MAPDK 5900 - MASTER'S PROJECT IN CONCEPT-BASED PRODUCT DESIGN

WASTE IS A RESOURCE!

A study on the opportunities in a new
Solid Waste Management in Iringa Municipality

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.. and the use of a design approach in a project that address environmental and social challenges in a developing country.

Partners: Anstonelle LTD - Runer Consult LTD - majiSolutions - Trice Design

All photos, illustrations, tables and graphical design in this report is made by Eirin Solberg

Summary

Municipal solid waste refers to waste in a solid form, produced in the daily day life of a society such as packaging, food scrapes, grass clippings, clothing, furniture, paper, electronics and so on. It is called municipal solid waste because it is in the responsibility of the local government and comes from our homes, schools, hospitals and businesses. It is produced 108 tons municipal solid waste in Iringa each day.

Iringa district is located approximately 500km from Dar Es Salaam and 263km from Tanzania's capital Dodoma. Iringa Municipality (IMP) is headquarter of Iringa district, which has an assumed population of 166 237 people. Iringa Municipality have 169 waste collection points, 56 of them are served with skip buckets. Most household waste is disposed of in people's own back yard and unofficial dumpsites are mostly seen in poor areas with huge lack of served collection points. The skip buckets are transported to the land filling where the waste is compressed and occasionally burned. The 15 acres land filling is located 7 km outside of the city centre, close to households in a highly populated area. It is one watchman in charge of the land filling, and he has no particular knowledge about waste management. 22-25 tons of solid waste is disposed of at the land filling each day, this is 20% of the waste produced. As much as 75-80 percent is organic waste, but the most revealing problem is all the disposable plastic bags that can be seen everywhere in the nature. Few options for recycling exist, and open dumping with open burning is the norm.

The research has addressed some problems and challenges connected to the current situation that has been chosen as focus areas in this project. The most noticeable ones are:
- harmful disposal of waste through burning and burying
- lack of knowledge about waste management
- poorly managed collection points and land filling
- lack of existing systems for recycling
- cost inefficient management

To approach these areas, four concepts has been chosen for further development:
- a new concept for the waste collection points with stations for separation of garbage.
- the design of bags from recycled waste to substitute disposable plastic bags.
- a ICT system with the intention to educate and inform about waste management and to ease the communication between the users, the workers and the management in the new service.
- strategies on how the establishment of CBO' s can benefit the privatizing of the SWM and how they can contribute to solve the problems addressed in the current situation.

The research question for the thesis is focused on the design process of the four concepts: "How can a design approach have effect in a project for solid waste management in Tanzania?" The process has been multi-disciplinary and the approach has been human centred with the aim of making a strategy for the privatizing of the solid waste business that does not exclude anyone in the society. The research tools have been supplemented with the use of some specific design tools. To answer the research question, the effect of those tools have been discussed in the conclusion. The motivation for this project have been to "improve the life of the 166 000 citizens of Iringa, and design a new system that can be adapted to other places in East-Africa".

Acknowledgement

I believe all problems in the world are design problems. Through this project, I want to give an example on how a design approach can be used to addresses environmental and social challenges in a developing country. After a five months stay in Iringa in Tanzania from autumn 2009 to spring 2010, I decided to travel back to do research on interesting topics for my final master thesis. The breakthrough came when I met Andrew Mwakibete who asked me questions about recycling and waste management in Norway. The burning of garbage was the first problem I got involved in when I got to Tanzania the first time, and through the time I lived there, I always hesitated to throw my household waste because I knew it would end up in the huge dump in the back of the compound. I was immediately interested in his business idea of privatizing the solid waste management in Iringa, and promised him to try to come back and work on the project. I am grateful I did, and this report describes the work done from the start of the project in January 2012 until the project was due in May 2012.

I have been lucky to work with ambitious people who are willing to use their knowledge, their time and their energy to improve the society they live in. This project is community driven, and many people have contributed with what is in their field of expertise. First of all, I would like to give a big thanks to Andrew Mwakibete who involved me in the problem and who has been brainstorming, prototyping and gathering information together with me from the very start. I also want to thank Ndey Emanuel for a very good cooperation on the research and the design of reusable shopping bags. This product was designed as an answer to the three first stages in the waste hierarchy; reduce, re-use and recycle with the motivation of fewer disposals to the land filling. Through Trice Design, Ndey aim to help more girls out of poverty with the production and sale of locally made design products in textile. Trice Design has already started the production of the bags, and I wish them the best luck with the sale and the expansion of the business.

More people have been involved in the project and many have been very helpful with providing information about the current situation. Among those who have been directly involved in the project are MajiSolutions and Joti Entertainment. I have also got support from people back home in Norway, and would like to start with thanking Per Grimstad for his time and his advises in the beginning of the project. I am also grateful that he introduced me to Terje Martin Halmø, who was very kind to give me a copy of his related book. This book has been well used and was of great value for the project. Last but not least, I would like to acknowledge the faculty of product design at the University College of Oslo and Akershus for accepting my choice of topic and allowing me to do my field research and spend the necessary time in Iringa. Thanks also to my supervisor Tore Gulden who have been flexible and given me guidance through e-mails and Skype.

We cannot end poverty by 2015, but we can do something. Poor people in developing countries can benefit greatly through a good functioned solid waste management. And let us not forget those who suffer the most in the lack of good systems; the children. I hope this project succeed in communicating the benefits and the opportunities in a well-designed solid waste management in Iringa, and thank you all for taking your time to read this report.

Waste is a resource!

Eirin Solberg
Oslo, May 2012

Requirements

The Master's degree project (PDM 5900) is the final subject unit of a two-year Master's program and entails a complete design project. In the master's degree project students will document their proficiency as a product designer and bring to bear the competencies they have developed through coursework and work practice.

Candidates' desired profile and role

Concept-based design candidates work with the design of products, services and concepts, both material and immaterial, with a focus on users' needs, dreams, desires, experience and context, coupled with the development of aesthetic sensibilities and skills related to materials, form and interaction of use.

Critical factors in the assessment of a concept-based design final master's project are the systemic and interrelated consideration of users, their contexts, experience of use, commercial factors, holistic thinking and interaction design, within an overall ability to identify design potential and opportunity. Critical attention will also be paid to students' willingness to experiment and their ability to develop an awareness of, reflect on and describe, both verbally and visually their design process, their learning process, their ability to involve others and the communication of design strategies and results.

The Master's Project Candidates should demonstrate an ability to act independently with regard to project planning, work process, use of methods and use of supervisors and other resource persons, both internally within the institution and externally (companies, organizations etc.).

The Masters' Project should demonstrate the candidates' knowledge, skill and general competence within the product, material and interaction design field or a combination of all three. Students should demonstrate their independent choice of a topic and content that leads to a research question and project approach. Relevant methods and theory should be involved throughout. The written assignment of the final master's project should include information resources that follow academic standards. The content should be an analysis of the design task, a documentation of the execution of the project - the design process - and a conclusion in relation to the initial research question. Choices and judgments made throughout the design process should be documented and justified through reflections on practice and theory. The project should be based on professional research ethics that lead to sustainable solutions.

Assessment criteria for project

The project will be evaluated in accordance with the approved project formulation, and in accordance with a demonstration of acquired knowledge, skills and general competence described in the study program and on the basis of the two introductory paragraphs of this document according to whether the design task is more conceptually or material oriented. Based on this the general evaluation criteria are: Consistency (coherence and logical construction) Relevance (to product design profession and to society) Context (users, significance within area of use, environment, production etc.) Originality (choice of subject, approach/design methodology and/or result) Professionalism (project management, execution and presentation of material).

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AIDS	Acquired Immune Deficiency Syndrome
CBO	Community-Based Organisation
CDM	Clean Development Mechanism
CDD	Commuity Driven Development
GDP	Gross Domestic Product
HCD	Human Centred Design
HIV	Human Immunodeficiency Virus
ICT	Infomation and Communication Technology
IMP	Iringa Municipality
LCA	Life Cycle Assesment
NGO	Non-Governmental Organisation
MDG	Millenium Development Goals
MSW	Municipal Solid Waste
PET	Polyethylene Terephthalate
PUR	Polyurethane
SA	Social Analysis
SIP	Sustainable Iringa Program
SWM	Solid Waste Management
TSH	Tanzanian Shilling
UN	United Nations
UNFCCC	United Nations Framework Convetion of Climate Change
URT	United Republic of Tanzania
USD	United States Dollar
WFP	World Food Program
WWF	World Wildlife Fund

1. Introduction

"We are already using nearly 30 % more natural resources than the Earth can replenish"

(WWF)

1.1 Background

In 1960, the world's population had reached 3 billions, something that had taken more than 200 000 years .[1] During the previous 50 years, we have more than doubled the population to the current 7 billions. More people means more human activities, and more human activities result in more ecological footprints and an increase in our impact on natural habitats and ecosystems. People are already using nearly 30 per cent more natural resources as the Earth can replenish, and we need to reduce our ecological footprints in order to preserve the world as we know it. If we continue on the same path, people are predicted to be using twice as many natural resources as the Earth can replenish by the year 2050.

During most of the time on Earth, people made no impact on the planet, but human activities have drastically changed during the last two centuries. A by-product from human activities is waste, something that can also be defined as the "end of life" of the goods used in the society. All the goods are first extracted from the planet and recourses are consumed. As example, we need 1,3 hectares of forest for every cubic metre of timber we use, and for every tonne of CO2 we release by burning fossil fuels, we need 0,35 hectares of forest to absorb it.[2]
This means that we cannot afford to accept waste as an end-of life phase of a product; waste is a resource!

1.1.1 Municipal Solid Waste

Municipal solid waste (MSW) refers to waste in a solid form, produced in the daily day life of a society such as packaging, food scrapes, grass clippings, clothing, furniture, paper, electronics and so on . It is called municipal solid waste because it is in the responsibility of the local government and comes from our homes, schools, hospitals and businesses. It does not include waste from bigger industries where the ones responsible for the industry also are responsible for the disposal of the waste they create. Municipal sewage networks and treatment are neither considered as a part of MSW.

MSW can be categorized into
- biodegradable waste; kitchen waste, garden waste, paper, cotton
- recyclable materials, plastic bottles, metal canes, glass, paper
- inert matter, porcelain, construction and demolition waste
- composite waste, tetra pack, textile
- domestic hazardous waste; batteries, spray cans, paint, fertilizer, medication, cleaning soap[3]

When a product has no longer any value for the user, it is disposed of as waste. This means the product has lost its personal value for the user by different reasons (trends, design, functionality) and are no longer attractive to keep. There are primarily two principles of waste handling; through mineralisation and recycling. Because mineralisation can be a very slow process, it is also important to add storing. Mineralisation can be done either through a biologic process (living organisms) or through chemical reactions (heat, burning).

A product has also something called material value, which refers to the price of the production and the value of the material. This value can be kept to a certain extend through recycling, but it gets often lost when a product is disposed of and mixed with other materials, and the separation needed for recycling is no longer economically efficient.[4] To keep the material value, we need to separate the waste in at least two groups before it is sent for disposal; bio-degradable waste and residual waste (everything else). This should be done already in peoples private homes, as it would be difficult to seperate them after the breakdown of biodegradable waste have started.

1 Leonard, A; "The Story of Stuff", Chapter: Introduction, Free Press, NY 2011
2 WWF International, "Roadmap For a Living Planet", 2008
3 Wikipedia; http://en.wikipedia.org/wiki/Municipal_solid_waste
4 Halmø, T.M; "Fast Avfall", Tapir Forlag 1984

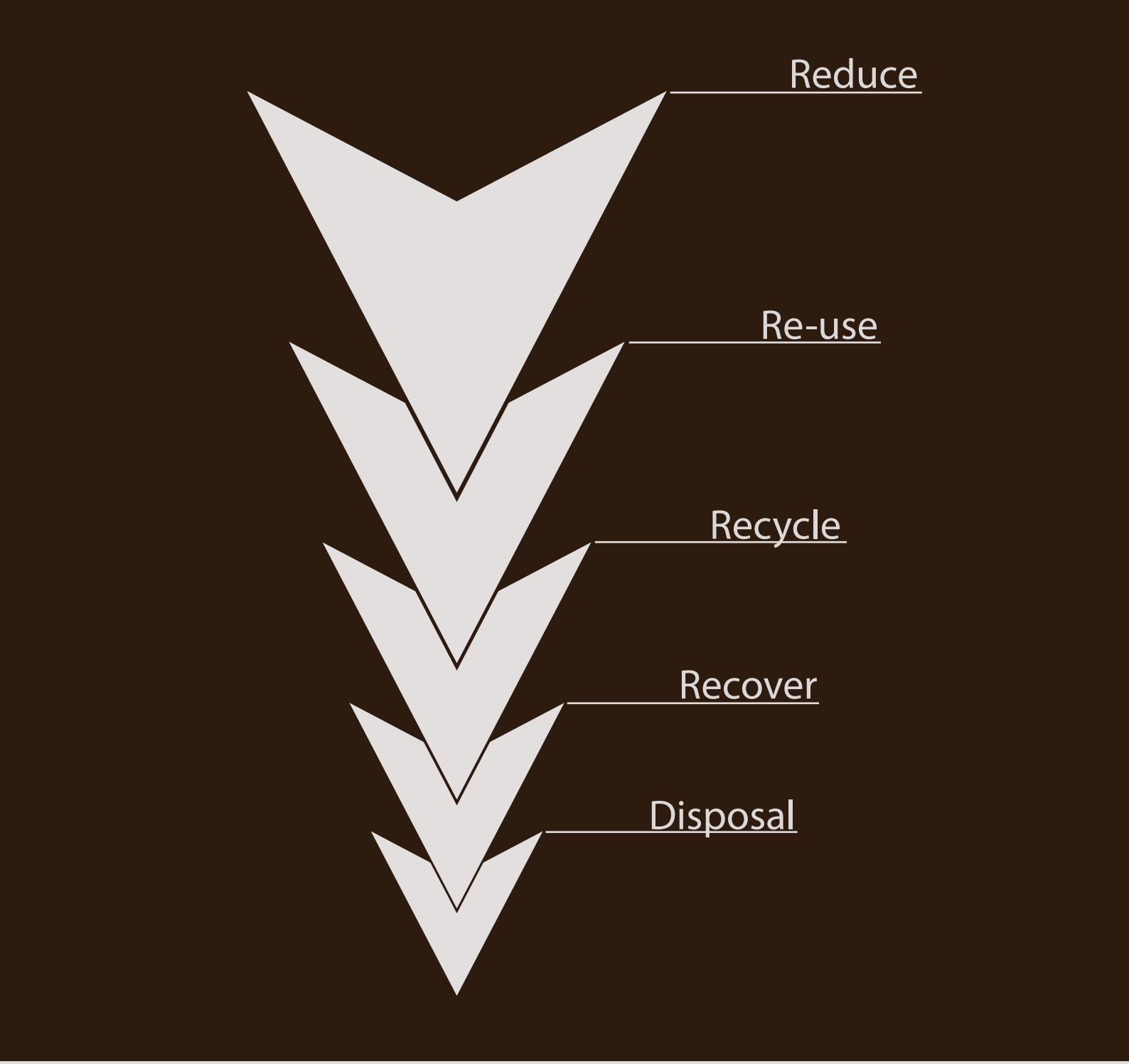


Fig. 1

1.1.2 The Waste Hierarchy

The "waste hierarchy" ranks waste management options according to what is best for the environment. The first priority is to prevent the generation of waste. This should be done by encouraging to reduce, preparing for reuse, invest in systems for recycling and recovery, and the result should be less waste for disposal at the land filling.

The reduce stage includes less use of materials, long lasting products with good quality and products designed for reuse. In the reuse stage, whole products or part of products are cleaned and prepared to be used with the same function more times. Recycling turn waste into new products, and this stage also include composting of organic waste. Recovery is also known as the waste-to-energy, and includes anaerobic digestion, incineration with energy recovery and gasification that produce fuel, heat and power. Disposal is the last option and only the waste that could not be included in one of the other stages should remain for disposal. This stage include landfill and incinerators without energy recovery.

1.1.3 Solid Waste Management

The system for collection, transportation and disposal of MSW is called solid waste management (SWM). This started to become practise in our western countries after different outbreaks of pandemics and waste related diseases, and it has traditionally been in the responsibility of the local government. The norm has been to collect garbage and transport it to landfills where it is buried and covered.

Even though landfill disposal is the last stage in the waste hierarchy, it is still the most common way of waste disposal. Landfills take up a lot of space, they smell and there are always leachate that is a risk for the health of the people living in the area around the landfills. The waste is primarily buried, but to get more space it is also often burned which causes pollution, smoke and ashes to the air. Landfills are always toxic, they create greenhouse gasses and they are a waste of natural recourses.

To burn the materials that could be reused or recycled can never be justified no matter what arguments are used. This is also when it is burned in incinerators. It does not matter how good the filters in the incinerators clean the emissions, the toxicants will never disappear, just change their appearance and get concentrated in the ashes that remains from the burning. The waste-to-energy incinerators are in a constant need of materials to run the system, and a lot of materials that could be recycled are burned instead. Producing energy in waste-to-energy incinerators only generate a small part of the energy consumed through production and distribution of a new product, and about 30% remain as ashes that has takes up land filling space anyway. [5]

We have become better in recycling and reuse of some products in the MSW. Plastic and glass bottles are two examples that are often cleaned and used for the same purpose several times before they get disposed of or recycled into new products with another function. Some materials get shipped over seas for recycling in especially Asian countries where they are in need of raw materials for production of new products. It is a couple of disadvantages with this practice; the first one is the energy consumed and the emissions released in the transport, and the second is that a lot of the materials just end up in the land fillings in the countries they are sent to, or in another word, in someone else's backyard. All this is a waste of resources and a result of badly managed systems.

With our growing population and growing consumption, SWM has become a industry private companies find business opportunities in. This can be from the collection of waste and the transportion for disposal, it could be through recycling or waste-to-energy plants or it could simply be through the sales of separated waste as raw materials for production. One of the risks when waste becomes a business, and we put value on waste in form of economic profit, is that it might exclude some groups in the society, some places in the country and some types of waste that does not generate the most profit. SWM should not only be a business, but a social responsibility. Because of an urge of economic growth, we are encouraged to go shopping and to consume more, and the result is the production of more waste. This is good money for some people in the solid waste business, but it is also a cause for destruction of our planet, bad living conditions for poor people, bigger gaps between poor and rich, more drastic water scarcity, growing air pollution and so on.

1.1.4 Economic growth

Gross national product (GNP) is the standard used to measure the economic growth in a country, and is based on the market value of all products and services made in a country during one year.[6] Economic growth refers to an increase in economic activities across the board, which means an increase in the trade and the services made and distributed by a country. What is often misunderstood is that a growth in the GNP automatically results in a growth of the living standards and the wealth of the people living there. Economic growth should have had the main goal to meet everyone's basic needs and to create healthier communities, but that is not the reality. The GNP of a country can rice with 2-3 percent in a year, and at the same time keep the income of its workers at the same level.[7]

5 Leonard, A; "The Story of Stuff", Chapter 5: Disposal, Free Press, NY 2011
6 Wikipedia; http://en.wikipedia.org/wiki/GNP
7 Leonard, A; "The Story of Stuff", Chapter 1: Introduction, Free Press, NY 2011

A developing country has a low GNP and has to grow more rapidly than a developed country to meet the people's basic needs and to create healthier societies. We do in fact have all the resources needed to do this; they are just not distributed well enough. Basic needs refers to food, cloths, heating and shelter.[8] To create a healthy society we also need to add healthcare, education, hobbies, sports, transport and workplaces. Infrastructure and the distribution of resources are key words to a sustainable growth of a country; it is just a matter of implementing the right systems.

The generation of waste is connected to wealth because it is a result of the people's ability to consume, and it is a function of the GNP because it is a result of the economic activity in the country. The problem is that all the side effects are not included when we measure the GNP. Increased economic activities means more production that again results in the extraction of natural resources. Better wealth in a country means more consumption of products which results in even more generation of waste for disposal.

1.1.5 Waste stream

An average American produce 2 kilo MCW per day, which is almost twice the amount of what they produced in 1960. The Americans are the biggest consumers in the world, and it is said that if all the people on the planet consumed as much as an average American, we would need five planets to fill the needs of natural resources. This is not about putting the responsibility on those who consume the most, but it is mentioned to explain what challenges we are facing in a growing population and a growing economy. As a comparison, the Norwegians produce an average of 1 kilo per day and the Chinese produce an average of 0,3 kilo per day.[9] It is easy to imagine that it is consumed more products in a developed country like USA than in a developing country like China where 16% of the
population live under the poverty rate with less than $1,25 per day (2005).[10] The gap between two industrial countries are more difficult to explain, but laws, systems, habits and attitudes towards production, consumption and disposal are essential factors that create difference in the amount of MSW generated.

This is also current in developing countries, where two neighbouring countries can have a very different waste stream. As example, a magnificent transformation has been done in Rwanda over the last 17 years, and the country is today the cleanest in East-Africa with the best infrastructure on the SWM. Laws, regulations, well-fonctioning systems, change in habits and a good attitude towards waste disposal has given results that are obvious for visitors when crossing the boarder from Tanzania. The differences between one country and another can be huge, but it is not only across boarders the amount and the type of waste can vary, also among different social groups in a society and from different areas in a city. When we talk about the waste stream in a developing country, it is important to differentiate the poor and the rich districts in a city. To be able to offer well-functioning systems, the situation and the needs in the different districts has to be analysed.

1.1.6 Waste in a developing country

The diagram at page 7 is based on research done by Norwegian researchers before the 1984. We know that the consumption has doubled in Norway since 1984, from 500 gram per person per day to the current consumption of 1000 gram per person per day. We can therefore also expect it has been an increased consumption among middle and upper class in the developing countries presented. On the other hand, the consumption among the lower class are more likely to remain the same today, as it was thirty years ago, due to an increased gap between poor and rich.

It is normal in many developing countries that 30-60 percent of the MSW is uncollected and that less than 50% of the population are served by the SWM. The poorest are often excluded from the SWM and areas that are

8 Halmø, T.M; "Fast Avfall", p: 32, Tapir Forlag, 194
9 Leonard, A; "The Story of Stuff", p. 190, Free Press, NY 2011
10 Wikipedia, http://en.wikipedia.org/wiki/Poverty_in_the_People's_Republic_of_China

Waste generated g/per person per day 1984	Lower class	Middle class	Upper class
Norway		500	
Kenya	200	400	500
Egypt (The Suez chanel)	200	230	400
Ethiopia (Addis Ababa)	160	110	290
The Philipines (Metropolitan Manila)	167	213	477

Table. 1

described as slum districts have often no system for the removal of waste. The SWM is a costly part of the municipality's budget, and lack of equipment and maintenance on existing equipment are two common problems. The systems are not developed to protect the local community against waste related diseases and it is not designed for the local community to benefit from the oportunities waste management could offer. Open dumping with open dumping with open burning is the norm.[11]

1.1.7 Promote micro-enterprises as part of a poverty reduction strategy

The solid waste business in developing countries has a great potential in creating workplaces for the poorest. This can be done through the establishment of community-based organisations (CBO) that are responsible for:
- managing and collecting household waste
- managing and collecting market waste
- separate waste to minimize the amount sent for land filling disposal
- inform and educate the local community to raise awareness about issues and problems of SWM
- street sweeping and emptying of public dustbins

Micro-enterprises can also be established through workshops in the production of new products from recyclable materials.

1.2 Waste in Tanzania

This report describes the situation in Iringa, a town in Tanzania in East-Africa. Like other East-African countries, Tanzania is facing a rapid urbanization and a growing middle class. Tanzania has 44.5 million inhabitants with an annual growth of 3%.[12] The country have sustained a high economic growth between 5-7% the recent years (7% in 2010), with export of goods as the main driver. Despite an economic growth, the number of people living under the poverty rate is increasing due to a rapidly growing population.[13]

The waste stream in the country has changed as a result of a growing population and a growing economic activity. There is also a change in the waste contents due to more import of products and more products sent from developed countries for second hand sale. Challenges Tanzania are facing due to more generation of waste are, to mention the most critical ones, the spreading of waste related diseases, infertile soil that damage the country's agriculture, unsafe drinking water and climate change in form of more unstable rain seasons and a warmer climate. Those factors are all an effect of the disposal of waste, and not the generation in it self.

There are some positive opportunities related to more consumption, and the most important one is the generation of more work places. A well-functioning SWM in Tanzania can create workplaces through the whole system; from the collection and transportation of garbage to the disposal with recycling plants and

11 World Bank, (http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTURBANDEVELOPMENT/EXTUSWM/0,,menuPK:463847~pagePK:149018~piPK:149093~theSitePK:463841,00.html)

12 World Bank: http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/AFRICAEXT/TANZANIAEXTN/0,,menuPK:287345~pagePK:141132~piPK:141107~theSitePK:258799,00.html

13 World Bank: http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/AFRICAEXT/TANZANIAEXTN/0,,menuPK:287361~pagePK:141132~piPK:141109~theSitePK:258799,00.html

waste-to-energy plants. With more import of products, the country can also benefit from the access to materials they have no production of in their country.

1.2.1 Iringa Municipality

Iringa district is located approximately 500km from Dar Es Salaam and 263km from the capital Dodoma. Iringa Municipality (IMP) is headquarter of Iringa district, which has an assumed population of 166 237 people. Iringa municipal consists of 14 wards; Kwakilosa, Kitanzini, Gangilonga, Mkwawa, Mtwivila, Kihesa, Mivinjeni, Mshindo, Ruaha, Makorongoni, Ilala, Mwangata, Mlandege, Kitwiru.

The majority of the citizens of Iringa are farmers, and agriculture is the most important sector in IMP's economy. About 80% of the households depend on agriculture as their primary economic activity.[14] Iringa has also a big potential within tourism, with Ruaha national park and Isimilla Stoneage as great tourist attractions.

14 Helstrøm, A; Solid Waste Management, an Economic Study for Iringa Municipality, December 2002

Fig. 2

Fig. 3

1.2.2 Iringa Solid Waste Management

The SWM in Iringa is based on a system where the citizens deliver their waste to skip buckets provided by IMP. There are 56 skip buckets provided which are transported and emptied at the 15 acre land filling in Kihesa-Kilolo, 7 km from the city centre. It is today one truck (one second truck has been out of order for more that ten years) and one driver, and the amount of waste transported to the land filling is 22-25 tons per day. It is assumed that 108 tons solid waste is generated per day, and the rest is taken care of locally by the citizens through burning, burying or dumping in unofficial dumpsites. At the land filling, the waste is compressed and occasionally burned to get more space. There is one watchman in charge at he land filling, and that person has no particular knowledge on waste management. The land filling is placed near to people's private homes, and causes a big threat to people's health.

IMP has 173 collection points for household waste, but only 56 of them are served. 8 out of 10 collection points are served in Gangilonga, which is the rich area of Iringa, while Mtwivila, an area that is characterized as a slum area, have only 1 served point out of 18. The municipality have also 50 street sweepers employed.

1.2.3 Sustainable Iringa Program

Under the overall supervision of the President's Office, Iringa City Council started the Sustainable Iringa Program (SIP) in 1997. 12 working groups where implemented in the program, and one of them is The Solid Waste Management Working Group. This group, and the waste management in Iringa, has so far been under the responsibility of the Department of Health of Iringa Municipality Council. Due to poor management and a lack of capital to maintain of the system, a suggestion was made in 2002 to privatise, or partly privatise, the SWM in Iringa. SIP and the Solid Waste Management Working Group did in 2002 an economic study with the aim to aid different stakeholders in their work within SWM. A second purpose of the study was to encourage the establishment of CBO´s to handle the collection of household waste.

The report from this project shows a huge lack of willingness to pay the solid waste tax, and it discusses the possibility of replacing solid waste tax charges with monthly fees to cover the service of the CBO`s. Through the solid waste management tax charges, four out of fourteen wards would give IMC an income of 11 000 000TSH (6000USD). From all of the fourteen wards, only 4 000 000TSH was collected in 2002.[15] The existing CBO`s got offered training in how to write a business plan, and how to write proposals to get financial support to start their business. In 2011, no business plans can be found and most of the CBO`s has stopped their business due to

15 Helstrøm, A; Solid Waste Management, an Economic Study for Iringa Municipality, December 2002

financial problems. The SWM is still the same, and as the city and the consumption is growing, IMP is today facing even bigger challenges.

To solve their SWM problems, IMC request in their latest proposal economic support for the implementation of 113 more skip buckets, 2 more vehicles, 400 street dust bins, one weighting scale at the dumping site, 60 new wheel barrows and funds to encourage establishment of CBO`s. The total amount requested is 2 725 200 000TSH (1 500 000US)[16], but there exist no strategy on how to change the system to become income generative and self-sufficient. They encourage through the report the citizens to separate their garbage, make compost from organic waste and to reduce their consumption, and they are aware of the growing problem with overfilled skip buckets and a badly managed land filling. Hence, the citizens are also encouraged to deal with their garbage locally, and the most common ways of waste disposal are to burn or bury it in private backyards, though this is forbidden in Tanzania by law.

