A material recovery facility for the municipality of Tshwane

'A waste stream strategy for the new material recovery facility'

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Foreword

After five months of study International Business in Turku, Finland at the Turku University I started my thesis research in February 2011 in Pretoria (Tshwane), South Africa. This thesis is for finishing my study Logistic & Economic of the Utrecht University. After five months, now June 2011 my thesis about the waste stream of a new material recovery facility is finished. The result of the thesis is now in front of you.

I was never able to achieve this result by my own. So first I would like to thanks Andre Beselaar and Jacco de Vyver of the waste department of the municipality of Tshwane for the support and the guidance during my thesis. After that I would like to thanks Frans Dekker for the data of the landfills. I also want to thanks the Dutch foundation 'Waste Management South Africa' who gave me the opportunity for doing my thesis in South Africa and fore feedback during my thesis.

Last but not the least I would like to thanks my first supervising lecturer Paul Postmes of the Utrecht University for giving knowledge, support and critical feedback during my thesis. I also would like to thanks my second supervising lecturer Herman van Tongerloo for his support and his knowledge during my thesis. Without the support and guidance of all these people I was never able to achieve this result, so thanks and dankie for everything.

Derk Jan Krijnen
Pretoria, South Africa
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Management summary

The landfills of the waste department of the municipality of Tshwane will run in a few years time out of capacity. This result will end up in opening new landfills, after the current landfills are out capacity. Opening new landfills is a situation that is far from a sustainable waste disposal and from an environmental friendly situation. The landfill will run fast out of capacity, because the amount of waste will increase every year because of an increasing GDP.

The current situation of the waste disposal of Tshwane is that the waste is dumped on landfills and that the waste is not separated at source. On the landfill pickers pick a low rate of recyclables out of the waste and sale the materials to recycle companies. This situation means that there is no clear, sustainable and profitable structure for waste removal, disposal and recycling for the municipality. The current situation is that 43 % of the waste stream is recyclable and that 57 % is not recyclable. The 43% of the waste stream have financial values, because it is recyclable. The only income that municipality have are the fees of waste removal of the waste containers. A strange situation is that the law forces the municipality with bills, declaration and strategies to start recycling, but the municipality is not able to or will to implement the laws. Beside this, companies in the recycle market have a high demand for recyclable materials. So the municipality don't want start recycling, the law force the municipalities to start recycling and the market have a high demand for recyclable material. To solve this contradictions and the current situation the municipality need to build a material recovery facility (MRF). A MRF is a concept of a facility that separates the waste per category and makes the material ready for recycling. The separation process is a semi-automatically process. The project of building a MRF needs to be pilot MRF in the Rosslyn industrial area on stand 64, Hendrick van Eck Straat. The MRF needs to start with the industrial waste of Rosslyn. When this MRF will be successful the municipality can build more of these facilities and save more landfill space.

This research about setting up a waste stream of a MRF starts with theoretical background of collection, separation the waste and selling the waste. The theoretical background of this process is the theory of reverse logistics. This theory is focused on reverse streams of materials, in this case waste, and the stages of the reverse stream. With this theoretical background the research start to analyse the current situation with an internal and external analyse. The internal analysis is focused on the amount, composition of the waste and the process of a MRF. The external analyse is focused on the external influences where the municipality doesn't have influence on. The internal and external analyse comes together in a SWOT analyse and confrontation matrix for developing a strategy for solving the problem situation. The main strategy that came out the SWOT analyses was to get a MRF operational as soon as possible with a simple collect, separate and output process. With this strategy the description of the desirable situation starts. When a MRF wants to get operational and successful, the MRF need to work with three critical success factors. The success factors are a constant collection process of waste, separation process with a separation station of a MRF and a contract with recycle companies for selling the materials.

To build a MRF the municipality must invest 5.675.000 Rand for building the MRF in Rosslyn. The running cost per year will be 6.399.359 Rand. For the upcoming five years the MRF will generate revenue average of 6.848.481 Rand per year. After two years the MRF will be profitable and it will have a positive return of the investment.

To solve the problem of running out landfill the capacity the municipality must build a MRF. To get a MRF operational and generate revenue, the municipality must implement a new collection schedule for the MRF, the MRF need separate eight types of materials, the MRF need to measure the weight of the incoming and outgoing waste trucks, and the municipality must make contracts with the recycling companies for selling the materials.

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1.0 Introduction

In this chapter the scope of the research subject will be introduced. The occasion of the research will be highlighted. Then the problem situation of the research will be described. Behind that the project objective will be described. Then the main- and sub questions of the research will be described. At last the research structure and the type of research will be discussed.

1.1 Occasion

The main issue of this thesis is waste management in Pretoria, South Africa. Waste is not a product that you dump on landfill but it is product that is looking for a new cradle. This system is the cradle-to-cradle[1] concept. The concept is hot concept since 2002 after the book of William McDonough and Michael Braungart. The concept is a new way of thinking in recycling. The thesis will use this concept as a starting point.

