater the production of WEEE: the annual production of WEEE varies from 1.3 kg/person for the lower class to 2.5 kg/person for the upper class;
- In the upper class, the share of equipment given for re-use at their end-of-life is high (around 42%) and this share decreases in lower classes; it suggests the existence of some "re-use loops" where equipments coming from upper classes are re-used by people of lower classes.

The existence of re-use loops of EEE in Fiji is qualitatively summarised in the qualitative flow diagram presented in Fig. III.3. In this graph, the thickness of the arrow is indicative of the size of the flow of EEE; however, the graph is qualitative and no scale for the size of the flow of EEE is used.

The "re-use loops" mainly come from upper class to middle and lower classes, and from middle class to lower class. The flow of WEEE leaving upper and middle classes towards landfill should be smaller than the flow of EEE entering the classes from retailers ($F_{UC2} < F_{UC1}$; $F_{MC2} < F_{MC1}$). Since most of the EEE for lower class comes from both high and middle class, the flow of WEEE leaving lower class towards disposal might be larger than the flow of EEE entering the class from retailers ($F_{LC2} > F_{UC1}$).

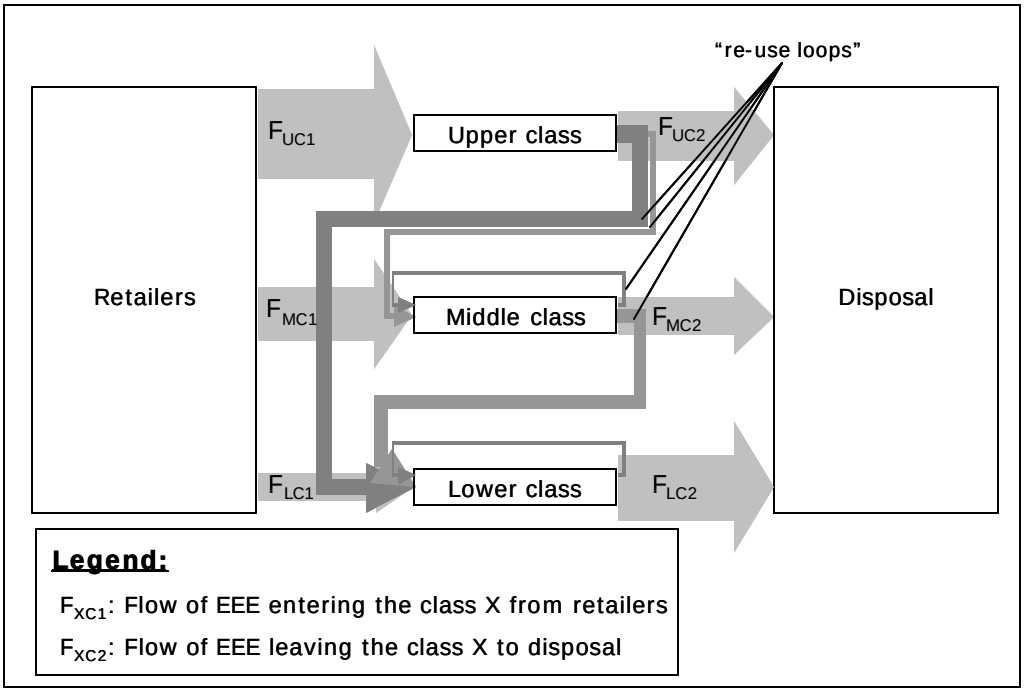

Figure III.3. Qualitative flow diagram for EEE in Fiji.

V. USE OF EEE BY SIX ORGANISATIONS AND CURRENT END-OF-LIFE TREATMENT

V.1. Introduction

Historically in developed countries, large governmental and commercial bodies have always played a key role in the setting-up of efficient recycling systems for WEEE, even before the existence of any policy: for example, Siemens and Digital Equipment in Europe, Sony and Ricoh in Japan have set-up some recycling facilities to recycle their own equipment and the equipment from their large customers. This phenomenon can be explained as the result of:

- The economy of scale of collection as larger users regularly change their stock of IT equipments,
- The financial capacity of the organisation to face the cost of the end-of-life recycling,
- The desire to show a good example to the public.

It is believed by the consulting team that the situation could be the same in Fiji and this is why some organisations were consulted on this issue.

V.2. Quantities of WEEE arising each year from the organisations and forecasted disposal costs

V.2.1. Methodology

In order to assess the size of the WEEE problem for large governmental and commercial bodies and to know better current practices, a survey was conducted on the use of IT equipment (computers, printers, copiers, fax, telephone) in some large organisations. The survey was led through face-to-face or telephone interviews using the questionnaire presented in Appendix III. 2. Five governmental and intergovernmental bodies and two commercial bodies were surveyed. Only one commercial body answered the questionnaire.

V.2.2. Hypotheses

The quantity of waste IT arising each year from each organisation is derived from the number of IT equipment currently in use by the following relationship: The quantity of waste IT produced is considered equal to the total weight of each type of IT equipment in use (year 2004) divided by the lfe expectation of each type of equipment (in years). Such a calculation can be considered as “static” as it does not integrate the annual growth of purchasing IT.

Also, in order to have some insights on the costs that could be implied by the management of end-of-life equipment, the number of units of each type of product arising every year as waste is multiplied by the cost of disposal as it is applied in Europe. The costs associated with the collection, sorting, transport and recycling of discarded appliances as they are calculated in Belgium, a country quite ahead on this issue was used: the data was found on [15]. Since such costs have not incurred in Fiji yet, it is called “potential cost” in this report.

Data used concerning the weight, life expectancy, costs of disposal of each type of IT equipment and the number of employees of each organisation are presented in Table III.3. This data is a mix of information collected through interviews with information collected from literature review (in particular [16-18]).

Table III.3. List of parameters used to calculate the quantity of WEEE arising from 6 organisations in Fiji.

	Type of Equipment	PC	Laptop	Workstation	Printer	Fax	Copier	Telephone	Number of Employees/ Users of IT Equipment
Weight (kg)		25	5	40	10	10	100	1	
Lifetime (year)		5	5	5	5	5	5	10	
Cost of Disposal (F$)		6	4	6	4	4	6	1	
Number of Items in use in 6 organisations	1 (G)*	3150	350	60	300	89	222	18000	18000
	2 (I)	80	20	10	30	10	15	100	80
	3 (I)	60	20	6	15	2	5	70	70
	4 (I)	150	30	5	25	7	10	112	110
	5 (I)	2400	100	30	241	74	200	600	12200
	6 (C)	550	10	30	600	30	30	600	550

*G: governmental body; I: intergovernmental body; C: commercial body

V.2.3. Results

Computed quantities of Waste IT equipment arising from each organisation are presented in Fig. III.4. Potential costs associated with their end-of-life treatment are also computed.

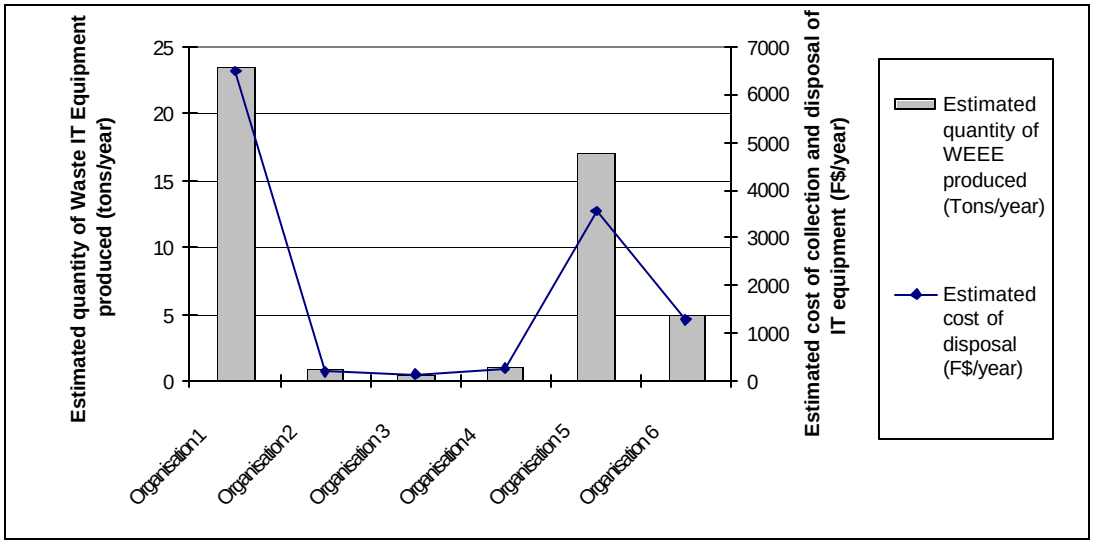

Figure III.4. Estimated quantity of Waste IT equipment arising each year from seven large organisations in Fiji – Computed associated costs covering collection and recycling of the equipment considering prices offered in Belgium.

V.2.4. Discussion on the results

The total annual quantities of waste IT equipment arising from these six organisations (estimated to a maximum of 50 tons per year) are not very high and would hardly require the development of a specific recycling activity. In comparison, recycling operations for IT equipment treats at least 2000 ton/year in Europe to reach the required economy of scale. However, this quantity is not negligible: if the recyclable collectors described in IV.2 of Part II collected the WEEE from these organisations, it would represent around 1% increase of their activity.

If prices of collection and disposal from Europe were applied, the cost for these organisations would be significantly high: in particular, Organisations 1 and 5 would have to allocate over six thousand dollars and over four thousand dollars per year respectively: this would represent a non negligible amount of money for these organisations.

The two most important organisations in terms of production of WEEE are in fact the two most important in terms of number of people.

It needs to be pointed out that although Organisation 1 and Organisation 5 produce the most WEEE, the quantity of WEEE produced annually per user is still very low (cf. Fig. III.5): this is linked to the fact that not every user is well equipped.

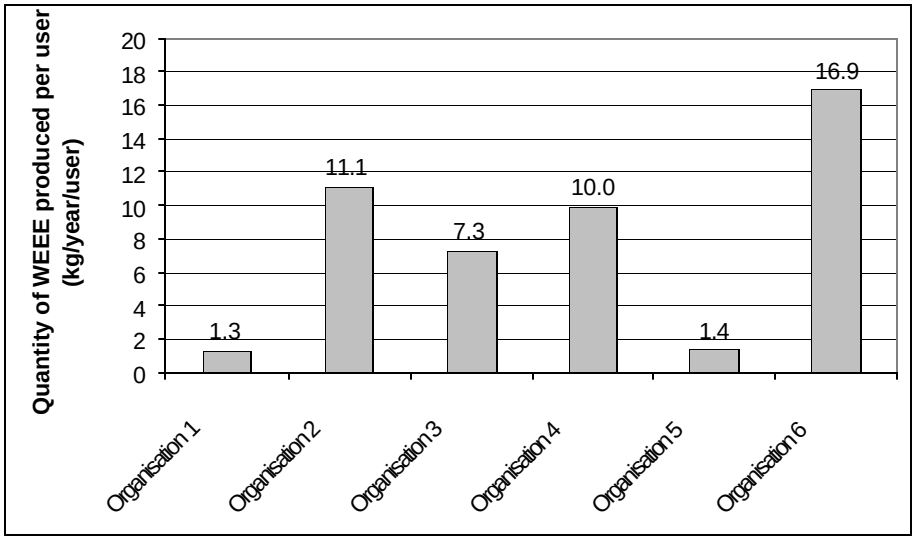

Figure III.5. Average weight of Waste IT Equipment produced per employee in six organisations in Fiji.

During the interviews, Organisations 1 and 5 stated that in the years to come the growth rate of purchasing IT equipment would be considerably high, to meet the requirements of users. Such a growth might increase the extent of the problem (and of the costs) of the end-of-life treatment of IT equipment.

The other organisations do not foresee major increase in IT equipment purchase, as each user is generally well equipped: increase in purchasing IT equipment is usually proportional to the increase in the number of staff.

V.3. Current practices of disposal in these organisations

During the interviews, it was possible to collect some qualitative data on the ways these organisations dispose their Waste IT equipment.

For all the organisations surveyed, when IT equipment reaches its end-of-life, it is:

- Usually stored internally; the duration of storage varies between 1 and 2 years;
- Then,
    - Either sold to employees, individuals or companies during auctions,
    - Given to schools or NGOs,
    - Recycled internally as components are re-used for other equipments,
    - Given to scrap collector for recycling; this option is usually very limited,
    - Or collected by waste collectors for disposal at the landfill.

However, no quantitative information on the amount of IT equipment oriented to each of these routes was collected.

A few people witnessed that Waste IT have sometimes been buried in the backyard of the organisation.

V.4. Willingness to assume the responsibility of the end-of-life of the products

To the questions C(b) of the questionnaire, most of the organisations answered “surely” or “maybe”: as “good corporate citizens”, they might indeed be ready to financially assume the disposal of the Waste IT.

The exact results of the survey on this question are presented in Fig. III.6.

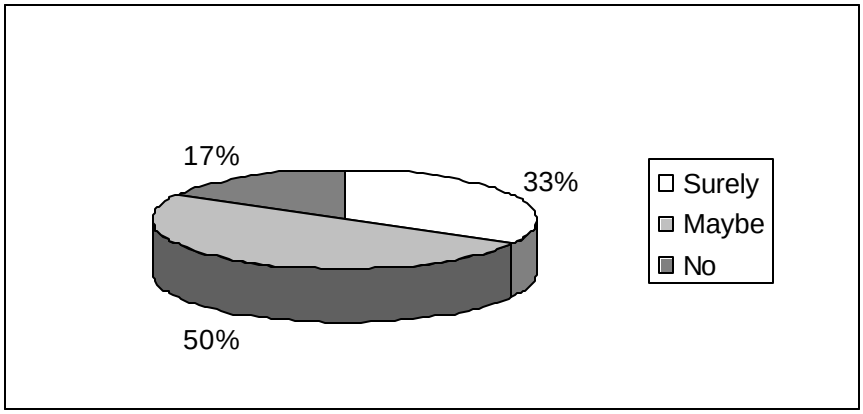

Figure III.6. Result of the question C(b) of the questionnaire for six organisations.

Organisations that answered ‘maybe’ to the question point out that:

- It would depend upon the price of the disposal,

- They would adopt such a practice if the recycler guaranteed that their recycling company have proper and environmentally sound practices.

The company that preferred not to assume financially the disposal of the Waste IT equipment stated that they would rather give it to schools or communities.

One organisation points out that, if such a cost for the disposal had to be supported at the purchasing stage by the new owner, it should be considered as a "disposal tax". Hence, this tax would conflict with the current trend on IT equipment in the Pacific where a 0% duty is often observed in order to facilitate the access of information technology to the population.

V.5. Trends in the production of Waste IT equipment for one organisation

V.5.1. Introduction

It can be foreseen from Fig. III.5 that the increase in the purchase of IT equipment in some organisations might be high in the next years as they will catch up with user rate per employee observed in other governmental organisations. Also as some re-use activity of obsolete equipment takes place in some organisations, it should be considered when conducting forecast of quantity of WEEE.