1.2.4 Privatizing of SWM

There are today 4 CBO's working in the solid waste business. They are located in Ilala, Makorongoni, Miyomboni and Ruaha. Their primary tasks are to collect household waste and bring it to the skip buckets, to empty public dustbins and to sweep the streets. KWBS, the CBO operating at the market place, has 13 women that collect garbage and sweep the streets and two men who collect the solid waste fees. They are paid with a salary that is just above the poverty rate, and many of the women are risking their own health due to their lack of equipments to protect them self against infections and diseases. The women working in the SWM are poor and therefore a vulnerable group to the contraction of HIV, and a high percentage of them is assumed to be infected, something that makes it even more important to protect them from new infections.

According to the manager in KWBS, the number of workers in their CBO should rise from 15 to about 30 to fill the needs. They have several applications from women who asks for jobs, but there is no capital to employ more workers. One of the problems is the people's poor willingness to pay the solid waste fees, and the CBO experience that many hotels and restaurants refuse because they have already paid solid waste taxes to IMP. The CBO also have to pay the municipality for the emptying of the skip buckets.

To avoid any complications and to have a better system on the charging of the solid waste fees, it could be a good strategy to fully privatise the system, and leave IMP out of the transportation of MSW to the land filling. Anstonelle LTD is one company that is interested in taking over the responsibility for this. They aim to solve the waste problems in town by putting value on waste in form of small payments for the deliveries of recyclable materials. It is also a great potential in the making of compost of organic waste, which again will benefit the agriculture in the region.

An assumed scenario that might work as a replacement for the existing system, is that Anstonelle encourage the establishments of CBO's and train them in how to separate waste and how to inform the local community about a healthy waste management. Anstonelle will pay the CBO for their deliveries to the stations for waste collection, and Anstonelle earn their income on the sale of recyclable materials and compost for agriculture. There are some good results from other places in Tanzania where some private enterprises pay local organisations for collecting PET bottles for recycling. These bottles are either recycled locally in Tanzania into plastic bags, or they are shipped to China to be recycled there. The price paid for one kilo of PET bottles range between 200TSH to 500TSH. This system does not exist in Iringa. There are no reasons to think this should not work in Iringa when it works in other cities in Tanzania, and should be tested. It can be assumed that no bottles will end up in the nature as long as it has been put an economic value on it that poor people can benefit from. This could also be done with organic waste and other content in the waste that could be recycled into new products for sale, and is something Anstonelle can introduce in their business model as a strategy to solve the waste problem in the region.

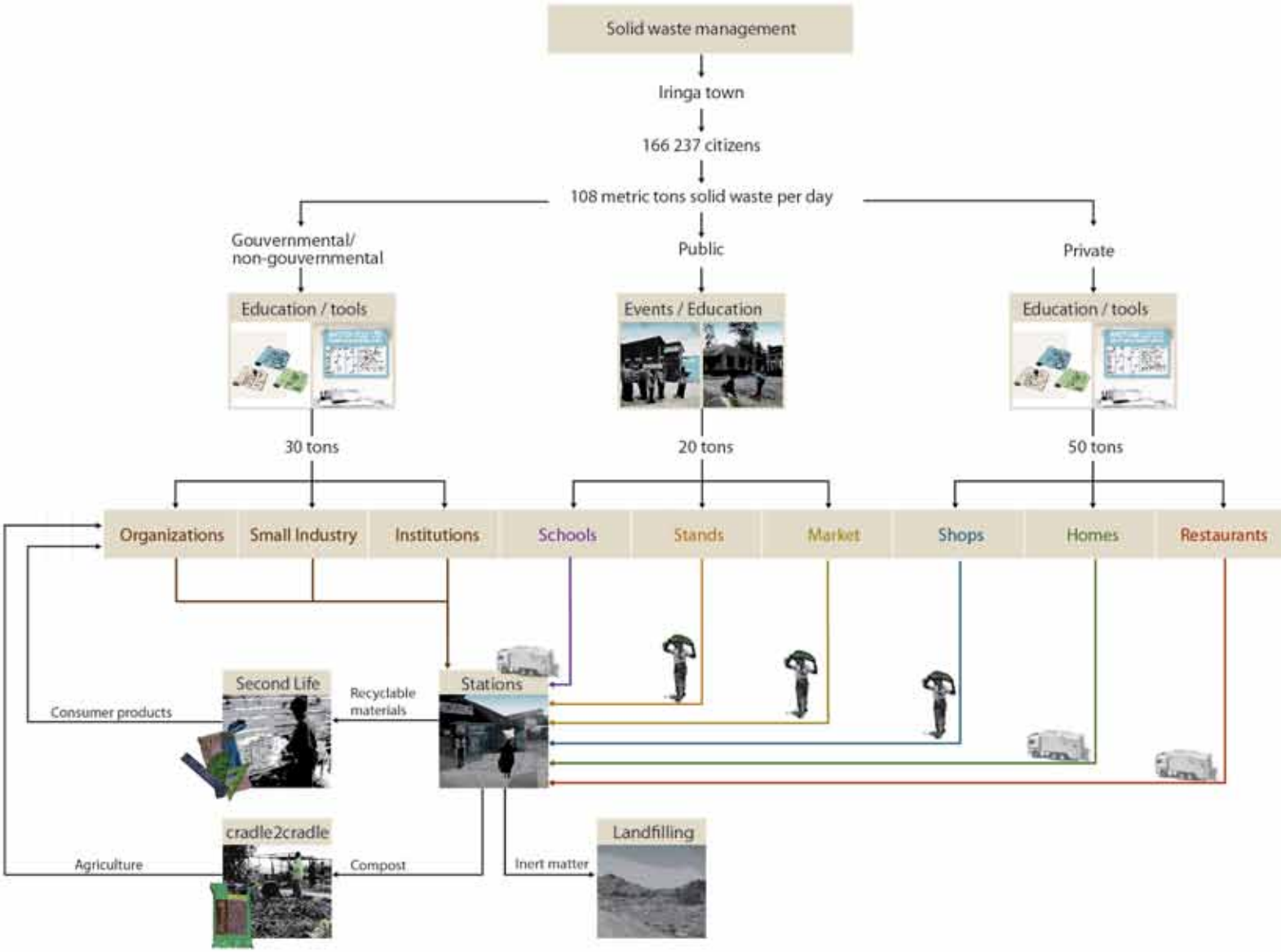
16 Tarimo, S.N; Proposal for Solid Waste Management in Iringa Municipality,Health Department, Iringa Municipal, April 2011

1.2.5 Process map

The process map presented explain a proposed strategy on how to handle the waste stream in Iringa, and include education and information about SWM, a pick-up service in addition to the skip buckets provided, and a plan on what to do with the recyclable waste in stead of land filling disposal. This process map has been done as previous work, and will be supplemented and adapted to new knowledge in this project.

The strategy is based on a fully privatized SWM with only one operating company. The research has concluded that the establishment of CBO's are important for a sustainable strategy where also the poor people in the society can benefit from the new system, and the CBO's should be included in the new process map.

Fig. 4



1.2.6 Household waste content in Iringa

A study on the waste stream in Iringa has bever been carried out, and no skip buckets have been emptied and the content measured.[17] The numbers IMP operate with are based on research done in other cities in Tanzania. It is estimated that 69 tons are produced from households, stands and market in Iringa each day (includes also restaurants and shops). 39 tons are produced through small industries, institutions and organisations.[18] This gives 108 tons each day, and an average of 0,65 kg per person per day. Based on research on a national level, IMP have calculated an assumed content in the waste. This calculation shows that biodegradable waste is the biggest group with a percentage of about 70%.

Type of waste:	Percentage:	Sources of MSW generated:	Tons/day:
Vegetable	62,5%	Household level	48 tons
Paper / cardboard	6,2 %	Stands and market	21 tons
Glass	0,3 %	Commercials	33 tons
Metal	1,2 %	Institutions	6 tons
Textiles	1,2 %	Total	108 tons
Plastic / rubber	1,8 %		
Bones	0,3 %		
Inert matter	27,3 &		

Table. 2

As pre-work to this project, small experiments have been done to get a better overview on the content in the household waste. Included in this research are workshops at the International School in Gangilonga and research on the waste content in households in the upper class in Gangilonga. The experiments show a waste generation of 0,4 kg per day where glass bottles counted for as much as 35% of the total amount. (Less than 50% of the meals and the drinks were consumed in the house during one week) The research conclude that it is produced more waste from recyclable materials in rich areas. They have a better knowledge on separation of waste, but do not reuse their products as much as they do in the poor districts. Many households in Gangilonga practise composting of organic waste in their own gardens, and they are more prepared for a system that require separation of their household waste than the people in Iringa are in general.[19]

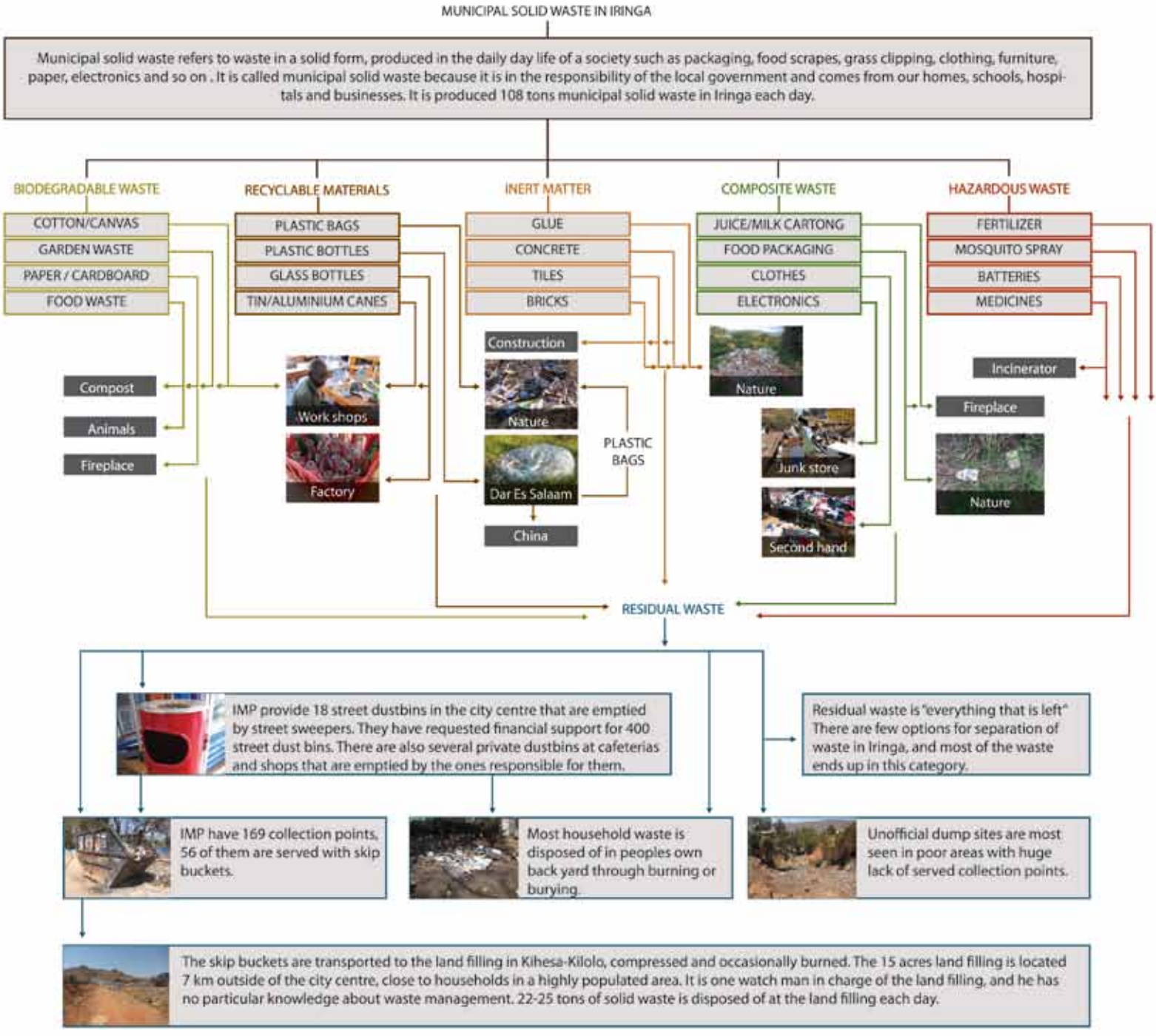
17 Helström, A. : Solid Waste Management, an Economic Study for Iringa Municipality, December 2002
18 Tarimo, S.N. : Proposal for Solid Waste Management in Iringa Municipality, Health Department, Iringa Municipal, April 2011
19 Solberg, E: The design of a sustainable business strategy for Anstonelle LTD, Solid Waste Management in Iringa town. University College of Oslo and Akershus, MAPDPRA, December 2011

1.2.7 Situation map

This mapping was done in an early phase of this project, and is based on the knowledge achieved through personal experiences and observation from the field research done from September 2011 to the start of this thesis in January 2012.

The situation map summarizes the situation in Iringa and explains where the products end up when their useful life is over. It gives examples on products that are dominant on the market in Iringa which are grouped according to the mentioned MSW categories. The map has been used as a tool to define the focus areas for this thesis, and the chosen focus areas will be further explained in next section.

Fig. 5



1.3 Objective

This project has focused on the collection, separation and transportation of solid waste in IMP, and suggests a strategy on how poor people in the country can benefit from a new SWM in Iringa. A product is also designed a as an answer to the three first stages in the waste hierarchy; reduse, reuse and recycle, based on the revelations from the research on the current situation. The report gives suggestion on how to recover and dispose of the waste that remains after the separation, but will not go into any details on this area. The motivation for this project has been to improve the life of the 166 000 citizens of Iringa, and to design a new system that can be adapted to other places in East-Africa.

As preparation for this project, a 18 weeks field research and system planning was done from August to December 2011.Throughout that period, the waste stream in the society has been mapped out in order to get an overview of the material contents, how much waste that is generated in average per day, what knowledge the local community has on waste management and how this is connected to their habits and attitudes. This report describes the work done from January to May 2011. It has adapted to new information and the objective is to present a more detailed plan on how to approach the waste problem in Iringa. A design approach has been implemented to the strategy making of Anstonelle's business idea.

The project is documented through this report, a sketchbook, a process book and three-dimensional prototypes.

1.4 Problem

For a European travelling by bus from Dar Es Salaam to Iringa, it is a sad sight to see all the garbage and the burned land on the side of the road. This is a huge contrast to the green and exotic nature it is surrounded by. It is astonishing to see how the passengers on the bus do not hesitate when they throw their garbage out of the window just as the buss is passing Mikumi National park. It is obvious that the people rely on nature for their living (in agriculture and tourism to mention the two most important sectors in the country's economy) and the question that has been raised among many visitors to the country is; why?

To get an answer to this question, it is important to remember that Europeans have also had the same attitude to waste disposal, and many still have, but changes have been made during last decades. This has been made for instance through campaigns arranged to change attitudes, education and information about waste management, illegalizing of the burning and wrong disposal and implementation of new systems such as dust bins for separation of waste. As two examples, Norway ran a campaign in the 1980s called "Keep Norway Clean" because of a growing problem with garbage thrown in the nature. And Denmark has just recently had a similar campaign presented in the exhibition "Challenge Waste" in 2011. The problem can still be seen in developed countries, but it has become a focus area for the governments who keeps working to find solutions to the problem. This is something a developing country like Tanzania do not have budget for.

1.4.1 Protecting the environment by putting value on waste

Projects for changing the attitude and the system of waste disposal in Tanzania have to be community driven, it requires some ambassadors among the normal citizens and it needs some drivers for change. Especially among poor people, the driver that can be excepted to generate good results are economic profit. This is why a privatizing of the SWM could be a solution to many problems; make it a business to clean up the city. It is no business without profit, and the business will not last without sustainable solutions.

Anstonelle is an entrepreneurial company with expertise on many different fields. As the main in-house competences are economy, laws, local politics, leadership and teamwork couching. They also have partners in the recycling industry, the ICT development and in agriculture. They are inspired by systems practised in developed countries, but are aware of the fact that a new solid waste system in Iringa has to be adapted to the needs of the people living there. It also has to be economically feasible in a town where neither the local government nor the

people are capable of paying for the service. "Protecting the environment by putting value on waste" is the strategy their business idea is based on, and a more detailed plan on how to do this has been needed.

1.4.2 Problems revealed in the research

The bad attitude the people have towards waste disposeal is connected to a lack of knowledge. A questionnaire handed out to random people in town show that a high percentage does not know which products that are biodegradable and which are not. Some people even think that all materials will disappear if they dump it in the nature. There is also a challenge to educate the people about separation of waste due to a low knowledge about what groups of materials the different products belong in. On the other hand, all the people know what organic waste is and will be able to separate this group from other type of waste.

Among those who filled in the questionnaire, most of them informed that they use the skip buckets provided by IMP. Some claimed that they only dispose of their garbage through the skip buckets, and some use a combination of this and local burning and burying. The problems with the skip buckets are that they are often overfilled, the fuel for transporting is expensive (the price have increased with 400% during the last ten years) and they are removed without getting replaced when they get transported to the land filling.

A third challenge is to make a plan about what to do with all the waste that will be collected through the new system. There is today 22-25 tons transported to the land filling, and the waste is compressed and burned to get enough space. If the new system is successful, the waste collected will be four times as much, and it has to be separated in an early stage to minimize the waste transported to the land filling.

One of the most revealing problems is the disposal of plastic, and especially plastic bags and PET bottles. Plastic is non-biodegradable and should not be buried down. Nor should it be burned because that releases toxicants such as dioxin, which is a cause to cancer and neurotic diseases.[20] Plastic bags are handed out in big amounts at the market place, and because they are already recycled from PET bottles in Dar Es Salaam, they cannot be recycled one more time. As long as it does not exist any systems for collecting plastic in Iringa, all plastic waste is either buried or burned as methods for disposal.

1.4.3 Focus areas for this project

The research has addressed some problems and challenges connected to the current situation that has been chosen as focus areas for this project. The most noticeable ones are:
- harmful disposal of waste through burning and burying
- lack of knowledge about waste management
- poorly managed collection points and land filling
- lack of existing systems for recycling
- cost inefficient management

To approach these areas, four concepts has been chosen for further development:
- a new concept for the waste collection points with stations for separation of garbage.
- the design of bags from recycled waste to substitute disposable plastic bags.
- a ICT system with the intention to educate and inform about waste management, and to ease the communication between the users, the workers and the management in the new service.
- strategies on how the establishment of CBO's can benefit the privatizing of the SWM, and how they can contribute to solve the problems addressed in the current situation.

20 Leonard, A; "The Story of Stuff", Chapter 5: Disposal, Free Press, NY 2011












How can a design approach have effect in a project for solid waste management in Tanzania?

1.4.4 Research question

The research question for the project is focused on the design process of the four concepts:
"How can a design approach have effect in a project for solid waste management in Tanzania?"

1.5 Methodology

The process has been multidisciplinary and the approach has been human centred with the aim of making a strategy for the new solid waste business that does not exclude anyone in the society. The research tools that has been used in the process are:
- mapping
- interview and conversations
- observation
- field research
- reading of previous reports (SWM reports from Tanzania)
- reading of related literature
- reading of reports from related projects

The research tools have been supplemented with the use of some specific design tools. To answer the research question, the effect of those tools will be discussed in the conclusion. The tools used are:
- scenario making
- visualization
- prototyping
- evaluation / testing of prototypes
- conceptualizing

1.5.1. Social Analysis

Social Ananlysis is an integral part of the design process and contribute to the technical analyses, stakeholder consultations, concideration of alternative design options and preparation of the final design.[21] A social analysis (SA) have been done in the first phase of the project to obtain the necessary social input and identify appropriate mechanisms for community participation in the design and in the implementation of the new system. The purpose has been to ensure that vulnerable social groups are not excluded from the benefits or affected by any factors of the new service.

The SA has been used to identify important stakeholders and the relationships between them, as well as assess the household's solid waste practises and problems, the user needs and service preferences and the willingness and ability to pay for an improved MSW system. Through the analysis done as pre-work to this project, the waste stream in the society has been mapped out to get an overview of the material content, how much waste that is generated, what knowledge the local community have towards waste management and how this is connected to their habits and attitudes.

1.5.2 Multi-disciplinary process

Bettina von Stamm and Anna Trifilova collected contribution from more than 200 creative innovators from more than 60 countries, and gathered it in a book called "The Future of Innovation" which was released in 2009. One of the chapters in this book is called "Let's get together" and what the contributors to this chapter all had together was the opinion that the future of innovation require multidisciplinary work where people from different backgrounds work together to create new products, services, systems and technology.[22] This has been of inspiration for this project, and the work has been based on a multidisciplinary process.

21 Asian Develpoment Bank; Handbook on Social Analysis, 2007, Publication STock No. 091707
22 Von Stamm, B. & Trifilova, A; "The Future of Innovation", Gower Publishing LTD, 2009

In a design context, a multidisciplinary approach can be done by bringing design thinking and business thinking together to find creative solutions on how to tackle complex challenges and make sustainable businesses. This practise has been tried implemented to the process of this project.

1.5.3 Human Centred Design approach

Human centred design (HCD) places the people in the heart of the process and the solution. The people are not necessarily the end-users, but they are all those affected by the new product, the service or the system. Hence, the life span of a product starts when raw materials are extracted, then the product is produced, transported, distributed, consumed and in the end disposed of as waste. This system is called the materials economy,[23] and all along this system there are people. A human-centred approach should take all the people into consideration, not only the end user, and design solutions for environmental, societal and human needs.

The American design company IDEO describe HCD in following way: "Human-Centred Design is a process and a set of techniques used to create new solutions for the world. Solutions include products, services, environments, organizations, and modes of interaction (.....)The reason this process is called "human-centred" is because it starts with the people we are designing for"

With funds from Melinda and Bill Gates foundation, IDEO has designed a Human-Centred Tool-Kit for use by non-governmental organisations (NGO) working in developing countries. The toolkit explains human-centred design as a three steps process;
- Hear: collect stories and inspiration from people.
- Create: translate what has been heard into framework, opportunities, solutions and prototypes.
- Deliver: realize your solutions through rapid revenue and cost modelling, capability assessment and implementation planning.

Through this, the solution should be desirable for the people, technically and organizationally feasible and economically viable.[24] The result should end in solutions that thrive sustainability, not only for the company, the service or the new product, also for the environment, the local community and all the people living and working among the materials economy of the new solution.

The SA analysis, the multidisciplinary process and the human-centred approach have been practised to find answers to the research question, and to design solutions for the motivation of the thesis; "improve the life of the 166 000 citizens in Iringa, and design a new system that can be adapted to other places in East-Africa".

23 Leonard, A: "The Story of Stuff", Chapter 1: Introduction, Free Press, NY 2011
24 IDEO; Human-Centred Design Toolkit, 2nd edition

2. Process

2 .1 Introduction

The process can be divided into three phases:
- Research and SA; mapping, observations, talks/discussions, participatory experiments, questionnaires, prototyping and testing of ideas, reading of reports and related literature
- Concept making; ideation, prototyping of concepts, mock-ups, visualisation
- Design; mapping, strategy making, prototyping of final solution, scenario making

2.1.1 Stakeholders

The stakeholders addressed through the research are:
- Tanzanian government; Ministry of Health and Social Welfare, Ministry of Sustainable Development and African Leadership, Ministry of Natural Resources and Tourism
- IMP; Department of Health and Social Welfare, Department of Urban Planning and Environment Management, Department of Agriculture and Lifestock, politicians responsible for the solid waste tax charge
- Workers in the government led SWM; watch man at the land filling, truck driver and street sweepers
- CBO's in the SWM; managers, street sweepers, waste collectors, solid waste fee collectors
- Public services; schools, hospitals, prison, other institutions
- Private business; shops, restaurants, market places, small industries, private schools, NGO's, agriculture
- Normal citizens; upper, middle and lower class, housekeepers

The participation of different stakeholders through the process has been found practical due to time and resources to be based on:

1. small experiments that has included the end users of the systems, Hence, to get a better insight in the knowledge and an understanding of what challenges should be expected to make sure the local community understand the purpose of and the function of the new system. These experiments have been done through:
- separation of waste by participants at the market
- separation of waste by house keepers in households
- questionnaires

2. Design and cooperation with experts in different areas in the project.
- prototyping, brainstorming and discussions with the entrepreneurs in Anstonelle
- prototyping with local craftsmen
- design with textile designer Ndey Emanuel
- discussions and concept making with ICT experts
- talks and discussions with CBO's working in the SWM
- talks and discussion with local industry
- talks and discussions with other stakeholders (politicians at IMP, local citizens, private companies)

The role of those who have been included in the design will be further explained in the next section.

2.1.2 Participation in the process

It has been an important strategy for the project to include in the process the people who will continue on the implementation of the business when the concept has been tested and the strategy is ready. The writer of this report have therefore had the superior responsibility of organizing the project and to do the design together with those who will remain in Iringa and continue on the realisation of the business. The writer will be referred to as the project manager from now on. Anstonelle, with the entrepreneur Mr. Andrew Mwakibete, is the company that requested help for the design of their business idea. Mr. Mwakibete have been brainstorming, prototyping and gathered information together with the project manager through the whole process.

Through an early phase of the project, partners and their potential role in the project was mapped out, and the partners Anstonelle have continued to work with is Majisolutions, Trice Design and Runer Consult. Anstonelle´s contact in Majisolutions is Hannes Schüricht, who has lived and worked as an ICT consultant in Iringa in 2010-2011. The company has made a software for mapping water sources in the world, with the starting point in Tanzania. This has been done due to the need of getting a better overview of the quality of the drinking water and the areas with lack of water sources and clean drinking water for the inhabitants. Majisoltions have been included in the process with the aim of making a concept for the use of ICT in the solid waste business.

Trice Design is a one-person company inIringa with textile designer Ndey Emanuel. She make purses from local textile for sale on the local market, and have been working together with the project manager on the design and prototyping of bags to substitute disposable shopping bags, and to make a concept for bags to be used for the collection of waste. Her interest have been to enable her company to expand through the making of bags for a higher production number, and in this way provide jobs for girls in the sewing industry in Iringa.

Runer Concult is a company that works in the plastic industry in Dar Es Salaam. The company is interested in expanding their business to also cover Iringa district. The company has not been included in the design making, but has been a good source for information about the plastic industry in Tanzania. The agreement with the manager, Mr. Martin M. Kitundu, has been to have a discussion on the opportunities after the suggested concept has been designed.

The project is community driven, and the aim is to enhance the living conditions of the people in Iringa. More people than who are referred to as partners have therefore been involved and interested to help with their field of expertise. Those who have done a job besides the providing of important information are local moviemakers, with the help of making a short movie to be shown on local television, and the Finnish musician Markku Liukkonen who have contributed with the soundtrack for the movie.

2.1.3 Timeline

The timeline has been set according to the four chosen focus areas for the project. The work on the four areas has been done separately, and they have been combined through scenario making and mapping in the last phase of the project. This has been done with the aim of having a clear presentation of the total project and a clear communication on how the different concepts are linked together in the final solution.

TIME LINE	JANUARY	FEBRUARY	MARCH	APRIL	MAY
PROJECT DESCRIPTION	▼	REPORTING	▼	▼	PRESENTATION
STATIONS FOR SEPARATION:	PROTOTYPE / COMPOSTING	CONCEPT MAKING	DESIGN / PROTOTYPING	SCENARIOS	DEADLINES:
MOBILE APPLICATION:	PLANNING	CONCEPT MAKING	DESIGN / PROTOTYPING	SCENARIOS	Project description: 10.01
BAGS:	RESEARCH / CONCEPTS	DESIGN / COMMUNICATION	TESTING / RE-DESIGN	SCENARIOS	▼ Phase one: 09.02
CBO's:	TALKS / MAPPING	CONCEPT MAKING	VISUALIZATION	SCENARIOS	▼ Phase two: 22.03
					▼ Phase three: 01.05
					The total project: 16.05
					Presentation: 30.05

fig.6

2.2 Waste collection points.

The starting point of this project was to do something with the poorly managed waste collection points in Iringa. The skip buckets that are used today function badly because of their small volume, and a lot of waste is disposed of on the side of the container. Because they are open in the top, flies and other insects that can spread diseases such as malaria and typhoid have an easy access to the waste. Other waste related diseases that can be spread through this unorganised system of waste disposal is yellow fever, tuberculosis and hepatitis[25]. Observations have revealed the problem with waste spread along the road when the skip buckets are transported to the land filling. They are also in such a bad condition that it is just a matter of time before they have to be replaced with new ones.

To add and replace the skip buckets with new skip buckets of the same type is not sustainable due to the mentioned problems and the cost of transporting such a small volume of waste on a long distance from collection point to land filling. The price of fuel has the last ten years increased with almost 400%, and it is expected to continue to increase in the future. The strategy is therefore to replace the skip buckets with a product that has capacity of collecting more waste before it is transported. This should also be closed in the top to prevent the spreading of waste related diseases, bad smell and the direct sight of the content in the containers.