Within South-Africa the awareness is rising about their waste production, because the landfills of Tshwane are starting to run out of capacity[2]. The municipality already closed two landfills that were out of capacity. The municipality must prevent of opening new landfills. According to Jean McKenzie[3], researcher of the Stellenbosch University, Landfills in South Africa are ticking time bombs because of the capacity problems. The government made a declaration that the country must reduce their waste production to 0% in the year 2020[4]. This declaration is a general long term objective. Awareness is rising, because South –Africa disposals the waste on landfills across the whole country. This thesis will be focus on setting up a waste stream of a Material Recovery Facility in the industrial area Rosslyn, Pretoria, South Africa. The research is part of a project, where more project members will work on. The principal of the project is the waste department of the Municipality of Tshwane. The entire project has duration of four years. My research will take 5 months.

The waste department of the municipality of Tshwane made contact with the Utrecht University in The Netherlands. The reason for this contact was that the municipality would like to have European students doing this research, because European students has different points of view about waste management according the municipality. Utrecht University will send out groups of students who will do research about the sustainability and feasibility of this project. These groups will rotate every five months. The first group of the project started in September 2010. Their assignment was to get a network going on of all local stakeholders in the Rosslyn industrial area. This involves convincing local companies with the necessity of separating at source (which means the companies need to separate all there waste on their own location). It is important that the recycling companies are willing to cooperate, because they will receive the waste from the separation centre. My research will follow up the findings [5]and recommendation of the previous group.

1.2 Problem situation

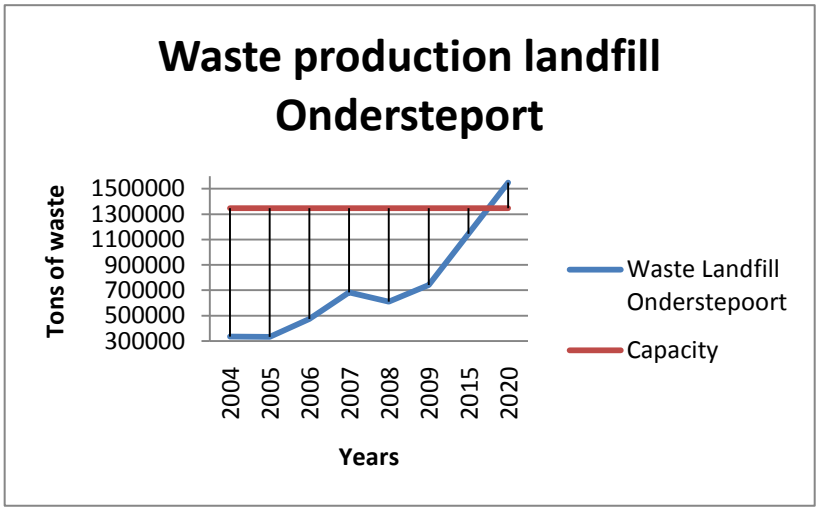
Disposal of waste on landfills isn't good for the environment and for sustainable management. Disposal is on the waste hierarchy[6] ladder the lowest step. With disposal waste on landfills you are

[1] (http://www.mcdonough.com/cradle_to_cradle.htm)
[2] (http://www.25degrees.net/index.php?option=com_zine&view=article&id=969:using-waste-resources-in-local-municipalities&Itemid=81)
[3] (http://www.sadelivery.co.za/files/back_issues/delivery/Edition1/defusing_landfill_timebomb.pdf)
[4] (http://www.environment.gov.za/ProjProg/WasteMgmt/Polokwane_declare.htm)
[5] (https://www.sharepoint.hu.nl/minor/ppp/Project%20Documents/Forms/AllItems.aspx?RootFolder=%2fminor%2fppp%2fProject%20Documents%2fZA%20ronde%2011%20%28waste%20Tshwane%2c%20Rosslyn%20%2b%20Mamelodi%29&FolderCTID=&View={09926605-F35D-4711-8E93-E6920D362A6A})
[6] (http://www.wastenet.net.au/information/hierarchy)

not able to create new economic values and you can't create new jobs. Disposal is also far away from an effective sustainable management strategy for waste handling. The main goal of the government of South Africa and the City Of Tshwane is to achieve a situation where you can recycle and re-use waste.

The current situation at the waste department of the municipality of Tshwane is that they dispose waste on landfills. When this situation will go further the landfills will run out of capacity. Line chart 1 of the landfill Ondersteport confirms this. This line chart is from Frans Dekker, Functional Head Landfill Management of the city of Tshwane. The line chart describes what the amount of waste is, this include all types of waste like industrial, domestic, en green waste. Line chart 1 doesn't show what the composition is of the waste. The thesis will do research to the composition of the waste. When this situation will go further of disposing waste on landfills the waste department of the municipality must close the landfill Ondersteport in 2017 and open a new landfill. The year 2017 is calculated by the average increase of waste per year during the last 6 years. During this last six year the GDP average increases with 3.7 %. The forecast of the GDP for the upcoming years is 3.8%[7]. The landfill Ondersteport is where the figures are from is located close by the Rosslyn industrial area.