In this paragraph, a forecast of Waste IT equipment produced by one organisation in Fiji is computed from 2004 to 2020. On top of the life expectation of equipment that was already introduced in section V.2, two new factors that influence the production of WEEE are introduced:

- The variable annual growth rate of purchase of IT equipment by the organisation,
- Re-use loops and storage practices.

To integrate these important factors, the consulting team modified a prediction model called Carnegie Model [19, 20] and adapted it to the Fiji context. A synthetic presentation of the Carnegie Model and its adaptation to the Fiji context is presented in Appendix III.3.

V.5.2. Hypotheses and methodology

The prediction of Waste IT equipment is only computed for Organisation 5, as enough accurate data is only available from this organisation. According to the purchasing office of Organisation 5, an annual growth rate of 15% has been observed for the purchase of IT equipment from 1996 to 2003. It is considered that such a growth rate will be observed until a saturation rate is reached, when the growth will be nil. The saturation rate is chosen equal to the average use of IT equipment in Organisations 2,3,4 and 6, i.e. 47kg of IT equipment per user. After [21], the decrease in the growth from 15% to 0% is evenly distributed during six years.

Life expectations, weights and costs of disposal of each type of equipment used in the model are presented in Table A.III.2 in the Appendix III.4.

Using the amount of IT equipment being used in 2004, the amount of IT equipment purchased from 1999 to 2004 was determined. More information on this issue can be found in Appendix III.4.

In Organisation 5, when obsolete, 30% of IT equipment is sold to individuals for further re-use. The remaining 70% of the equipment is usually stored for one year and then disposed.

V.5.3. Results

The forecasted amount of waste IT equipment produced and to be handled by Organisation 5 from the year 2004 to 2025 is computed in Fig. III.7.

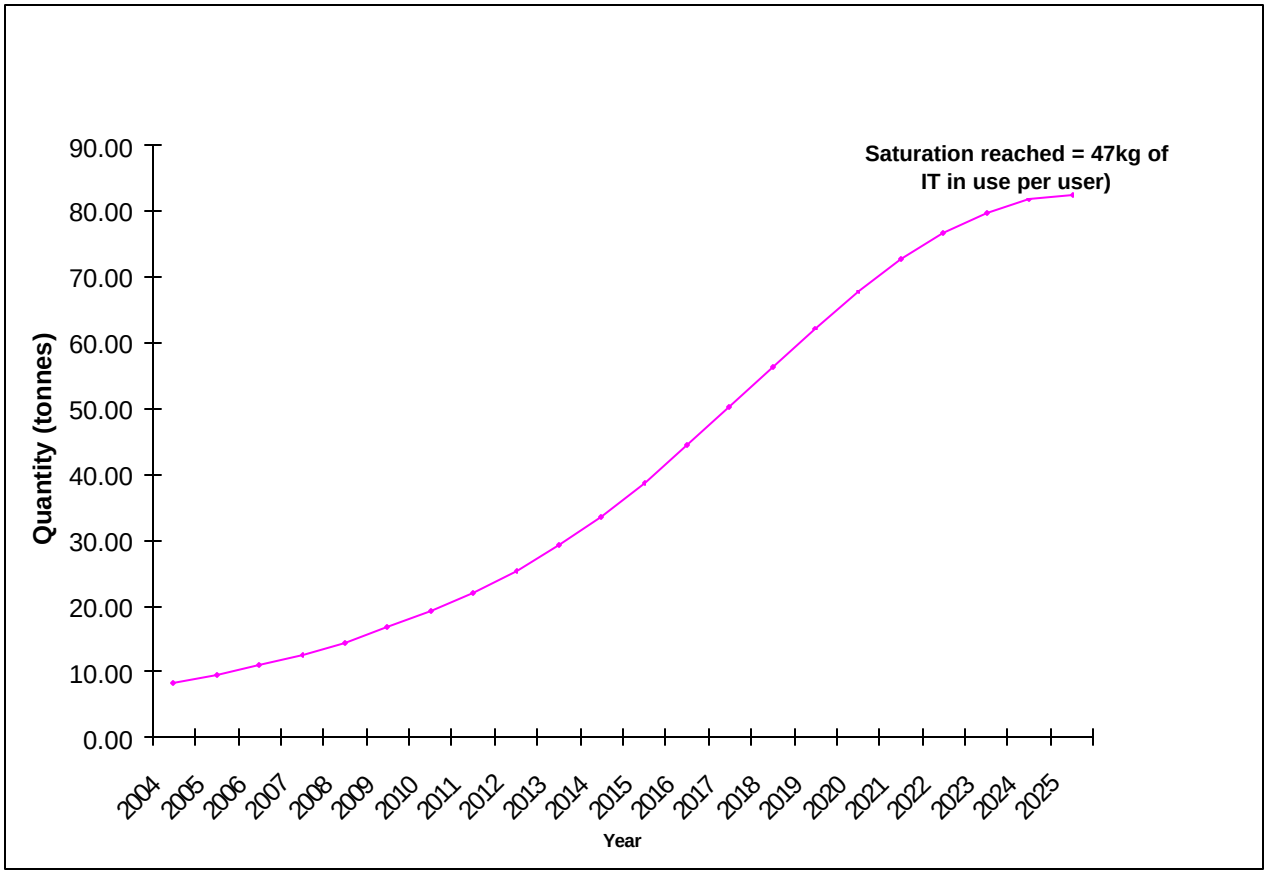

Figure III.7. Forecast of the quantity of Waste IT equipment arising each year from Organisation 5 considering variable annual growth rate of purchasing.

V.5.4. Discussion

Fig. III.7 shows that the current increase of purchasing IT equipment reflect an exponential growth of the amount of Waste IT equipment produced and to be managed by Organisation 5 until 2015. Then, the curve should be transformed in a "S-shape" curve and should reach a maximum in 2025. The potential costs associated of the disposal of WEEE should follow the same curve. It is forecasted that Organisation 5 will produce around 68 tons of WEEE annually in 2020 and 82 tons in 2025.

These results have two main implications:

- Waste IT will more and more become a critical (and probably expensive) problem for large organisations with increasing purchasing rates;
- Increasing quantities will more and more justify the setting-up of separate collection systems and treatment for WEEE.

VI. CURRENT TREATMENT OF WEEE IN FIJI

VI.1. Introduction

As stated earlier, very little information was available on the production and current treatment of WEEE in Fiji. The surveys that were led among individuals, institutional users, retailers and recyclers provide enough information on the current treatment received by WEEE in Fiji. It is described in this part.

VI.2. Summary of the information collected from households and organisations

Although the surveys concern mainly the use and the practices of EEE and IT equipment by households and some organisations, they give some answers on the way EEE are managed when they reach their end-of-life.

WEEE is usually stored for some time then:

- Re-used by others: this concerns quite a significant share of the stream;
- Recycled internally (i.e. reuse of some components for other purposes);
- Recycled by scrap metal recyclers: this route seems very limited;
- Or landfilled: this route seems to represent the biggest share of the WEEE stream.

VI.3. Collection and treatment of WEEE by recyclable collectors

The three largest recyclable collectors in Fiji were consulted to know if they collected any WEEE, and to better understand their treatment practices. This survey was completed using the questionnaire presented in Appendix III.5.

VI.3.1. Current activity of recyclable collectors

Recyclable collectors collect and treat **a lot** of air-conditioning systems as part of the scrap metals they collect from industries and households. They usually dismantle the systems and sort ferrous and non-ferrous metals.

However, they collect very limited number of other WEEE. **Sometimes**, some companies give them some old IT equipment, for e.g. computers (see Fig.III.8): they usually dismantle these products, extract valuable materials (e.g. copper cables, aluminium casing and printed circuit boards), which are re-sold and dump the remaining materials.

One collector pointed out that they do not accept WEEE like fridges, as the company they work for usually does not handle equipment with fluids.

According to all the recyclable collectors, WEEE is currently being landfilled in large quantities (cf. Fig.III.9).

(a) (b)

Figure III.8. Some WEEE stored at a recyclable collector plant in Fiji – (a) end-of-life steel dominated equipment (b) end-of-life computers.

VI.3.2. Future activity

All surveyed recyclable collectors stated that they would definitely be very interested in the market of WEEE in Fiji and argue that they would be key players in their treatment as:

- They have the knowledge of outlet routes for valuable materials,
- It is part of their activity to dismantle products and sort valuable materials.

However, they pointed out that they would need some training to better handle these complex and sometimes dangerous goods.

Pointing-out that there is today a global market for WEEE (cf. [22]), one waste collector suggested that his role would be to collect and group the WEEE and to ship them overseas where they would be dismantled and recycled.

Also, considering that only a small share of materials of WEEE is valuable and a great share is either inert waste (e.g. plastics) or dangerous waste (e.g. Cathode Ray Tube, plastics with flame retardant) that need to be properly handled, all waste collectors made clear that the proper disposal of WEEE would cost money to the last owner. They then suggested two options:

- Either a treatment and disposal paid by the last owner,
- And/or a storage and treatment warehouse subsidised by the government.

VI.4. Activity of retailers concerning EEE sales, WEEE collection and treatment

VI.4.1. Selling information

Through information communicated by some retailers, it was possible to find out that:

- All EEE comes from overseas countries, in particular from Asia;

- The share of products manufactured by Japanese companies are high for washing machines, air conditioning systems, stove / microwaves, computer and printers, radio-set, TV-set, video and DVD players, Hi-Fi and copiers;
- 55% (for consumer equipment) to 80% (for IT equipment) of the products are sold in the main cities Suva and Lautoka;
- Very few customers have requirements concerning environmental performances of products; the most important environmental criterion for customers seems to be the energy consumption.

VI.4.2. Take-back information

It was possible to obtain the following information from retailers:

- Several retailers of EEE have some repair centres for EEE in Fiji; thanks to these centres, the life expectation of equipment is extended;
- Very few customers ask retailers to take-back their end-of-life equipment;
- Some trade-in facility is arranged by some retailers (in particular Retailer 1) for customers to purchase new sets: all equipment collected by retailers is dumped at the Lami dump;
- Only one company (Retailer 4) declared having a “zero landfill” policy, according to the environmental policy of its parent company: none of its equipment should be landfilled; instead, it should be sent to Australia for remanufacturing and recycling; however, as its operation is recent in Fiji, the company acknowledged not having faced any take-back of equipment so far;
- Most of the retailers would be ready to play a role in the take-back of end-of-life EEE that they put on the market.

VI.5. Conclusions on current treatment of WEEE in Fiji

After consulting the main stakeholders that could be involved in WEEE collection and treatment, it is possible to have a clearer idea of the current treatment of WEEE in Fiji. In Fiji, WEEE is usually:

- Stored internally; the duration of storage varies between 1 to 2 years in organisations and 2 years for individuals;
- Then,
    - Sold or given to other persons for re-use: the share of re-used equipment varies strongly between organisations; and for individuals, it was assessed and gave an average of 34% (see Table III.2); after re-use, WEEE must be mainly oriented to landfill;
    - Recycled internally as components are re-used for other equipments,
    - Given to scrap collector for recycling; this option seem very small,
    - Or disposed at the landfill (as shown on Fig. III.9): this option seems the most common.

Figure III.9. Photograph of a part of a WEEE (probably a VCR) seen at the Vunato rubbish dump in Lautoka.

Fig. III.10 summarises this situation in a qualitative flow diagram of WEEE in Fiji. In this graph, the thickness of the arrow is indicative of the size of the flow; however, no scale for the size of the flow of WEEE is used.

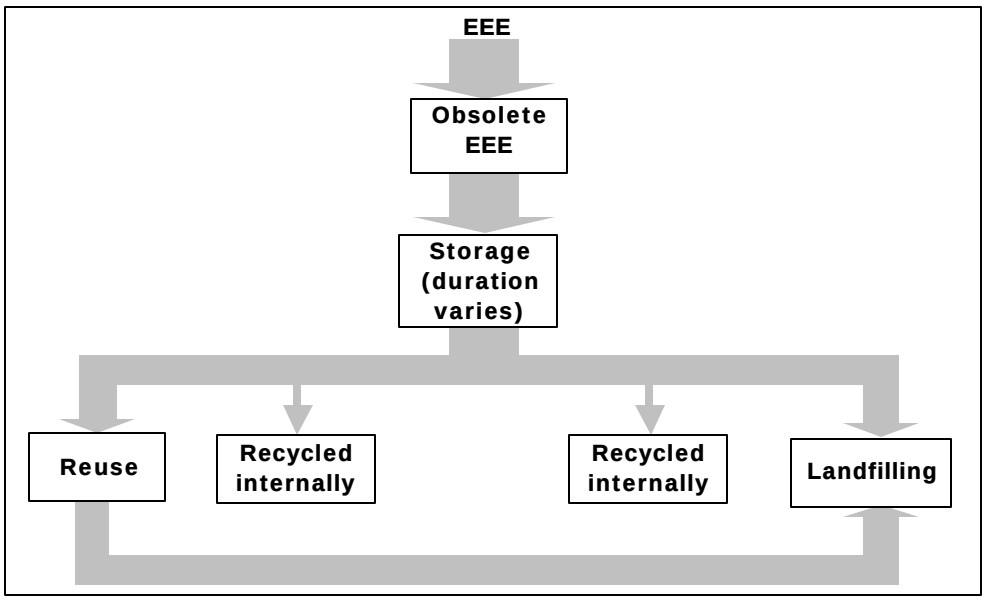

Figure III.10. Qualitative flow diagram of WEEE in Fiji.

VII. FORECAST OF WEEE ARISING IN FIJI IN THE NEXT 16 YEARS

VII.1. Introduction

This study aims to determine the quantity of WEEE and its constituents that would be available for take-back and recycling in Fiji from 2004 to 2020. It makes it possible to emphasise:

- The growing importance of the WEEE problem due to constant growth in the selling of this equipment;
- The impacts of the re-use and storage of obsolete equipment on the quantity of WEEE available for take-back;
- The role that WEEE could play in the development of some recycling activity in Fiji.

VII.2. Methodology & hypothesis

VII.2.1. Forecast model used

To carry out this study, the Carnegie Model was adapted to the Fiji context with a lot of modification. The Carnegie model has been widely used worldwide to predict the amount of WEEE arising in countries. In particular, it has been used to predict the amount of WEEE produced in Ireland (cf. [23]). More information on the Carnegie Model and its adaptation to the Fiji context can be found in Appendix III.3.

VII.2.2. Data used to run the model

Data on sales of EEE was collected from two sources:

- The Fiji Island Revenue and Customs Authority (FIRCA), with data collected from their import database;
- Some retailers, through interviews using a questionnaire.

For each source of data, a three-step approach was adopted:

- Step one: acquiring sales/import data,
- Step two: applying the modified Carnegie Model,
- Step three: calculating material arising from the waste stream.