2.2.1 Minimize the waste sent to the land filling

As mentioned in the introduction, there are transported 22-25 tons of solid waste to the land filling every day. This is only 20% of the waste generated, but it is still a challenge to get enough space for the waste. It is therefore compressed and occasionally burned. The new system should have capacity to collect the whole amount of 108 tons, which means a new strategy is needed to be able to minimize the amount sent to the land filling.

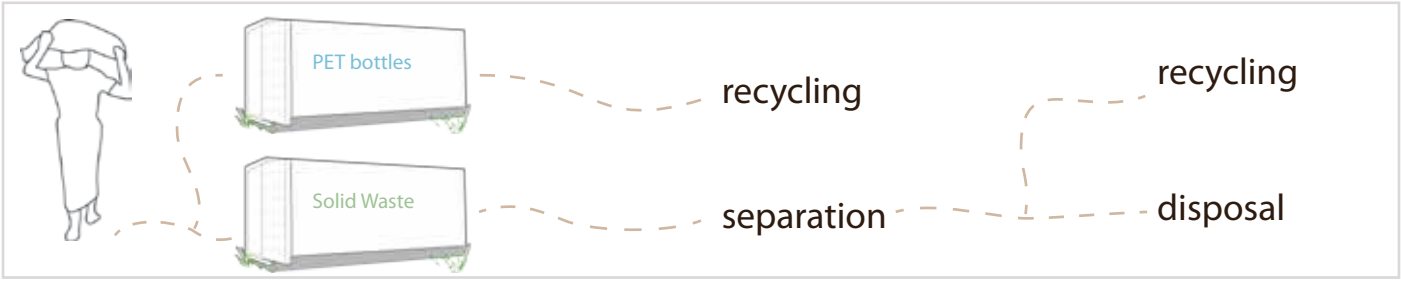
To minimize the waste, the waste hierarchy has been used as a tool in the strategy making, and separating is the stage that is suitable for the collection point. To solve the problem with overfilled skip buckets and to save transport costs, it has been chosen to replace the skip buckets with shipping containers. A 20 feet shipping container can take 24 tons before it has to be emptied. To not need too heavy equipments 15 tons should be set as a maximum. 15 tons is three times as much as the skip buckets have capacity for, and it will only be needed to transport 8 containers per day to take all the 108 tons of waste.

25 Halmø, T.M; "Fast Avfall", Tapir Forlag 1984

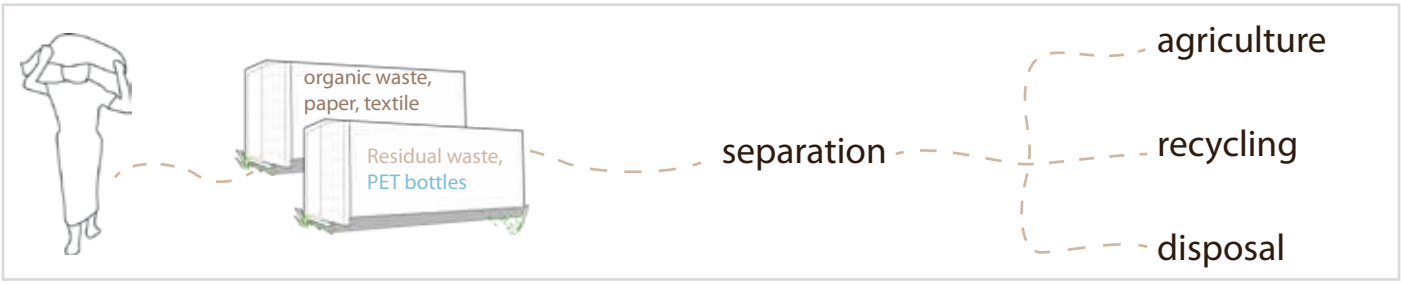
Beside of the volume, the qualities of shipping containers are:
- easy availability in Tanzania
- easy to install
- easy to move
- easy to empty
- easy to adjust
- long durability
- closed roof
- can be painted

2.2.2 Principle of separation

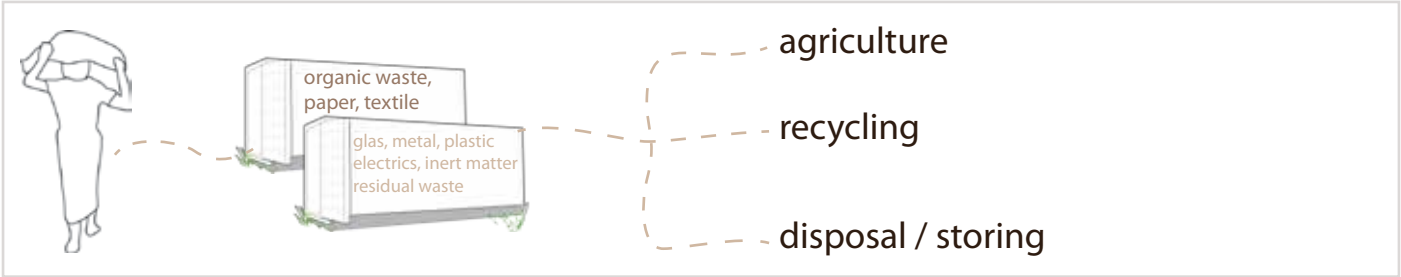
With the use of shipping containers as criteria for the project, different concepts on how to arrange the separation of garbage have been discussed. The first concept is based on the existing system, where the skip buckets are replaced with shipping containers, and the system of collecting PET bottles are practised. This concept is thought to have some few collection points of PET bottles, and serve the 169 waste collection points with containers for solid waste. This require separation of waste at the land filling, where materials for recycling will be sent to partners and the rest will be disposed of in the existing way.



The second concept is based on a partly separation of waste at the collection points with two containers: one for organic waste, paper and textile and one for everything else plus PET bottles. The containers are placed together at the collection points. This system allows the organic waste to start a composting process before it is taken out to the land filling to complete the process. The rest of the waste is separated at the land filling, and what can be recycled are sent to partners.



The third concept aim to reduce the transport of waste to the land filling, and is based on a fully separation of waste directly at the collection points. This requires an efficient composting process in the stations, and a system where compost and separated materials are sent directly from the stations to the partners. All the materials that cannot be separated, and the inert matter that has to be stored away, will be sent to the land filling for storing and disposal.



2.2.1 Discussion

The collection points have changed their function to become stations for separation, and are hereby referred to as stations. The main goal with the new system is to make sure the MSW in Iringa are disposed of in the most responsible way. Results from SWM projects in other developing countries has shown that the people deliver their garbage as indicated as long as the waste is picked up and removed as promised.[26] This means; it cannot be a risk of failure in the pick-up from the stations. Hence, it would be wise to have Anstonelle responsible for the emptying of the stations, and let the partners collect their materials from a site that is out of view for the users of the system. This point exclude principle number three for further development.

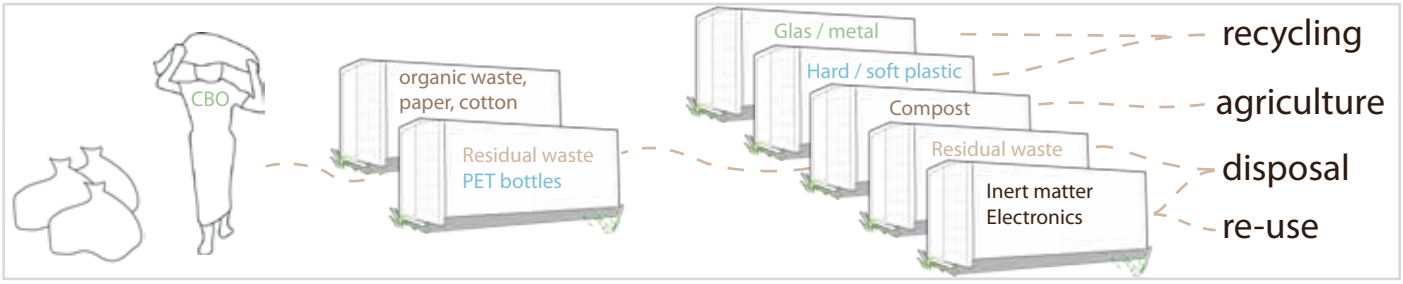
To achieve the goal "dispose of in the most responsible way", the system require a more complicated separation than principle number one. It has to be expected that it will be too difficult to separate waste for composting after the degradation has started, and the separation of this has to be done already in the stations. The project will therefore focus on a further development of principle number two.

2.2.2 Further development of the chosen principle

Anstonelle aim to solve the waste problem by "putting value on waste". To do this, the strategy is to establish CBO's, train them in waste management and pay for deliveries of waste that has a value for further sale. This will help providing organised deliveries and separation. The more complicated the separation at the stations are, the more important will it be to have watchmen in charge of the stations. This creates two scenarios that has to be discussed:

- the stations are managed by Anstonelle, and the CBO's gets payment for deliveries of separated waste to Anstonelle.
- the stations are managed by the CBO's, and Anstonelle buy separated waste and compost from the CBO's.

In both of the scenarios, the waste distribution channel will be: Waste producers - CBO's - Anstonelle – Partners. It will be less management for Anstonelle if the CBO's are in charge of the stations, but Anstonelle will loose control on the amount of waste going in and out. The risk is that the CBO's will sell compost and materials for recycling also to other companies or directly to private people. It is also a risk of manipulating of numbers and data, and the stations need to be designed to avoid those two problems to happen.



2.2.3 Benefits

By having the CBO's collecting waste and bringing it to the stations, Anstonelle will have to relate to the workers in the CBO's only. The teaching of waste mangement and separation of waste will have this channel: Anstonelle - CBO's - waste producers. Anstonelle's offer to the CBO's will give the oportunity of creating more workplaces for poor people in the SWM in Iringa.

The system used in Dar Es Salaam for collecting PET bottles function very good, and it is reasonable to excpect the system of paying the CBO's for deliveries will be sucsessful too. As long as there is a value on it, the waste will be delivered to the stations and Anstonelle will gain good control of the waste stream in Iringa. Compost for agricultural projects and materials for recycling will be products for sale through this system.

26 Halmø, T.M; e-mail correspondence

WASTE = FOOD

2.3 Cradle2Cradle

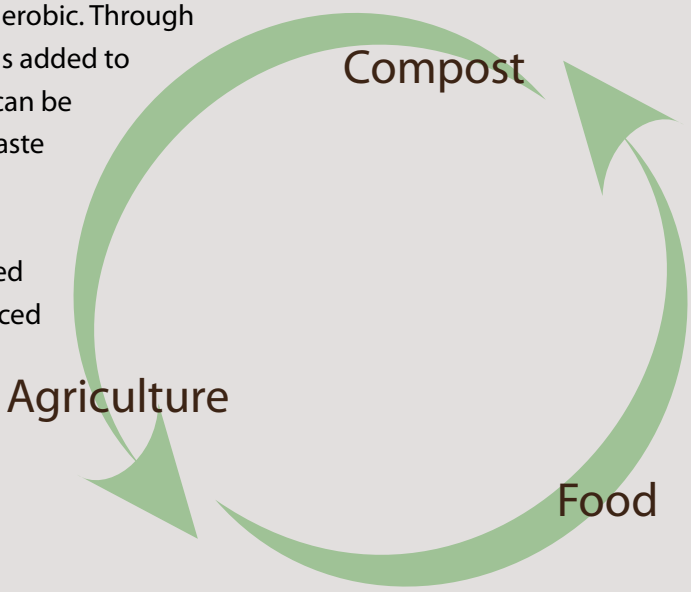
Social and environmental life cycle assessment (LCA) is the analysis of the social and the environmental impact of a product through its life cycle; from the extraction of resources (cradle) to the disposal (grave). A typical products life cycle is based on a cradle-to-grave principle; when their useful life is over they are disposed of as waste. In the nature, there is no such thing as waste. When one life is over, it becomes food and nutrient for new life, what can also be called a cradle-to-cradle system. [27]

75-80% of the solid waste in Iringa is cradle-to-cradle products and should become food for plants and animals or nutrient for soil when they are disposed of. When the waste is burned, it doesn't only pollute the air, but a lot of resources get lost. Agriculture is the most important sector in Iringa's economy, and the majority of the people make their living through farming. Infertile soil is one of the consequences from climate change and fertilizer is a high expense for the farmers, who are considered the poorest group of workers in Tanzania. By changing the system from burning to composting of biodegradable waste, the agriculture in the municipality and the lives of the farmers will improve through the providing of compost as a substitute to infertile soil and fertilizers. The impact of the biodegradable waste will change from destruction to creation of new life, and composting should therefore be criteria in the design of the new solid waste system.

2.3.1 Principle of composting

There are two main principles for composting; aerobic and anaerobic. Through an anaerobic method, the organic waste is covered and no air is added to the waste. This results in a higher generation of methane that can be further burned to generate electricity. The fourth face in the waste hierarchy, recover, is used in this principle.

With an aerobe method, the waste is mixed and regularly turned to continuously add more air. This reduces the methane produced and avoids methane emissions to the atmosphere. This is also the most fast of the two presented principles.

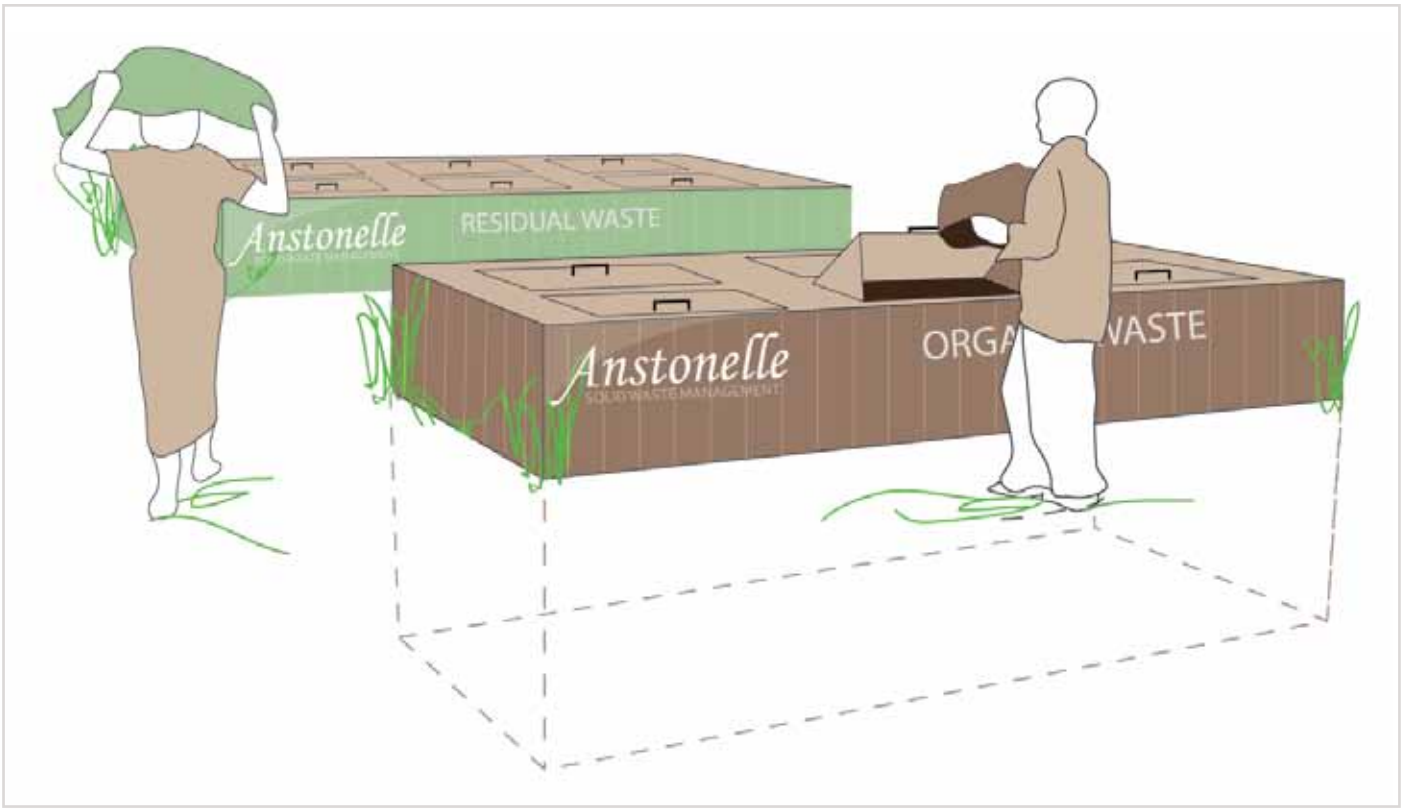


27 Cradle to Cradle, Re-making the Way We Make Things, W. McDonough, M. Brangaurt, Douglas and Melntyre LTD 2002

2.4 Concepts for the stations

The stations should be visible without harming the aesthetics in their surroundings, they should be easy to manage both for the people who throw their garbage and for the truck driver who transport them. They should signalize their purpose and their functionality in a good way and it should be clear for the users where to throw the different type of waste. Because the containers are easy to adjust, many in Iringa use them as shops and bars. When they are used for this purpose, they are painted and doors and windows are added to them. The industry and equipments for doing this exist locally in Iringa.

One of the concepts for how to implement the stations in the society, with focus on functionality and aesthetics, was to dig the containers two meters down in the ground and manage them from the top. This would have made a good ergonomic solution and the containers would have been less dominant in their surroundings. But research has concluded that to dig something down in the ground will create a lot of problems. By example, the hole will be filled up with water in the rain season and the equipments needed to lift a container from the top have to be heavier than if the containers are lifted from the bottom.



The second concept is therefore to build a small ramp and only dig the container 40-60 centimetres down. The truck will have access to lift the containers from the bottom, and it will be no big problem with water in the rain season. The stations will in this way range a little bit more than two meters above the ground, but the stairs and the ramp made of concrete will make a nice frame and create an organized look.Nor does this require too much digging, compared to concept number one where 30 cubic metres of soil would have been removed.

The doors will be placed on the side of the container, which means less waste can be thrown in them before they have to be emptied. Because the stations should not take more than 15 tons, this could be a good solution to avoid a weight that is higher than the equipments can handle. The inside volume for waste disposal will be 27-28 cubic meters. It is difficult to estimate the weight of one cubic meter of organic waste, but through the scaling of the organic waste collected in the research, we can assume a volume of 27-28 cubic meters will be about 15 tons for transporting.

A third concept that has been discussed is to avoid any digging and place the containers on the ground with stairs for good access to the doors. The organized look is kept, but the container will raise 2,7 meters abow the ground, and the whole construction might look very massive in its surroundings. With the truck driving regularly for transporting, a concrete floor in front of the container will make the ground look nicer over time. Because of the massive look of concept number three, the most organized and best looking principle seams at this point to be concept number two.

2.4.1 Chosen concept

It has been discussed how the strategy can be made realistic according to financial support, how to generate income to make the business sustainable and the size of the service provided to cover the needs of waste collection. When it comes to founds to projects in developing countries, the business need to be economically self sufficient over time. Anstonelle can apply for financial support to implement their business, but they cannot expect any funds to cover maintenance and future expenses for running the business.

The products Anstonelle will get profit from are first of all through the sale of raw materials for recycling and through the sale of compost. The containers IMP have today are still in function, but the problem is the capacity of only collecting 20% of the waste generated. If Anstonelle start their business with collecting organic waste and PET bottles, they can cover the remaining 80% and they can offer a system to solve the problem with waste that is disposed of illegally. The chosen concept is therefore to offer stations for the collection of organic waste, and let IMP still control the land filling and their skip buckets with residual waste. When Anstonelle has got their business up running, they can start to plan a fully privatizing where they also control the separation of waste at the land filling.

It is today seven skip buckets at the marketplace. Anstonelle can for instant replace two of them with their stations, and let IMP place the two remaining skip buckets more strategic to offer a better collection in wards with few served collection points.. It is 113 un-served points that Anstonelle can cover with their stations. 113 stations is much more than needed to collect all the waste generated, but because of long distances between each point, it should be planned stations on at least half of the remaining points. If Anstonelle apply for funds to implement their service with 60 stations, and IMP still control their 56 skip buckets, only one container for organic waste is needed at each station.

One disadvantage with keeping the skip buckets in the start of the new business is that lots of organic waste can be expected thrown also in the skip buckets. It is therefore important to have the CBO's as ambassadors for the new system, and give them the responsibility to spread the message about how to separate organic waste from the rest. If the CBO's also offer to pick up organic waste from their clients, it can be expected that their service will result in a high percentage of organic waste to the stations.

To avoid the disposal of other type of waste in the stations, the stations could be closed with a lock, and only the CBO's working in the district where the station is placed will have access. The people in Iringa are usually good in respecting each other's work and responsibility, and as long as the workers in the CBO's are visible and do a good job in getting clients, this system can work well in the society.

The concept for the stations is so far designed only for the collection of organic waste. The collection of PET bottles could be based on a system where bags are used and delivered directly to the recycling plant. Because it is evident to have the pick-up of both the organic waste and the PET bottles at the same place, it could also be implemented to the stations a bin for a pick-up truck to empty.

2.4.2 What if?

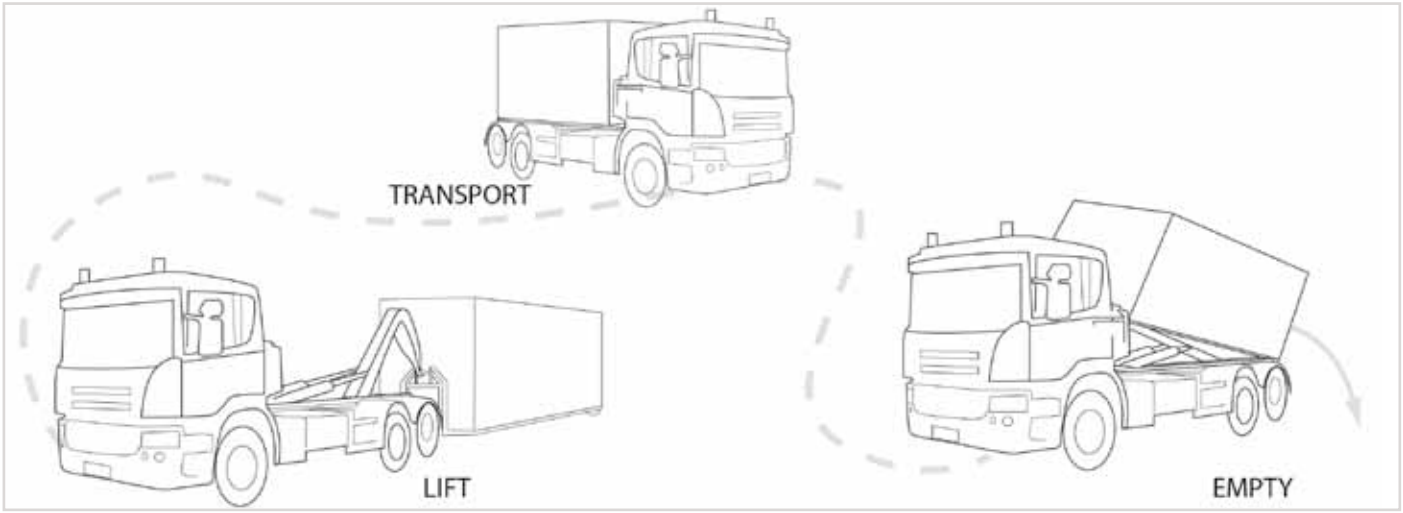
The design of the stations has focused on the practical aspects; how can they be placed and adjusted for easy handling? The principle has been to build a small ramp to enable the truck to lift it without too heavy equipments. They are placed about 50 centimetres under the ground with stairs for easy access to the doors. This is a costly solution and it is a risk that it will not be carried out in the end. It can also cause complications when the solution requires digging in the ground due to the different foundations at the collection points. Because the stations have changed to only consist of one container, the problem with a massive look has decreased, and it is easier to make a solution with the container placed on the ground without harming the aesthetics in the society too much.

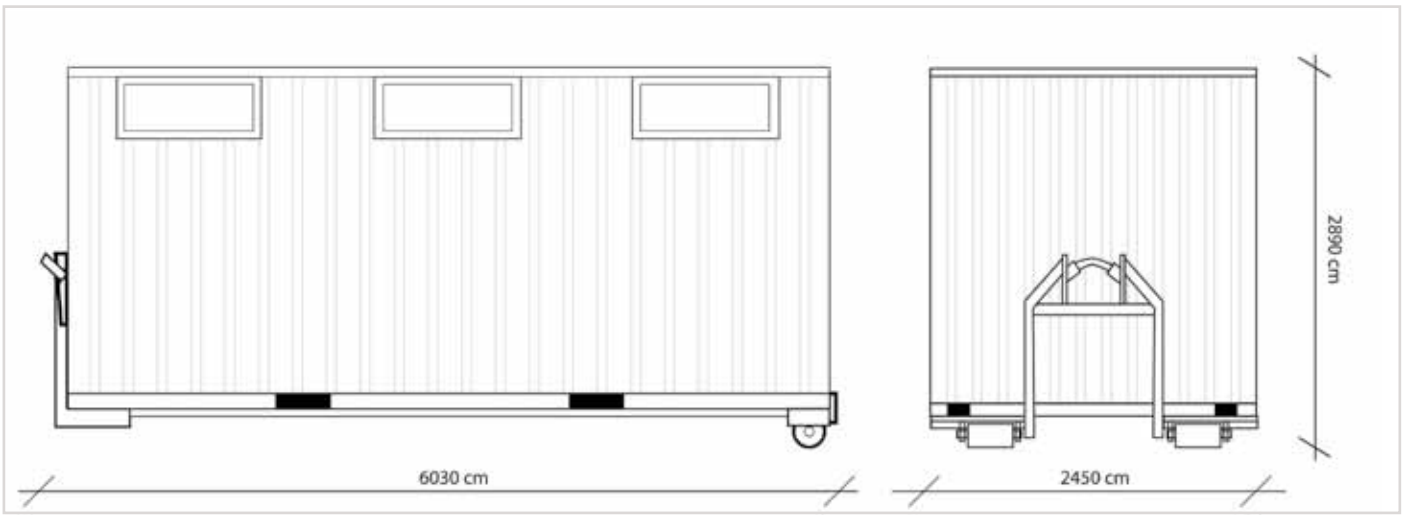
The stations are made with an industrial shipping container in steel, but the purpose is to produce compost for use in agriculture. Could the aesthetics be more soft and friendly with the use of organic plants that again communicate the result of the service? As shown in the drawing, as soon as it is placed something natural and green around the container, the industrial look turns out to become less dominant and it is easier to place the stations more nicely in a neighbourhood.

What if it is added an organic material to the container? The use of wood will change the entire look and it is a material that could be linked to the production of compost. The concrete stairs could also be covered with timber to invite people to sit down and in this way make the stations a nice meeting place in the local community. It was built a prototype in the beginning of the project to test composting in a locally made woodbin, and to make the design of a bin to be placed in peoples yard. This bin could be implemented to the stations with the purpose of collecting plastic bottles.

It is positive to use a locally made product to support the local handicraft, and the woodbins are a good option to other bins that exists in Iringa. The woodbins have a flexible lid that is easy to handle, made from timber cut in pieces and connected together with canvas in the middle. This also makes a nice solution for the seating areas on the stairs because it will have a curved shape around the squared concrete for more comfortable seating. The principle is inspired by Scandinavian woodwork and architecture, and it is designed and made by a local carpenter who lives and work in Iringa. The timber will be vanished to better resist rain season and termites, and the timber is eucalyptus from legal plantations.

The solution for the further work on the stations will be based on a combination of the presented concepts. The container is placed on the ground to make it easy to lift for the truck driver and to avoid too expensive implementation costs. The principle for lifting, transporting and emptying of the container is planned maintained by a truck equipped with a hook lift as shown in the illustrations. To make sure a hook lift could handle a weight of 15 tons, data for three different types have been provided by Cargotec Norway. Their hook lifts can take 17-20 tons, but the container needs to be equipped with wheels in the back and a mechanism for grip in the front of the container.
It exists standardized tools to place on the container for the use of these types of lifters. It could also be possible to





make these adjustments locally, something that should be discussed with Sido, the company that might be used to make the doors on the containers.

The stairs around the station are made from local bricks covered with concrete. This is a low-price solution with the approximately unit price of 200TSH for one brick and 20 000TSH for a five litres bag of concrete. With estimation that the solution requires 1000 bricks and ten bags of concrete, the cost will be about 400 000TSH (260USD) exclusive the work. Based on the prototyping of the wood bin, the total price of all the woodwork will be 250 000TSH (160USD). To add a basketball net in is an easy way to make sure the local community will keep the area in front of the station clean. This could be added to the stations as long as it doesn't complicate the transporting of the container. Hence, the stations can function as a meeting place with a nice aesthetic look in its surrounding to a low implementation cost with the use of local materials and local handicraft. One hence is the design of the doors. They might be heavy and noisy when they are produced from metal, and they might create an atmosphere inside of the container that increase the bad smell and living organisms like flies.