The result of the calculation is that number of waste production is doubled in the year 2020, if you compare this with the year 2009. This situation is the same for almost all the landfills in the Municipality of Tshwane. When the municipality will not solves this problem, than the municipality of Tshwane will be forced to open new Landfills in the area of Tshwane. The Waste department of the municipality came up with an idea for trying to solve this problem with creating a pilot project of building a Material Recovery Facility (MRF) in the Rosslyn industrial area nearby the landfill. If this project will succeed, than the MOT can build more of these centres.



Line chart: 1 Waste production landfill Ondersteport from 2004 to 2020

The pilot project will start with the separation of the waste of the Rosslyn area. With this new material recovery facility, a new chain will be created in the reverse waste stream. The Municipality does not know with what logistic strategy they want to manage the new material recovery facility. The logistic strategy is focused on the incoming stream, the separation process and the outgoing stream of the material recovery facility. The important part is what the tasks and roles will be of the material recovery in the waste reverse stream. This is the point that needs to be investigated.

1.3 Objective

The essential objective[8] of this project is to do research about setting up as waste stream of a Material Recovery Facility (MRF) in the Rosslyn industrial area. This research will give the project a recommendation about the waste stream of a MRF. The total research about more subjects the project will take three years. The theories that will be used for the research are theories of waste

[7] (http://www.businessweek.com/news/2011-02-17/south-africa-s-ber-raises-2011-gdp-forecast-to-3-8-from-3-4-.html)

[8] (http://www.carrieretijger.nl/functioneren/management/leidinggeven/doelen-stellen/smart)

management, logistics and Business Administration. The direction of the process view is the incoming and separation, out coming waste stream of the facility. With this objective I want to achieve a step in the research for a profitable Material Recovery Facility (MRF) in the industrial area Rosslyn, Pretoria. The research is focused on the practical side of the process of the MRF. The research is relevant, because the municipality must safe landfill space. The research will be a feasibility study. A feasibility study is a research that is aimed to the strengths, weaknesses threats and opportunities of a new enterprise. The study is focused on cost and values. There are different types of feasibility studies. This feasibility study is focused on the economic and operational factors.

The stakeholders of this project are the companies in the Rosslyn industrial area, the municipality of the City of Tshwane, the Utrecht University and the recycle companies. The communication between the stakeholders is managed by the project organisation. The objectives are on two ways measurable. This is with progress meetings with the project principles and the stakeholders. The second measurable way is to work with milestones. In the current situation there is enough support at the side of the municipality. The stakeholders of the projects need to be convinced in the goal of the project. This is in special the companies that will supply the waste and the companies that recycle the waste. The objective is that the stakeholders must see the sustainable and environmental urgency of the project.

The objective of this research takes place in the term of February 2011 to June 2011. This term is broken up in three terms. The first term is the orientation phase; this phase will take 3 weeks. The second phase is the research phase; this term will take 10 weeks. The last phase is the recommendation phase this will take 7 weeks. The inspiring parts of the project objective are the upcoming demand for sustainable management and reverse logistic streams. These are interesting subjects, because the worldwide markets have demand in this kind of business subjects.

Mission

Beside an objective the project also need to have a mission. The mission of the new Material Recovery Facility in Rosslyn is described with a mission statement. A mission statement[9] is developed to see what the organization's purpose, primary objective and primary function is for a new developing organisation. The mission statement of the Rosslyn MRF will be. With a mission statement an outsider can see in a nut shell where an organisation stands for.

'The MRF Rosslyn is an organisation who efficient collects, separate and re-use industrial waste on a responsible manner. The process will reduce the waste stream to landfills. The MRF sales the waste to recycling companies and other companies who can reproduce waste materials. The MRF stands for efficient, cooperation and sustainable waste treatment'

[9] (http://www.businessplans.org/mission.html)

1.4 Main- and sub question

To achieve a main question for a research, you need to know the current situation and the desirable situation of your project. With a description of the situations a foundation will be made for the main question. The factors that are unknown are the blockades. The following points are the current- and desirable situation, blockades and main question and sub questions of this research.

Current situation

- Waste from the Rosslyn area is dumped on Landfills
- There is no financial value generated out of the waste by the municipality
- Landfill in Tshwane are running out of capacity
- The waste stream is a mixed waste stream

Desirable situation

The structure of People, Planet, Profit (PPP) is used for the desirable situation. These three factors are used for sustainable development.

People

- Job creation with building a Material Recovery Facility

Planet

- Safe landfill space of the landfill Ondersteport

Profit

- Waste separation process in the Rosslyn with a Material Recovery Facility (MRF)
- Create a financial value out waste stream

Blockades

- The amount of tons of waste of the Rosslyn industrial area produce
- The different type of materials the waste the Rosslyn industrial area produce
- The new waste stream with a Material Recovery facility
- The Current players of the recycling market in the City of Tshwane

The following main question is generated with the description of the current – and desirable situation and the blockades.

What will be the waste stream strategy for the new material recovery facility in Rosslyn Pretoria that needs to be built after a research of three years, for creating support by the waste suppliers, and the by recycling companies?