Step one: acquiring sales & import data

Identified retail companies were sent the questionnaire presented in Appendix III.6 in order to collect the relevant information on retail sales of EEE in Fiji. The questionnaire was sent to the most prominent retailers of EEE in Fiji. Among the 17 retailers initially consulted, 8 have answered the questionnaire after repetitive reminders by fax and phone. The annual sales for the year 2003 were collected, as well as the companies' growth rate from the answered questionnaires. The information communicated by retailers has been quite consistent for the quantity of EEE put on the market and for the annual growth rates.

FIRCA gave information on the sum of EEE imported from 2002 to 2003. Using the constant growth rate obtained from the retailers, the presumed import of 2002 was calculated, as shown in Appendix III.7. As no growth rate of imports of EEE was collected from FIRCA, the constant growth rate communicated by retailers was used also for the model for FIRCA.

Step two: applying the modified Carnegie Model

Each subcategory of WEEE has associated parameters that were used for the model; these are stated in Appendix III.7 in Table A.III.3.

Cellular Phones were an exception for the application of standard growth rates. In Fiji, cellular phones were introduced in 1994 and from then a rapid growth took place (+23% of annual growth). According to Vodafone, the market is predicted to reach saturation in the year 2005, hence a lower growth rate (4%) is applied from 2005 to 2020.

Using the required data, the modified Carnegie Model is used to calculate the quantity of WEEE that is produced and will be produced in Fiji by the year 2020.

Step three: material Composition of WEEE

According to several studies, in particular [14], WEEE are composed of five categories of materials: ferrous metals, non-ferrous metals, glass, plastic, and “other”. Appendix III.7 in Table A.III.4 states the percentage composition in weight of each category as can be found in the literature. This composition is applied to the quantity of WEEE produced in Fiji each year.

VII.3. Results of the modelling

VII.3.1. Forecast of quantity of WEEE arising in Fiji from 2004 to 2020

The forecasted quantity of each subcategory of WEEE that should arise in Fiji by 2020 is computed in Fig. III.11 and Fig.III.12 using respectively data communicated by FIRCA and data communicated by retailers.

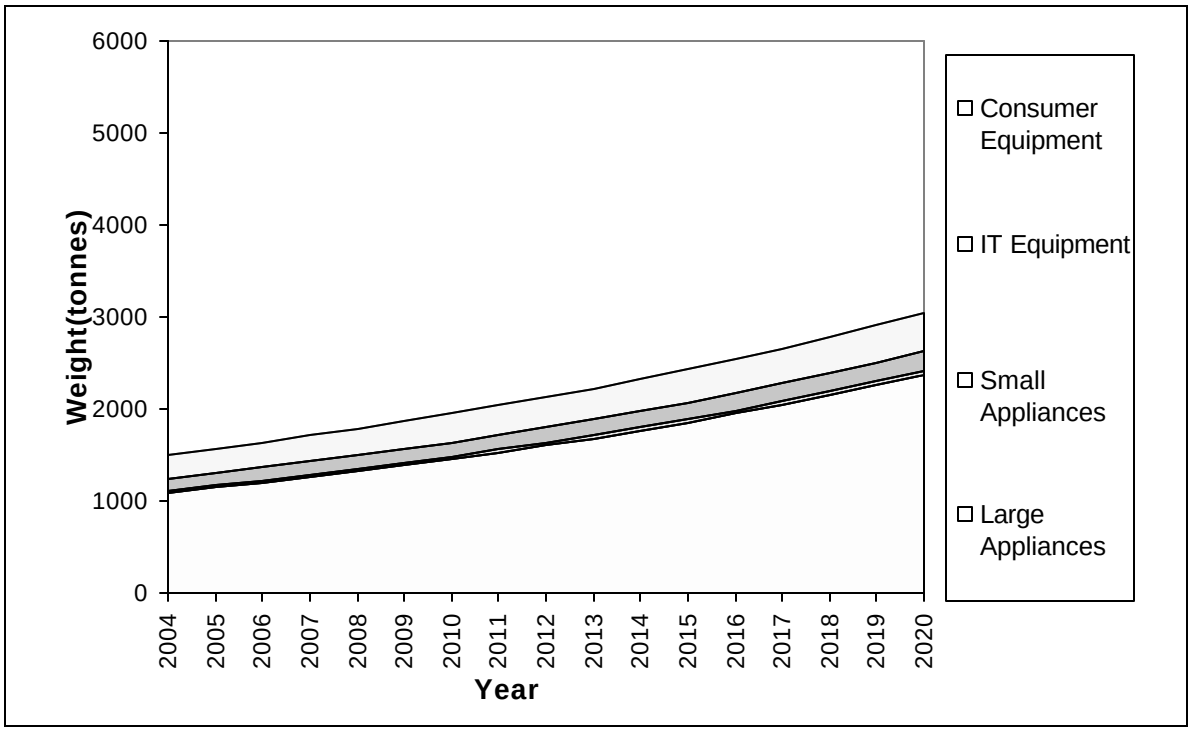

Figure III.11. Forecast of quantity of WEEE arising in Fiji from 2004 to 2020 (data from FIRCA).

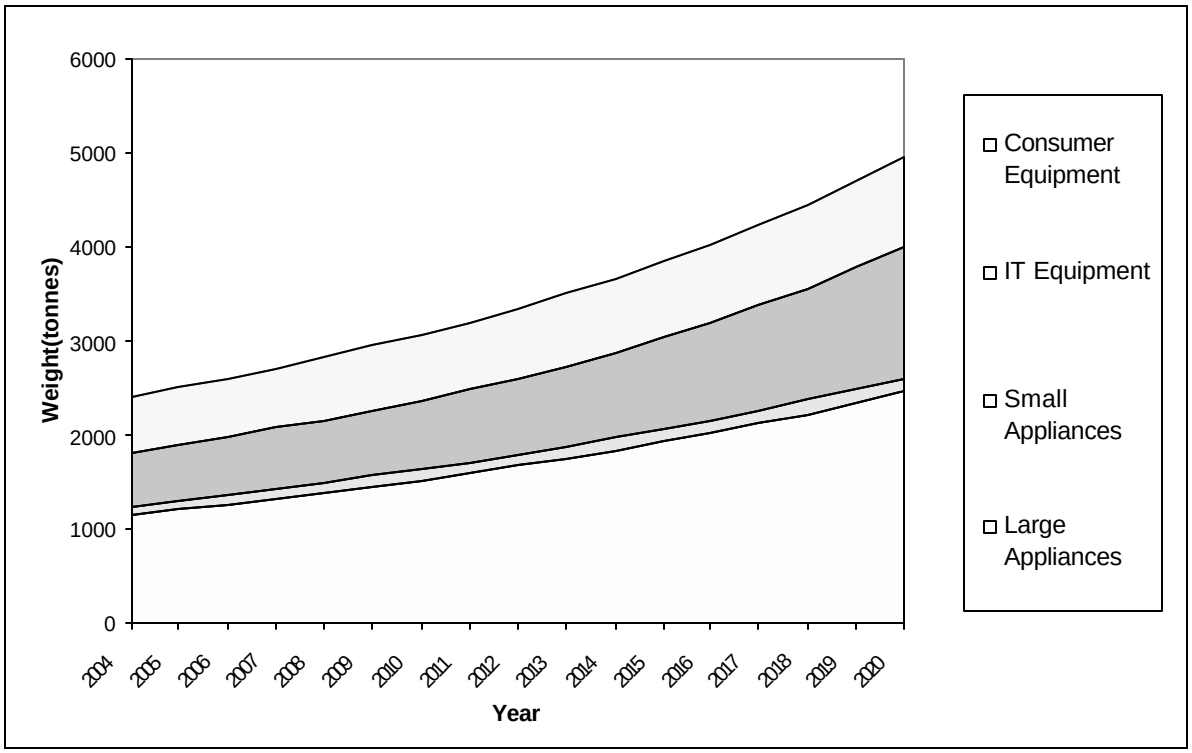

Figure III.12. Forecast of quantity of WEEE arising in Fiji from 2004 to 2020 (data from some retailers).

The comparison of these quantities of WEEE is presented in Fig. III.13.

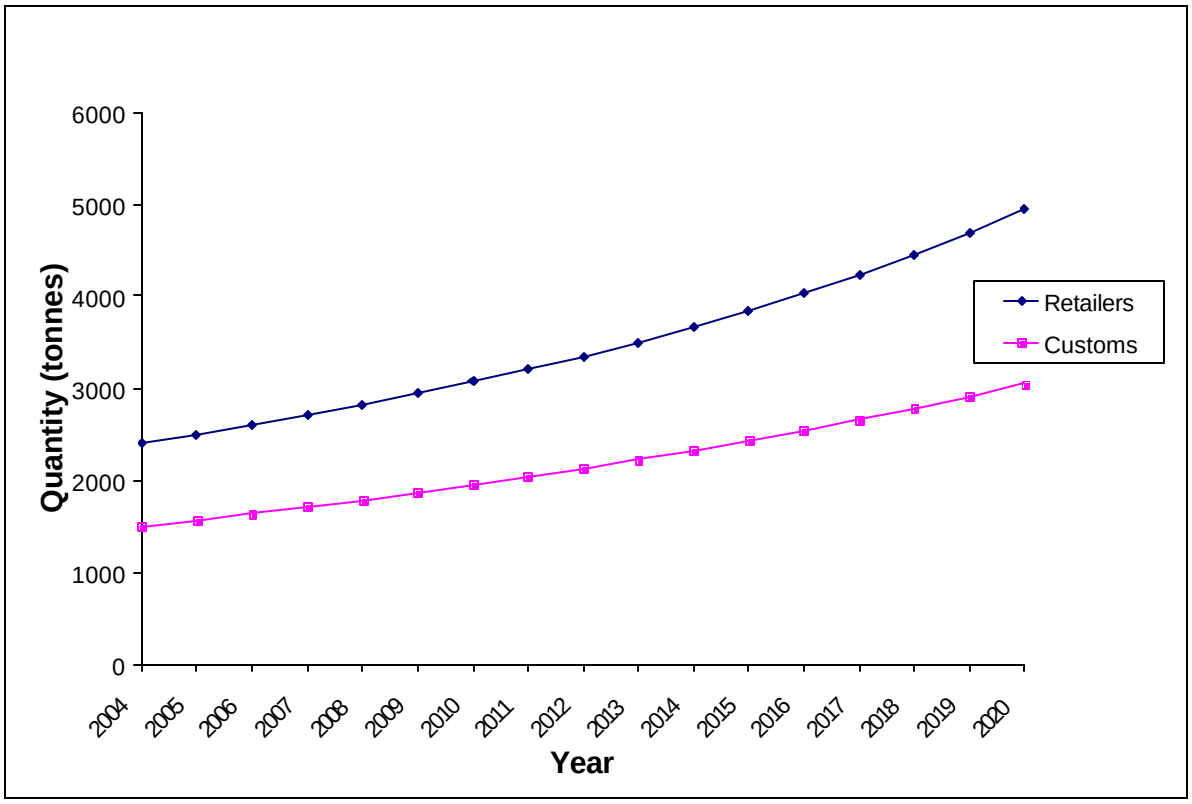

Figure III.13. Comparison of the forecasts of total quantity of WEEE arising in Fiji from 2004 to 2020 for data obtained from FIRCA and data obtained from some retailers.

VII.3.2. Annual generation rate of WEEE per person

Introduction

Raw data might not be very easy to interpret, as it is not comparable to other countries. However annual generation rate of WEEE is, thus it can be used as a yardstick.

Hypotheses

The quantities of WEEE calculated above are divided by the population of Fiji. For this, it is considered that the population of Fiji was 775,077 in 1996 and will have until 2020, a constant annual growth of 0.8%, as stated in [24].

Results

The average generation rate of WEEE per person and per year in Fiji is presented in Fig. III.14 for data collected from FIRCA and from retailers.

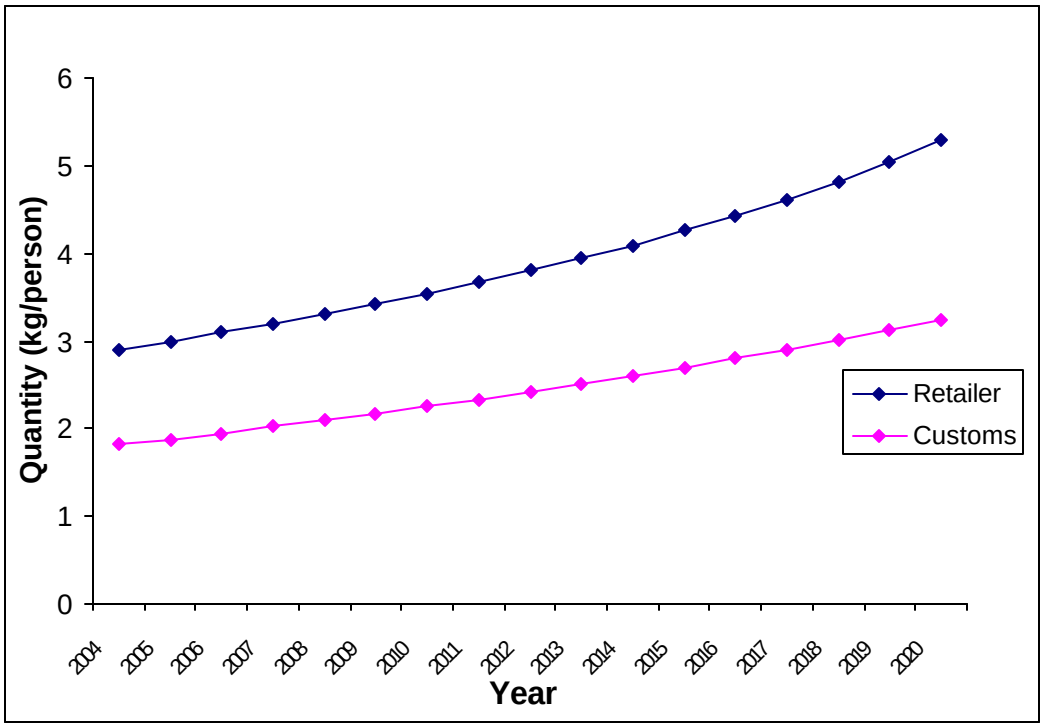

Figure III.14. Comparison of the generation rate of WEEE from 2004 to 2020 for data from FIRCA and data from some retailers.

VII.3.3. Forecast of quantity of materials arising in Fiji from WEEE from 2004 to 2020

Using the average material composition of WEEE given in Appendix III.7 Table A.III.4., the forecasted quantity of each material constituting WEEE to be produced in Fiji until 2020 is computed in Fig. III.11 and Fig.III.12 using respectively data communicated by FIRCA and data communicated by retailers.