The extra woodwork on the solution presented below will make the stations more expensive, but it will be a good camouflage to the unfriendly look of the container. The extra costs could be defended with the argument that it will increase the chance of a successful business if the stations are accepted in the community because of its friendly and well integrated look. The doors are less heavy when they are in wood, they are not completely air tight and they let gasses out and air in for a better atmosphere and less bad smell on the outside of the container. The solution will be further developed and presented through renderings later in this report.



"Plastic is not the enemy. But it's our understanding of disposal and reuse that's to blame!"

David de Rothschild





2.5 Plastic Bags

The research has revealed problems connected to the use and the disposal of plastic bags. There are only some few types of plastic bags that are allowed to use in Tanzania, and some of them are produced locally from recycled plastic. The problem with plastic bags from recycled plastic is that they cannot be recycled again, which makes the product "less bad" and not an optimal solution.

The plastic bags that are produced from recycled PET bottles are in three different types;
- disposable shopping bags made from a thin black plastic film
- disposable bags for garbage made from a thicker black plastic film
- reusable bags for transporting food, made from thick and strong plastic that is plaited together as a bag.

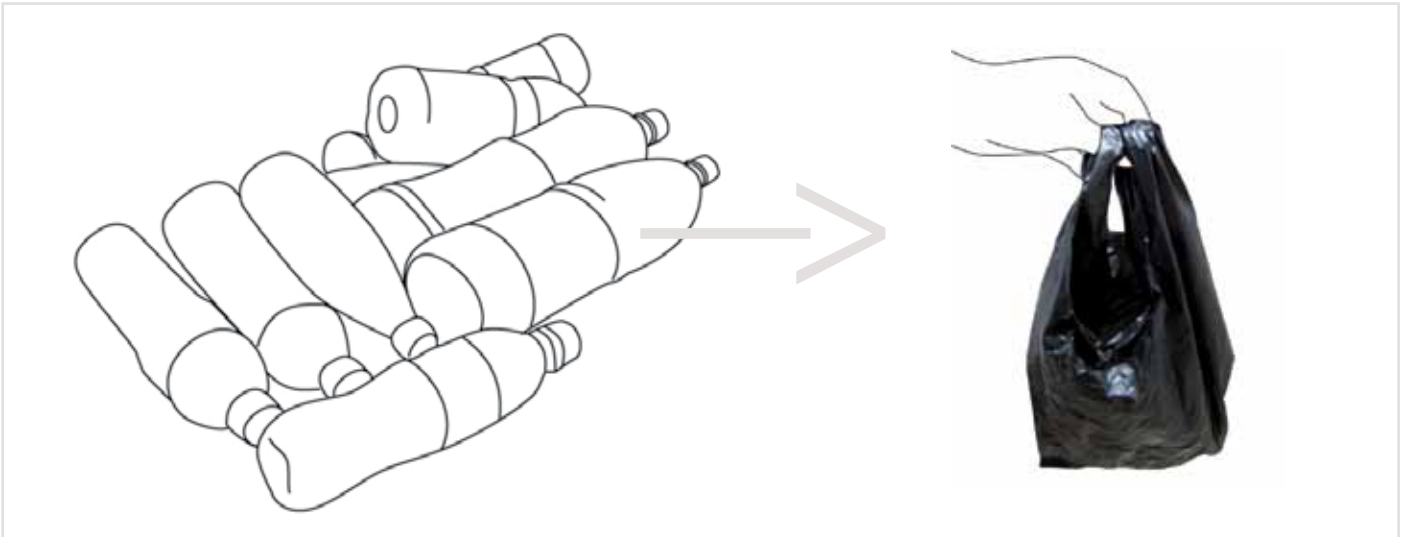
All of these three are low price products, and they are produced and used in a huge amount.

The shopping bags are the most eye-catching problem to waste disposal and the bags can be seen everywhere in the nature. Because those plastic bags can not be recycled one more time, one solution to this problem is to forbid them. This has been done successfully other places in Africa, hence in Rwanda and in Zanzibar, and it is only a matter of a change in attitude.

A substitute to plastic bags for shopping is paper bags, but paper bags have though a couple of disadvantages. Tanzania is a country where forest conservation is a huge focus area, and there are not enough resources to replace all plastic bags with paper bags without harming the nature. It is also a problem that they are not water proof, and many hesitate to use them for products such as meat, fish, fruits and vegetables. Plastic bags for garbage should also be waterproof to avoid leakage from the waste. To design a better option for plastic bags, the bags should be:
- waterproof
- low in price
- produced without harming the nature
- a solution to wrong disposal

2.5.1 Bags from recycled PET bottles

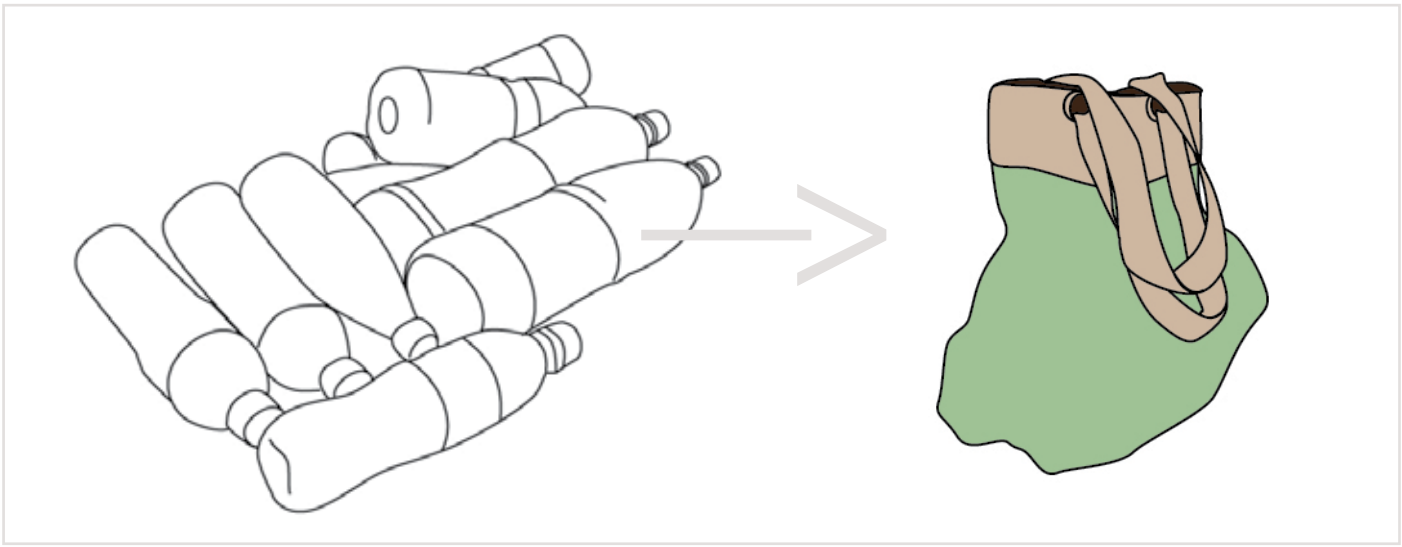
It is mentioned that the problem with bags made from recycled PET is that they cannot be recycled again, and they are disposed of after use. The plastic film that is produced in Tanzania is thin, has a low quality and signalise a one-time usage. Because there are already problems with the disposal of PET bottles, recycled PET is still a good material to use when designing new bags, the design challenge is therefore to make bags that are



meant for re-use and in this way encourage to a change in habit. Because Anstonelle aim to solve the waste problem by putting value on waste, the bags should be designed from recycled waste and the use of new materials should be avoided as far as it can.

2.5.2 Recycling PET bottles into fibers

One option to recycling PET bottles into a plastic film is to recycle it into fibres for use to make textile. By doing this, we change from downcycling the bottles into a low quality material to recycling into a new material with its own good qualities. The biggest export product in the world is cotton, and textile is a material with an increasing demand worldwide. Polyester from recycled PET is a good option, not only because it help solving a waste problem, but also because it, unlike the production of cotton, does not require big areas of land that could be used for food production. Producing polyester from PET bottles is a growing trend in countries such as China and India, and it could also be an industry for both export and local use in Tanzania.



It is a three stage process to recycle PET bottles into fibres: PET bottle collection / separation - production of clean bottle flakes - conversion into fibres. From there, the fibres will be sent to the textile production. To recycle polyester can be done cost efficient with the plant capacity of 5 000-20 000 tons per year, but this will depend on the market where the final product is sold. [28]

28 Recycling Polyester Industry, Dr Ulrich K. Thiele, Polyester Technology Service, Bruchoebel, Germany

It is about one and half tons of plastic waste produced in Iringa each day, and a big amount of this are PET bottles. Most of the PET bottles are colourless, some are also green, blue and brown which has to be separated in the workshop. Sido in Iringa, have one machine for chopping plastic to the price of 2,7 million TSH (2000 USD) This machine can take hundred kilos per hour, means one machine will have the capacity of taking the amount of bottles that can be expected to be collected each day. With efficient collection and separation, a recycling plant in Iringa can be done economically efficient based on the provided information.

2.5.3 Runer Consult

Runer Consult is a company based in Dar Es Salaam. They have collection points for PET bottles and agreement with some few organisations to collect bottles for them to pick up. In their workshop, they chop the bottles into small pieces and export them to partners in China for recycling. The manager, Mr. Martin N. Kitundu, have plans of expanding his business and wants to partner with Anstonelle to also cover Iringa Municipality.

Anstonelle can send plastic to China through Runer Consult as a short term strategy, but Runer Consult is interested in setting up their own recycling plants in Tanzania, and could start the production of polyester locally in Iringa. This will save a lot of transport cost and pollution They also have some product ideas for further development, and have agreed to discuss with Anstonelle the product concept from this project to see if they can start the production.

2.5.4 Trice Design

Ndey Emanuel in Trice Design was contacted in an early phase of the project to help brainstorming on the design of bags to replace disposable plastic bags. Before the use of polyester was decided, research was done on other options of materials that could be used. Sisal and canvas was brought up as potential materials because they are already produced in Tanzania, and the idea of making a concept with the use of bamboo fibres was discussed. To get a better insight in materials that are already produced in Tanzania, a visit to the textile industry in Morogoro was done.

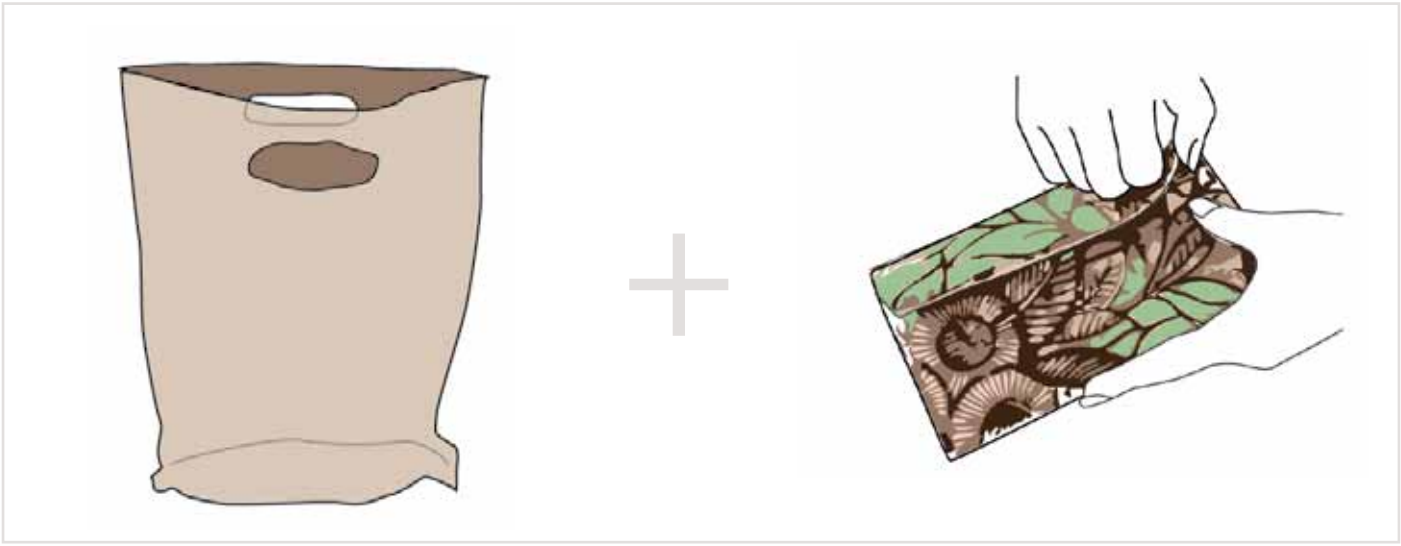
The received information on the meetings at the different factories excluded sisal and canvas due to price and quality. The material is very robust, and there will be a costly business and a high risk to start up a competition to the existing factories. To get a lower price on the production of the new bags, the concept started to focus on the use of collected waste.

At the factory for kitenge, traditional textile made from cotton, the idea of collecting leftovers from the local sewing industry was brought up. Nearly all the Tanzanian women use Kitenge in different styles, and there is a huge production of local clothes with this fabric in Iringa. By using kitenge, the bag will fit very well to the clothes the women wear, and the fabric comes with colours and pattern for any taste.

2.5.5 Bags made of kitenge

There are already many bags at the market in Iringa made from this local textile, and the challenge is to make a product the women would choose to use for shopping. Because of theirs traditional African look, first of all tourists buy the existing bags. They are not particularily suitable for grocery shopping because they are not waterproof or water-resistant. Other weaknesses with the existing bags in kitenge are their size and their "cheap" look. Women in Tanzania care a lot about looking representative and good, and they dress up nicely with different hairstyles, coloured nails and classy shoes. Their purses are often big and an important accessory to their outfit.

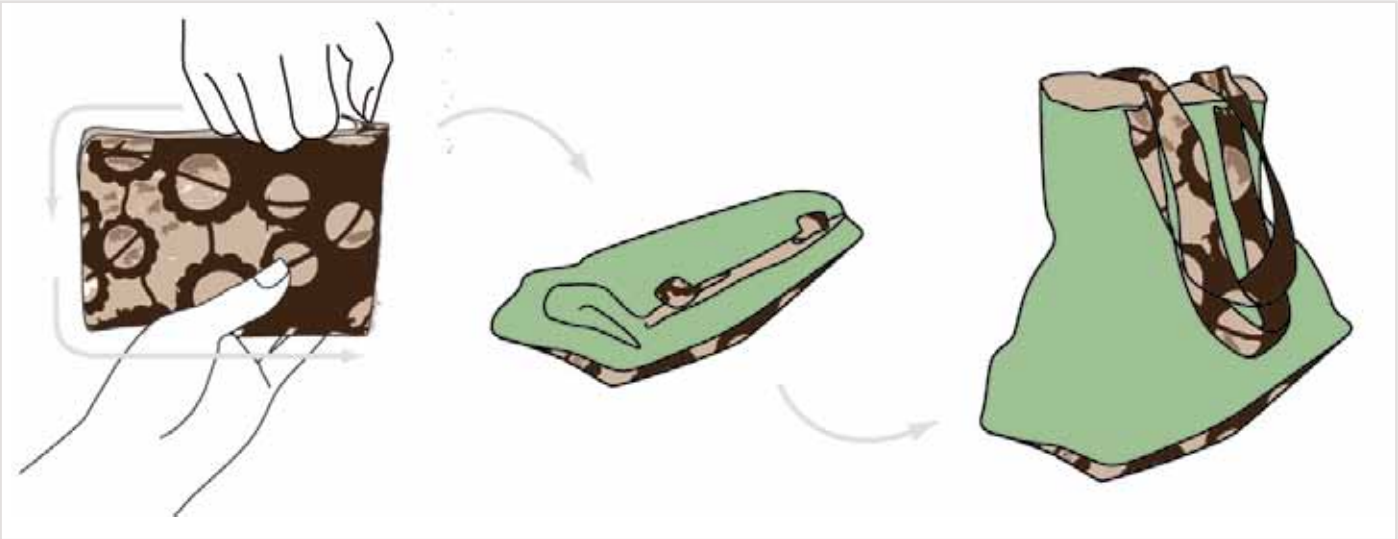
Trice Design makes purses where they combine kitenge and other fabrics, and keep their African origin in a modern style. This is also a good concept for the new bags, and the design started to be shaped around the combination of kitenge and polyester. To succeed in making a bag the women would choose to use for shopping, it need to be a bag in addition to their purses and not a replacement. The use of kitenge will make it suitable to the clothes they wear, but to make it more realistic that the women would carry the bag with them, it was decided to make it foldable so it could fit into another purse. There are also at the market in Iringa some small practical wallets made from kitenge, and this was the inspiration for giving the bag an extra value as a wallet when it is folded.



2.5.6 Prototyping the shopping bags

It has been produced several mock-ups to see how the combination of kitenge and polyester can be done nicely. Different ways to place the materials together have been discussed (ref. sketch book and process book), and it has been a criteria for the design to use as little kitenge as necessary due to the sizes of the leftovers that will be used in the final production. The chosen principle have been to make the design of the wallet in kitenge, and use polyester on the inside part that will be extended when the bag is unfolded. The kitenge is placed as an extra protection and strengthening on the bottom of the shopping bag, and textile is repeated on the handles for a total look.

It has been chosen to use a zipper to close the wallet to protect the items inside of the wallet, and it is suitable for the design because of its flexibility. The most challenging part has been to find zippers that are easy to open and close. It is in general very difficult to find good accessories in Tanzania for use in textile production, and the quality is often weak. It has been tested different types of zippers, and the final choice landed on a medium sized type



that exists in a wide range of colours. This type is also easy to handle for the user, and it is discreet in its look. The zippers have also been the most difficult part to sew, and there is still need for improvement before the product is ready for sale.

The extended part have had starting point in an medium sized disposable shopping bag and the size of the wallet have been adapted to the inner textile and made in a size that ensure enough space to place money, keys and cell phone. The design of the disposable bag is used as a template also for the shape, and the shopping bag have got a squared look with folded sides. For a more comfortable use, the handles are designed for the bag to be carried from the users shoulders. The colours of the zipper, the kitenge and the polyester have been carefully selected to match each other, something the wide options on colours on the kitenge have made easy.

As a strategy for further production, one girl has been trained in producing the prototypes. The bags are also designed for an efficient production, and the time the girls will use on sewing the bags have been tested. After 10-15 produced bags, one girl can easily make one in one hour. According to Ndey Emanuel, the production cost for one bag (excluded textile) will be no more than 500TSH, and will still ensurs a fair salary and good working conditions for the girls. It can be made three bags from one meter of polyester, and the total production cost of the prototype have been less than 2000TSH. This cost will be even lower if the polyester is bought directly from the factory.

2.5.7 Testing of prototype

The prototype have been used and tested before the final re-design. The feedbacks from the users have been to add some pockets for putting money, keys and sell phone when the bag is unfolded and to make the polyester water-resistant. The polyester is already more water-resistant than for instant cotton, but this can be easily improved by extra impregnating at the factory. It has been concluded that there is no need to make the bag water-proof, the important factor is to make it easy to clean and resistant to dirt and water.

The pockets can either be fixed on the inside of the polyester or on the outside of the kitenge, as long as the clean design on the wallet is kept. It has also been discussed if it should be attached a string to the bag for use around the hand wrist when the bag is folded, hence to make it safer to carry the bag in the users hand at the market place. It has been chosen not to add this detail because it will be a disturbance to the look on the unfolded bag, and the bag is not designed to be carried alone when it is folded, but inside of another purse

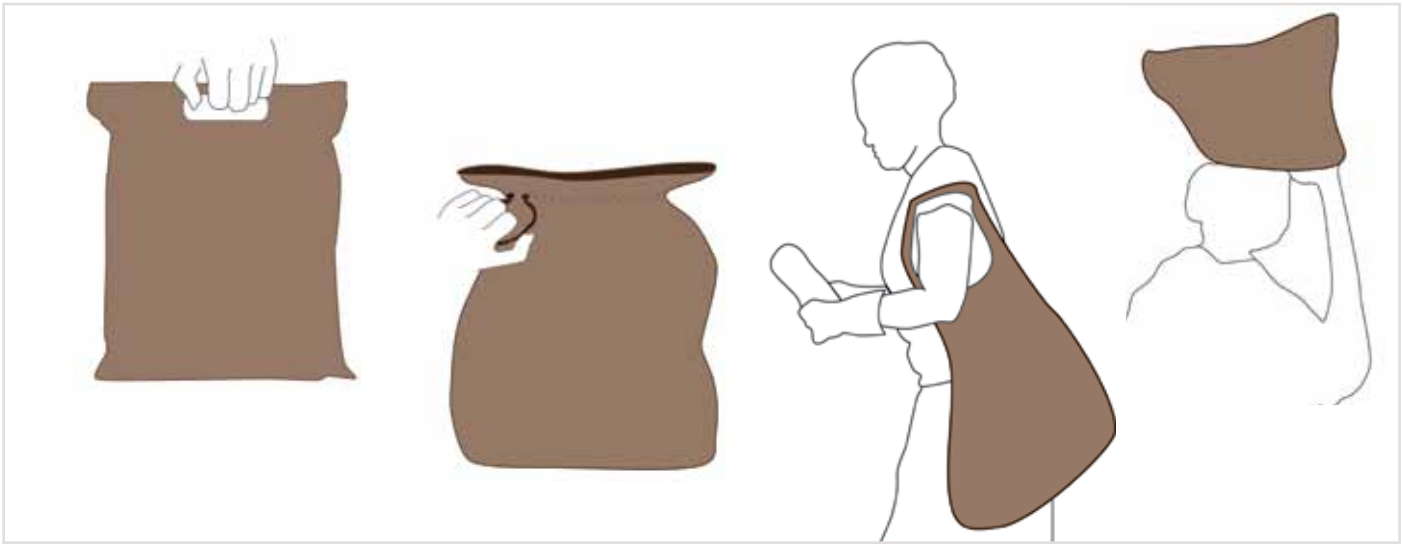
The recommended market price, after the suggested improvements are done and the bag is ready for sale, have ranged from 8 000 to 12 000TSH.

2.5.8 Bags for collecting waste

The existing options for bags to collect waste are either the black plastic bags made from recycled PET bottles or the plaited plastic bags used for transporting food. The first one is meant for a one-time usage, the second one is in such good quality so it can bee reused several times. To not encourage to the production of more waste, the bags should be reusable, and the plaited bags have been discussed implemented to the system. They have a low production price (market price is 1500TSH) and they can be produced in different colours and with different printings for easy separation of plastic bottles and organic waste.

The bags were tested at the market for collection of organic waste. Two problems observed through this experiment was the bad grip they gave because of the smooth surface and the stiff plastic without any handles, and that they leak easily because of their plaited structure. It is also unlucky communication if the same bags for transporting fresh food are used for transporting food waste. It where therefore concluded that the bags need to be produced for the purpose of collecting waste, and need a new design for use in the SWM.

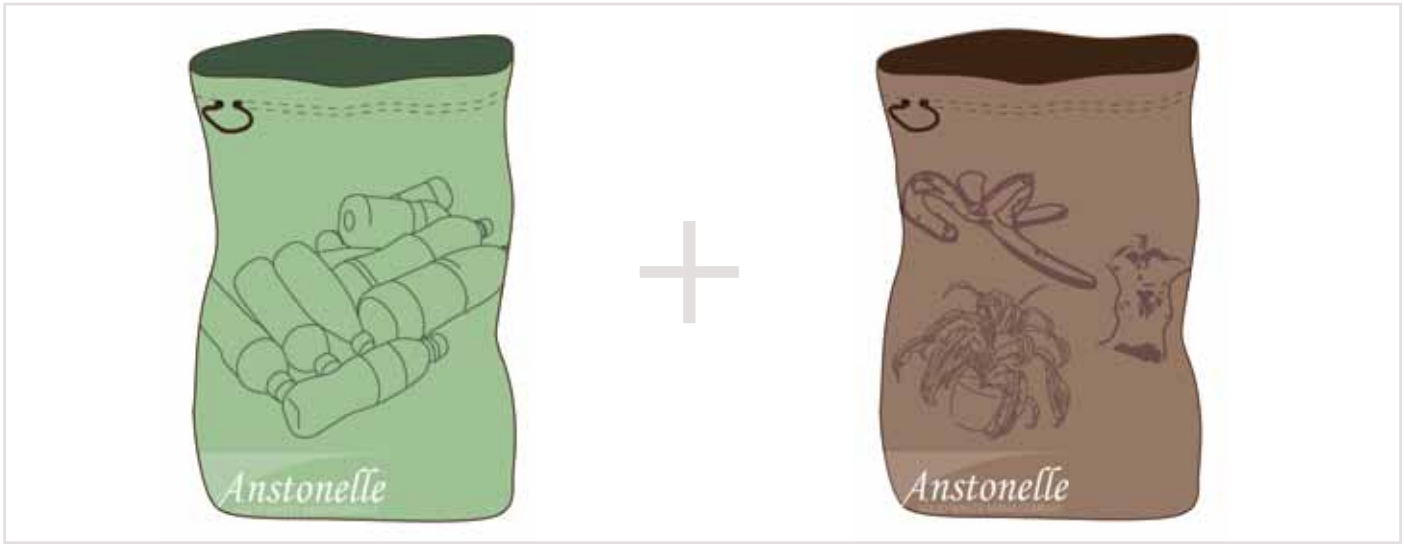
If the bags need handles for a good grip depends on the grip on the material and the distance the bags are carried. It might be more important to make sure the bags can be closed and that they are waterproof, so that they can be carried on the top of the head, which is the most typical principle of how the East-African woman carry things.



2.5.9 Waterproof polyester

Because it is already a part of the strategy to produce textile from polyester fibres, this textile can also be used for producing the bags for collecting waste. To make them waterproof, they need to be coated either with acryl, silicon or polyurethane (PUR). The coating will be on the inside of the textile, and will avoid the water from the organic waste to absorb through the textile. This will allow the bags to be carried on the top of the head if the user prefers that. The bags will be flexible for printing and textile with different colours can be used on the bags. As long as this do not make the textile too thick and too difficult to fold, the coated polyester could also be used for the shopping bags to make them better suitable to carry products which contains liquid.

The dimensions of the bags have been chosen to be the same as the plaited bags, which allows two bags to be produced on one meter of textile. The production time on the sewing of the bags was tested when the prototypes where produced, and the estimated production costs included textile is about 1000TSH. The price of the coating and the printing is not included in that estimate; this depends on the technique used and the production number of the bags. The conclusion is anyway that those bags will be cheaper to use than the existing bags because of their long durability, they can be designed to communicate their purpose in a good way and the production of them will create more workplaces through small enterprises for printing and sewing.



Promoting micro-enterprises as part of a poverty reduction strategy

2.6 We cannot end poverty by 2015, but we can do something.

Leaders from 189 nations agreed in September 2000 on a vision for the future: a world with less poverty, hunger and diseases. This agreement shaped the framework of the United Nations eight Millennium Development Goals (MDG), with the rather ambitious aim of ending poverty by the year 2015. One of these goals, goal number three, is to "achieve full and productive employment and decent work for all, including women and young people". Gender equality and the empowerment of women are at the heart of the MDG and are preconditions for overcoming poverty, hunger and disease.[29]

The unemployment rate in Tanzania is high, particularly among young people and women. The unemployment rate among young people (15-24 years) was in 2006 14,9% and 12,6% among women. The proportion of the population living below the national food poverty line is 16,5% and the proportion of people living below the international basic needs poverty line (less than 1,25USD per day) is 33,3%[30]. A national program against child labour had the aim to reduce children engaged in child labour from 25% to 10% by the year 2010, and to ensure the right to schooling for all children.[31] This goal is yet not achieved, and many households depend on the children to work to provide enough income for the family.

Approximately 87% of the poor live in rural areas with poverty highest among households dependent on agriculture.[32] Farmers are counted as the poorest group of workers in Tanzania, and about 80 of the population are employed by the agriculture sector. The small holders in the agriculture are facing many challenges included high taxes, competition from bigger industry and unstable crops due to climate changes. The World Food Programme (WFP) work to provide food assistance for farmers to enable them to stay on the land and replant for the next season. But it is a pressing urge for more initiatives to be done.

Tanzania has no social security arrangements for people who work in the informal, agricultural and extractive s ectors, and the majority of unemployed individuals in Tanzania are not covered by any form of protection.[33] Young mothers, widows and people living with HIV are among the most vulnerable groups in Tanzania, and in the highest risk of being unemployed. Many in those groups work for a salary far below the poverty line, and the most common is to work on short contracts or without contracts at all. This situation leads to prostitution, sexual abuse and child labour. Access to a decent and well-paid work can greatly reduce the vulnerability of individuals and their families, and reduce the necessity for children to work. We cannot end poverty by 2015, but we can do something.

2.6.1. Women in Iringa

Iringa is the region in Tanzania with the highest HIV/AIDS rate, and it is expected that 15% of the people living here is affected. The most vulnerable groups for contracting HIV are students and people living under the poverty line, and about twice as many women than men are infected by the virus. Many women living with HIV loose their job or have difficulty of finding a job because of their condition, and are forced to live in extreme poverty relying on family members to help them.