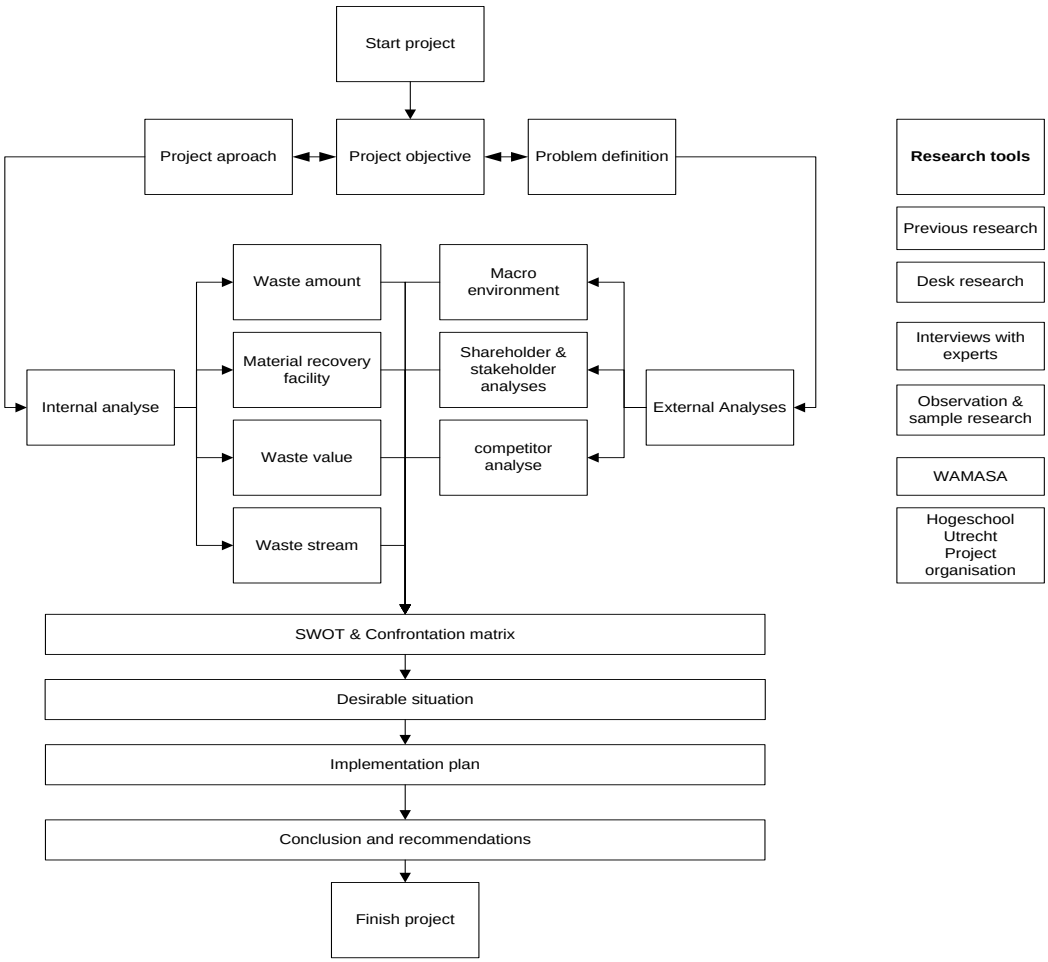
The objective of this main question is to develop a strategy for the waste stream process of the separation centre. The process consist the input stream, throughput stream and outgoing stream. Whit the following sub questions the main question will be answered.

1. What is the current waste stream of the Rosslyn industrial area?
2. What amount of waste is currently produced in the Rosslyn industrial area?
3. What is the influence of the theory of reverse logistic on the waste stream of a material recovery facility?
4. How can you create support by the shareholders and stakeholders for getting a MRF operational in the future?
5. What will be the collecting process of waste in the starting phase of the new MRF?
6. What will be the separation process of waste in the starting phase of the new MRF?
7. What will be the output stream of waste in the starting phase of the new MRF?
8. What are the investments, running costs and benefits of the waste stream?

9. How should the new waste stream of material recovery facility need to be implemented after the research of three years?

1.5 Research structure

Flowchart 1 is the structure of the research. The structure is divided in six parts. The parts are project description, the current situation with the internal- and external analyses, the SWOT analyse with a confrontation matrix, desirable situation with solutions, the implementation of the solutions and the conclusion and recommendations. The required data for these six parts are founded with qualitative and quantitative research. The way of founding the data is described in chapter 1.6. Alongside the research structure the research tools are showed that will be used during the research.



Flowchart 1: Research structure

1.6 Type of research

The research has three types of research literature study, qualitative research and quantitative research. In this chapter the three type of research will be discussed.

Literature study

The literature study is based on the problem situation. The problem situation gave the factors and the search questions for the search of literature. The search strategy was to search for the key words reverse logistics, waste management, Material Recovery Facility, waste South Africa. The search with the key words was done in an online databases[10], online libraries[11], books of the Utrecht University

[10] (http://web.ebscohost.com, http://www.picarta.nl)
[11] (http://www.netlibrary.com, http://www.mediatheek.hu.nl/Informatiebronnen)

and the internet. The result of these sources was books and articles. The type of literature was primary and secondary literature. The results of search was enormous, so specific artless and books were selected.