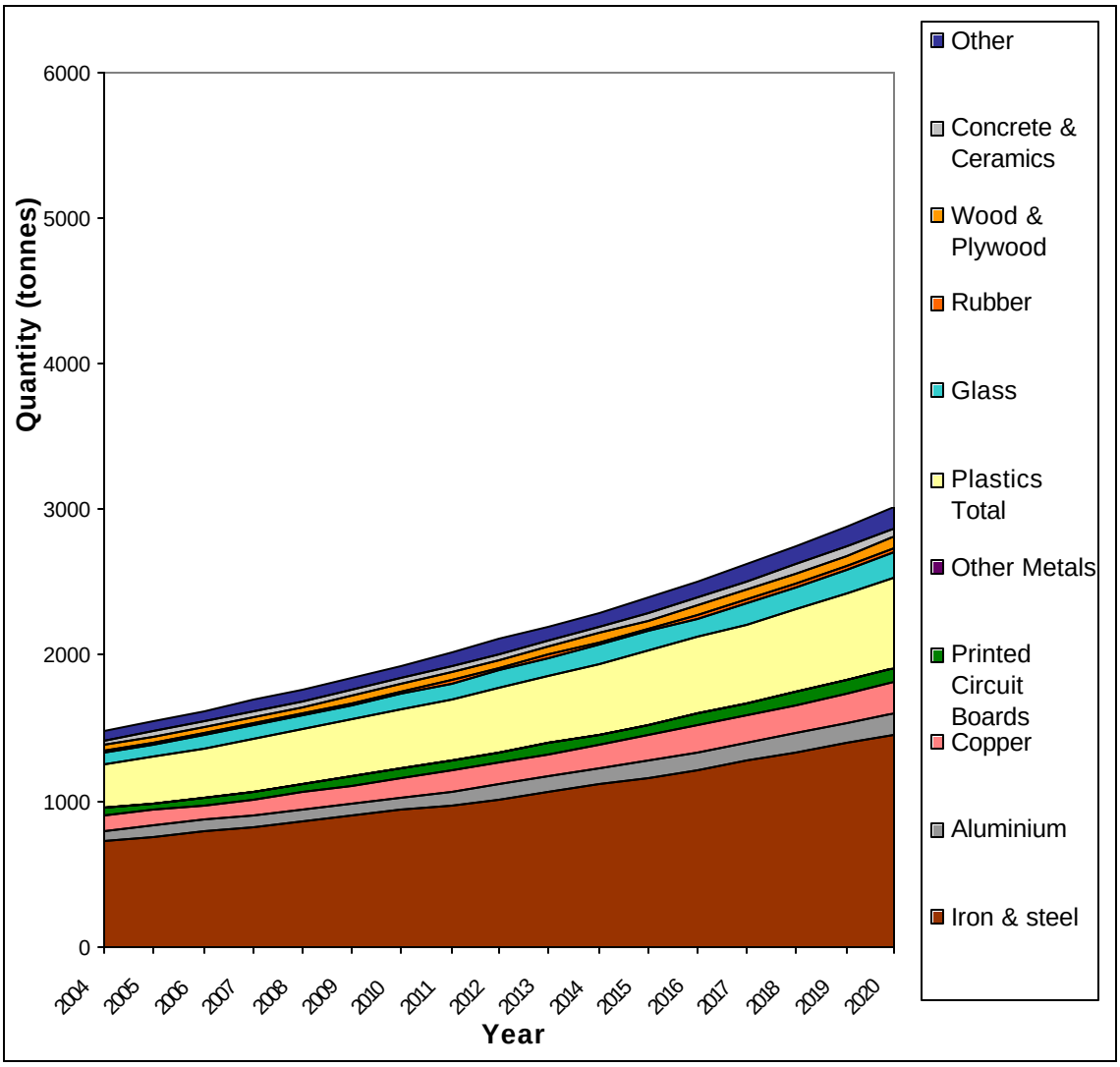

Figure III.15. Forecast of quantity of materials arising from WEEE in Fiji from 2004 to 2020 (data from FIRCA).

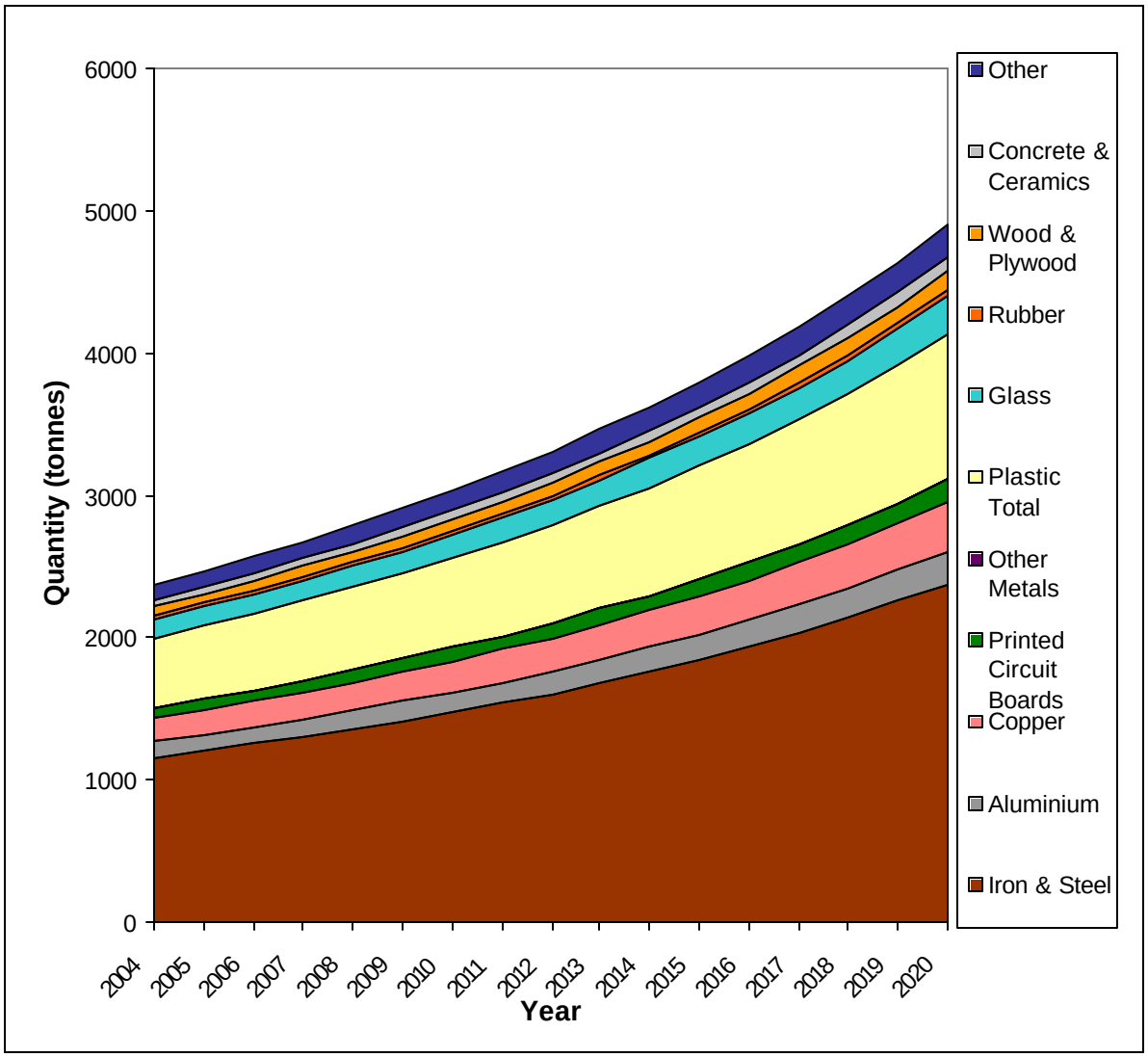

Figure III.16. Forecast of quantity of materials arising from WEEE in Fiji from 2004 to 2020 (data from some retailers).

VII.4. Discussion

VII.4.1. Consistency of data

Firstly, these results show a very low consistency between data communicated by FIRCA and by some retailers: quantities of EEE sold by retailers seem to be 60% higher that the quantity of EEE imported in Fiji as given by FIRCA. This difference obviously appears in the forecast of WEEE to be produced in Fiji.

None of them can be fully reliable:

- FIRCA acknowledge that the quality of its data depends on the accuracy of work of the person entering the data in the database, over which FIRCA has little control;
- Data communicated by retailers could not be fully trusted as some commercial interests could be at stake.

Hence, it can hardly be concluded, which data is more reliable and should be used to run the forecast model. Further studies should be conducted to answer this question. This underlines the usual difficulty to collect accurate and reliable data in the South Pacific.

However, the study gives an indication of the scale of the problem of WEEE. For the purpose of this study, quantities computed from the data provided by FIRCA are considered as the lower limit quantities; quantities computed from the data provided by the retailers are considered as upper limit quantities.

VII.4.2. Share of WEEE within the solid waste stream

No information on the forecast of the total quantity of solid waste to be produced in Fiji is currently available. However, it is possible to compare the quantity of WEEE to be produced with the quantity of solid waste to be produced in the Greater Suva area until 2020 as this information is given in [25]. Therefore, considering the upper and lower limits of our calculations, the WEEE produced in Fiji should represent:

- In 2004, between 1.8 and 3% of the solid waste produced in the Great Suva area;
- In 2020, between 2.1 and 3.6% of the solid waste produced in the Great Suva area.

These figures are low compared to the share of WEEE within the solid waste stream in Europe that was assessed as 4% in 1998. However, the figures from Europe include some categories of WEEE such as professional equipment (e.g. cables, circuit breaker) that are not included in the calculation for Fiji. However, according to Fig.III.8, the average annual increase rate of the quantity of WEEE in Fiji is between 3.75 and 7.5% per year until 2020, which is higher than the 3 to 5%, increase calculated in Europe.

VII.4.3. Materials arising from WEEE

According to the calculation presented in Fig.III.15 and III.16, the quantity of materials arising from WEEE in Fiji should be:

- For non-ferrous metals (aluminium, copper, printed circuit boards):
    - In 2004, between 221 and 361 tons;
    - In 2020, between 450 and 750 tons;

  In 2004, this quantity represent between 10 and 17% of the total quantity of non-ferrous metals collected by recyclable collectors in Fiji;
- For ferrous metals:
    - In 2004, between 718 and 1172 tons;
    - In 2020, between 1459 and 2429 tons;

  In 2004, this quantity represents between 65% and 105% of the total quantity of ferrous metals collected by recyclable collectors in Fiji.

Large quantities of plastics (between 309 and 504 tons in 2004; between 628 and 1044 tons in 2020), some of it containing brominated flame retardants, glass, lead, and diverse pollutants (batteries, etc) will also arise from WEEE and will need special treatment.

Therefore, the production of all these materials from WEEE will be:

- An opportunity for recyclable collectors to extend their activities of collection of valuable materials (non-ferrous and ferrous),
- A challenge for all stakeholders to set-up adapted systems to collect and treat important quantities of potentially hazardous materials.

VII.4.4. Conclusions

The quantities of WEEE produced in Fiji are still comparatively smaller than quantities produced in developed countries like Europe and Japan. However, due to high growth rate of this equipment, the WEEE problem is increasing very rapidly in Fiji, i.e. possibly faster than in developed countries.

Some innovative approaches will be needed to collect and appropriately treat the rising quantity of WEEE produced in Fiji.

VIII. RECOMMENDATIONS FOR BETTER MANAGEMENT OF WEEE IN FIJI

VIII.1. A road map towards better management of WEEE in Fiji

During the study, it was found out that the quantities of Waste Electric and Electronic produced in Fiji is rapidly increasing. It is believed that most of WEEE is being landfilled and very little is recycled. Therefore, WEEE could rapidly become an important environmental problem in Fiji.

In order to improve such a situation, several actions should be taken, including further studies, policy-making, pilot projects, capacity building of recyclers and awareness actions.

As product-specific approaches are new worldwide, a fortiori in Fiji, it is too early to prioritise these actions. A road map towards better management of WEEE in Fiji is suggested below with a non-prioritised list of possible actions (cf. Fig. III.17). Experiences elsewhere (mainly in Europe and Japan) showed that plans for a WEEE-specific policy is a good starting point of any strategy. However, to be efficient, all the actions should be led at the same time. The contents of each of these actions are described below.

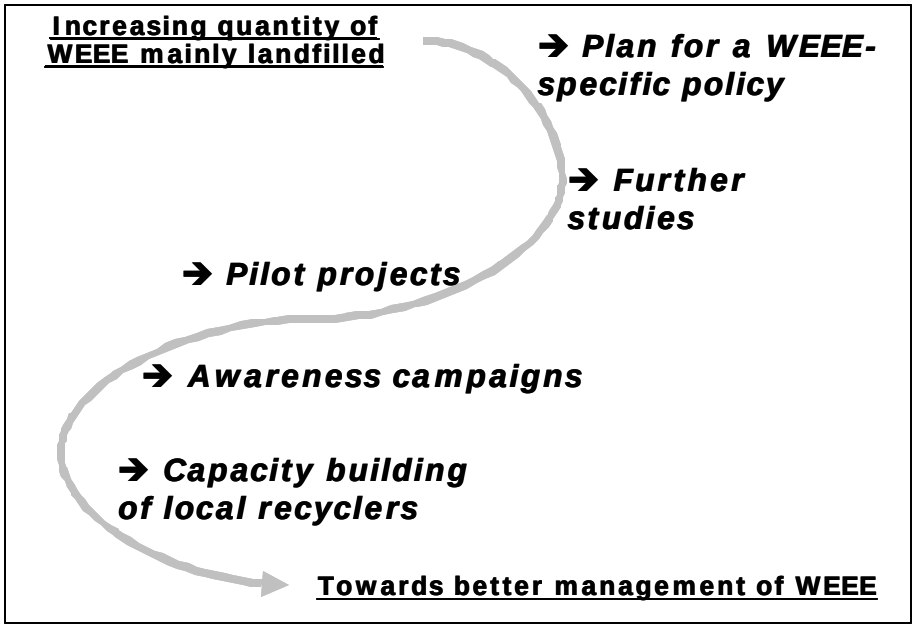

Figure III.17. A road map towards better management of WEEE in Fiji.

The objectives of better management of WEEE in Fiji should reach the following objectives:

- The quantity of WEEE produced in Fiji should be limited,
- The quantity of WEEE landfilled should be decreased,

- And the quantity of WEEE re-used and recycled should be increased.

VIII.2. Policy

The challenge of better management of WEEE should involve further development of policies, in particular:

- To modify the policy on solid waste disposal so that it prevents the landfilling of WEEE without previous treatment, as WEEE cannot be considered as "residual waste"; the hazardous and recyclable contents of WEEE should be extracted and appropriately treated;
- To develop a WEEE-specific policy that would define the responsibilities of producers/importers, the government, municipal councils and users; such a policy should include:
    - Some collection targets,
    - Some recovery targets,
    - Some technical requirements for the treatment of WEEE,
    - Some financing mechanisms to ensure that enough money is provisioned for the treatment of WEEE; this could for example include a tax applied to the product at its importation, or a tax paid at its purchase.

VIII.3. Further studies

Further studies are needed so that the WEEE problem in Fiji is fully understood. In particular, further studies should focus on:

- The impacts on health and the environment of WEEE in Fiji;
- The actual quantity of WEEE imported and sold in Fiji: data from FIRCA and from retailers will have to be studied in order to know why they are different and which one should be preferably used;
- The actual behaviour in terms of consumption, re-use and storage of individuals and organisations: this should be studied using larger and more representative samples; the survey of practices of household should be based on the income of the households rather than on its external appearance.