29 United Nations; The Millenium Development Goals, report 2011
30 The United Republic of Tanzania, Ministry of Finance and Economic Affairs; National Social Protection FrameworkPoverty, Education and Empowerment Division, Dar Es Salaam, 28 October 2008, chapter two, p.6-7
31 The United Republic of Tanzania, Ministry of Finance and Economic Affairs; National Social Protection FrameworkPoverty, Education and Empowerment Division, Dar Es Salaam, 28 October 2008, chapter two, p.11
32 The United Republic of Tanzania, Ministry of Finance and Economic Affairs; National Social Protection FrameworkPoverty, Education and Empowerment Division, Dar Es Salaam, 28 October 2008, chapter two, p.6
33 The United Republic of Tanzania, Ministry of Finance and Economic Affairs; National Social Protection FrameworkPoverty, Education and Empowerment Division, Dar Es Salaam, 28 October 2008, chapter two, p.14

The occupations with most women employed are within the sewing industry and in households where they work as cooks, cleaning personal and maids. Many of the women also rely on agriculture for living, and sell their products at small stands by the street. The salaries in these occupations are low, and many uneducated girls and women have to accept a salary lower than 40 000TSH per month. This equals a daily payment of less than 1USD.

Iringa have got three universities, and the rate of girls taking an education is increasing. It is a good progress that the access to education becomes better, but there are still flaws in the system that makes the girls who are going to school even more vulnerable. The HIV rate among girls in Iringa who study is as high as 25% and the universities

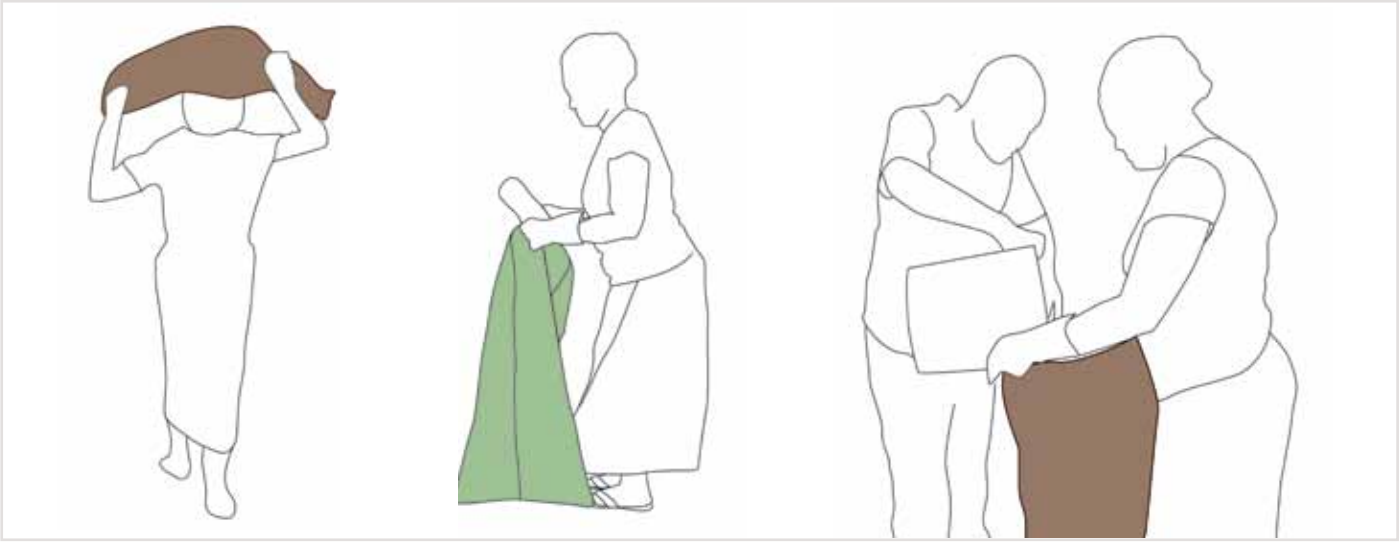
encourage through campaigns the students to graduate with A's, not AIDS. When they graduate, the work opportunities are limited, and the situation after school is often unemployment. They will also have to pay down their expensive school loan. The creation of more workplaces for girls is highly essential to increase their independency and make them less vulnerable for abuse and the risk of living their life in extreme poverty.

2.6.2 Micro-enterprises in the SWM

The creation of jobs for poor people in the private sector, including small enterprises, has an important role to play in poverty reduction. For many people in Iringa, work means to be the owner or the employee in a micro- or small enterprise. A micro-enterprise is often referred to as an enterprise with less than 5 employees, but when we talk about creating workplaces for poor people in a developing country, micro-enterprises can be given another definition than the number of workers employed in the company. Through this section, the report wants to highlight the importance of community driven development and the encouragement of establishing micro-enterprises as part of a poverty reduction strategy. The number of workers in the enterprises is therefore not the main issue when defining if the business qualifies for being referred to as a micro-enterprise, but rather important is the type of work, the management and the service or goods sold.

This report places the CBO's in the heart of a poverty reduction strategy as important micro-enterprises in the local community in Iringa. As mentioned in the introduction, there are today four operating CBO's in the SWM in Iringa; Ruaha, Miyomboni, Mkonongoni and Ilala. The CBO operating at the marketplace in the city centre of Iringa, KWBS, have been helpful in providing information about the situation. They are also willing to participate in a pilot project to test new concepts for expanding the business, the number of workers and the income of the enterprice. The target group for the expanding of the CBO's are poor women. This process is based on the provided information (ref. process book) and observations of the workers in KWBS.

Fig. 7



2.6.3 Collecting waste

Anstonelle could plan a strategy where they follow a western system with pick up of garbage from door to door. This would require less implementations costs (only trucks, no stations), but the company would have needed to invest more in training the local community in separating their waste. In a country where many of the inhabitants cannot read and write, it is assumed to be unrealistic to train all of the inhabitants in a city to separate their garbage. To train some workers in the CBO's are much more realistic. Anstonelle will also benefit from having more people working in the new system. One and each worker will function as ambassadors for the new SWM through the establishment of their own clients and the spreading of information about separation and safe handling of waste. In this way, the new SWM in Iringa will be community driven, and not controlled by one big company.

Because the SWM is a women dominant business, it has a great potential of expanding and create more workplaces for women. The chosen concept for the stations is based on the CBO's in charge of the deliveries, and they have the overall responsibility to make sure only organic waste are thrown in the stations. The tools they use for transporting waste from stands, hotels, restaurants and so on are locally made push sheets with three wheels. This is the most normal tool for the transporting of all kind of products, such as fruits, vegetables and different materials for construction. Some other businesses also have bicycles or motorcycles that are re-built for more easy transport. Because it might be a little bit too radical, it is unrealistic to think it will be accepted that the women drive a motorcycle. Bicycles could be used as a tool also for waste pick-up, but more realistic in the near future is to base the pick-up on the existing push sheets they already use, even though it is a little bit heavy. The manager at KWBS

has informed about his workers physical condition, and he gives the women work they can manage physically from day-to-day.

Anstonelle have discussed with the manager in KWBS their interest in participating in a pilot project where Anstonelle provide tools for separation of waste and KWBS bring it to one station close to the market place. Through this discussion, the tools needed got mapped out, and the basic tools should be bags, gloves and clothes as well as some push sheets. To make the CBO's more visible, the company's logo should also be printed on t-shirts for the women to wear.

2.6.5 Discussion

It is a fine line between taking advantage of poor people and to give them opportunities. As an example, many street children could benefit from a system were they can get money on collected bottles, but Anstonelle should never encourage children to work. The new system will take away food sources for the street children, but children should never find their food in containers like they do in Iringa today. There are other ways Anstonelle can compensate for the children, for instant through donating compost for orphanages to grow their own vegetables. This will help giving the orphanage extra food and extra income from the sale of vegetables, which again will enable them to house more kids. Anstonelle could also run programs where street children learn about agriculture and how to produce food for their own living. Anstonelle is a social enterprise, and all profit in the company should go back to the local community. Because street children is a group that will be affected by the new system, profit should go back to programs street children benefit from.

The CBO's are not the only micro-enterprises that can be established through the new SWM, but also workshops where the workers produce products from recycled waste. This thesis gives the example of girls in the sewing industry through the production of the bags. Other materials could also be used in a second-life workshop, especially glass and metals such as aluminium and tin. Through the access to cheap compost, many small enterprises in agriculture will also benefit. This report does not go into any deeper details on this, but there are many opportunities for poor people if the SWM is well organized. And the most important argument for the establishment of micro-enterprises and workplaces for women; the need of the family's children to work will reduce.

To engage even more people, the bags for collecting waste could have had a concept everybody could benefit from; buy one bag, and you are ready to start your business. With this concept, all those who need extra money could collect bottles or organic waste and delivered it to the stations in exchange from a small amount of money. It is some few reasons why this concept have not been further developed; it encourage children to work, it makes it possible for also those who are not included in the target group to earn on deliveries and it makes it easier to manipulate numbers and misuse the system. The new system needs to be well organized and easy to control to avoid misuse. To better control the business and avoid manipulation with numbers, concepts for software for use in the SWM have been developed as a tool to use in the SWM.

ICT for solid waste management

2.7 Software for solid waste management

All the big mobile operators offer a type of mobile banking where the costumers have registered an account through their mobile phone. From this account, they can as examples pay their electricity or they can send money to another person. This is a well-used system because of its flexibility. Not all Tanzanians have a regular bank account, credit card or easy access to a bank, but almost all Tanzanians have access to a mobile phone and to a regular grossery shop. To use this service, they enter an USSD-code and they choose what action they want to perform from a menu received on the phone. To send money, they easilly charge their account with voucher bought in the chop, enter the USSD-code for sending money and enter the telephone number to the person they want to send it to. The person who receive the money will get a sms with a code. With this code, he can go to a shop where they sell voucher and get his money in TSH.

This system has been inspiration for the development of a mobile application for saving and reading data from Anstonelle's service. The idea behind the development of a software for SWM was to gain fully controll on the waste stream in Iringa. So far, all numbers IMP operate with are based on assumptions and research done other places in Tanzania, and no research has ever been done on the MSW in Iringa. Through the use of USSD-codes and SMS', the software has been developet with the main purpose to:

- save data about the amount of solid waste in Iringa
- save data about waste content in separated groups
- read data about Anstonelle`s results
- send out information about waste management and separation of waste
- ease the communication between the customers in the pick-up service and the workers of Anstonelle

Cheating and manipulating of numbers is a daily problem in Tanzania, and when Anstonelle put value on waste, they have to expect this also to be a major challenge in their business. This means that Anstonelle must have a water proof system where all numbers are registered and controlled with eachother to reveil any flaws or negative numbers.

2.7.1 Specification and USSD-codes

There was an option in the beginning of the project to involve ICT-students in the project through Tanzict's incubators in Dar Es Salaam. Due to the time limit of this project, it was decided to continue the work with maji-Solutions. MajiSolutions already have a demo of software for use in the water-sector, and are willing to adapt the

software for use in the SWM. Spesification and five scenarios of use have been sent to majiSolutions for further development (ref. process book).

Mr Jukka Siltanen at Tanzict has been helpful with information, and he has also introduced the project manager to Mr. Anthony Kigombola. Mr. Kigombola has created a connection to Vodacom's USSD-server, wich makes it possible to forward requests made through USSD-codes to majiSolution's software. The price for one USSD request is 25TSH, and will be charged by the mobile operator. This connection is further followed up by Mr. Hannes Schuricht in majiSolutions, and tried implemented to the application for solid waste management.

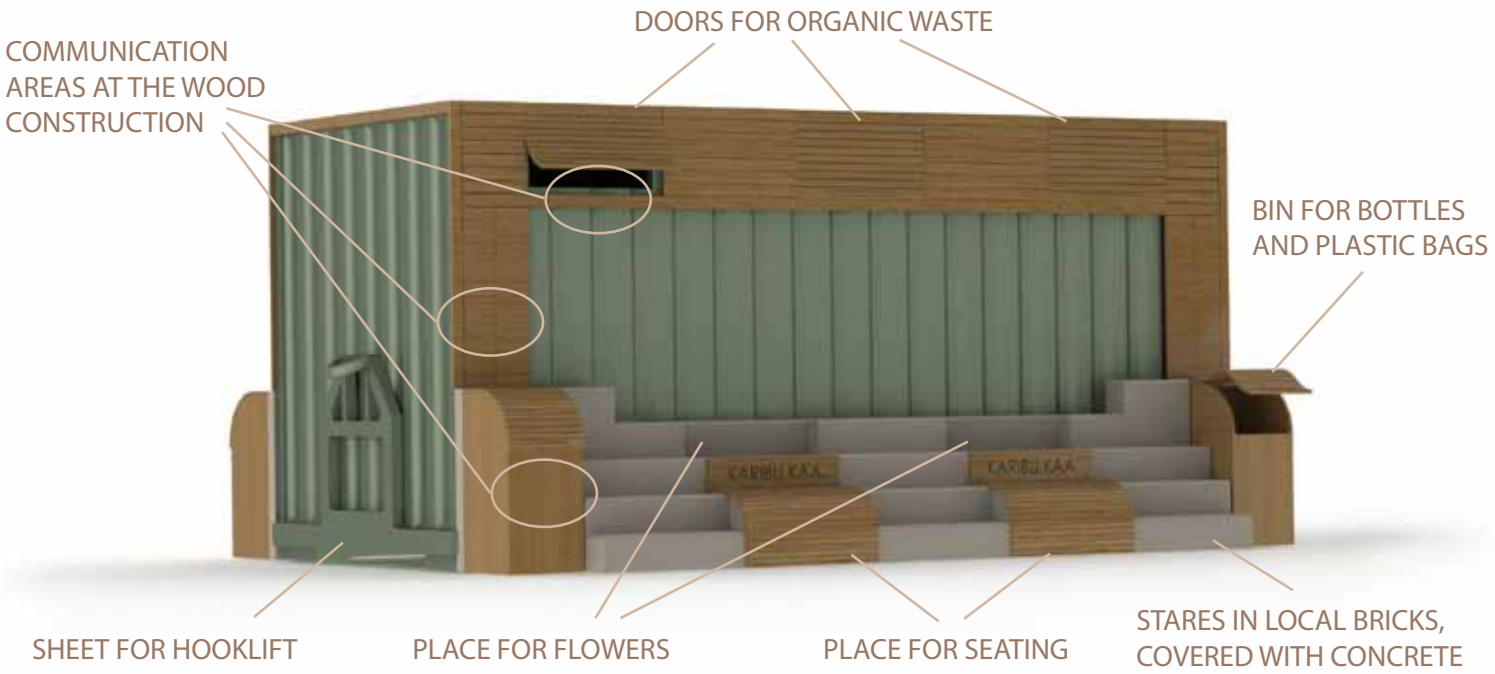
2.7.2 Planning of three commercials for local TV

Iringa have several local radio channels and one local television channel. Most people have access to radio and TV's, which makes this important medias for information and education. As example, the local radio station Ebony FM promote them self with the slogan "We inform and educate in an entertaining way". For Anstonelle to inform the local community about their service, different TV commercials have been planned in cooperation with Joti Entertainment.

The movies should tell short stories about Anstonelle's service; how it function and how it benefits the local community. It should be used for information and education as well as it should tempt and encourage the citizens to use the service. One of the stories could be to show how the separation of organic waste results in the production of compost that can be used in agricultural projects. Another can inform about the payments that can be received through the deliveries of drinking bottles, and a third one can be used to encourage the woman to use Trice Design's shopping bags for grocery shopping.

There are many ways of promoting Anstonelle's service through the use of ICT-medias. But Anstonelle should be careful about promoting them self as a big company that have made business from waste. It could be wise to focus all the advertising on the micro-enterprises and the benefits of the local community. The most important with these videos are to encourage people to use the services provided by the CBO's and inform about the separation of waste into three groups: organic waste, PET-bottles and residual waste.

3. Design Response



3.1 Design stations

The stations are designed for the people, and they are designed as a meeting place in the local community. The industrial look on the container has been toned down with the use of timber and all companies logos have been removed to avoid messages that communicate "business" in this service. There are planned communication areas on the timber to explain where the different type of waste should be thrown. These areas could also be used to explain which CBO that is in charge of the station and what the result of the separation means for the community.

The sizes of the stairs around the containers are made to ensure good ergonomics without giving the impression of being too big and heavy. Four stairs gives a distance of 140 cm from the top of the stair and up to the doors, and for those who need a shorter distance, an additional level have been set next to the woodbins. The hard concrete has been made friendlier with rounded seating areas in wood. Behind these seating areas there are also made place for growing flowers. The use of wood and flowers has also been chosen because it is a direct result of the service with the composting of the organic waste for use in agricultural projects.

3.1.1 Local handcraft and materials

The total design on the stations has been based on what is realistic to make in Iringa with the use of local craftsmen and local materials. The stations are made in three parts; on flexible container with a sheet to be lifted onto the truck with a hooklift, and two fixed concrete staircases with woodbins and wood cover for seating areas bolted to the concrete. Sido will do the work on the metal before the wood is attached to the container, and the work on the staircases will be done by local craftsmen directly on the site where the stations are planed to be. The stairs are made in local bricks, which is a low cost solution with easy availability. They are covered with concrete for long durability. It was suggested to use padlocks on the doors to avoid disposal of unwanted waste, but it have been decided to wait and see if there is any need for it. The padlocks will immediately make the stations look less friendly, and work against the ambitions of creating a social meeting place.

The carpenter who has been involved in the project from the very start will continue to have the responsibility for all the woodwork. He is behind the principle of the flexible lids on the bins, and the same principle has been used in the design of the doors on the container and on the sitting areas at the stairs. The use of Scandinavian inspired woodwork made by a Tanzanian carpenter describes very well the cooperation the work in this project is based on. Anstonelle will use timber from a legal plantation, and eucalyptus from Green Resources outside of Iringa is suggested. The timber is vanished to resist termites and survive the rain season. The methode for attaching the timber

to the container will later on be discussed with the carpenter, to find the best solution based on the tools that exist in Iringa.

Technical drawings are attached as appendix to the report. These drawings are made for the craftsmen in Iringa to read, and does not follow any standards. The experience through this project have been that drawings should be made three dimensional for easy communication and the attached sheets have three-dimensional illustrations in addition to simple 2D-drawings with the most important measurements.

3.2 Scenario of a future situation

There are six women working at KWBS, the CBO in charge of Anstonelle's station near the big market in Makorongoni. KWBS have four stations in the ward where they work, and at each station there are six women working on collecting waste from hotels, restaurants, shops and stands. They used to be 13 women in charge of the collection of waste to the skip buckets and two men in charge of the collection of solid waste fees, but after the skip buckets have been supplemented with Anstonelle's stations, they have increased the number of workers to 34; 10 women are in charge of bringing residual waste to the skip buckets and six women on each of the four stations have the responsibility of collecting organic waste and drinking bottles to Anstonelle's stations.

To employ more people became possible because they have got extra income from the sale of waste to Anstonelle. Each time the station is full of organic waste, Anstonelle pay them for the job of separating and bringing the waste to the stations. This is also the situation with the drinking bottles they put in the woodbins attached to the station. They get 200TSH for each kilo they collect, which is the same as 24 1,5kilos bottles. Anstonelle provide two different types of bags for the collection of waste; one green that is meant for plastic bottles and one brown that is meant for organic waste. When those bags are too dirty or need to be exchanged with new ones, the workers throw them in the woodbins for the truck driver to collect together with the bottles. At the plant where Anstonelle clean and chop the plastic into small pieces before they are transported to Dar Es Salaam, they also clean the bags for reuse. The bags that cannot be reused are sent to Dar Es Salaam for recycling together with the bottles.

When the truck driver comes to transport the container to the compost site, he always brings some compost and sometimes also some new flowers for the stations. He makes sure the area around the container looks clean, takes care of the flowers and gives the workers his normal speech on organic waste. He is the contact person between the workers in KWBS and Anstonelle, and they can ask him all questions regarding separation of waste.






Promoting micro-enterprices as part of a poverty reduction strategy

3.2.1 Micro-enterprices - Continuation of scenario

KWBS is only one out of fourteen CBO's that works in the SWM in Iringa. It is one CBO located in each ward in the municipality and they have all the same responsibility as KWBS. Upendo is located in Miyomboni and the business is based on a system where all the workers have their own clients and their pick-up service use the standard charges for solid waste fees. They use the same push trolleys that are normally used for transporting food and different construction materials, and they often work in a team of two to make it less heavy to push. One day, they might have enough money to buy a small vehicle, but at least they are good company for each other when they work in team.

The workers have more responsibility than only collecting waste; they sweep the streets, empty public dustbins and teach their clients about separation of waste into three groups. The three groups are organic waste, drinking bottles and residual waste. They also change between each other to watch the station and help people who wants to deliver their waste by them self. This ward has also some industry, but Upendo only collect municipal solid waste, not waste from bigger industry. Factories have got their own containers and have private contracts for the collection of their industrial waste, something that is not part of Upendo's responsibility.

When Upendo collect solid waste fees from shops, restaurants, hotels and so on, they use the standard scheme they have got from the government. They are allowed to collect the fees instead of solid waste taxes, but their agreement with IMP is that Upendo pay for each time the skip-buckets are collected by IMP's truck driver. Anstonelle is planning a fully privatizing of the SWM, and when they are ready to replace the skip-buckets and start separating waste at the land filling, Upendo will no longer have to pay for the transporting. That will enable them to expand their business and employ even more workers.

When Anstonelle have started to separate waste at the land filling, their plan is to establish more local micro-enterprises. Those enterprices can produce items for sale made from recycled waste, such as glass bottles and tin canes. All the micro-enterprises are dominated by the most vulnerable group in Iringa; poor women. They provide workplaces through their co-operation with Trice Designs and the sale of their shopping bags, through the CBO's working in the SWM and later on, also through women groups working with the production of recycled items for sale through Anstonelles showroom in the city centre.

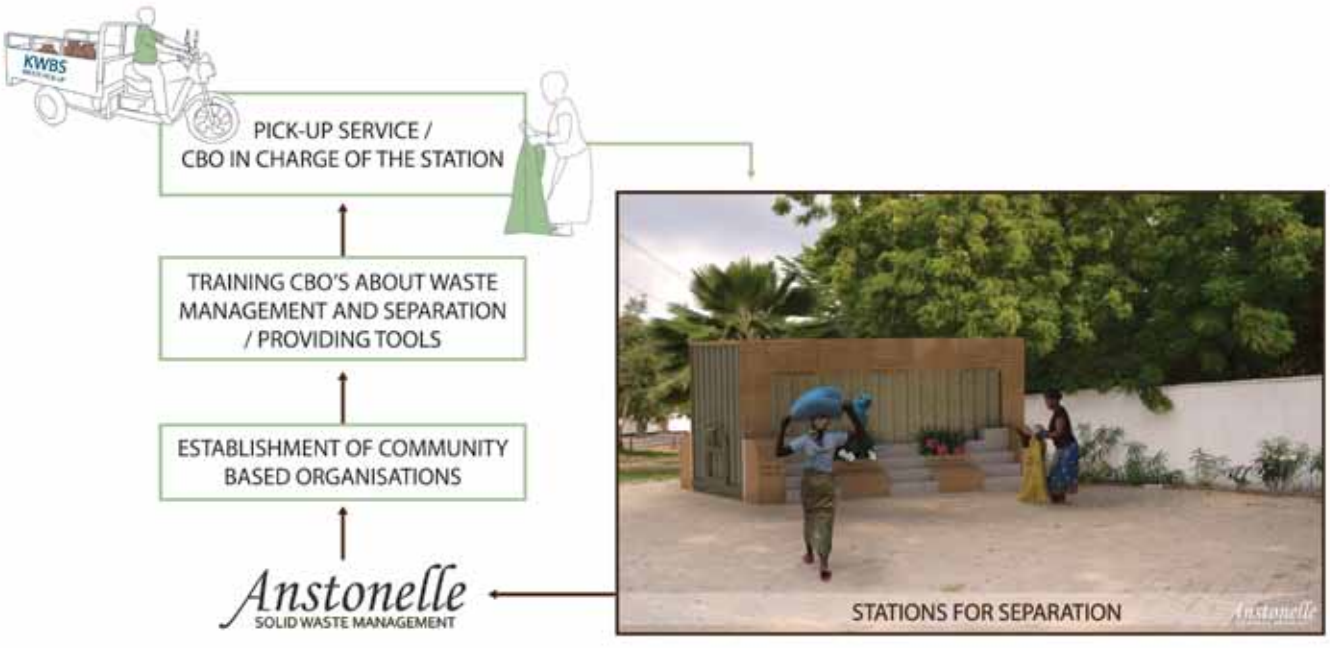


Fig 8





ICT for Solid Waste management

3.2.2 ICT - Continuation of scenario

Even though Upendo have their own manager, they need to be regularly in contact with Anstonelle, more than only talking to the truck driver twice a week. That is why all the workers have a got a SIM-card for use on their private phone, and a lot of the communication happens through USSD-codes on the phone. Each CBO and each station have got a number, and when the station by example needs pick-up, the workers send a USSD code to Anstonelle and they get sent back to them a menu where they choose their action. On the menu, the code 02 means "need pick-up", they enter that number, then the number of the CBO and the station, push "send". By sending the code for "pick-up", the software save the information and put the station on the map of the truck driver's next route.

If the workers in the CBO's have any questions they need answers to, they can also send a sms to Anstonelle's customer care, or they can request a meeting by sending an USSD-code with their number and the code 04. Every morning, a message is sent to them from Anstonelle, with different tips about how they can succeed in their business. For instant, how to inform people about their service and how to ensure their clients more easily remember to separate their waste. The system with USSD-codes has also a function for them to send messages with problems they experience. These messages are saved in a database, and the team at Anstonelle work continuously on problem solving strategies that can help the CBO's in their work.

The software is developed, on request from Anstonelle, by majiSolutions. To get the function with the USSD-codes implemented to the software, Anstonelle introduced majiSolution to Anthony Kigola. He could offer a system with the use of USSD-codes through Vodacoms network to the price of 50TSH per USSD-code. He could also offer SMS for the price of 25TSH, and Anstonelle use those to send information about waste management and separation of waste to all those who have registered into their service. Because this service use Vodacom's network, the co-operation have resulted in Vodacom as main sponsor for Anstonelle.

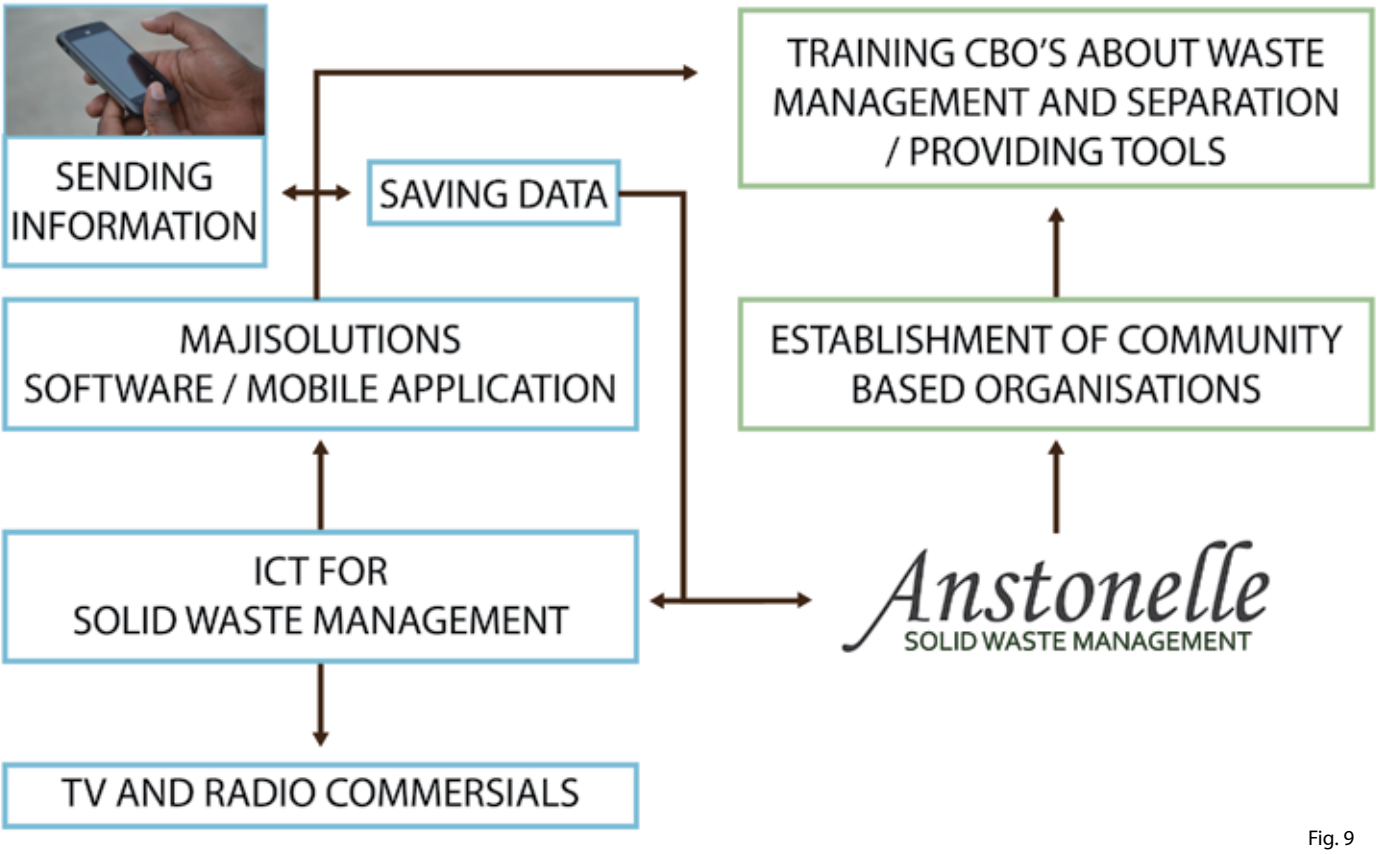


Fig. 9

The communication and information is one of the main reasons of why this software was developed. Another function Anstonelle benefit from is to keep track of all the waste coming in and out to both their compost site and to their plastic plant. This help getting a better overview on the waste stream in Iringa and can be used to calculate how much waste and what type of waste that is produced. For all the organic waste coming in, the software can also calculate how much methane emissions that have been avoided through composting instead of land filling disposal. This is a function the company use when they are now applying to UNFCCC to be approved as a CDM business. If they get that approval, they can enter the international market with the sale of greenhouse offsets, which will be an extra income for the company and a nice bonus for being environmentally concerned.