Qualitative research

The qualitative research is based on different methods. The method that is used in the orientation phase is desk research and observations. The desk research is used for interviews and for general knowledge of waste management. Interviews were held with the director of collection (waste department, municipality of Tshwane), location manager(waste department, municipality of Tshwane), sales manager of Akura (company who build MRF's) ,national procurement manager of Nampak (recycling company), location manager of Mondi Recycling(recycling company), development manager of Consol(recycling company) and with Jacques professor civil engineering of Tshwane university of Technology. In total seven people were interviewed. The choice of persons who were interviewed was based on the waste stream of a MRF. For the incoming stream the people of the municipality were interviewed. For the building the MRF the sales manager of Akura and for the outgoing stream the persons of the recycling companies. The topics of the interview were the working of the recycling market, the financial value of waste and the objective of a MRF. The type of interview was an 'unstructured interview'. During all the interviews the same topics were used. On this way you are able to the compare the visions of the recycle companies about the recycle market. Using the same topics in different interviews has a positive effect on the reliability of the results of the interviews

Beside the interviews also observations of the waste stream were carried out. The subjects of the observation were Landfills; existing MRF's, waste trucks, and recycle companies. These observations types I have carried out are 'field observations[12]'. In total three observations were carried out. The following factors were observed; landfill Ondersteport, the on and off loading of the waste trucks and the companies in the Rosslyn area.

Quantitative research

For the quantitative research a sample research has been carried out. A sample research is that you only focus at a small part of your research population. The population of the research are the 139 companies in the Rosslyn area. The units of the research are the companies of Rosslyn. All units together are the population of the research. The sample research is a random sample research so all the companies in Rosslyn have the equal chance for taking part in the sample research. During the sample research 13 waste containers of a content of 6m3 have taken part in the sample research. These 13 containers represent 9% of the population. The containers are sorted out by hand on the basis of recyclable and non recyclable materials. With this sorting you can analyse the composition of the waste stream, volumes of the waste and you can simulate a separation process of a MRF.

Representativeness and validity

The waste containers that have taken part in the survey were the waste containers from the 139 companies in Rosslyn. The containers that were examined were containers of small, medium and large companies of the Rosslyn area. The MRF will receive the waste container from these companies.

Reliability

The representativeness of the qualitative research is higher than the reliability. The reason for this is that the project organisation has to less capacity for doing a large sample research, and that yearly

[12] (N, Wat is onderzoek? Praktijkboek methode en technieken voor het hoger onderwijs, 2008)

season and the economic situation also plays a key factor in the waste composition. The reliability rate is in this case 45%[13]; a research is reliable when the reliability rate is 99 %. This means that 19 of 20 situations will end up with the same results. The results of the separation sample will not be totally accurate. The result will have a deviation of the reality. In this case the deviation will be 5 %. This means that the results of the sample have deviation of 5 % the reality. The population of the research is all the companies in the Rosslyn industrial area. In total this are 139 companies. I expect that the result of the research will be 50% of the reality. With an expected result of 50%[14] the accuracy range is the greatest. The results is that the sample research needs to investigate 29 containers with the reliability rate of 45 %, the deviation of 5%, population of 139 and the expected result of 50 %.

1.7 Book mark

In chapter 2 the theoretical background of the thesis will be described. In chapter 3 the current situation with an internal and external analyse. In chapter 4 the desirable situation will be discussed. After that in chapter 5 the implementation of a MRF will be showed. Behind that in chapter 6, the conclusion will be described with the answers of the sub and main questions. Following in chapter 7 the recommendations. Later on in chapter 8 are the sources of this research.

2.0 Reverse logistics

In this chapter the theoretical background of research will be described. The theory of reverse logistics and his stages and the waste supply chain will be discussed. Reverse logistic is part of supply chain management. Reverse logistics has the objective of reducing dissipation and pollution in the reverse chain. According to Wessel J. Pienaar and John J, Vogt[15] the definition of reverse logistics is. 'Reverse logistics is the management of all activities involved in the flow of goods, demand information and money in the opposite direction to the primary logistics flow, a reduction of generation of waste, and the management of the collection, transport, disposal, and recycling of hazardous waste in a way that maximise the long-term profitability of the business'

2.1 Forward supply chain VS Reverse supply chain

The normal situation of a supply chain is that focus forward. This means the flow from production to the shop and finally to the customer. The reverse supply chain is focused on the opposite. The stream starts by the customer and ends by a production location of new products. The general difference between these supplies chains are showed in the table 1.