Using the results of the two last studies, it would be possible to run the Carnegie Model again with higher degrees of accuracy.

Also, in order to improve the economy of scale of local dismantling of WEEE, the possible collection of WEEE in other Pacific SIDS (e.g. Solomon Islands, Vanuatu, Samoa, etc.) and its transport to Fiji for further treatment should be studied.

VIII.4. Pilot projects

Several pilot projects on the take-back of WEEE should be organised. It should include the take-back of WEEE:

- From individuals, firstly in big cities like Suva and Lautoka, where a majority of WEEE is produced, secondly in other areas; such a scheme could be led by municipal councils in cooperation with some retailers and the recyclers;
- From business and institutions: this should be led between the users and the recyclers.

During such pilot projects, the development of mechanisms for WEEE to be re-used by others should be encouraged. Also, some innovative financial mechanisms should be developed so that the costs of the collection and of the disposal of the WEEE are not supported by people (e.g. schools) who do not have this capacity.

Such pilot projects should contribute:

- To increasing the local knowledge concerning the reality of take-back operations: quantity of WEEE actually taken back are usually lower than the quantity of WEEE theoretically available; also, equipments are not in as good conditions as one can imagine
- To increasing the local knowledge concerning the costs associated to collection and disposal of WEEE,
- To raising the awareness among users, producers/importers and retailers,
- To developing the expertise of recyclers for the collection, the treatment and the recycling of WEEE.

Ferrous metals being the most important material found in WEEE, the pilot projects could be led in conjunction with clean-up operation of other ferrous-dominated products (e.g. cars).

VIII.5. Awareness of users

Awareness concerning end-of-life treatment

Awareness campaigns should be developed for individuals for them:

- To give obsolete but still in working condition EEE to other potential users (schools, lower income communities),
- Not to landfill WEEE: this could be done for example when asking producers to put on products or on packaging the sign of the Fig.III.18,
- To give their WEEE for recycling.

Using the “good corporate citizens” argument, some awareness campaigns targeting businesses and governmental institutions should be developed with the same objectives. Governmental and intergovernmental bodies would be expect to show a good example when giving their equipment for re-use or contracting recyclers for the collection and appropriate treatment of their equipment.

Figure III.18. Example of a sign that should appear on EEE or on their packaging.

Awareness concerning environmental attributes of EEE

On the WEEE issue, there is increasing emphasis worldwide on preventative approaches so that "more easily recyclable" products are preferably developed by producers and purchased by customers.

Awareness campaigns concerning the recyclability of EEE should therefore be developed. As recyclability criteria are not fully recognised worldwide yet (see e.g. the QWERTY/EE method [26] and the ReSICLED method [27]), this should be done later on (in 2006-2008). Once these criteria are recognised worldwide, they should be adapted to the Fiji context as what is "recyclable" in Europe or in Japan is not necessarily "recyclable" on the same extent in Fiji. Producers and importers of EEE should be a part of such an approach, as they will see recyclability as a competitive advantage.

Such awareness campaigns will have to be led by the Department of Energy that has developed a successful eco-labelling scheme for household appliances on energy [28]. The development of multicriteria (energy use, recyclability, ozone depleting substances) eco-labels adapted to the Fiji context should then be encouraged. On this issue, the economic criteria being the most important criteria for Fijian customers [29], the eco-labelling approach should probably be focused on the cost of the collection and the treatment. This could be supported by preferential tariffs for importation.

Again, governmental and intergovernmental bodies would be expected to show a good example when purchasing equipment that is indeed easily re-usable / recyclable.

VIII.6. Development of the capacity of local recyclers

Recyclable collectors so far collect and dismantle very few WEEE in Fiji. Their capacity to deal with WEEE should be extended so that WEEE collected in Fiji are not sent to Asian countries but are locally dismantled and contribute to the creation of jobs. Activity of recyclers of WEEE may be subsidised by the state as it has been widely done in Europe when giving e.g. some tax reduction on the employment of some categories of people (e.g. for long time unemployed or disabled people).

During our survey, all waste collectors declared that they would be happy to receive training on how to deal with WEEE. Training could in particular focus on:

- Optimised dismantling of WEEE using appropriate tools,
- Testing components for them to be re-used,

- Extracting and storing and finding some outlets for pollutants (e.g. ozone depleting gas, Cathode ray tubes, batteries, etc.).

This should lead to the setting-up of a limited number of licensed WEEE recyclers that have environmentally sound practices on WEEE and that are able to produce destruction certificate, as required by some institutional users. This should also contribute to an improvement of the practices of the recyclers.

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CONCLUDING REMARKS

During this study, many data on integrated SW management in the Fiji Islands have been collected, treated and, on their basis, conclusions have been drawn.

For the management of SW in the Western region of Viti Levu, data concerning the current practices of SW collection and disposal (size, organisation, procedures) have been collected and compiled for 6 urban areas. Also, the activity of the recycling industry in the region has been reported and analysed. The management of SW in some hotels has been surveyed.

On this basis, some recommendations for better SW management in the region have been drawn up: they firstly concern the setting-up of proper and enlarged SW collection and disposal systems in the region; also, some recommendations concerning waste minimisation and recycling, essential components of integrated SW management, have been given.

For the handling of Waste Electric and Electronic Equipment, a large consultation of all stakeholders (the Fiji Customs, individual and institutional users, retailers and importers, recyclers) has been undertaken. Data concerning the size of the market of EEE in Fiji and on current practices of users have been collected. It was found that most of WEEE is currently being land filled in Fiji.

Using this data, and considering the current growth of sales of EEE in Fiji, it was possible to run a well-known model to forecast the quantity of WEEE and material constituents / components that should arise in Fiji until 2020. It has been shown that WEEE is a growing problem in Fiji. These computed quantities have been analysed, and recommendations aiming at developing reduce, re-use, recycling and appropriate treatment of WEEE in Fiji have been drawn up.

Recommendations given for those region-specific and product-specific approaches involve further studies, policy-related actions, technical / pilot projects, training or awareness campaign. The setting-up of proper collection and disposal system of SW is for both issues an objective that should be viewed as a priority. However, preventative measures, i.e. concerning waste minimisation and waste re-use / recycling / recovery, should not be neglected and should go together with this first objective.

Fig.2 is a tentative organisation of some of the recommendations given in this report according to two axes: the time frame (short-term, middle-term, long-term) and the level of preventativeness (end-of pipe to middle-of-pipe).

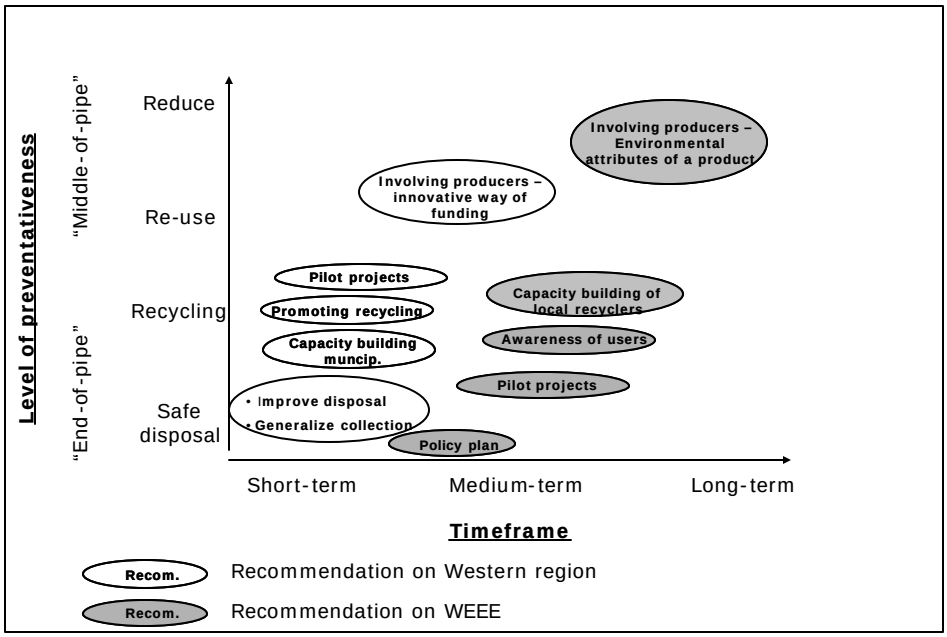

Fig.2. Tentative organisation of the recommendations drawn up in the report in terms of time frame and of level of preventativeness.

APPENDIX

Appendix of Part II

Appendix of Part III

APPENDIX II.1 – QUESTIONNAIRE FOR MUNCIPAL COUNCILS IN THE WESTERN REGION

Waste Management in the Western Region of Vitu Levu
Town Council Questionnaire

Town:
Questionnaire completed by:
Date:

A. WASTE COLLECTION AND HANDLING

(a) *Approximately* what is the population covered by the collection system?

(b) Who is in charge of the collection (Public service / private company)? How many vehicles are assigned to this task? What is their type/capacity? What is the collection frequency?

(c) How many people are involved in the collection of waste?

(d) Have you got any quantitative (tons/week) and qualitative (composition) figures concerning the waste you do collect?

(e) *Approximately*, what is the share of domestic / commercial / industrial / hotel in the waste production?

(f) What are the costs of the collection? How are these costs supported by the population (through tax)?

(g) Have you got any comment on waste collection?

B. CURRENT DISPOSAL PRACTICES

(a) How many official dumping sites are in use? Where are they situated (mangrove, populated area, etc)?

(b) What are the current practices on these sites?

Waste compactation	☐	Cover of waste	☐	Control of site access and use	☐
Control of fire	☐	Monitoring and record keeping	☐	Health and safety training of staff	☐
Separation of hazardous waste	☐	Other?	☐		☐

(c) How many people are working on the dumping site? What is the machinery available at the site?

(d) How many scavengers do operate on the site?

(e) What is the remaining life of the dumping site?

(f) Are there some closed official dumping sites on the municipality land?

(g) Are there some unofficial dumping sites in use? How big are they?

(h) How would you assess the frequency of **roadside dumping?**

Very frequent ☐ Seen sometimes ☐ Never seen ☐

ocean dumping?

Very frequent ☐ Seen sometimes ☐ Never seen ☐

open burning (by whom?)

Very frequent ☐ Seen sometimes ☐ Never seen ☐

(h) Have you got any comment on waste disposal?

C. PRACTICES OF WASTE MINIMIZATION / RECYCLING

(a) Are you aware of any initiative of waste recycling in your area? Please describe (organization, type of waste, quantity, etc)

(b) What are the obstacles for the waste collector (city council of contracted company) to sort waste and to sell it for export ?

(c) Have you got any idea for future actions on waste minimization/recycling?

(d) Is there any education / awareness program going on in the area?

D. TOWARDS IMPROVED PRACTICES OF WASTE MANAGEMENT

(a) Please rate (from 1 to 6 in order of importance) the expected obstacles towards better waste management practices – Please describe.

Education	☐	Legislative framework (e.g. land, litter law enforcement, etc)	☐	Costs of operation	☐
Investment costs	☐	Management structures (persons, machinery)	☐	Availability of a new site?	☐
Others?	☐		☐		☐

(b) For the operation of a regional landfill, what would be the arrangements you would prefer? Why?

Managed by city/town councils	☐	Partnership / joint-venture with private companies	☐

(c) Please rate (from 1 to 5 in order of importance) the expected benefits that would be associated to better solid waste management?

Improve public health	☐	Convenient and cost effective service to community	☐	Protect the environment (quality of rivers, ocean)	☐
Protect the visual environment (tourism)	☐	Other?	☐		☐

(d) Please describe your ideas for improved practices of waste management in your town/city
Waste minimization:
Waste recycling:
Waste safe disposal:
Collection and handling:

(e) Have you got any plan for the rehabilitation of the current dumping site? Whose land is it?

(f) Have you got any comment / remark concerning current and future waste management?

APPENDIX II.2 – INFORMATION ON ORIGINAL DATA COLLECTED AND ON RATIOS USED TO HOMOGENISE DATA

The type of data originally collected from municipal council concerning the SW collection and the SW disposal are summarized in Table A.II.1.

Table A.II.1. Type of data originally given by municipalities.

Municipality	SW collection	SW disposal
Ba TC	Load/week	Load/year
Lautoka	Load/month	Load/month
Nadi	Ton/week (given by contractor)	NR
Ra RLA	kg/hab/day (given by RLA)	Our calculation
Sigatoka	Ton/week (given by contractor)	NA
Tavua TC	Load/week (given by Town council)	Load/week

NA : non available ; NR : non relevant

The conversion table used to render data collected from municipal councils comparable is presented in Table A.II.2.

Table A.II.2. Conversion table used to turn data comparable.

Type of conversion	Value	Source
Density of uncompacted SW	260kg/m^3	[1]
Density of uncompacted green waste	170kg/m^3	[2]
Fullness coefficient	90% for SW 75% for green waste	[3] [2]
Truck capacity	• Ba : 3.5ton/load for SW ; 1ton/load for green waste • Lautoka : 4 tons/load for SW and green waste • Tavua : 20m^3/load • Industries: 5tons/load	

APPENDIX II.3 - ASSESSMENT OF PRACTICES AT THE RUBBISH DUMPS IN THE WESTERN REGION

Methodology used

Since the studied sites are "rubbish dumps" and not "modern landfills", the consulting team suggest for the assessment to only put penalties and no bonus

The performances of the rubbish dumps are assessed according to the following criteria (after [4]):

- **Site location**:
  - ----: Any of the following sub-criteria: Mangrove area (N)*; coastal area (N) ; close to habitation or schools (N); coarse soil (N)
  - ---: Coarse soil (N)
  - --: Coarse soil protected by clay (I)
  - 0: Clay area
- **Environmental impacts**: no collection of leachates (I), no collection of storm water (I); no collection of landfill gas (I); current open burning (I,N) ; occasional open burning (I,N) (5 sub-criteria)
  - ----: 5 of the above criteria,
  - ---: 4 of the above criteria,
  - --: 3 of the above criteria,
  - -: 1 or 2 of the above criteria.
- **Nuisance impacts**: complaints concerning traffic (I), odor (I, N), smoke (I,N), noise (I), visual impact (I); presence of birds on the site (N), litter outside (N) (7 sub-criteria)
  - ----: 7 of the above criteria,
  - ---: 5 or 6 of the above criteria
  - --: 3 or 4 of the above criteria
  - -: 1 or 2 of the above criteria
- **Site management**: no fence around the site (I,N); no locked gate at the truck entrance (I,N); no record keeping (I,N); no control of dissemination of fire (I,N); no waste compaction (I,N); no (or rare: less than once a year) covering of waste (I); no separation of hazardous waste (I); no H&S training for staff (N) (8 sub-criteria)
  - ----: 7 or 8 of the above criteria,
  - ---: 5 or 6 of the above criteria,
  - --: 3 to 4 of the above criteria,
  - -: 1 to 2 of the above criteria.