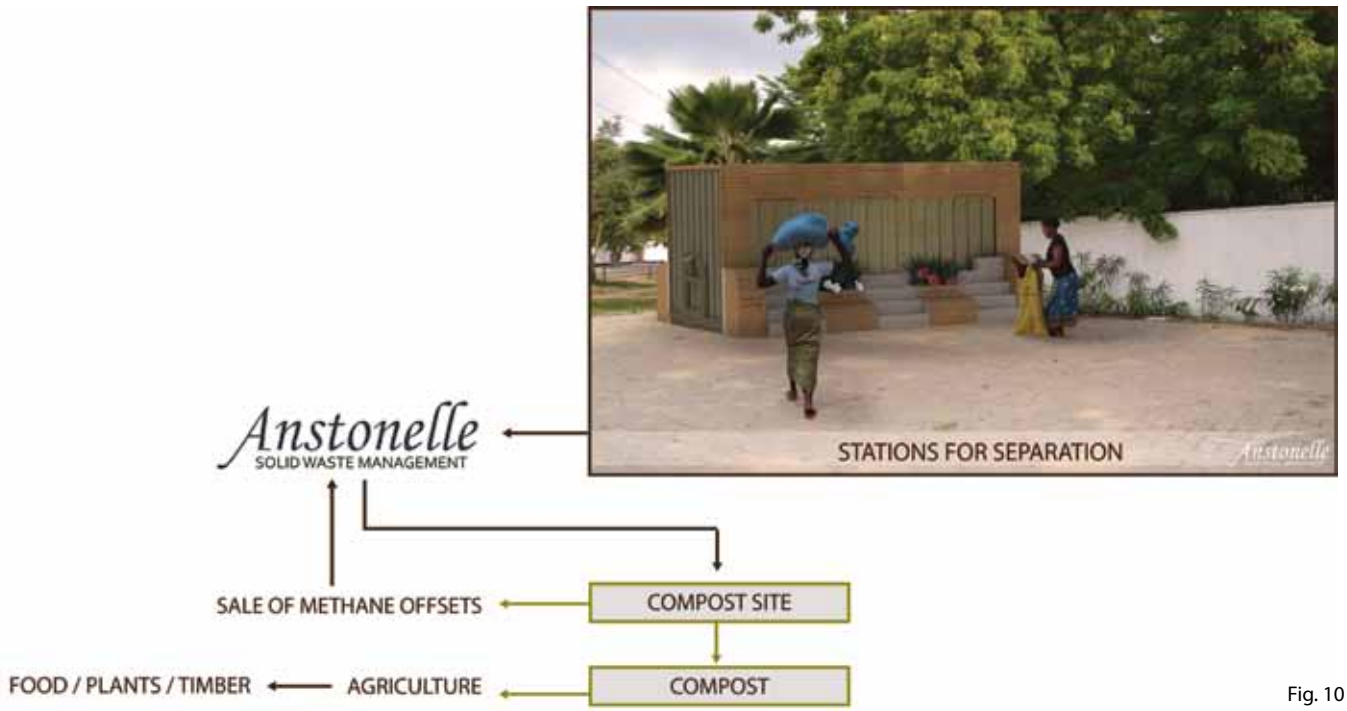


Fig. 10

As part of their communication strategy, Anstonelle are regularily talking about waste regarded topics on Ebony FM and they have three commercials running daily on local television. The commercials tell the story about how the local community benefit from the new solid waste management; through a cleaner town and the creation of workplaces. They explain the function of the stations, the separation and collection of waste and describe for the people whathappens to the waste after it has been delivered to the stations. Through these short movies, the local citizens can see how organic waste becomes compost for use in agriculture and how plastic bottles becomes textile for use in the sewing production. (A prototype of one of the videos is saved on the CD attached to this report)









Reduse your waste with reusable shopping bags made from recycled materials

- a design cooperation with Ndey Emanuel

3.2.4 Trice Design - Continuation of scenario

The movie about the plastic bottles also tells the story about the new shopping bags made by Trice Designs. It e xplain how the new purses are produced by recycled PET-bottles, and the story goes like this: The collected plastic bottles gets chopped in small pieces at Anstonelles plastic plant and transported to their partner, Runer Consult, in Dar Es Salaam. Runer Consult have a network in China and send the plastic for recycling into fibres at one of their partners recycling plant in China. Polyester fibres are sent back to Runer Consult that sells it to the textile industry in Morongoro. The textile gets produced in different colours and covered with PUR to make it waterproof.

Trice Design buys the textile from the industry and collects leftovers of kitenge from the local sewing production. The girls make the bags in different colours and with different patterns, which can be bought in Anstonelle's show room and at stands in the market place to the price of 5000TSH. The movie ends with the bags in use by local women at the marked place, and show how it can easily be folded, carried in the women's handbags and used as a wallet before they are needed for grocery shopping.

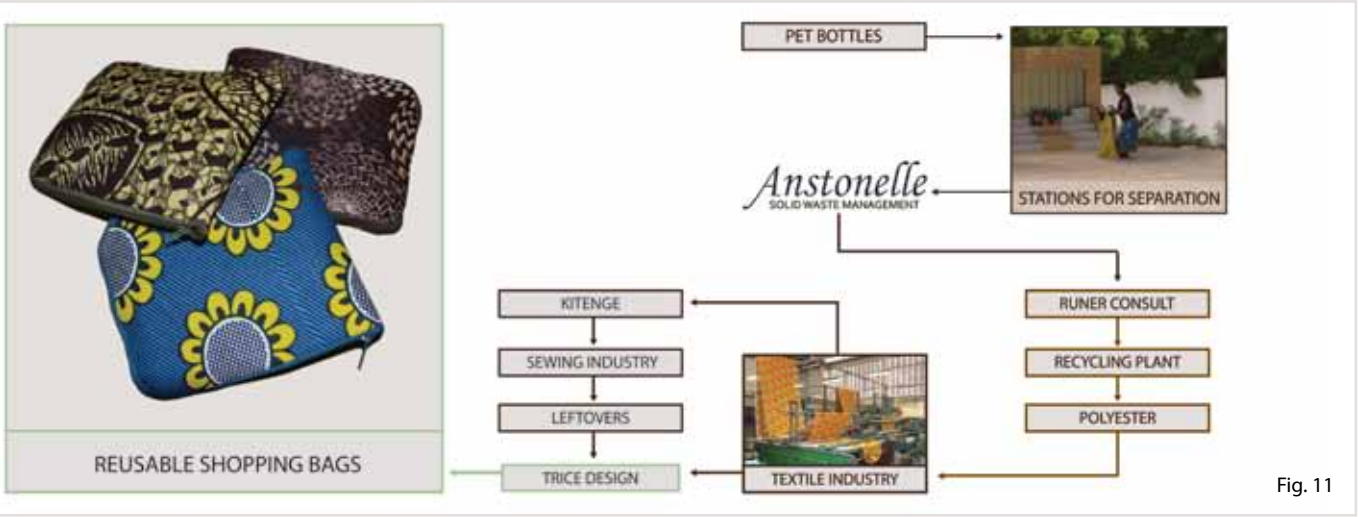


Fig. 11

3.3 Current situation of the shopping bags

Trice Design has during this process produced more than 50 bags and starts to become ready for sale in Iringa. They are currently two girls working on the bags. They have improved the zipper and got a nicer finish than the first prototypes. The bags are first of all made for sale in Tanzania, and the focus has been to produce a low-cost bag that suits the women's traditional clothing.

Through their e-shop, Trice Design can also sell their bags in Norway or in another western country. After having tested the bags in Norway, it seem to be a better solution for the market here to offer two sizes on the bags; a mother and a daughter-concept. This can be done with one bigger bag that has the function as a small purse when it is folded, and one smaller bag that function as a wallet when it is folded. The bags can also have more accessories and be sold to a higher price. This will be further discussed with Ndey Emanuel.

Sending the plastic bottles to China for recycling is not a optimal solution. There is a long way to go before Runer Consult could be able to start their own recycling plant in Tanzania, but this is a future strategy and under discussion with Mr.Martin Kitundu.

4. Strategy

Short-term strategy

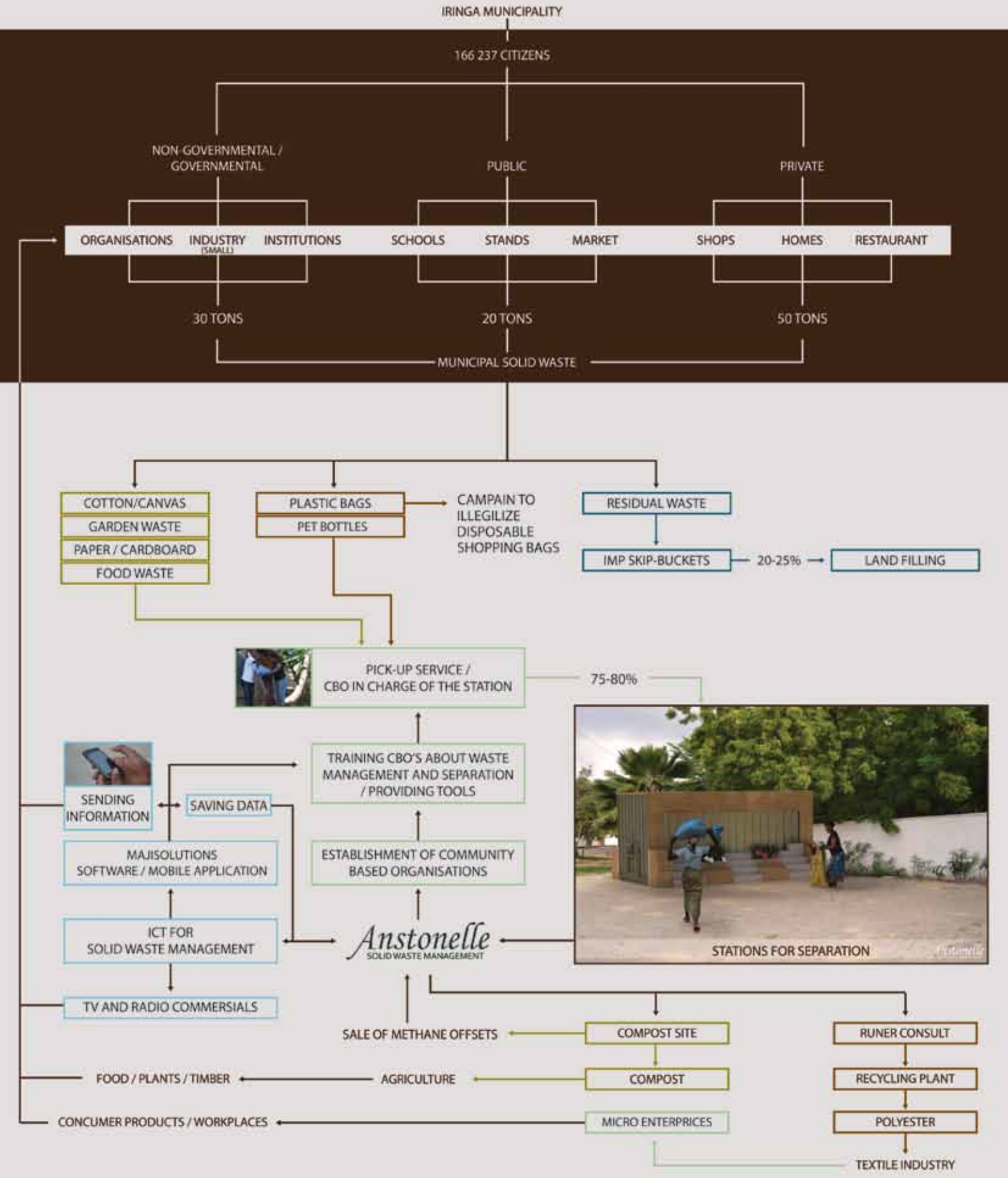


Fig. 12

4.1 Short-term

There is made one short term and one long term strategy for Anstonelle's Solid Waste Management. The strategies are illustrated through process maps that show the connection between Anstonelle and their partners, and how the waste producers receive back from Anstonelle's service.

The short term strategy is made as an "door opener" for Anstonelle to enter the market with a partly privatizing of the SWM. The skip-buckets provided by IMP will be supplemented with stations for separation. The short term strategy has been described in the design response in this report and includes:
- establishments of CBO's in the SWM
- collection of organic waste for composting
- collection of PET-bottles for recycling
- development and use of ICT for SWM.
- a cooperation with Trice Design and campaign to illegalize disposable shopping bags.

There will be practised an aerobe methode for composting. This will reduce methane emissions to the atmosphere compared to land filling disposal, and Anstonelle will apply for approval as a CDM business through UNFCCC's methodology for small scale CDM project activities.

The network for recycling PET bottles is already established. Anstonelle will collect the bottles, and sell them to Runer Consult who will send them to their partners for recycling.

4.2 Long-term

The long-term strategy is based on a fully privatizing of the SWM in Iringa where the skip buckets are replaced with stations for separation. This strategy will be further planned after Anstonelle has been established on the market with their short-term strategy, and includes so far:
- separation of waste at the land filling
- sale of raw materials
- establisments of more micro-enterprises
- waste-to-energy plant

Through a more complete separation, micro-enterprises where they produce small items for sale from recyclable materials can be established. This could be done through small women-groups where they for instance produce small items for sale from glass moulding production or/and moulding of aluminium / tin. Anstonelle can also establish a wider network of partners for recycling and reuse of collected products.

With the right partners involved, the composting method could change from aerobe to anaerobe. This method increase the methane produced through composting, and the methane can further be burned and converted into electricity. The electricity could either be produced for own usage or a cooperation can be done with Tanesco, Tanzania Electric Supply Company.

Long-term strategy

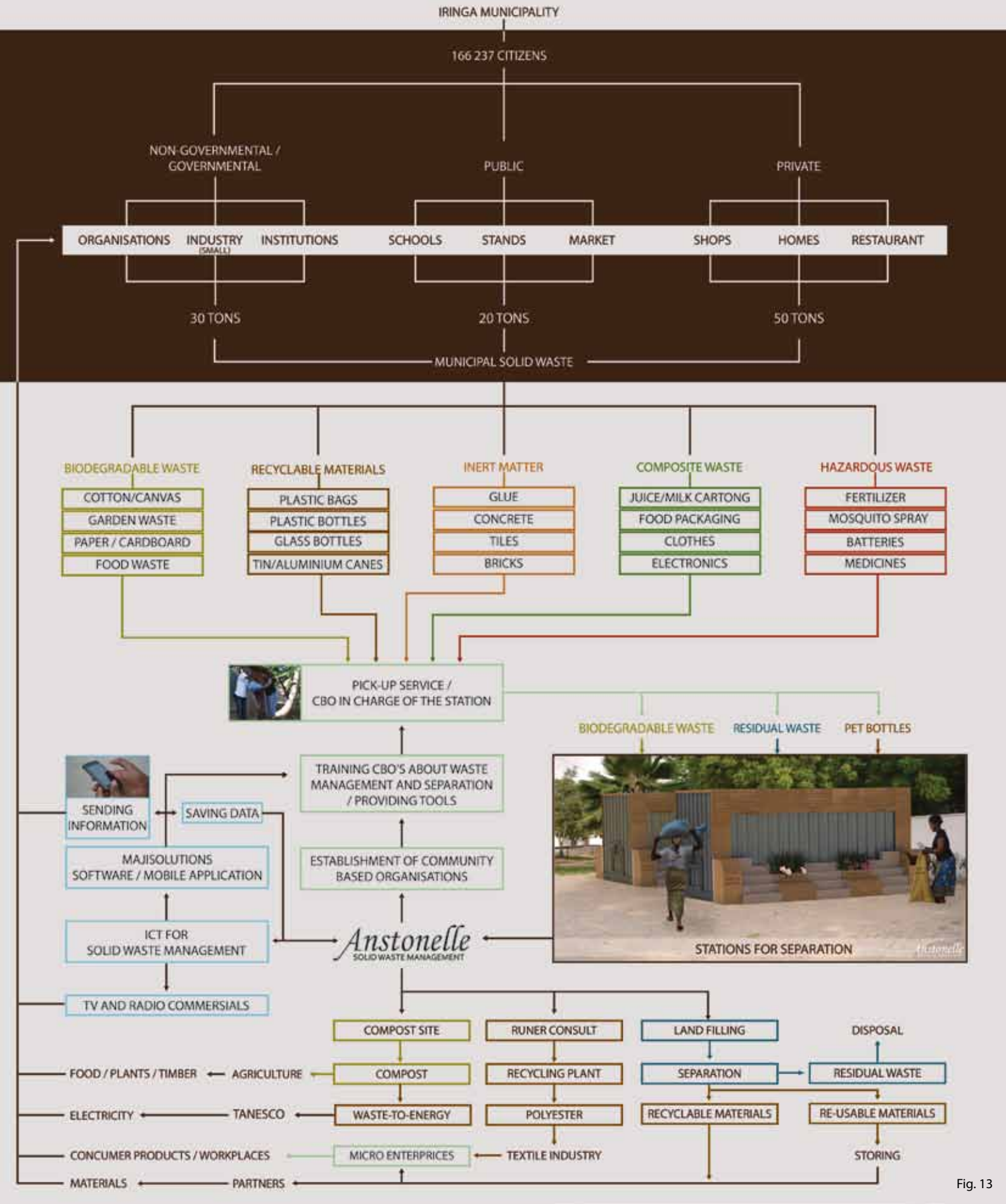


Fig. 13

5. Conclusion

5.1 The new system

The starting point of this project was to do something with the poorly managed waste collection points in Iringa, and the research addressed some problems and challenges connected to the current situation. These challenges was set as the focus areas in this project.

- harmful disposal of waste through burning and burying
- lack of knowledge about waste management
- poorly managed collection points and land filling
- lack of existing systems for recycling
- cost inefficient management

IMP requests in their proposals for SWM more skip-buckets to be able to collect more waste. The research in this project has revealed different problems connected to the existing system and has concluded that more skip-buckets will not solve any problems. The reasons for this are that IMP does not have the capacity to collect more waste and bring it to the land filling as long as they do not have any plans for how they can make the system economically efficient. The land filling does not have space for more waste, and the money for more transporting does not exist.

The project has resulted in new concepts for how to deal with waste in Iringa and suggest a strategy on how to make the collection of waste a business where the local community can benefit. The strategy is a partly privatizing of the SWM, with Anstonelle as a company to ease the responsibility of the government. This is in the beginning done by collcting organic waste and plastic bottles. When the company is established on the market, they can start to plan a fully privatizing where they also separate waste at the land filling.

This is not a project for charity, nor is it a public service provided by the government, this is business. Like all businesses, it depends on the people to use the service. That point is the biggest difference between the new system and the SWM provided by IMP. Unlike the current situation where IMP encourage people to take care of their waste locally due to low capacity in the SWM, Anstonelle have to encourage the people to use their stations. In this way, they will work for a cleaner town and avoid disposal in private backyards.

5.1.1 Analysis of the stations

Because Anstonelle wants to encourage people to use their service, the fact that the stations are space consuming is not a disadvantage. The size makes them visible in the society, something the design have taken advantage of; instead of making the stations less visible, the areas around the containers have been expanded with seating areas that invites the people to use it as a meeting place.

As a meeting place, the stations invites to discussions and help raising awareness about waste management. This could lead to change in habits and a better attitude towards the disposal of waste. The new service will also have a societal impact through

- the creation of workplaces: especially for the most vulnerable groups
- a cleaner town: less disposal of waste in the nature and in private backyards
- the prevention of waste related diseases: closed roof on the container
- a better access to compost for use in agriculture
- less land filling disposal : less greenhouse gasses to the atmosphere

With the use of local craftsmen and local materials, the maintenance on the stations will be easier and cheaper than if the stations where based on an imported system for waste management. This also makes it less expensive to implement. The timber is the most vulnerable material, but also an easy part to change when needed. The wood frame and the concrete stairs help keeping the organized look even though the whole station looks a little bit tired. With the use of fresh flowers, the stations will look appealing even though they show sings of many years of use.

How can a design approach have effect in a project for Solid Waste Management in Tanzania?

5.1.2 How the design approach have had effect in the project.

The SA analysis, the multidisciplinary process and the human-centred design have been practised to find answers to the research question, and to design solutions for the motivation of the thesis; "improve the life of the 166 000 citizens in Iringa, and design a new system that can be adapted to other places in East-Africa". Different social groups have been addressed throughout the process. Poor women and young girls constitute the most important constillations who can benefit from the new system. Also the role of local craftsmen has been identified. One group that will be affected by, but are not included in the new system are street child. As further development, Anstonelle could do research on the situation and find solutions on how this group can benefit from the new system as well.

The design tools used in this project have been specifically chosen in order to ease the communication between the different stakeholders in the project. The visualisation of problems, opportunities and concepts has led to discussions on a multi-disciplinary basis, and the business ideas have been presented local politicians, ICT-developers, partners in the
project, engineers, craftsmen and local citizens. The visualisation has been done through illustrations, mock-ups and prototyping, scenario making, the use of photography's and mapping. The mapping has been a very good communication tool as well as it has been helpful in the addressing of problems and the making of the total strategy.

The prototyping in the early phase of the project has had a thinking-by-doing function, and been an engaging method that has led to brainstorming on new concepts and new designs. By testing concepts through prototyping, it has been more easy to "kill darlings" when the result has not worked out as expected. It has also been easier to go further on with the project after one idea has been tested, and no ideas have been excluded without being tried first. This have resulted in good cooperation situations where no-one have showed any signs on being displeased or felt run over in the process. Contacts with local craftsmen have been established through the prototyping, and new people who could have a future role in the project have been identified. As example, the design of the compost bins have got shaped by involving a local carpenter. The form vernacular that makes this design have been extended on to the total design on the stations. Those bins where in the beginning meant as bins for sale to private homes, but got another function in the end of the project.

The design approach has resulted in the design of a product as an answer to the first three stages in the waste hierarchy. The problem with disposable bags was identified through observations and mapping, and ended in a design co-operation with Trice Design. The whole process through the making of these bags has been based on communication through mock-ups, illustrations and prototyping. These bags can work as products that enable change of habits. Furthermore this might might lead to the change of attitudes among towards waste among young people through awareness of waste problems and resources.

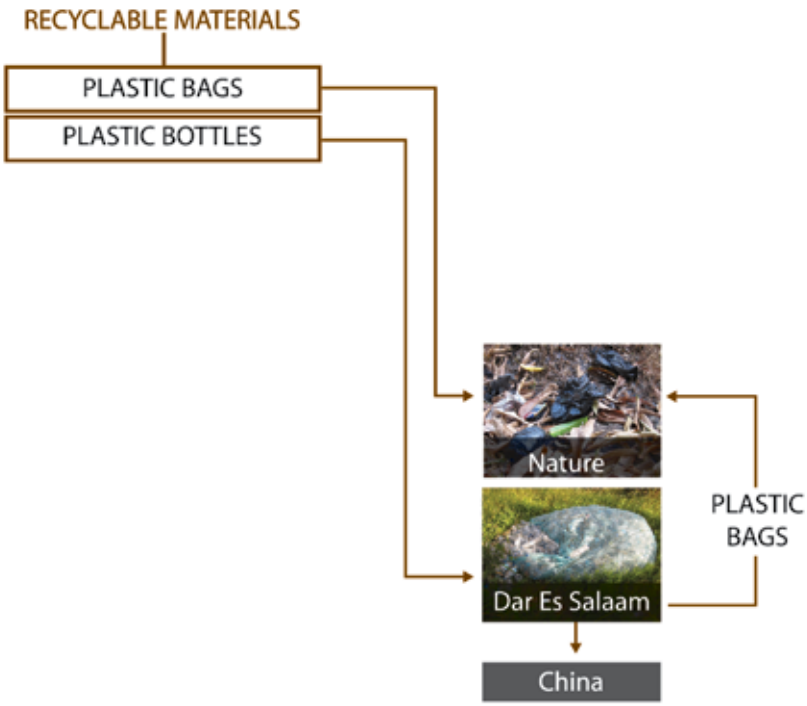


Fig. 14

The main focus n this project has been to find solutions to avoid disposal of waste at the land filling and in private backyards. One problem is to deal with the collection and transportation of waste, but even more important is to find solutions on what to do with the waste after it is collected. As mentioned in the introduction, we are nearly using 30% more natural resources than the Earth can replenish. To burn or burry materials that could be recycled cannot be justified. By including design in the strategy making of a new SWM, we can find new concepts to reduce consumption and make new design on products from recycled waste. The last one is especially of current interest for people in developing countries because it provides workplaces for poor people. With a more complete separation of waste, more workshops can be established and more workplaces can be created. This is an important result of a well-designed SWM.

5.1.3 Learning outcome

Due to an inclusive process, many of the people who have been involved in the project feel ownership to the final solutions, which makes it more likely to become a reality in the future. There are several people in Iringa and in Tanzania who wants to take the project further. The most important learning outcome has been the identification of the importance of including those who will remain in Iringa and work on the realisation of the project; this work would not have been of any value if not the local people were involved in the process. The multi-disciplinary process has also made the work more interesting and knowledge from different disciplines reduce to risk of failure.

The making of fancy design solutions have not been focus in this work, but the use of design tools been tested in a context where there is no tradition of implementing design as a method in the planning of new systems. The effect of using a design approach in a project for SWM in Tanzania, have had greater impact than what was expected from the start of the project. The repeated phrase "we need more skip-buckets" proofs this aspect. The designers' way of challenging existing systems and traditional doing with new solutions and new design is highly current also in projects that address social and environmental challenges in developing countries.