Forward supply chain	Reverse supply chain
Product flow visible	Products flows less visible
Low handling costs	High handling costs
Distribution costs are known	Distribution costs are not precisely known
Works with marketing and sales forecast	You can't forecast reverse streams(unpredictable)
Stick distribution routings	Difficult to pre-define distribution routings
Unit costs low	High unit costs
Uniform product quality	Different qualities
Uniform pricing	Pricing depends on many factors

Table 1: Forward supply compared with Reverse supply chain

[13] (http://www.allesovermarktonderzoek.nl/Marktonderzoek/Steekproef/Aselect.aspx)
[14] (http://www.allesovermarktonderzoek.nl/Marktonderzoek/Steekproef.aspx#Formule%20steekproefgrootte)
[15] (Wessel J)

The waste supply chain is a reverse supply chain. By developing a strategy for a MRF the difference between the two chains must take into account.

2.2 Phases reverse logistics

The following figure shows the stages of the reverse logistics process. I will describe by every stage the main objective and important factors. The stages are the theoretical[16] stages of reverse logistics. The stages were described in the book Business logistics management of Pienaar,W. Vogt, J.

Stage 1: Receipt

The objective of this stage is the manner of reception the goods or material. The important factors in this stage are handling, forms of transport of the goods/material and unit costs.

Stage 2: Sort and Stage

The objective of this stage is sorted and staged the goods/materials for the initial returns processing. The important factor in this stage is the way how the goods are received or have been returned. The characteristics of the goods so the type, size and volumes play in this stage an important role.

Stage 3: Returns processing

The objective of this stage is that the products/material will be sub-sorted according to their type and sort. In this stage the waste is moving from the sort and stage location to the processing station. In the processing station the products/material will be separated and it will get its own location. The important factors in this stage are employees and staff, because these persons are separating the products/materials and give them a temporarily location.

Stage 4: Return analysis

The objective of this stage is to analyse the receiving products/material after the separation in the returns processing stage. In this stage companies or organization are repacking or refurbishing the products/materials. With this repacking the company of organisation wants to achieve a higher value or revenue of the products/materials. Import factors of this stage the quantities, quality, the financial value and the market situation.

Stage 5: Support operations

The objective of this stage is the place where the products/material needs to be distributed to. This is the outgoing stream after the separation. The question will be 'which party will receive the returnable's and on which manner and for which price" The important factors in this stage are inventory costs, amount output products/material and time windows.

2.3 Waste supply chain

In general the waste management industry has got five chains who release the process. These chains are the producers, collectors, the handlers, the recyclers and the material producers. I did not focus on the commercial supply chain; from product producer to the shop, by this supply chain description. The parties are highly depended on each other, because they receive the waste from each other. A figure of the waste supply chain is in appendix I.

1. **Producers**

The first party of the waste supply chain are the producers. These are individuals or organisation that produces the waste. These parties have got the most influence on the whole waste stream, because these parties give the starting point of the process. This party also determines the level of the economic value of the waste and the composition. Low levels of these parties are already separating at source.

[16] (Wessel J)

2. Collectors

The collectors are the group that collect and receive the waste from the producers. The core business of the collectors is transporting the waste. In this situation there are two collectors, the Municipality of Tshwane and commercial companies. The commercial companies are competitors of the Municipality of Tshwane, because they both have the same type of customers (producers). The collectors handle over the waste to the handlers.

3. Handlers

The handlers are the organisations who receive the waste from the collectors. In this case the handlers are the municipality and recycling companies. The collectors dump the waste on the landfills or they bring the waste to the recycle companies. When the collector dumps the waste on the landfill, the waste will be separated by hand by informal pickers. After the picking the recycle companies will receive the waste.

4. Recyclers

The recyclers are starting in the most of the time with separating the waste. Sometimes the waste producers separates the waste at source the main task of the recycling companies is to separate, clean and repack the waste. After this value creating they can sell it to the material producers.

5. Material producers

The material producer receives the waste from the recyclers. The material producers are in this manner able to produce new material for new products.

6. Commercial supply chain

The starting point of the commercial supply chain is that the companies purchase the new product. After the purchase the products goes to the warehouse or directly to the shop. The customer buys than the products in the shop. After this buying point the customer use the product. After the product is used by the customer, the customer has produced waste. The customer has become a waste producer.

2.4 Key elements of reverse logistics for a MRF

The key element of reverse logistics is that you recovery[17] the value of the returning materials, you add value to the material and that you safe pollution in the process. The material is this case waste. The reverse process must be tuned to no loss of value process. The second key element is value added logistics. Value added logistics[18] (VAL) are logistic processes where activities add value to a product or material[19]. Examples of VAL are packing, assembly and labelling. The MRF in Rosslyn must added value to the waste during processes separation.

3.0 Current situation

In this chapter the current situation of the problem situation will be described. The description is splits up in an internal and external analyse. The internal analyse will be focused on the process of a MRF. This means what is the amount of waste the MRF will receive what will be the composition of this waste and the financial value. Beside that the theory of a Material Recovery Facility will explained. The external analyse will be focused on the external environment of the waste stream of a MRF. The

[17] (Geyer R, 2004)

[18] (http://www.logistiek.nl/woordenlijst/index.php?abc=V)

[19] (http://www.logistiek.nl/experts/id11954-De_toevoegde_waarde_van_reverse_logisticsactiviteiten_kansen_voor_logistieke_sector.html)

analyses are structured with three levels Macro, Meso and Micro. The result of the current situation is that you are able to make a SWOT analyse.