---

* The data was:

- Either collected through interview (I),
- Or noticed during the inspection (N).

Results

The results of the assessment are presented in Table A.II.3 below.

Table A.II.3. Assessment of performances of current rubbish dump in use in the Western region of Viti Levu.

Rubbish dump name	Site location	Environmental impacts	Nuisance impacts	Site management	Global performance (ranking)
Maururu (Ba TC)	0	--	-	---	6- (①)
Naria (Ra RLA)	----	----	---	---	14- (④)
Sandunes (Sigatoka TC)	----	----	---	---	14- (④)
Takoloa (Tavua TC)	-	--	-	--	6- (①)
Vunato(Lautoka CC, Nadi TC)	----	---	-	-	9- (③)

APPENDIX II.4 - ASSESSMENT OF THE FREQUENCY OF OCCURRENCE OF ILLEGAL DUMPING IN THE WESTERN REGION

Table A.II.4. Frequency of occurrence of backyard, roadside, ocean / river dumping and open burning in urban and rural areas of municipalities of the Western Region.

Municipality	Backyard dumping		Roadside dumping		Ocean / river dumping		Open burning	
	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural
Ba TC	0	✓✓	✓	✓✓	✓	✓✓	✓✓	✓✓
Lautoka CC	0	✓✓	✓	✓✓	0	✓✓	✓✓	✓✓
Nadi TC	✓	✓✓	✓	✓✓	✓	✓✓	✓	✓✓
Ra RLA	0	✓✓	0	✓✓	0	✓✓	0	✓✓
Sigatoka TC	0	✓✓	0	✓✓	✓	✓✓	0	✓✓
Tavua TC	0	✓✓	0	✓	0	✓	0	✓

✓✓ : very frequent ; ✓ : seen sometimes ; 0 : never / hardly seen

APPENDIX II.5 – QUESTIONNAIRE FOR RECYCLERS IN THE WESTERN REGION

Waste Management in the Western Region of Vitu Levu
Recycler Questionnaire

Recycler Name:
Questionnaire completed by:
Date:

A. YOUR ACTIVITY IN WASTE HANDLING + DISMANTLING + EXPORT / RECOVERY / RECYCLING

(a) Type of activity:

(b) Origin of the waste handled: share of individuals / industrial)? In Fiji?

(c) Current size of the activity (in tons/year)?

(d) Number of staff involved in this activity

(e) Please describe the limiting factors that bother the development of your activities (e.g. investment cost, operating costs, community involvement, etc)

(f) Describe your ideas on further development of your recycling activity? What studies should be done?

(g) Describe your ideas on further technological development of your recycling activity

(h) How could the government or donors be of any help for the development of your activities?

(i) Describe your ideas concerning the integration of your company in a regional initiative for better waste management?

APPENDIX II.6 – QUESTIONNAIRE FOR RESORTS IN THE WESTERN REGION

Waste Management in the Western Region of Vitu Levu
Hotel Questionnaire

Hotel:
Questionnaire completed by:
Date:

A. PRESENTATION OF THE HOTEL

(a) Describe the type of accommodation: backpacker (less than F$60 a night) / middle market (less than F$150 a night) / upmarket (more than F$150 a night)

(b) What is the capacity of the hotel? How full is it usually?

(c) How many staff are working in the hotel?

B. WASTE GENERATION AND CURRENT DISPOSAL PRACTICES

(a) *Approximately* describe the type and quantity of solid waste produced in your hotel. When possible, please differentiate guests and staff production.

(b) Please describe your disposal / recycling practices

(c) Please describe your further ideas on Reduce / Re-use / Recycle

(d) Please describe the drivers of your management or of change in the future? How would you assess the environmental awareness of your guests?

Type	Staff	Guest	Disposal / recycling practices
Paper / cardboard			
Plastics (PET bottles)			
Plastics (other)			
Glass (beer bottles)			
Glass (wine bottles)			
Food scrap			
Green waste			
Metals (Aluminium)			
Metals (others)			
Construction & Demolition waste			
Other (please describe)			

(e) Have you got any comment / remark concerning current and future waste management in the Western region of Viti Levu?

APPENDIX II.7 - ASSESSMENT OF THE PERFORMANCES OF RESORTS IN THE WESTERN REGION

Table A.II.5. Analysis grid used to assess the performances of four resorts surveyed in the Western region of Viti Levu.

Name of the resort (location)		Resort A	Resort B	Resort C	Resort D
Management and disposal practices for each type of solid waste	Paper / cardboard	--	--	--	-
	Plastics (PET bottles)	---	+	---	-
	Plastics (other)	-	-	---	-
	Glass (beer bottles)	+	+	+	+
	Glass (wine bottles)	-	-	--	-
	Food scrap	+	+	+	-
	Green waste	---	0	0	-
	Metals (Aluminium and others)	-	-	---	-
	Construction & Demolition waste	-	+	--	-
	Other (please describe)				+
Total performances		-11	-1	-12	-6

Rules used for the analysis

For this analysis, it is considered that for each category of waste identified in the Table A.II.5.:

- A re-use or a recycling treatment get a '+',
- A poor composting of green waste gets a '0',
- A landfilling at the public dump gets a '-',
- An onsite treatment with low impact on health and the environment gets a '--',
- An onsite treatment with high impact on health and the environment gets a '---',
- The performances are summed for all categories of SW.

This rating is based on the recommendations on solid waste disposal made in [5].

APPENDIX II.8 – DISCUSSION PAPER ON BETTER ENVIRONMENTAL PRACTICES AT USP

"TOWARDS MAKING USP A GREEN UNI"

Koshy, K. Mathieux, F., Mataki, M.

"...Students learn that it is sufficient only to learn about injustice and ecological deterioration without having to do much about them, which is to say, the lesson of hypocrisy. They hear that the vital signs of the planet are in decline without learning to question the *de facto* energy, food, materials, and waste policies of the very institution that presumes to induct them into responsible adulthood."

Orr, David W, 1992.
In *Ecological Literacy: Education and the Transition to a Postmodern World,*
Albany, New York: State University of New York Press, p. 104.

1. INTRODUCTION

Through teaching, research and consultancy, USP departments and centres are currently very active in the region to advice governmental and non-governmental organizations for them to adopt more environmentally friendly practices. Moreover, environmental protection is well recognized as a key element of USP curriculum.

However, little attention has been given so far to the environmental practices of the organization itself. Despite past discussion at the USP Advisory Group on the Environment (AGE) and the formulation of a discussion paper on waste management at USP by William Peter, Chief Technician at the Chemistry Department, little has been achieved so far. Efforts should be put into place to resurrect this initiative now. The resolve should be to move USP towards becoming a more sustainable ecosystem and being labeled a "green" university.

This discussion paper is based on William Peter's paper on waste management. However, some elements were added and some modifications have been made in order to adopt a more holistic approach, where not only waste management is addressed, but also energy and water use, transportation, life cycle perspective, etc.

2. WHAT ARE BETTER ENVIRONMENTAL PRACTICES?

Implementing better environmental practices at USP is not only the management of garbage. It is also the proper management of all resources such as energy, water, transportation, landscaping, time and money. It

would thus involve a number of actions concerning the management of ordinary and hazardous waste, the use of energy and water, transportation within and outside USP.
By encouraging the adoption of better environmental practices, the University reduces its environmental impact and operating costs.

3. WHY DOES USP NEED BETTER ENVIRONMENTAL PRACTICES?

i. To promote environmental sustainability by being part of the local and global efforts to effectively reduce environmental impacts
ii. As a regional institution of higher learning, USP should be seen as setting, maintaining and implementing the highest possible standards in environmental performances for others in the region to follow
iii. During their stay at USP, students should experience the best environmental practices so they can replicate them in their future professional and personal life
iv. Staff from the USP that carry out environmental consultancies and who are resource persons at seminars and workshops, need to be able to perform these duties knowing that the institution that they represent is "practicing what they are preaching"
v. Economical reasons

4. WHAT SHOULD USP AIM FOR IN ITS ENVIRONMENTAL PROTECTION POLICY?

i. Target some environmental impact reductions: e.g. waste reduction by 50 % within ten years and then eventually "zero-waste" status within twenty to thirty years through minimisation, re-use and re-cycling policies; e.g. energy use reduction by 20% within 5 years through energy efficiency and education; e.g. global warming potential reduction by 10% within 10 years through energy efficiency, education, incentives to use public transports
ii. Reduce and where possible eliminate the use of harmful / hazardous substances
iii. Outline clearly the environmental good practices promoted at USP
iv. Encourage waste management research / projects appropriate to the South Pacific
v. Through monitoring, ensure that the quality of our wastewaters meet regulated standards
vi. Review purchasing policies to include a policy where as far as is practical, low impact products are purchased
vii. Provide better environmental practices awareness and training programmes for staff and students
viii. Form a environmental management system in charge of the formulation and the implementation of a USP Environmental Management Policy where USP is regarded as a "green university"

ix. Integrate in this system replication mechanisms for other USP centres in the Pacific

Some examples of current initiatives and of possible future initiatives are given in Table A.II.6.

Table A.II.6. Current and possible future environmental initiatives at USP.

Area	Environmental concerns	Current initiatives	Possible future initiatives
Waste	Waste paper	A few departments / sections at USP have their waste paper collected by a local recycling company	Generalize it to all USP departments / sections
	Chemicals	A lot of hazardous chemical wastes are being stored awaiting proper disposal options	• Assessment of chemicals used at USP • Promote proper environmentally friendly use, disposal and export of chemicals • Reduce their use • USP through the Chemistry Department should make arrangements with Fletcher Challenge Steel and Fiji Industries for the burning of combustible non-halogenated waste organic solvents in their furnaces.
	Organic waste	Food scrap from the dining hall has been taken away by a farmer to be used as animal feed	Set-up an in-house composting unit at USP to process food scrap as well as gardening waste. The resulting compost can be used within the campus to replace chemical fertilisers or sold if there is excess.
	General waste		USP should encourage research and studies on appropriate waste management practices suitable for the South Pacific. Students' projects to study waste management issues (surveys and audit, laboratory studies on processes) should be vigorously promoted where appropriate.
Energy	Energy use		Promoting energy use reduction: • Raise awareness on the energy consumption of lighting, ventilating, computer use • Formulate energy use good practices for USP • Facilitate / promote the purchasing of low energy consumption devices
	Energy source		• Promote the use of renewable energy

Water	Water use		• Rise awareness on water conservation
	Wastewater		• Through monitoring, ensure that the quality of our wastewaters meet regulated standards
Transportation			• Promote low impact driving practices • Promote the use of public transport

5. WHERE DO WE BEGIN?

Set up a:

- USP "Green Uni" Committee,
- **OR** a student (MSc or post-diploma) "Green Uni" project,
- **OR** a USP project,

to initiate and co-ordinate the following activities:

i. Carry out a waste, energy, and transportation audit at USP
ii. Formulate and implement strategies and policies concerning all environmental impacts
iii. Set-up an environmental management system (that may be based on the ISO 14001 system or on any other recognized and appropriate system)
iv. Implement practical strategies, e.g. in-house green waste composting, waste sorting
v. Suggest environmental performance indicators and maintain data on environmental performances at USP
vi. Co-ordinate better environmental practices awareness training for staff and students
vii. Seek advise/direction from with other universities overseas (e.g. Finland, France) that already have adapted environmental protection policies in place
viii. Study the integration of the environmental management system into USP practices and organization

6. WHAT IS REQUIRED TO ACHIEVE ALL OF THIS?

- A focal point to co-ordinate and manage the initiative – PACE-SD or IAS or SPAS?
- A genuine commitment and support towards more environmentally friendly practices from USP Administration, every staff and student
- Awareness raising amongst staff and students on better environmental practices
- Some initial financial resources
- Monitoring and evaluation.

APENDIX II.9 TOWARDS BETTER PRACTICES OF SOLID WASTE MANAGEMENT IN THE TOURISM INDUSTRY

Introduction

The consulting team decided to report initiatives and ideas in the Appendix as they could constitute a basis for a guide of good practices for SW management in the industry.

Drivers of better SW management in resorts

After our interviews with the management of resorts and other persons involved in this field (e.g. Ms Diane Walker from Mamanuca Environmental Society, Ms Batiri Thaman from IAS at USP), we identified the following drivers for resorts to improve their SW management practices:

- Because of the pressure of their guests and the fragility of the surrounding ecosystems, none of the upmarket resorts can afford to have a landfill on the island,
- Limitation of costs for resorts situated on remote islands: sending SW to the mainland by barge costs money and resorts try to limit it,
- Some resorts are trying to get the Green Globe 21 International Ecotourism Certification [6]: one of the criteria of the certification scheme being “Solid Waste Management”, some resorts know that they have to continuously improve in this particular field; however, Ms Walker thinks that the Ecotourism certification will be a real driver only in a couple of years.

Some ideas for better practices on solid waste management in resorts

A number of current or foreseen practices identified during our survey are described below:

The Fijian garden: an approach to limit the use of canned food for guests and staff

In many resorts, tin cans are widely used for the food of guests and staff. Tin cans create a solid waste problem as there is no any economically viable recycling scheme for them so far in Fiji.

Resort B is beginning to develop its concept of Fijian Garden: a Fijian gardener will soon be in charge of growing local vegetables (e.g. cassava, dalo, etc) in a specific area of the resort. According to the manager of Resort B, this garden should contribute to the promotion the Fijian culture and of the Fijian cooking among guests and staff. Ultimately, such an activity should contribute to the decrease of the use of tin can food, and therefore of solid waste management problem. This would contribute to promote a traditional way of life, for which, as pointed out by R. Thaman, “*historically most waste produced within the Pacific Island States was fully biodegradable and or*

readily absorbed and/or diluted by the sheer vastness of the surrounding sea" [7].

A key issue: the training of staffs for separation at source

As described in the last paragraph, Resort B has developed some innovative and efficient practices for the management of its solid waste. When the current manager took his position, he set-up some sorting bins for staff for them to sort at source the solid waste produced. Unfortunately, these bins have been empty most of the time (cf. Fig. A.II.1(a)). Moreover, the sorting at source which is done in the kitchens to extract scrap food for composting is usually very poor (cf. Fig. A.II.1(b)).

(a) (b)

Figure A.II.1. Some examples of solid waste segregation on Resort B – (a) segregation bins are often empty near staff quarters; (b) scrap food sorting is often poor.

According to the manager of Resort B, training of staff for the separation at source is a key issue that will only be achieved with the time.

Transfer station and composting unit at Denarau Island

Eight months ago, Waste Management Ltd and William & Gosling Ltd began together a transfer station on Denarau Island with the aim of collecting and sorting different types of waste either coming from resorts on Denarau Island, or coming by barges from resorts situated on remote islands (e.g. Resort B). From the transfer station, solid waste is either sent to recyclers (e.g. for scrap metals) or collected by individuals (e.g. timber), or stored (e.g. green waste) or sent to Vunato landfill in Lautoka.