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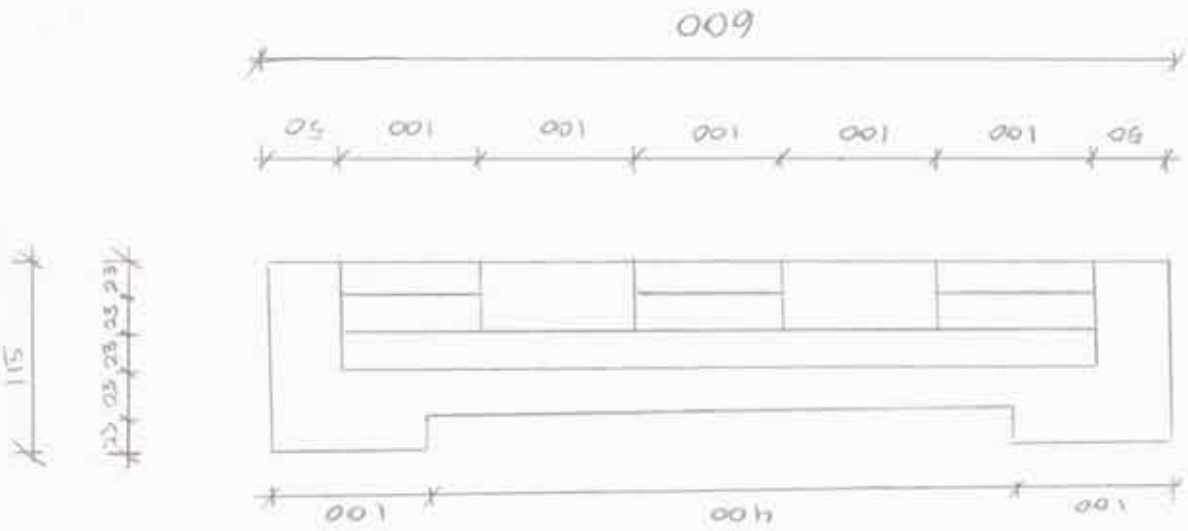
with Ms. Siv Ahlberg at Finnpartnership
with Mr. Mashata Thomas at Sido
with Mr. Anthony Kigombola
with Mr. Rune Moe at Cargotec Norway AS
with Mr. Zab at The Biodegradable Bag Company LTD

Appendix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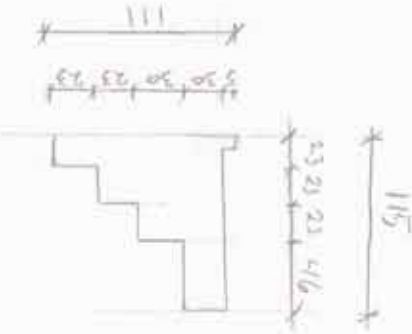
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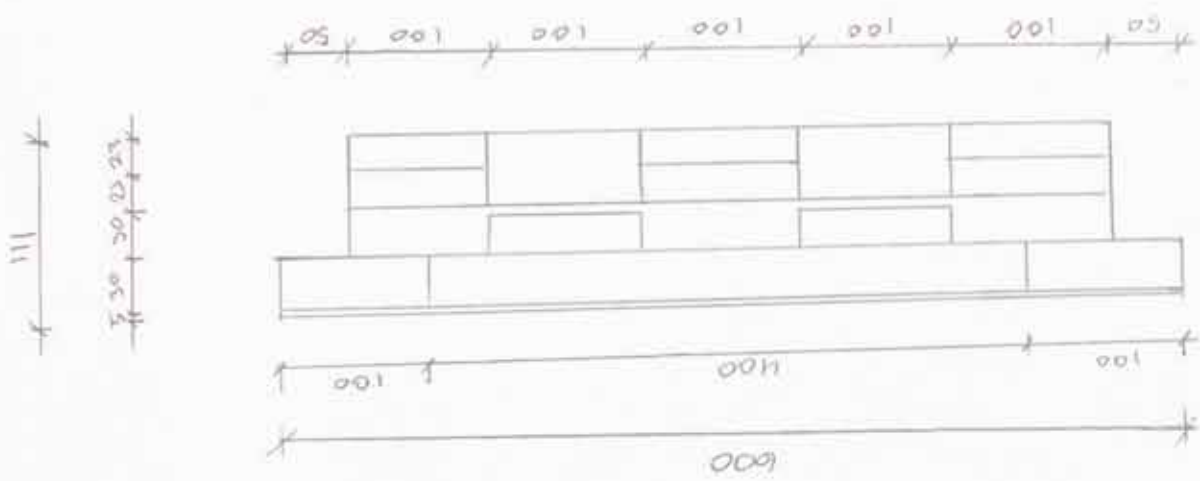
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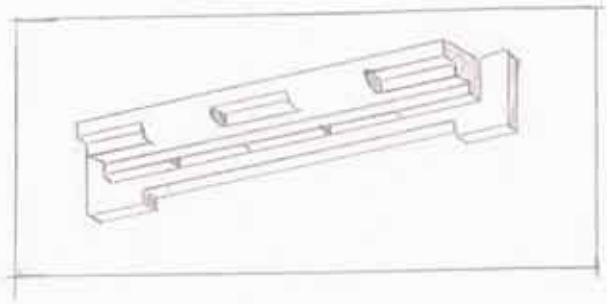
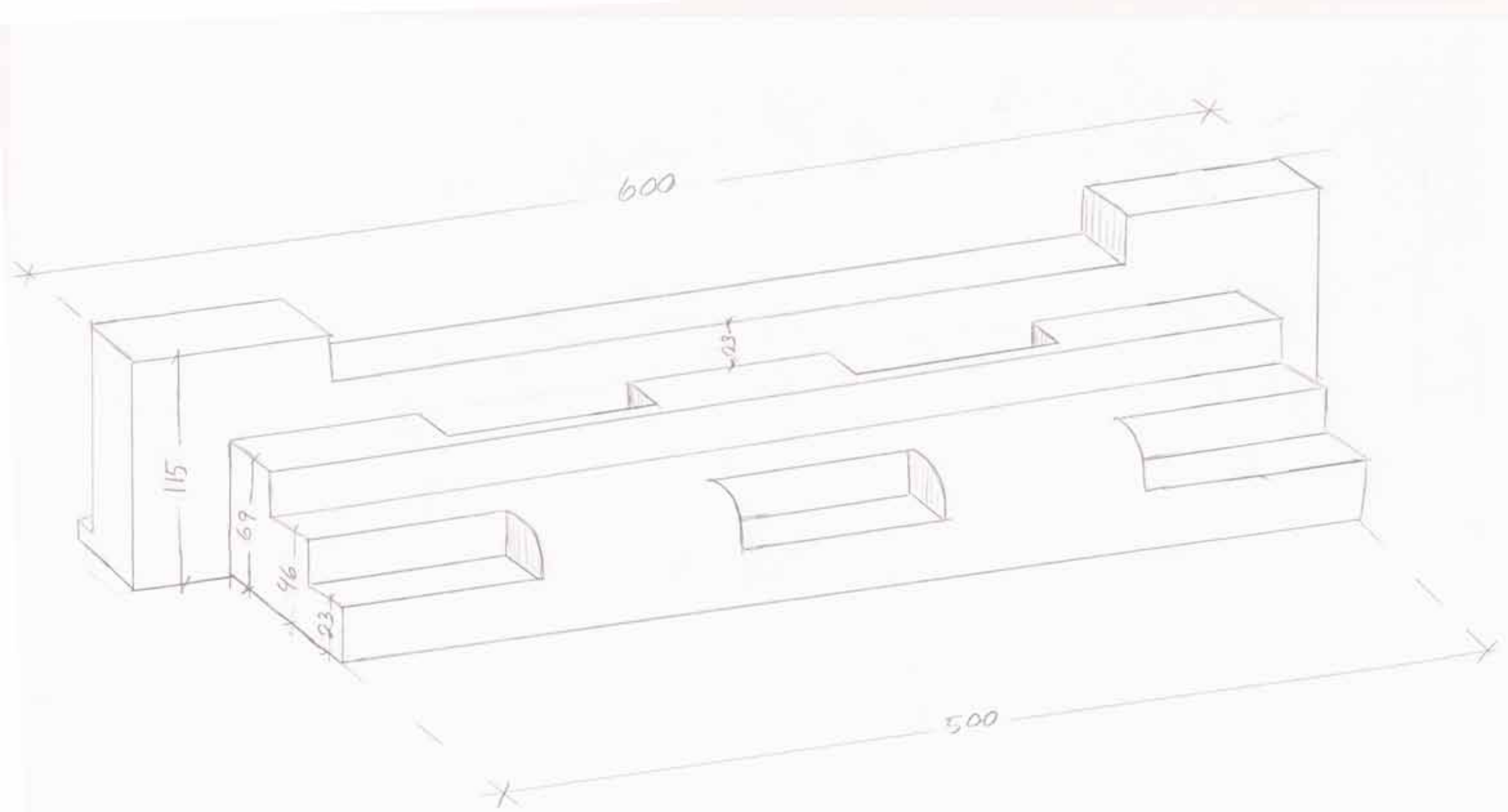
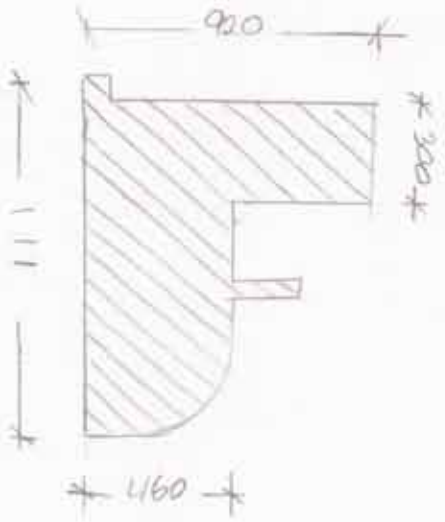




STAIRS

LOCAL BRICKS/CONCRETE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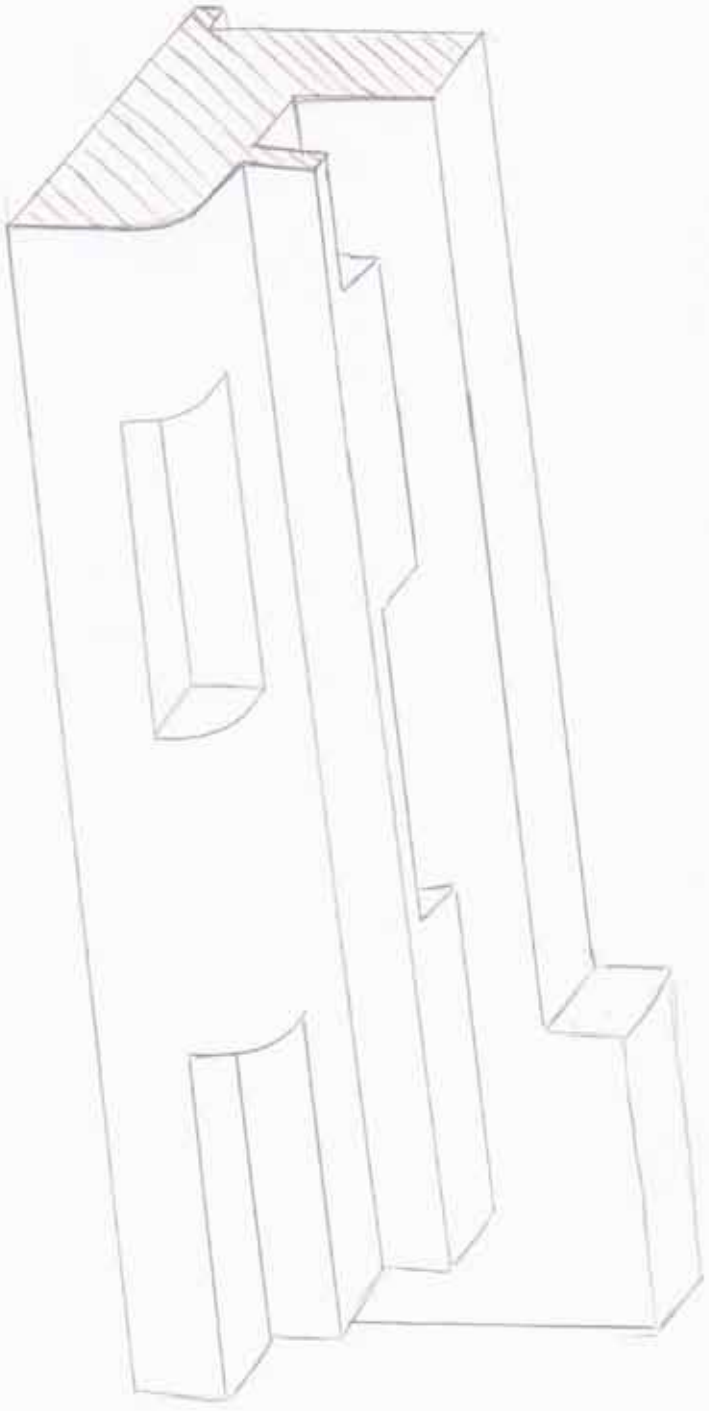


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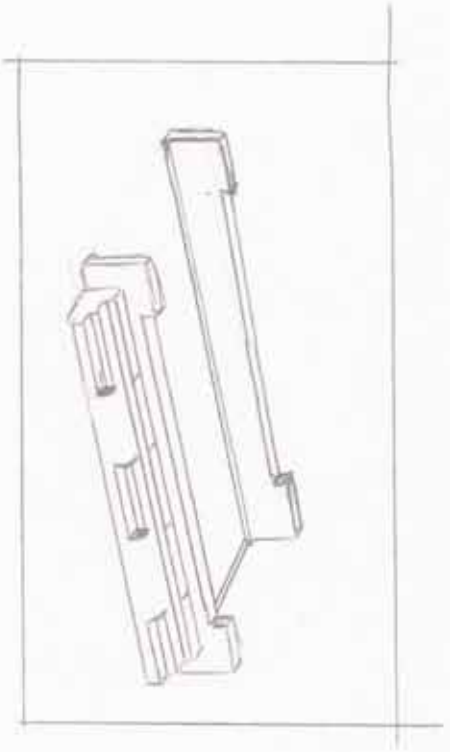

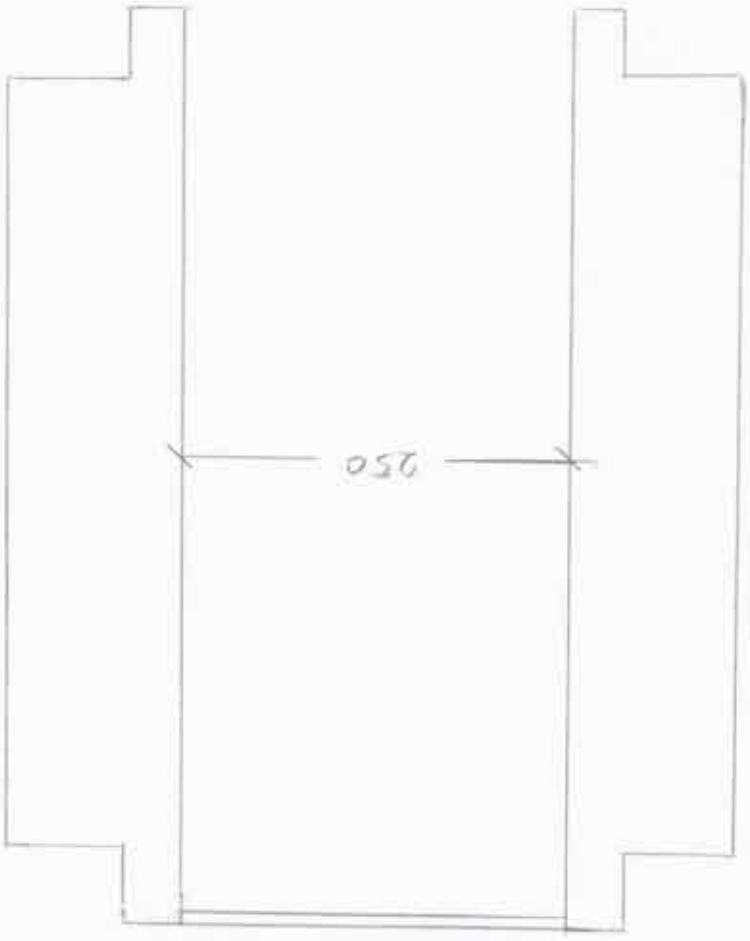
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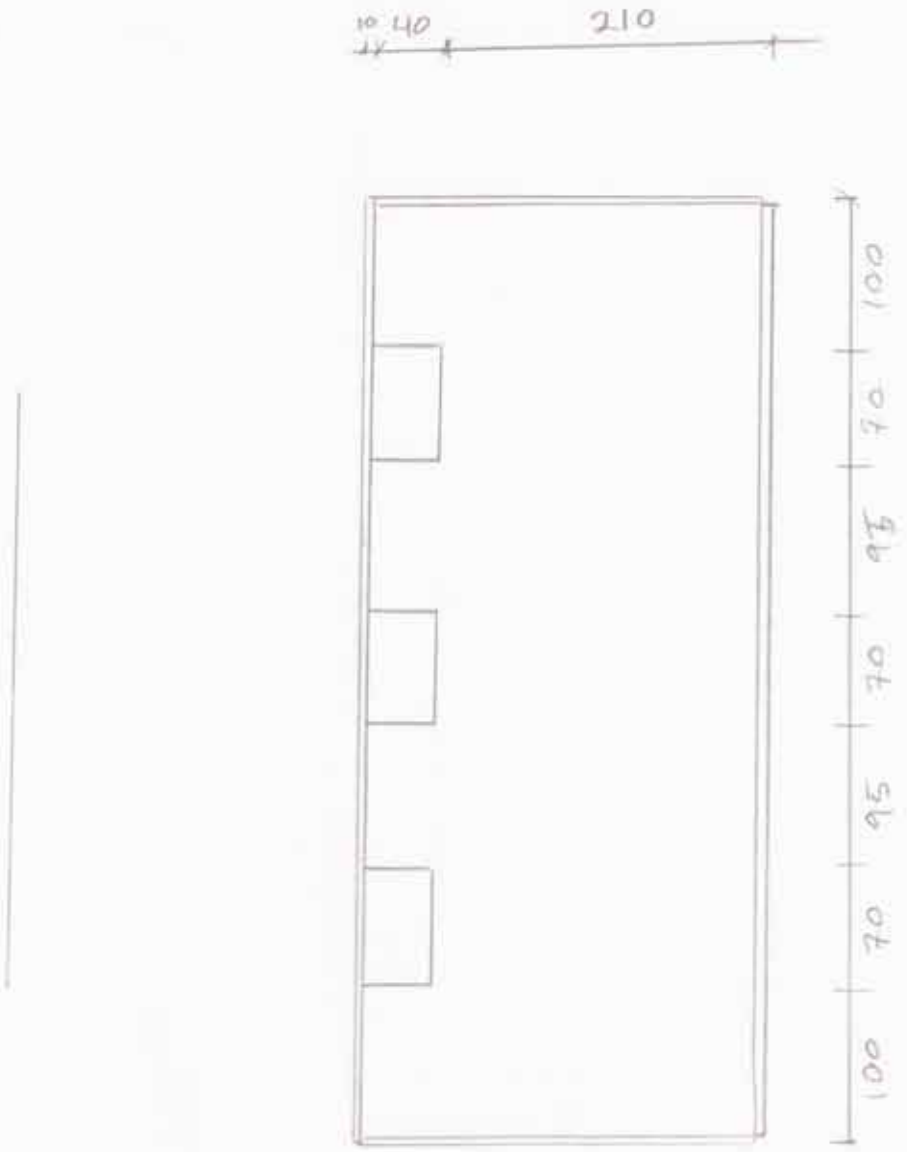
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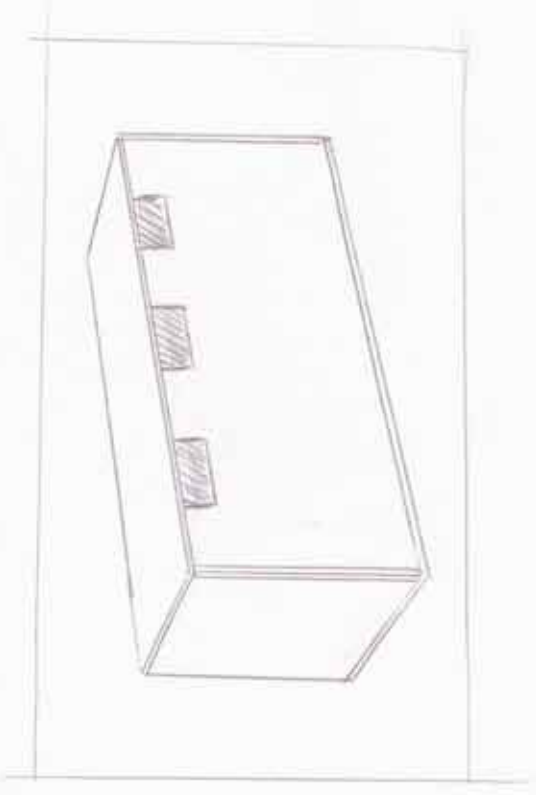
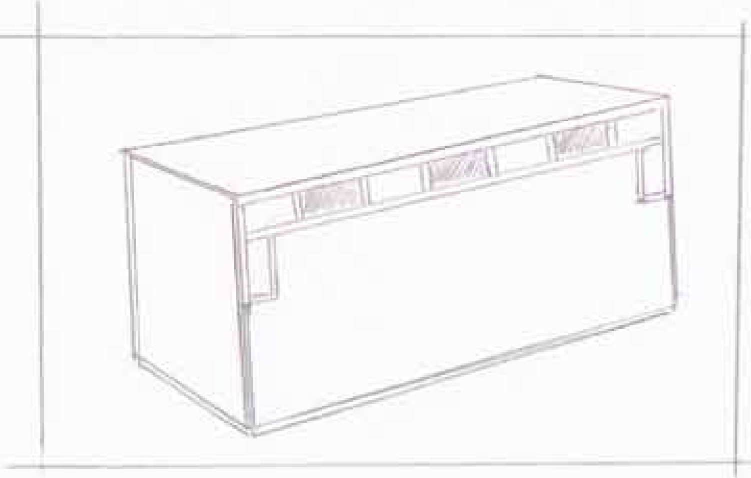
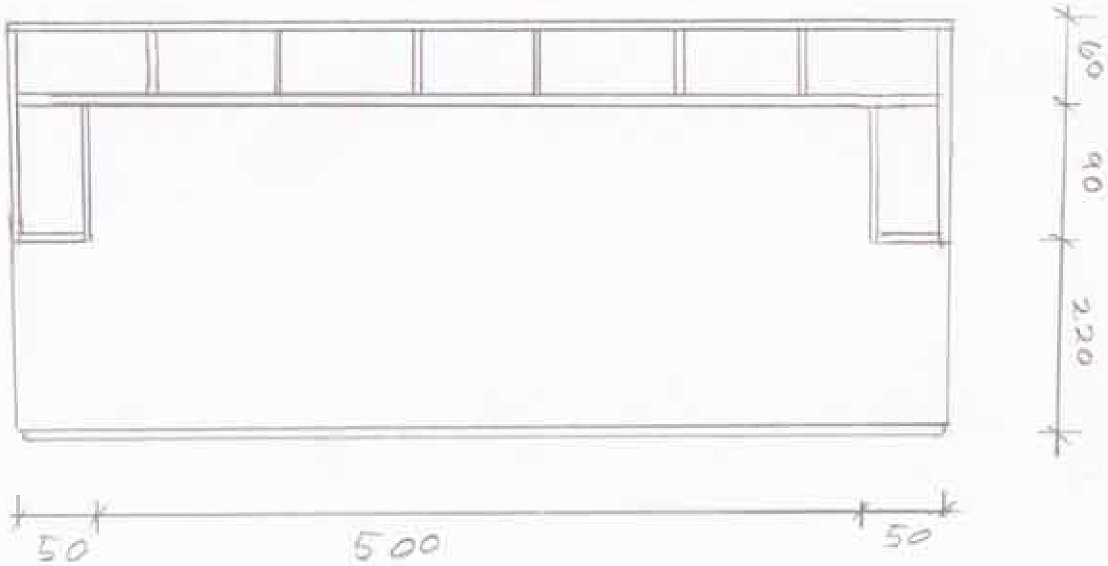