3.1 Internal analyse

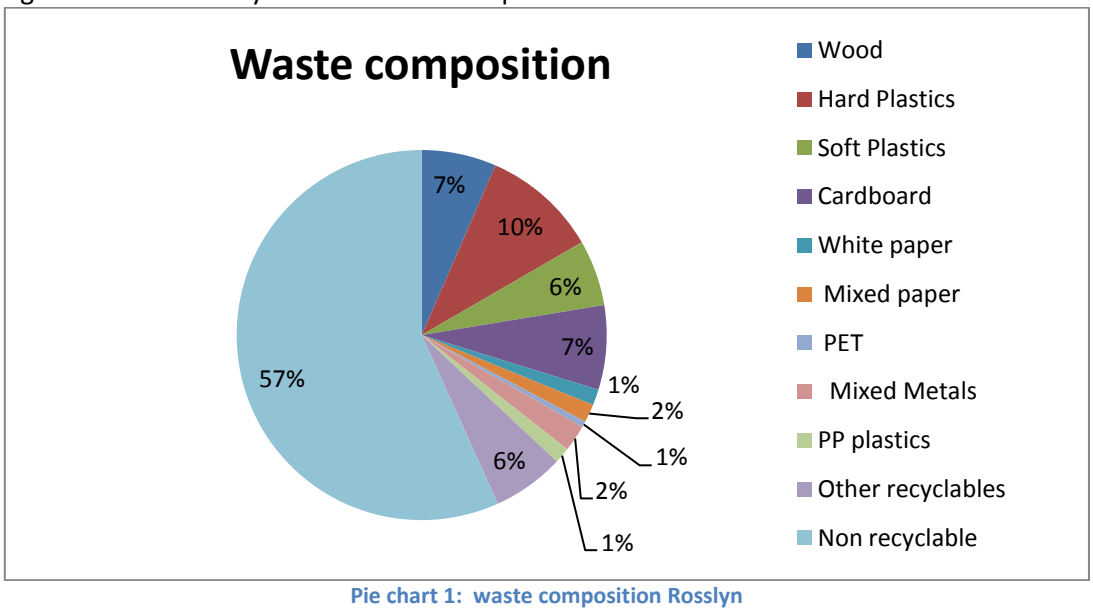
3.1.1 Collection of the waste of Rosslyn industrial area

For analysing the current waste stream of the Rosslyn area you need to determine the total waste production of the area. At this moment the waste of Rosslyn Industrial area goes to the landfill Ondersteport. The type of waste that currently comes from the Rosslyn area is Industrial dry waste[20] . This type of waste is determined by the municipality of Tshwane. At the Landfill site Ondersteport, the municipality is not measuring the amount of incoming waste because the landfill doesn't have scales. The landfill Ondersteport has its own service area; the area where waste is coming from. The Rosslyn area is part of this service area. A sample survey was set up for analysing the amount of waste that area produces. During this survey 13 waste containers have been investigated. The topic of the sample research was the composition of the content of the waste and the weight of the waste.

According to the results of the survey (appendix II) the average weight of a waste container of 6m3 is 475, 5 KG. The fleet department of the waste division of the municipality plans on a daily basis 9 pickups for each driver of a lugger (waste truck). The Rosslyn area has the capacity of 7 luggers. All the luggers are used daily. The truck drivers work 27 days a month. The total amount of waste that the pick monthly is 475.5 KG average weight waste container *9 pickups of waste container per day *7 luggers active in the Rosslyn area *27 workdays this results is 809 tons monthly. It is 27 working days because there is also waste removal on Saturdays.

3.1.2 Waste composition

The result of the survey shows the composition of the waste of the Rosslyn industrial area. The results of the sample research are in appendix II. During the survey, the content of waste container of 6m3 was separate by hand. The results of the composition are reproduces in pie chart 1. The composition is not totally reliable for the whole population, because only 13 containers have been investigated. The reliability number of this sample is 45%.



Pie chart 1: waste composition Rosslyn

[20] (Dekker).

The main materials that are inside the waste containers are non recyclable. These materials are dirty, so not recyclable or they are too small for recycling. The conclusion of this composition is that 43 % of waste stream is recyclable and that 57% is not recyclable.

3.1.3 Financial value of waste

During the qualitative research, interviews were held with recycling companies who recycle the materials that come out waste. The recycle companies are located in the surrounding of Pretoria and Johannesburg. The recycle companies that were interviewed were Mondi, Nampak, and Consol. The topic of these interviews was *'financial value of waste'*. According to the waste companies the influence of demand and supply on the price of waste is very high, because the fluctuating demands of the market. The following prices are average prices of the materials. The prices that are shown in the table 2 are the average prices that the recycle companies give for the materials in the term of February 2011 to June 2011. All the prices are in tons.