In particular, green waste has been stored for 8 months at this transfer station (see Fig.A.II.2). According to the people interviewed at Waste Management Ltd and Williams & Gosling Ltd, some shredders have been bought and are on their way to Fiji: this machinery will be used in the next months to shred the green waste and to produce some usable compost to be used in the region.

Figure A.II.2. A view of the storage of green waste on Denarau Island.

Recycling of PET bottles in some hotels

According to the management of Resort C, PET bottles are the biggest challenge being faced in term of SW management as:

- The consumption of PET bottles is very high among backpackers,
- Empty PET bottles are often found on the shores of the island,
- There is no collection system in place in the Ra Province,
- Their current management (mainly burnt on site) is not satisfactory at all from air pollution and smoke/smell perspectives.

Despite repetitive calls to Coca-Cola Amatil to obtain a collection bag for empty PET bottles, no bag was obtained. Management of Resort C would be now ready to initiate some initiatives to initiate the collection and the recycling of PET bottles. According to them, such an initiative would not be a question of money, as they could find some innovative ways of funding it.

The idea of initiating a pilot collection scheme for the collection of Coca-Cola PET bottles has been suggested. It would consist in:

- Collecting empty PET bottles in bags at the Ellington Wharf, which is used by all resorts and residences,
- Contracting a company (for example Coca-Cola, or the company that collects empty beer bottles) to bring the PET bottles to the Coca-Cola collection center in Lautoka; Coca-Cola would then be in charge of the transport and of the recycling of the collected bottles,
- Finding some innovative mechanisms to finance such a system, e.g. the involvement of Coca-Cola Amatil, the implementation of the user-pay principle, etc.

According to them, such an initiative would contribute to:

- Solving some waste-related problems of many hotels on the islands,
- Showing a good example to communities in the vicinity (see Fig.A.II.3),

- Raising a green image of Nananu-I-Ra Island among guests.

Similar systems should be set-up with other producers of PET bottles.

A quick survey on a sample of 20 guests showed that a great majority would be ready to economically contribute to such a system. Also, a majority of the guests would prefer a system where buyers pay a visible fee each time they purchase a PET bottle. The fee system was preferred to a "tax system" where guest would pay a daily tax for the management of the empty PET bottles.

However, the following obstacles to such a collection system were identified:

- The system will need the cooperation of all resorts and residences on Nananu-I-Ra,
- The problem of poor SW management in the surrounding communities will have to be tackled at the same time.

Promotion of good practices from resorts towards surrounding communities

Since 2000, Resort D has been leading in conjunction with a local NGO some actions on:

- Its own liquid waste management,
- Conservation areas around the resort.

Being conscious that in order to protect its surrounding environment, communities living in the area should be associated, the resort is also trying to promote good practices among the communities through:

- Participatory, Learning & Actions workshops organized by the resort with the communities,
- The influence of staff, which can "bring" good practices learnt at the resort to their living places.

Such a system where the resort shows a good example to local communities is schematised in the Figure A.II.3.

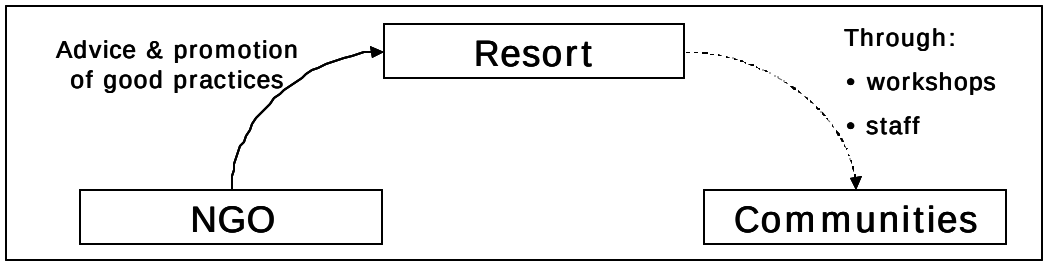

Figure A.II.3. Schematization of the system initiated in Resort D: good practices adopted at the Resort are promoted to the communities through workshop and through staff.

Several interviewed persons (e.g. Ms Fulori Nainoca at the Resort D; Ms Batiri Thaman from IAS at USP) agreed that such a system could be applied for the promotion of good practices on SW management. They also made clear that management of resorts was sometimes reluctant in initiating actions before villages: they therefore pointed out that the system should be accompanied by specific promotion actions towards communities.

APPENDIX II.10. LIST OF PERSONS CONTACTED DURING THE STUDY IN THE WESTERN REGION

Government Body :

Mrs. Premila Kumar Senior Environment Officer Department of Environment 331 28 79		

City / town Councils / Local Rural Authority :

Mr. Dip Narayan Health Inspector Ba Town Council Ba 667 42 77	Mr. Rajandra Pratap Health Director Lautoka City Council Lautoka 666 04 33	Mr. Sakaria Serau Health Director Nadi Town Council Nadi Tel: 670 01 33
Mr. Christopher Pesamino, Acting Subdivisional Health Inspector Mr. Penioni Matatigo, Assistant Health Inspector Ra Rural Local Authority Rakiraki 669 43 18	Mr. Azam Khan Town Clerk Sigatoka Town Council Sigatoka 650 00 18	Mr. Pradeep Sharan Town Clerk Tavua Town Council Tavua 668 10 10

Recyclers / waste handlers:

Mr. Alex Dall General Manager IA Traders 22, Namoli Avenue Lautoka 666 53 53	Mr. Brian Mc Lister General Manager Waste Management PO Box 2378 Lautoka 666 6666	Mrs. Meed Hem Raj Administration Manager Nagan Engineering 8(b) Old Kings Road Yalalevu, Ba 667 00 74
Mr. Peter Bray Managing Director Waste Recyclers PO Box 3081 Lami 336 10 55	Mr. Ron Pennefather Production Manager Carlton Brewery Ltd PO Box 696 Suva 331 58 11	Mr. Rowland Fenton Production Manager Shailendra Prasad Coca-Cola Amatil Ratu Dovi Road Private Mail Bag, Suva 339 43 33

Resorts:

Ian & Jody Manager Kontiki Lodge Nananu-I-Ra Island 669 42 90	Ms Fulori Nainoca Mr. Floyd Robinson Fijian Resort Cuvu Sigatoka 652 01 55	Mr. Bruce Rounds Resort Manager Mana Island Resort Tel: 666 1455

Other interviewed persons on SW management in resorts:

Ms Diane Walker Mamanuca Environmental Society 672 04 48 992 09 92	Ms Batiri Thaman Institute of Applied Sciences USP Private Mail Box Suva 321 2969	Mr. Viliame Koyamaibole Department of Tourism GPO Box 1260 Civic Towers Building Suva 331 27 88

APPENDIX II.11. LOCATION AND CADASTRAL MAPS OF THE RUBBISH DUMPS

Map ①: Location map of Maururu rubbish dump (Ba TC)

Map ②: Cadastral map of Maururu rubbish dump (Plan number 2256, Lot 3B)

Map ③: Location map of Naria rubbish dump (Ra RLA)

Map ④: Cadastral map of Naria rubbish dump (PT/CT/11562)

Map ⑤: Location map of Sandunes Rubbish dump (Sigatoka TC)

Map ⑥: Location map of Tavua and Vatukoula area

Map ⑦: Detailed location map of Takola rubbish dump (Tavua TC) on EGM's industrial park

Map ⑧: Location map of Vunato rubbish dump (Lautoka CC and Nadi TC)

Map ⑨: Cadastral map of Vunato rubbish dump (LDSW Plan number 440A, Lot 1)

APPENDIX III.1 – QUESTIONNAIRE FOR HOUSEHOLDS USERS OF EEE

Questionnaire completed by:

Date:

A. PRESENTATION OF THE HOUSEHOLD

(a) Where is the household located?

In Suva ☐ In another urban area? ☐ In rural area ☐

In which area? Where?

(b) How many people live in the household?

B. INFORMATION ON ELECTRIC ELECTRONIC EQUIPMENT (EEE) IN USE IN YOUR HOUSEHOLD

(a) *Approximately* describe the quantity of EEE in use in your household, stored or discarded in the last 10 years

EEE category	Large Appliances				Small Appliances			IT equipment				Consumer equipment			
EEE Type	Fridge	Washing machine	Stove Micro -wave	Air-cond. Appl.	Iron	Blender	Toaster	Com-puter	Print er	Tele-phone	Cellular phone	Radio-set	TV - set	Video-DVD	Hi-Fi
Number of items **in use**															
Did you buy it **new**? (Y/N)															
Where do you usually buy it?															

Number of items **stored** (since when?)															
Number of items **re-used** (10 years)															
Number of items **recycled** (10 years) (by who)															
Number of items **disposed** (10 years)															

C. YOUR AWARENESS TO ENVIRONMENTAL MATTERS

(a) When purchasing new EEE equipment, do you ask any question about environmental performances of the products (e.g. energy consumption, ozone layer depleting substances, recyclability, etc.)?

Never ☐ Sometimes (which one?) ☐ Often (which one?) ☐

APPENDIX III.2 – QUESTIONNAIRE FOR INSTITUTIONAL USERS OF IT EQUIPMENT

Name of the company / organization:

Questionnaire completed by:

Date:

A. Presentation of the company / organization

(a) Describe the type of organization

Private Company ☐ Government body ☐ Regional Organization ☐

Approximately, how many people do work in your organization in Fiji (and use IT equipment)?

(b) Where are your offices based

Suva ☐ All over Fiji ☐ Other (where?) ☐

B. Information on IT Equipment in use in your company / organization

(a) *Approximately*, how many PC desktops, laptops, server/workstations, printers, photocopiers, telephones and fax machines are in use in your organization?

(b) How many of each of these EEE do you usually purchase annually?

(c) What is the *approximate* annual growth of purchasing each of these EEE?

(d) Where do you usually purchase the equipment (Fiji / oversea retailer)?

(e) What is the *average* life expectation of each of these EEE?

Type of WEEE	PC desktop	Lap-top	Server/ Work-station	Printer; Fax-printer machine	Photo-copier	Tele-phone	Fax-machine
Number of items currently in use							
Number of items purchased per year							

Annual growth of purchasing							
Place of purchasing (Fiji / oversea)							
Average life expectation							

B. Information on EEE end-of-life practices

(a) When a EEE reaches its end-of-life, do you usually:

Repair / Upgrade it ☐ Store it? (where? How long?) ☐ Recycle it (where?) ☐ Dispose it (where?) ☐

C. Your awareness to environmental matters

(a) When purchasing new IT equipment, do you ask any question about environmental performances of the products (e.g. energy consumption, recyclability, etc.)?

Never ☐ Sometimes (which one?) ☐ Often (which one?) ☐

(b) In the future (2010, 2015?), in order to ensure proper management of end-of-life IT equipments, would your organization be ready to contract a company that would collect and recycle your IT equipments? (*Indicative costs* based on experience in Belgium would be: F$6 per PC desktop; F$4 per laptop; F$4 per printer; F$4 per fax machine; F6$ per photocopier; F$1 per telephone;)

Surely ☐ Maybe ☐ No ☐

D. General Comment

(a) Do you have any comment / remark concerning the issue of Waste Electric and Electronic Equipment?

E. Confidentiality

(a) Do you want your name and the name of your company be mentioned in the report for the acknowledgments?

Yes ☐ No ☐

APPENDIX III.3 – THE CARNEGIE MODEL AND ITS ADAPTATION TO THE FIJI CONTEXT

Background

The model has been developed in 1997 by the researchers of the Green Design Institute at the Carnegie Mellon University, the USA. It was initially designed to predict the amount of computers that would reach their end-of-life in the USA [8, 9].

The Carnegie model has been widely used worldwide to predict the amount of WEEE arising in countries. In particular, it has been used to predict the amount of WEEE produced in Ireland (cf. [10]) and in South Australia (cf. [11]).

The original model

The Carnegie Model is based on the following pathway of a PC: a PC is purchased, is used and eventually becomes obsolete.

There are four options the owner has regarding that PC:

1. The computer could be sold or given away to another individual (reused),
2. The computer could be stored by the original owner,
3. The computer could be taken apart, and individual materials are sold (recycled),
4. The computer could be landfilled.

Options 1 and 2 are interim stages whereby the computers will eventually reach the landfill, only delayed.

Figure A.III.1 is a diagrammatic representation of the PC's pathway for the Carnegie Model:

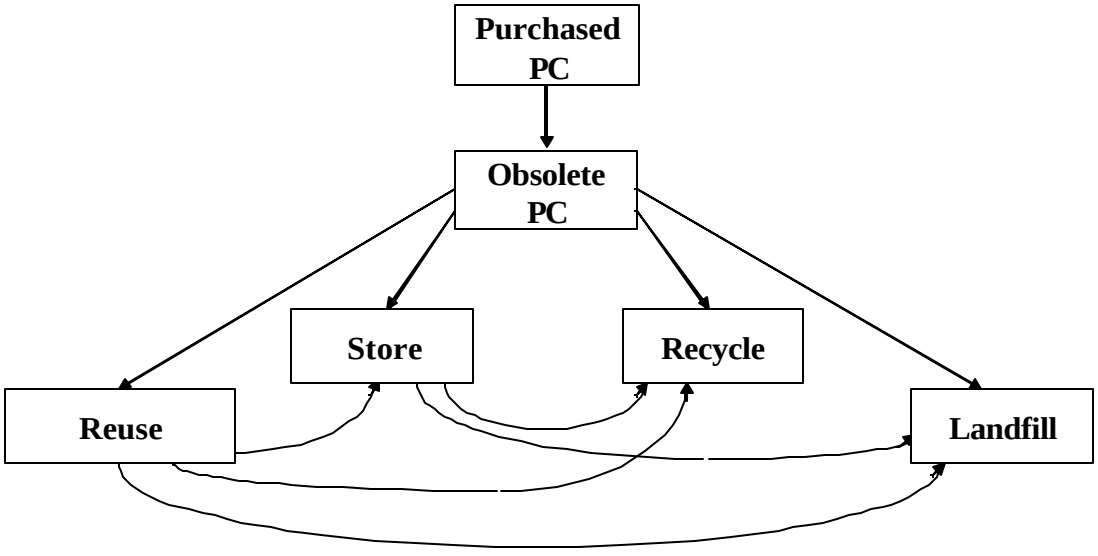

Figure A.III.1. Graphical representation of the pathway of a PC according to the Carnegie model [8].

The parameters (variables) used in the original Carnegie Model:

- **General Parameters**
  - Original Lifetime of PC
- **Parameters for Obsolete Machines**
  - % Obsolete Reused
  - % Obsolete Recycled
  - % Obsolete Stored
  - % Obsolete Landfilled
- **Parameters for Reused Machines**
  - Lifetime of Reused PC
  - % Reused Recycled
  - % Reused Stored
  - % Reused Landfilled
- **Parameters for Stored Machines**
  - Lifetime of Stored PC
  - % Stored Recycled
  - % Stored Landfilled

Adapting the Carnegie Model to the Fiji context

The consulting team modified the original Carnegie Model so it can be used for the Fiji context.