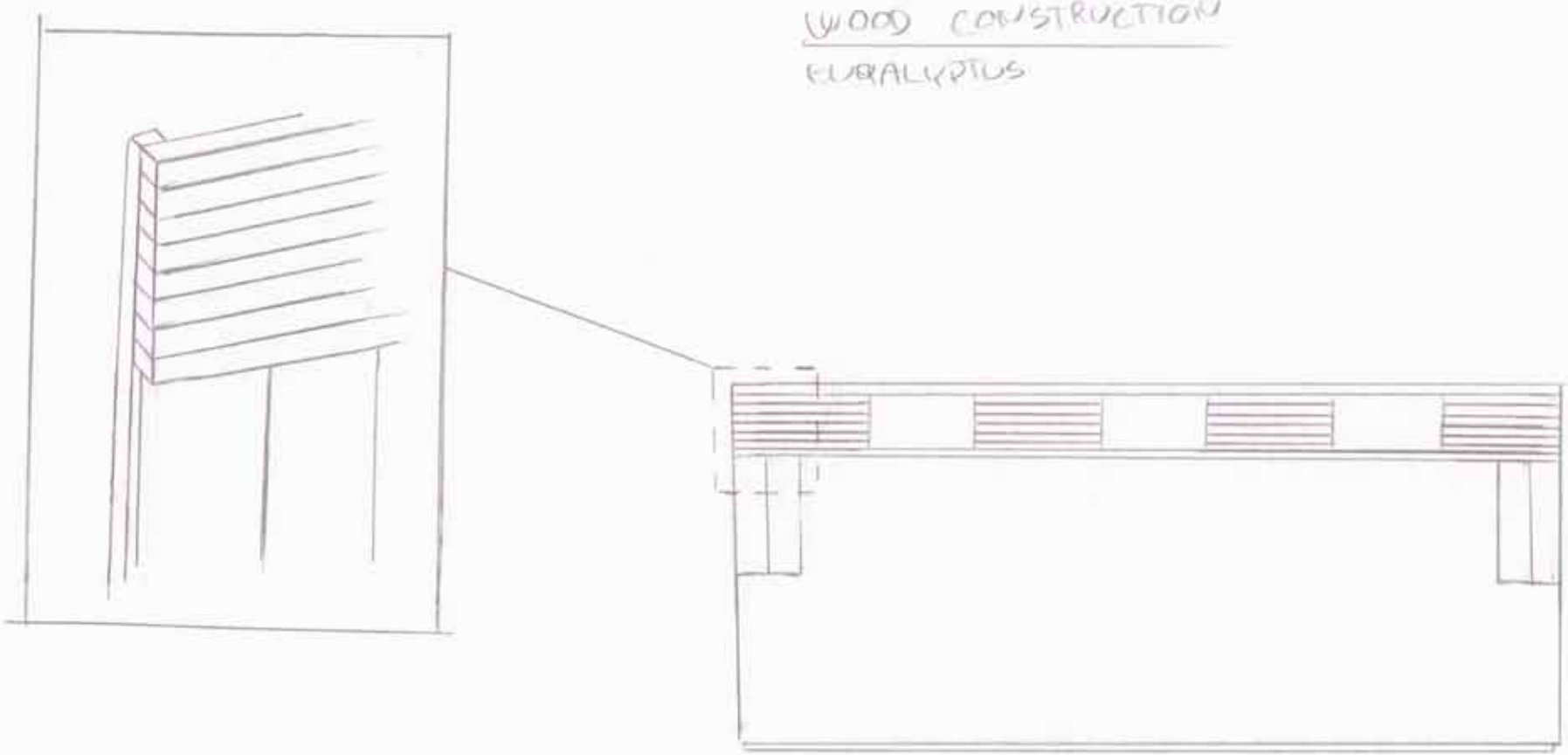
WOOD CONSTRUCTION

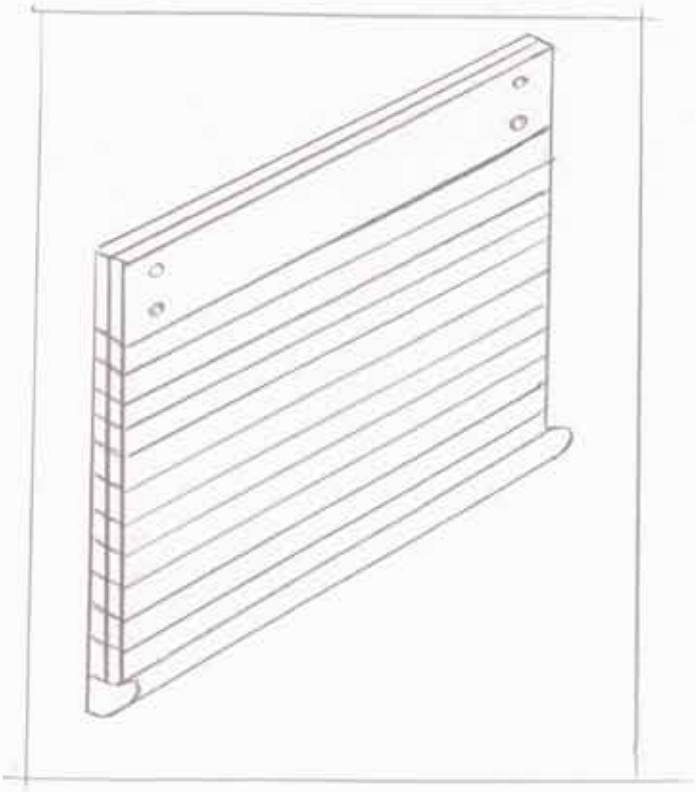
EUQUALYPTUS



WOOD CONSTRUCTION

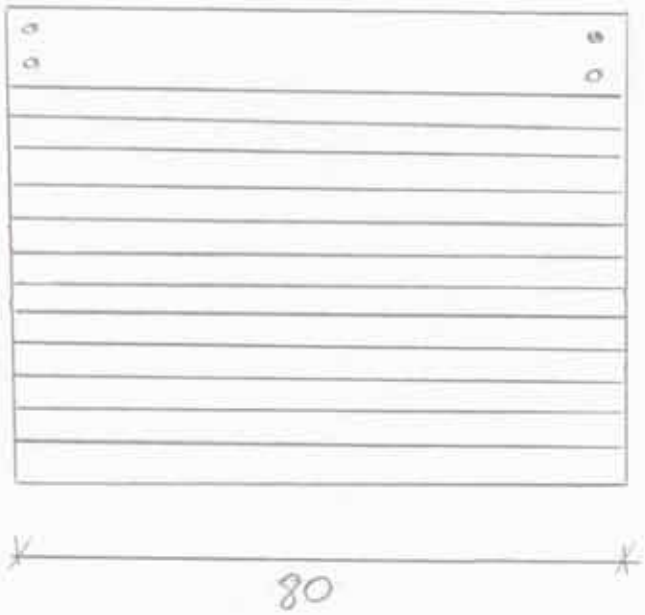
EUCALYPTUS

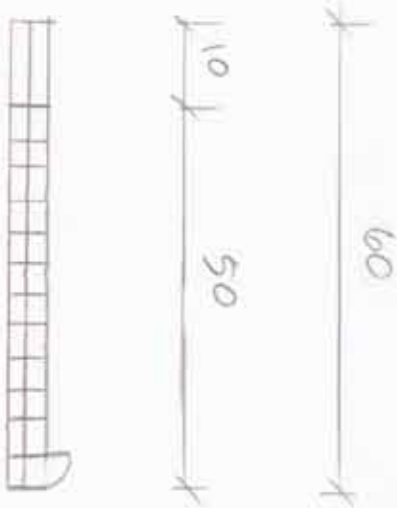


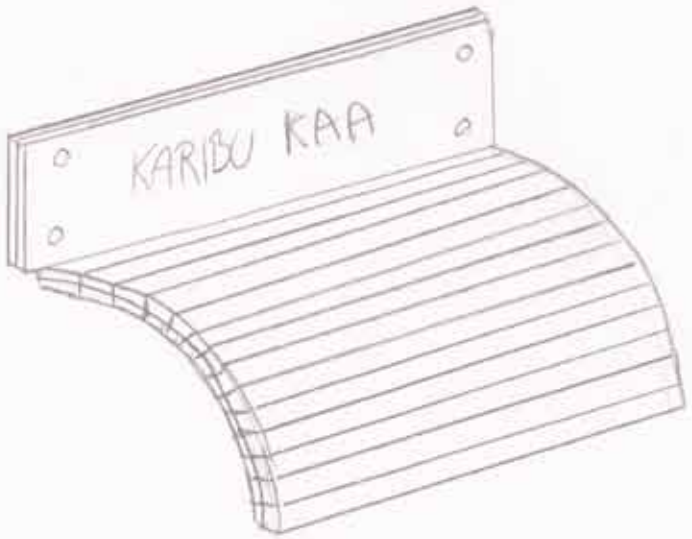


DOOR FOR ORGANIC WASTE

EUCALYPTUS/ POLYESTER

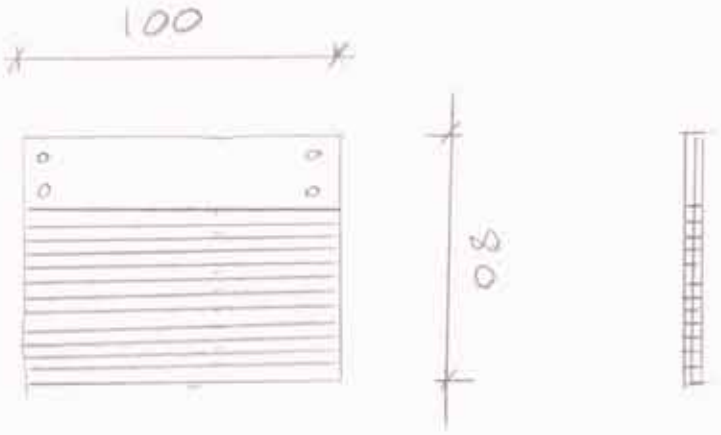


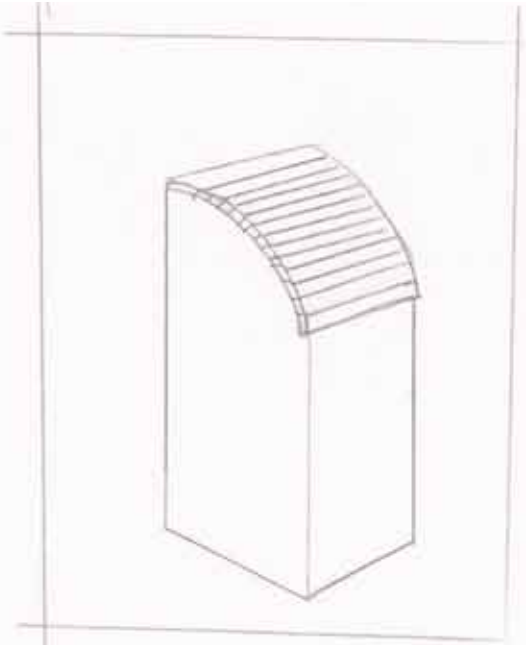




WOOD SEATING

EUCALYPTUS





WOOD BIN

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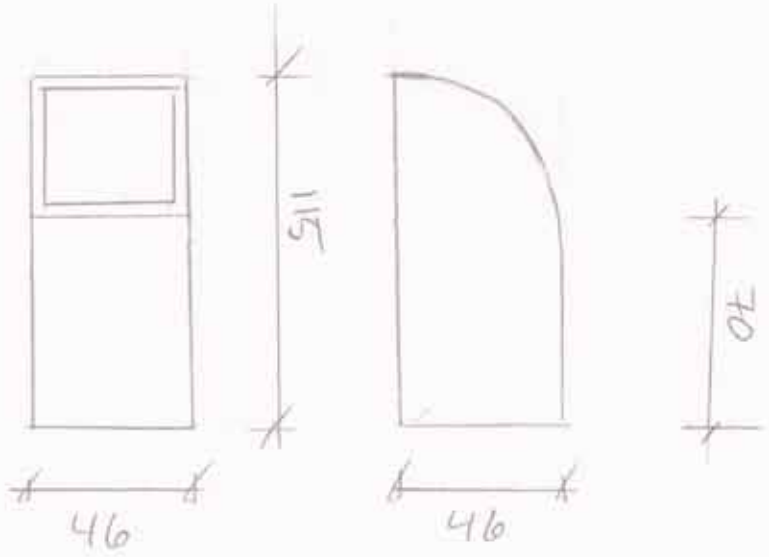

Flak

Huvudmåtten för ett 6 m flak, enligt svensk standard SS 3021, visas nedan. För övriga mått, se standarden.

En lastbärare kan också bestå av en container, en tank, ett grusflak, ett maskinflak, etc.

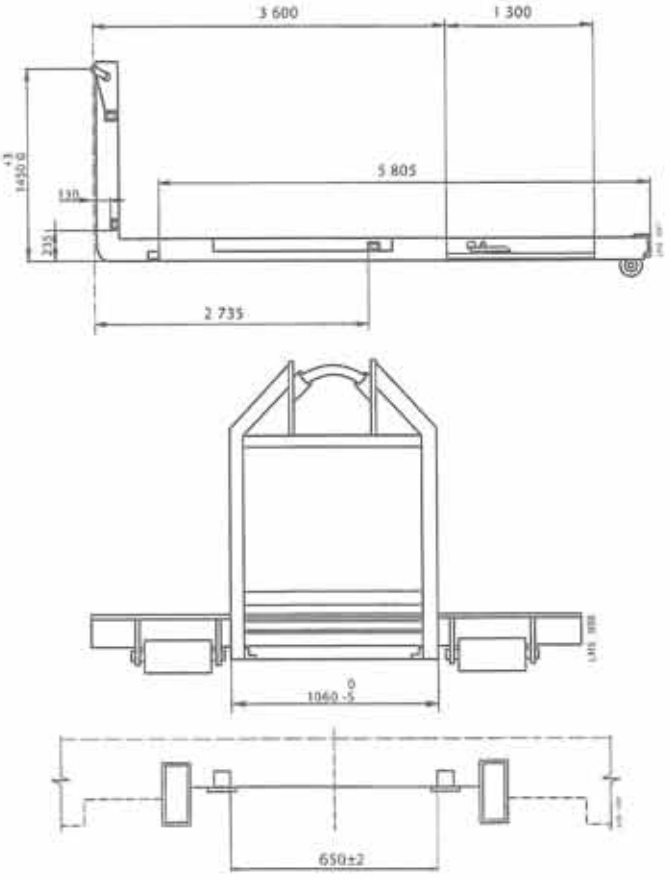

Bild 5. Flak 6 m, måttuppgifter i mm

Indicative simplified baseline and monitoring methodologies
for selected small-scale CDM project activity categories

III.F. Avoidance of methane emissions through composting (cont)

7. In case of co-composting, if it can not be demonstrated that the organic matter would otherwise been left to decay anaerobically, baseline emissions related to such organic matter shall be accounted for as zero, whereas project emissions shall be calculated according to the procedures presented in this methodology for all co-composted substrates.

8. The location and characteristics of the disposal site of the biomass, animal manure and co-composting wastewater in the baseline condition shall be known, in such a way as to allow the estimation of its methane emissions, using the provisions of AMS-III.G, AMS-III.E (concerning stockpile), AMS-III.D "Methane recovery in animal manure management systems" or AMS-III.H respectively.

Project activities for composting of animal manure shall also meet the requirements under paragraphs 1, and 2 (c) of AMS-III.D. Further no bedding material is used in the animal barns or intentionally added to the manure stream in the baseline. Blending materials may be added in the project scenario to increase the efficiency of the composting process (e.g. to achieve a desirable C/N ratio or free air space value), however, only monitored quantity of solid waste or manure or wastewater diverted from the baseline treatment system is used for emission reduction calculation. The following requirement shall be checked *ex ante* at the beginning of each crediting period:

(a) Establish that identified landfill(s)/stockpile(s) can be expected to accommodate the waste to be used for the project activity for the duration of the crediting period; or

(b) Establish that it is common practice in the region to dispose off the waste in solid waste disposal site (landfill)/stockpile(s).

9. The project participants shall clearly define the geographical boundary of the region referred in paragraph 8 (b), and document it in the CDM-PDD. In defining the geographical boundary of the region, project participants should take into account the source of the waste i.e. if waste is transported up to 50 km, the region may cover a radius of 50 km around the project activity. In addition, it should also consider the distance to which the final product after composting will be transported. In either case, the region should cover a reasonable radius around the project activity that can be justified with reference to the project circumstances but in no case it shall be more than 200 km. Once defined, the region should not be changed during the crediting period(s).

10. In case produced compost is handled aerobically and submitted to soil application, the proper conditions and procedures (not resulting in methane emissions) must be ensured.

11. In case produced compost is treated thermally/mechanically, the provisions in AMS-III.E related to thermal/mechanical treatment shall be applied.

12. In case produced compost is stored under anaerobic conditions and/or delivered to a landfill, emissions from the residual organic content shall to be taken into account and calculated as per the latest version of the "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site".

Indicative simplified baseline and monitoring methodologies
for selected small-scale CDM project activity categories

III.F. Avoidance of methane emissions through composting (cont)

TYPE III - OTHER PROJECT ACTIVITIES

Project participants shall apply the general guidelines to the SSC CDM methodologies, information on additionality (attachment A to Appendix B) and general guidance on leakage in biomass project activities (attachment C to Appendix B) provided at <http://cdm.unfccc.int/methodologies/SSCmethodologies/approved.html> *mutatis mutandis*.

III.F. Avoidance of methane emissions through composting

Technology/measure

1. This methodology comprises measures to avoid the emissions of methane to the atmosphere from biomass or other organic matter that would have otherwise been left to decay anaerobically in a solid waste disposal site (SWDS), or in an animal waste management system (AWMS), or in a wastewater treatment system (WWTS). In the project activity, controlled aerobic treatment by composting of biomass is introduced.

2. The project activity does not recover or combust landfill gas from the disposal site (unlike AMS-III.G "Landfill methane recovery"), and does not undertake controlled combustion of the waste that is not treated biologically in a first step (unlike AMS-III.E "Avoidance of methane production from decay of biomass through controlled combustion, gasification or mechanical/thermal treatment"). Project activities that recover biogas from wastewater treatment shall use methodology AMS-III.H "Methane recovery in wastewater treatment". Project activities involving co-digestion of organic matters shall apply methodology AMS-III.AO "Methane recovery through controlled anaerobic digestion".

3. Measures are limited to those that result in emission reductions of less than or equal to 60 kt CO_2 equivalent annually.

4. This methodology is applicable to the composting of the organic fraction of municipal solid waste and biomass waste from agricultural or agro-industrial activities including manure.

5. This methodology includes construction and expansion of treatment facilities as well as activities that increase capacity utilization at an existing facility. For project activities that increase capacity utilization at existing facilities, project participant(s) shall demonstrate that special efforts are made to increase the capacity utilization, that the existing facility meets all applicable laws and regulations and that the existing facility is not included in a separate CDM project activity. The special efforts should be identified and described.

6. This methodology is also applicable for co-composting wastewater and solid biomass waste, where wastewater would otherwise have been treated in an anaerobic wastewater treatment system without biogas recovery. The wastewater in the project scenario is used as a source of moisture and/or nutrients to the biological treatment process e.g. composting of empty fruit bunches (EFB), a residue from palm oil production, with the addition of palm oil mill effluent (POME) which is the wastewater co-produced from palm oil production.

Indicative simplified baseline and monitoring methodologies
for selected small-scale CDM project activity categories

III.F. Avoidance of methane emissions through composting (cont)

Boundary

13. The project boundary is the physical, geographical site:

(a) Where the solid waste would have been disposed and the methane emission occurs in absence of the proposed project activity;

(b) In the case of projects co-composting wastewater, where the co-composting wastewater would have been treated anaerobically in the absence of the project activity;

(c) Where the treatment of biomass through composting takes place;

(d) Where the products from composting (compost) is handled, disposed, submitted to soil application, or treated thermally/mechanically;

(e) And the itineraries between them (a, b, c, and d), where the transportation of waste, wastewater, where applicable manure, product of treatment (compost) occurs.

Baseline

14. The baseline scenario is the situation where, in the absence of the project activity, biomass and other organic matter (including manure where applicable) are left to decay within the project boundary and methane is emitted to the atmosphere. The baseline emissions are the amount of methane emitted from the decay of the degradable organic carbon in the biomass solid waste or manure. When wastewater is co-composted, baseline emissions include emissions from wastewater co-composted in the project activity. The yearly Methane Generation Potential for the solid waste is calculated using the first order decay model as described in the latest version of the "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site". Baseline emissions from the manure composted are calculated as per the procedures of AMS-III.D.

Baseline emissions shall exclude emissions of methane that would have to be captured, fuelled or flared to comply with national or local safety requirement or legal regulations.

$$BE_y = BE_{CH4,SWDS,y} + BE_{ww,y} + BE_{CH4,manure,y} - MD_{y,reg} * GWP\_CH_4 \quad \textbf{(1)}$$

Where:

$BE_{CH4,SWDS,y}$	Yearly methane generation potential of the solid waste composted by the project activity during the years *x* from the beginning of the project activity (*x*=1) up to the year *y* estimated as per the latest version of the "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site" (tCO_2e). The tool may be used with the factor "f=0.0" assuming that no biogas is captured and flared. With the definition of year *x* as 'the year since the project activity started diverting wastes from landfill disposal, *x* runs from the first year of crediting period (*x*=1) to the year for which emissions are calculated (*x*=*y*)'
$MD_{y,reg}$	Amount of methane that would have to be captured and combusted in the year *y* to comply with the prevailing regulations (tonne)
$BE_{CH4,manure,y}$	Where applicable, baseline emissions from manure composted by the project activities, as per the procedures of AMS-III.D
$BE_{ww,y}$	Where applicable, baseline emissions from the wastewater co-composted, calculated as per the procedures in AMS-III.H
GWP_CH_4	*GWP* for CH_4 (value of 21 is used)

Project Activity Emissions

15. Project activity emissions consist of:

(a) CO_2 emissions due to incremental transportation distances;

(b) CO_2 emissions from electricity and/or fossil fuel consumption by the project activity facilities;

(c) Methane emissions during composting process;

(d) Methane emissions from runoff water;

(e) In case the compost is stored under anaerobic conditions and/or delivered to a landfill: the methane emissions from the disposal/storage of compost.

$$PE_y = PE_{y,transp} + PE_{y,power} + PE_{y,comp} + PE_{y,runoff} + PE_{y,res\ waste} \quad \textbf{(2)}$$

Where:

PE_y	Project activity emissions in the year *y* (tCO_2e)
$PE_{y,transp}$	Emissions from incremental transportation in the year *y* (tCO_2e)

$PE_{y,power}$	Emissions from electricity or fossil fuel consumption in the year *y* (tCO_2e)
$PE_{y,comp}$	Methane emissions during composting process in the year *y* (tCO_2e)
$PE_{y,runoff}$	Methane emissions from runoff water in the year *y* (tCO_2e)
$PE_{y,res\ waste}$	In case produced compost is subjected to anaerobic storage or disposed in a landfill: methane emissions from the anaerobic decay of the residual organic content (tCO_2e)

16. Project emissions due to incremental transport distances ($PE_{y,transp}$) are calculated based on the incremental distances between:

(i) The collection points of biomass and/or manure and the compost treatment site as compared to the baseline solid waste disposal site or manure treatment site;

(ii) When applicable, the collection points of wastewater and treatment site as compared to baseline wastewater treatment site;

(iii) Treatment sites and the sites for soil application, landfilling and further treatment of the produced compost.

$$PE_{y,transp} = (Q_y / CT_y) * DAF_w * EF_{CO2} + (Q_{y,treatment} / CT_{y,treatment}) * DAF_{treatment} * EF_{CO2} \quad \textbf{(3)}$$

Where:

Q_y	Quantity of raw waste/manure treated and/or wastewater co-treated in the year *y* (tonnes)
CT_y	Average truck capacity for transportation (tonnes/truck)
DAF_w	Average incremental distance for raw solid waste/manure and/or wastewater transportation (km/truck)
EF_{CO2}	CO_2 emission factor from fuel use due to transportation ($kgCO_2$/km, IPCC default values or local values may be used)
$Q_{y,treatment}$	Quantity of compost produced in year *y* (tonnes)
$CT_{y,treatment}$	Average truck capacity for compost transportation (tonnes/truck)
$DAF_{treatment}$	Average distance for compost transportation (km/truck)

17. For the calculation of project emissions from electricity and/or fossil fuel consumption by the project activity facilities ($PE_{y,power}$) all the energy consumption of all equipment/devices

installed by the project activity shall be included e.g. energy used for aeration and/or turning of compost piles/heaps, chopping of biomass for size reduction, screening, drying of the final compost product and for the runoff wastewater treatment. Emission factors for grid electricity used shall be calculated as described in AMS-I.D "Grid connected renewable electricity generation". For project activity emissions from fossil fuel consumption the emission factor for the fossil fuel shall be used (tCO_2/tonne). Local values are to be used, if local values are difficult to obtain, IPCC default values may be used.

18. Methane emissions during composting ($PE_{y,comp}$) shall be calculated as follows:

$$PE_{y,comp} = Q_y * EF_{composting} * GWP\_CH_4 \quad \textbf{(4)}$$

Where:

$EF_{composting}$ Emission factor for composting of organic waste and/or manure (t CH_4/ton waste treated). Emission factors can be based on facility/site-specific measurements, country specific values or IPCC default values (table 4.1, chapter 4, Volume 5, 2006 IPCC Guidelines for National Greenhouse Gas Inventories). IPCC default values are 10 g CH_4/kg waste treated on a dry weight basis and 4 g CH_4/kg waste treated on a wet weight basis.

$EF_{composting}$ can be set to zero for the portions of Q_y for which the monitored oxygen content of the composting process in all points within the windrow are above 8%. This can be done via sampling with maximum margin of error of 10% at a 90% confidence level. For this purpose a portable oxygen meter can be used with lancets of at least 1 m length. In the case of forced aerated in-vessel and forced aerated pile composting systems continuous measurements may also be done using online sensors

19. Project emissions from runoff water from the composting yard ($PE_{y,runoff}$) are calculated as follows:

$$PE_{y,runoff} = Q_{y,ww,runoff} * COD_{y,ww,runoff} * B_{o,ww} * MCF_{ww,treatment} * UF_b * GWP\_CH_4 \quad \textbf{(5)}$$

Where:

$Q_{y,ww,runoff}$	Volume of runoff water in the year y (m^3)
$COD_{y,ww,runoff}$	Chemical oxygen demand of the runoff water leaving the composting yard in the year y (tonnes/m^3)
	For e*x ante* estimation, the volume of runoff water may be based in the area of the composting yard and the yearly average rainfall, and the COD for domestic wastewater may be used. For *ex post* calculations the measured volume and COD shall be used
$B_{o,ww}$	Methane producing capacity of the wastewater (IPCC default value of 0.25 kg CH_4/kg COD)
$MCF_{ww,treatment}$	Methane correction factor for the wastewater treatment system where the runoff water is treated (*MCF* value as per relevant provisions in AMS-III.H)
UF_b	Model correction factor to account for model uncertainties (1.12)[1]

20. Methane emissions from anaerobic storage and/or disposal in a landfill of the produced compost from the biological treatment ($PE_{y,res\ waste}$) are calculated as per the latest version of the "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site". In addition, if storage of biomass under anaerobic conditions takes place due to the project activity that doesn't occur in the baseline situation, methane emissions due to anaerobic decay of this biomass shall also be considered.

Leakage

21. If the project technology is the equipment transferred from another activity or if the existing equipment is transferred to another activity, leakage effects are to be considered (LE_y).

Monitoring

22. In the case of construction of new composting facilities or expansion of capacity of existing composting facilities, the emission reduction achieved by the project activity will be measured as the difference between the baseline emission and the sum of the project emission and leakage.

$$ER_y = BE_y - (PE_y + LE_y) \quad \textbf{(6)}$$

Where:

ER_y	Emission reduction in the year y (tCO_2e)
LE_y	Leakage emissions in year y (tCO_2e)

[1] Reference: FCCC/SBSTA/2003/10/Add.2, page 25.

In the case of increase of capacity utilization of existing composting facilities, the emission reduction achieved by the project activity will be measured as the difference between the baseline emission and the sum of the project emission and leakage, multiplied by the factor *r* as follows:

$$ER_y = (BE_y - PE_y - LE_y) * (1 - r) \quad \textbf{(7)}$$

The value for *r* is defined as:

$$r = WCOM_{BAU} / TWCOM_y \quad \textbf{(8)}$$

Where:

$TWCOM_y$	Total quantity of waste composted in year of (tonnes) at the facility
$WCOM_{BAU}$	Registered annual amount of waste composted (tonnes) at the facility on a business as usual basis calculated as the highest amount of annual compost production in the last five years prior to the project implementation

23. In case of projects involving increase of capacity utilization of existing composting facilities, the historical records of annual amount of waste treated at the facility in the last five years prior to the project implementation and additional information to cross check the historical records (e.g. invoices of compost sales) shall be provided for project activity validation.

24. The operation of composting facilities shall be documented in a quality control program, monitoring the conditions and procedures that ensure the aerobic condition of the waste during the composting process (e.g. temperature, moisture during different composting stages).

25. Soil application of the compost or slurry in agriculture or related activities will be monitored. This includes documenting the sales or delivery of the compost final product/slurry. It shall also include an in situ verification of the proper soil application of the compost/slurry to ensure aerobic conditions for further decay. Such verification shall be done at representative sample of user sites. The conditions for proper soil application ensuring aerobic conditions can be established by a local expert taking into account the soil conditions, crop types grown and weather conditions.

Project activity under a programme of activities

26. The following conditions apply for use of this methodology in a project activity under a programme of activities:

In case the project activity involves the replacement of equipment, and the leakage effect of the use of the replaced equipment in another activity is neglected, because the replaced equipment is scrapped, an independent monitoring of scrapping of replaced equipment needs to be implemented. The monitoring should include a check if the number of project activity equipment distributed by the project and the number of scrapped equipment correspond with each other. For this purpose scrapped equipment should be stored until such correspondence has been checked. The scrapping of replaced equipment should be documented and independently verified.

27. Relevant parameters shall be monitored as indicated in the Table III.F.1 below. The applicable requirements specified in the "General Guidelines to SSC CDM methodologies" (e.g. calibration requirements, sampling requirements) are also an integral part of the monitoring guidelines specified below and therefore shall be referred by the project participants.

Table III.F.1: Parameters for monitoring during the crediting period

No.	Parameter	Description	Unit	Monitoring/ recording Frequency	Measurement Methods and Procedures
1	Q_y, $Q_{y,treatment,i}$	Quantity of solid waste(excluding manure), produced compost	tons	Monthly	On-site data sheets recorded monthly using weigh bridge. Weighbridge will be subject to periodic calibration (in accordance with stipulation of the weighbridge supplier), also cross check with sales of compost
2	$Q_{y,ww,runoff}$	The runoff wastewater from composting yard	m³	Monitored with periodic measurements sufficient to comply with confidence/precision level of 90/10	Measurements are undertaken using flow meters or direct measurement of the accumulative volume overtime. Consisting of the wastewater applied in excess (i.e. moisture over and above the field capacity of the biomass being composted) and rainwater in the case of unroofed sites
3	$COD_{y,ww,runoff}$	The chemical oxygen demand of the runoff wastewater from composting yard	t COD/m³	Samples are representatively taken from unfiltered wastewater and measurements shall ensure a 90/10 confidence/precision level	Measure the COD according to national or international standards. COD is measured through representative sampling

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III.F. Avoidance of methane emissions through composting (cont)

No.	Parameter	Description	Unit	Monitoring/ recording Frequency	Measurement Methods and Procedures
4	CT_y, $CT_{y,treatment}$	Average truck capacity for transportation	tons/truck		On site measurement
5	DAF_w, $DAF_{treatment}$	Average incremental distance for raw solid or product transportation	km/truck	Annually	On site measurement, assumption to be approved by DOE
6	$TWCOM_y$	Total quantity of waste composted in year y at the facility	tons	Monthly	In the case of increase of capacity utilization of existing composting facilities, it is used for the calculation of the factor *r*
7		Check of aerobic conditions of the composting process			Technical measures shall be provided to ensure the aerobic conditions of the composting process. Oxygen content of the gas phase inside the windrows needs to be monitored, it can be done via multiple sample measurements throughout different stages of the composting process, with maximum margin of error of 10% at a 90% confidence level. For this purpose a portable oxygen meter can be used with lancets of at least 1 m length to measure oxygen in representative points within the spatial dimensions of windrow.

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III.F. Avoidance of methane emissions through composting (cont)

No.	Parameter	Description	Unit	Monitoring/ recording Frequency	Measurement Methods and Procedures
					In the case of forced aerated in-vessel and forced aerated pile composting systems continuous measurements may also be done using online sensors. O_2-measurement-instrument will be subject to periodic calibration (in accordance with stipulation of instrument-supplier)
8		Parameters related to emissions from electricity and/or fuel consumption			As per the procedure in the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" and/or "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion". Alternatively it shall be assumed that all relevant electrical equipment operate at full rated capacity, plus 10% to account for distribution losses, for 8760 hours per annum
9		Parameters related to methane emissions from anaerobic disposal in a landfill of the solid waste (excluding manure)/compost			As per the latest version of the "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site"

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III.F. Avoidance of methane emissions through composting (cont)

No.	Parameter	Description	Unit	Monitoring/ recording Frequency	Measurement Methods and Procedures
10		Parameters related to baseline methane emissions from animal manure			As per relevant provisions in AMS-III.D
11		Parameters related to baseline emissions from wastewater co-composted			As per relevant provisions in AMS-III.H

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History of the document

Version	Date	Nature of revision
10	EB 59, Annex 5 18 February 2011	To correct the equation for emission reductions calculation in the case of an increase in capacity utilization of existing composting facility.
09	EB 58, Annex 21 26 November 2010	To deconsolidate AMS-III.F to limit the methodology to composting only; anaerobic digestion of biomass will be covered in the new methodology AMS-III.AO.
08	EB 48, Annex 20 17 July 2009	To include composting of manure and to clarify that the baseline waste disposal methods are to be assessed *ex ante*.
07	EB 47, Annex 24 28 May 2009	Provide more guidance regarding the calculation of project emissions from the compost taking into account specific characteristics of the composting technology/measure employed.
06.1	09 February 2009	Corrected title of the "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site".
06	EB 41, Annex 19 02 August 2008	The applicability of the methodology is expanded to include controlled anaerobic digestion of solid organic waste which otherwise would have been left to decay in a waste disposal site.
05	EB 33, Annex 34 27 July 2007	Revision of the approved small-scale methodology AMS-III.F to allow for its application under a programme of activities (PoA)
04	EB 31, Annex 25 04 May 2007	Includes project activities that enhance the capacity utilization of existing compost facilities and provides methods to determine the eligible increased capacity utilization based on the historical records of the annual amount of waste composted at the facility.
03	EB 28, Annex 28 15 December 2006	The applicability of the category is expanded to include co-composting of wastewater along with biomass solid wastes; Methods to calculate baseline emissions from the co-composted wastewater are included and parameters for avoided methane emissions from the composted solid waste are revised. See paragraph 50 of the EB 28 meeting report. Removed the interim applicability condition i.e. 25 ktCO2e/y limit from all Type III categories.

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III.F. Avoidance of methane emissions through composting (cont)

02	EB 24, Meeting Report, Para. 64 12, May 2006	Introduced the interim applicability condition i.e. 25 ktCO2e/y limit from all Type III categories.
01	EB 23, Annex 22 24 February 2006	Initial adoption.
Decision Class: Regulatory **Document Type**: Standard **Business Function**: Methodology		