This model was not confined to PCs but was extended to all electric and electronic equipment (EEE) identified in III.1 of Part III. The parameters for each type of EEE were given unique values.

In the Carnegie model, when a PC had become obsolete the owner had four options, however in this model the owner has only three options: recycling of WEEE does not take place in Fiji, and if so, in very limited amounts, hence the option of recycling is eliminated. Thus, the owner has either a choice of Storing, Reusing or to Landfill the IT equipment.

The model was also modified to give the presumed weight produced by IT equipment annually and cumulatively.

The duration of re-use of a product is calculated as 3/5 of the initial lifetime, as suggested in [8].

APPENDIX III.4 – HYPOTHESES AND DATA USED FOR MODELING THE QUANTITY OF IT EQUIPMENT ARISING FROM ORGANISATION 5

Hypotheses

Re-use and disposal behavior

According to our information, 30% of obsolete IT equipment are usually sold to individuals after its initial use at Organization 5. The remaining 70% is stored for one year and then landfilled. Such situation is summed-up in the Fig. A.III.2 below.

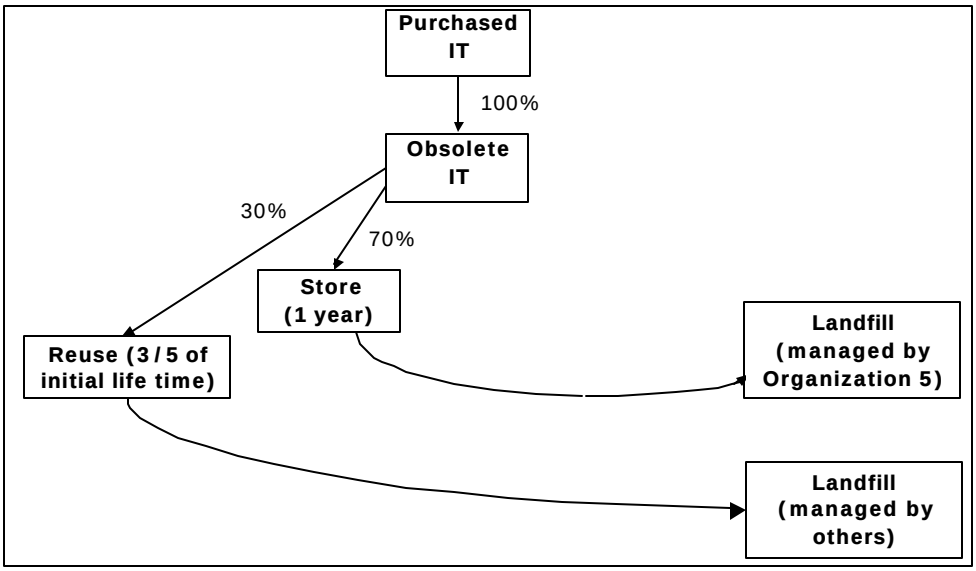

Figure A.III.2. Graphical representation of the pathway of IT equipment in Organization 5 (adapted from [8]).

Derivation of the amount of IT equipment purchased in 1999

All IT Equipment currently being used in 2004 has been purchased from 1999 to 2003, assuming that the lifetime of IT equipment is five years. Prior to 1999 it is either reused, or stored or landfilled.

Therefore, the regression of the number of items purchased as to be calculated since 1999, as shows the following equation:

Regression of purchase since:

= 2004-max(initial lifetime)

= 2004-5-0=**1999**

Organization 5 has currently (year 2004) in use the following IT Equipment:

Table A.III.1. IT equipment currently being used at the Organization 5.

PC	2400
Laptop	100
Workstations	30
Printers	241
Photocopiers	200
Fax	74

The number of IT Equipment currently being used is distributed among the five years, with a constant growth of 15% each year. With the equation given below it is possible to calculate the purchases made in 1999.

$$\text{Purchase in 1999} = \frac{number\_equipment\_in\_use\_2004}{(1+1.15\ +1.15^2+1.15^3+1.15^4\ )}$$

Summary of variables used for the model

Table A.III.2. List of parameters used to run the prediction model of Waste IT equipment arising from Organization 5.

Type of equipment		PC	Laptop	Workstations	Printer	Fax	Copier
Weight (kg)		25	5	40	10	10	100
Lifetime (year)		5	5	5	5	5	5
Cost of disposal (F$)		6	4	6	4	4	6
Annual growth (%)		+15	+15	+15	+15	+15	+15
Obsolete machine	% obsolete re-used	30	30	30	30	30	30
	% obsolete recycled	0	0	0	0	0	0
	% obsolete stored	70	70	70	70	70	70
	% obsolete landfilled	0	0	0	0	0	0
Re-used machine	Lifetime	3	3	3	3	3	3
	% re-used recycled	0	0	0	0	0	0
	% re-used stored	100	100	100	100	100	100
	% re-used landfilled	0	0	0	0	0	0
Stored machine	Time stockpiled (year)	1	1	1	1	1	1
	% stored recycled	0	0	0	0	0	0
	% stored landfilled	100	100	100	100	100	100

Moreover, it should be noted that 30% of IT equipment sold to individuals for further re-use are not managed by Organization 5 anymore at the end of their life but by individuals. Therefore, this equipment is not computed in the forecasted amount of IT equipment reaching its end-of-life.

APPENDIX III.5 – QUESTIONNAIRE FOR RECYCLABLE COLLECTORS

Recycler Name:
Questionnaire completed by:
Date:

A. Management of Waste Electric and Electronic Equipment (WEEE)

(a) Did you ever managed any WEEE (large & small household appliances, IT equipments, consumer equipments, professional equipments) in the past?
Which ones?
Please describe how you handled them

(b) Are you aware of their composition? They are composed of **valuable materials** (aluminium, copper, steel, printed boards), **pollutants** (gas, batteries, etc) and a mix of other materials (glass, plastics, etc).

Yes ☐ No ☐

(c) Some big WEEE producers (regional organizations, companies) could be interested to be provided a service of WEEE collection and treatment (*Indicative costs* based on experience in Belgium would be: F$6 per PC desktop; F$4 per laptop; F$4 per printer; F$4 per fax machine; F6$ per photocopier; F$1 per telephone)

Would you be interested by such a market?

(d) If yes, would you then be interested to be trained on best practices to handle, dismantle and treat WEEE?

APPENDIX III.6 – QUESTIONNAIRE FOR RETAILERS

Name of the company / organization:
Questionnaire completed by:
Date:

A. ELECTRIC AND ELECTRONIC EQUIPMENT (EEE) IMPORTATION / SELLING INFORMATION IN FIJI

(a) *Approximately* describe the type, quantity, brand and country of origin of the EEE you import / sell in Fiji.

Type of WEEE				
Annual quantity (unit or tons)				
Annual growth (since 1995)				
Share of the market in Fiji (%)				
Brands (share (%))				
Country of origin				

(b) *Approximately* describe the customers distribution of your EEE selling in Fiji

Type of customers	Individual	Company	Government / Institutions
Share (%)			

(c) *Approximately* describe the geographical distribution of your EEE selling in Fiji

Type of area	Main cities (Suva, Lautoka)	Other area
Share (%)		

B. INFORMATION ON EQUIPMENT END-OF-LIFE PRACTICES

(b) What is *approximately* the average life expectation of the products you import / sell in Fiji?

Type of WEEE				
Life expectation				

(c) Do you have a repairing or upgrading activity of EEE in Fiji?

C. AWARENESS TO ENVIRONMENTAL MATTERS.

(a) How often do your customers ask to take back end-of-life equipments?

Never ☐ Sometimes ☐ Often ☐

(b) How often do your customers ask you about environmental performances of your products (e.g. energy consumption, ozone layer protection, etc.)

Never ☐ Sometimes ☐ Often ☐

(c) In the future (2010, 2015?), in order to ensure proper management of end-of-life EEE, would your organization be ready to play a role in the take-back (e.g. collecting old EEE when customers buy new equipment).

Surely ☐ Maybe ☐ No ☐

D. GENERAL COMMENT

(a) Do you have any comment / remark concerning the issue of Waste Electric and Electronic Equipment?

E. CONFIDENTIALITY

(a) Do you want your name and the name of your company be mentioned in the report for the acknowledgments?

Yes ☐ No ☐

APPENDIX III.7 – HYPOTHESES AND DATA USED FOR MODELING THE QUANTITY OF WEEE ARSISING IN FIJI

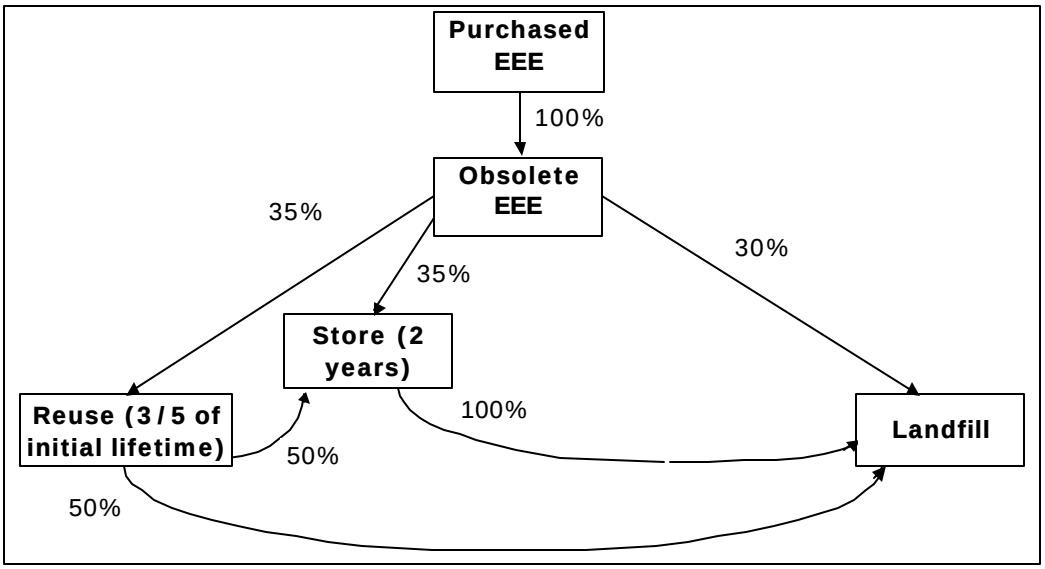

Figure A.III.3. Graphical representation of the pathway of EEE equipment in Fiji (adapted from [8]).

Parameters used

Table A.III.3. List of parameters used to run the prediction model of Waste Electric & Electronic equipment arising in Fiji

		Large Appliances				Small appliances			IT Equipment						Consumer Equipment			
		Fridge	Washing Machine	Stove/Microwave	Air-Conditioner Appl.	Iron	Blender	Toaster	Computer	Printer	Telephone	Cellular phone	Copiers	Fax	Radio-set	TV-set	Video-DVD	Hi-Fi
Weight		48	46	51	65	7	7	1	25	10	1	1	100	10	2	35	10	7
Year 2003	Retailers	9111	10750	18977	3167	7571	15606		14000	14000	30000	40000	2000	5000	14500	13692	18333	13167
	Customs	7343	5660	12336	10795	2243	4079		2853	1248	15365	189	544	414	9259	5176	10352	5324
Obsolete Machine	Initial Lifetime (years)	10	10	10	10	5	5	5	5	5	10	3	5	5	10	10	5	5
	% Obsolete reused	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
	% Obsolete recycled	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	% Obsolete stored	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
	% Obsolete landfilled	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Reused Machine	Lifetime (3/5 of initial Lifetime) years	6	6	6	6	3	3	3	3	3	6	1.8	3	3	6	6	3	3
	% Re-used Recycled	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	% Re-used stored	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
	% Re-used landfilled	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Stored Machine	Time Stockpiled (years)	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	% Stored recycled	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	% Stored Landfilled	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
% Sell Growth		7	5	4	5	4	2	2	4	4	5	varies check V.X	2	2	3	3	3	3

Table A.III.4. Approximate percentage composition in weight of WEEE (after [12]).

Material Type	Composition (%)
Iron steel	47.90%
Aluminium	4.70%
Copper	7.00%
Other Metals (non-Ferrous)	1.00%
Plastics total	20.60%
Glass	5.40%
Rubber	0.90%
Wood & Plywood	2.60%
Concrete & Ceramics	2.00%
Printed circuit boards	3.10%
Other	4.60%

Adoption of Model for Fiji- add on

Since growth rate and sales varied among all the WEEE, they were added as extra parameters in the Fiji Model.

Determination of EEE Imported in 2002 using data from Customs

$I_{Data\ Customs} = I_{2002} + I_{2003}$

$I_{2003} = I_{2003} + (1+x/100)$

Therefore;

$I_{Data\ Customs} = I_{2002}\ (1+ (1+x/100)$

APPENDIX III.8. LIST OF PERSONS CONTACTED DURING THE STUDY ON WEEE

EEE Retailers/importers:

Mr. Shanyan Singh General Manager Bondwell Computers PO Box 565 Suva 321 3000	Mr. Dennis Fong Manager Mr. Ben Steven Dell – Office Products PO Box 1215 Suva	Mr. James Datta Managing Director Mr. Pranil Chaudry Homecentres GPO Box 15278 Suva
Mr. Harilal Jamnadas Manager Narhari Electrical GPO Box 1199 Suva	Mr. Aslam Khan Managing Director Mrs. Komila Chandra Vodafone Fiji Ltd Private Mail Bag Suva 331 20 00	Mr. Joe Rokovu Sales Manager Mr. John Lal Xerox P.O.Box 13496 Suva 338 53 07
Mr. Winston Thomson Managing Director Mr. S. Chetty Telecom Fiji Limited Private Mail Bag Suva 330 40 19		

EEE users:

Mr. Raymond Lee IT Services USP Suva 321 20 85	Mrs. Leba Mataitini Purchasing Manager Mr. Pravin Adhip USP Suva 321 2859	JICA ICT Project USP Suva 321 26 52
Mrs. Marie-José Quintard IT Manager Secretariat of the Pacific Community Nabua Private Mail Bag Suva 337 0733	Mr. Franck Martin IT Manager South Pacific Applied Geoscience Commission Nabua Private Mail Bag Suva	Mr. Stephen Keevil IT Manager Mr. Tale Maimanuku Pacific Islands Forum Secretariat Private Mail Bag Suva 331 26 00

	3381 377	
Mr. Abel Caine Assistant Manager Mr. Vassist Prasad ITC Services - Government of Fiji 310 Victoria Parade P.O.Box 784 Suva Ph: (+679) 330-6005		

Government bodies:

Ms. Nirupa Ram ODS Project Officer Fiji Department of Environment 3rd Floor, Fiji FA House Suva 331 16 99	Mr. Intiyaz Kahn Energy Analyst Department of Energy PO Box 2493 Suva 338 60 06	Mr. Jagat Narayan Deputy Director Mr. Gopal Naiker Fiji Islands Customs Service GPO Box 175 Suva 330 23 22

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