Material	Price per ton
Cardboard	R 400,00
White paper	R 800,00
Mixed paper	R 150,00
Mixed metals	R 17815.00
PETE	R 6.393,60
HDPE (Hard plastic)	R 3.596,40
LDPE (Soft plastic)	R 14.252,40
PP	R 2.064,60

Table 2: Prices of waste given by recycle companies

3.1.4 Current waste stream

The flow chart in appendix III shows the current waste stream[21] of the waste of the Rosslyn industrial area. According to the theory of supply chain management these kinds of waste stream are push process/stream. This means that customer determine when the waste collectors and the process starts. In this kind of streams you can only speculated or forecast the amount of material that go through your process. The waste stream starts at the client; the client is in this case the companies in Rosslyn. The waste stream has two finish points, a finish point by the recycling companies and by the Landfill. According to the figures of Frans Dekker, Landfill manager, about the landfill Ondersteport 7 %[22] of the waste goes to the recycling companies. With a MRF this number will increase and it will save capacity of the landfill Ondersteport. The composition of the waste that is dumped on the landfill is mixed. This means that all kind of type of waste is in the same waste stream. This kind of waste stream effects the separation and recycling process. In the appendix IV you see the geographic locations of the clients and the landfill Ondersteport and the location where the MRF will be built.

Separation process & outgoing waste stream

The current separation process[23] is located on the Landfill Ondersteport. This separation is a process that is operated by informal pickers. These informal pickers are independent workers. The workers collect and separate the waste from the incoming waste trucks. The waste trucks are dumping their waste on the landfill, after that the informal pickers start separating. The informal pickers have only a few minutes for their separation process, because after a few minutes a next waste truck is arriving on the landfill for dumping his waste. The separation process of the informal pickers is only focused on the materials with highest financial value. The other material will be disposed on the landfill. The informal pickers sell their materials to the recycling companies. This selling is the outgoing stream of the landfill Ondersteport. At the moment there are no measurements of this stream.

[21] (http://www.tshwane.gov.za/Services/WasteRemoval)
[22] (Dekker, Landfill management 2011,Waste volumes Received, Recycled and Disposed in Landfill), by Frans Dekker
[23] (Landfill Ondersteport visit 21-2-2011)

Costs and benefits of the current waste stream

The costs of the current waste stream are the cost that exists in the process from client to landfill. The costs are focused on transport costs of the waste. The transport costs are cost for fuel, maintenance and labour. The fixed costs of the process are the labour costs. These are the labour costs of the truck driver and the co-driver. The truck that is used for the waste transport is a lugger truck. The variable costs are for the maintenance and the fuel of the trucks. The factors that influence the variable costs are kilometres that a truck drives per month. According to the fleet management of the waste department, 7 trucks are accountable for the waste transport in the Rosslyn area. With these numbers the following cost and benefits analyse is generated. The costs are per year.

Turnover		**R**	**481.950**
Fixed costs	Labour costs drivers	R	270.832
	supervisors	R	193.874
Variable costs	Fuel costs	R	137.262
	Maintenance	R	38.381
Total costs		R	640.351
Profit		R	-158.401
Budget municipality for Rosslyn industrial area		R	158.401

Table 3: Cost and Benefits analyse

De turnover is based on the waste fees[24] that companies need to pay for their waste removal and on the amount of waste containers that are in the Rosslyn area. The kilometres are the total kilometres that a lugger drive from the Rosslyn area to the landfill Ondersteport and back is. The process of waste removal process is in this current situation not profitable, so the municipality have in the current situation a budget for 158.401 Rand for the waste removal of the Rosslyn area.

3.1.5 Materials Recovery Facility

A material recovery facility (MRF)[25] is a facility that receives, separate and prepares recyclable material from municipal, commercial and industrial waste for the recycling companies. The project is focused on building a MRF in the Rosslyn industrial area. Generally there are two types of material recovery facilities, a dirty facility and a clean facility. This both facilities have different characteristics and objectives.

Dirty MRF

A dirty MRF is a facility that deals with a mixed waste stream (also called residual waste).The characteristics of a mixed waste stream are that the waste stream has dry- and wet waste mixed through each other. Paper, metals, plastics and oil are examples of components of a mixed waste stream. Mostly this waste a mixed waste stream are collected in black plastics bags or in containers and sent directly to the material recovery facility. In this situation the waste producer did not separate the waste at the source. A dirty MRF can be manual managed or technological managed; this depends on the surroundings of the facility. A dirty MRF is a basic way to separate waste and mostly manually managed or semi automatically in South Africa, which means that people open the bags with their hands or other equipment and just sort out the recyclables in different containers before they get baled.

The most of the time dirty MRF's work with domestic waste, because these streams are the most of the time mixed with food rests. In general this kind of facility has conveyor systems, bag splitters,

24 (http://www.tshwane.gov.za/AboutTshwane/CityManagement/CityDepartments/Financial%20Services/Budget%20and%20Tariffs/Tariff%20Waste%20Management.pdf)

25 (Recycling and Waste Directory supply chain, environlink Northwest UK, 2009)

screens or trammels, and magnets handpicking or other sorting techniques for to divide the waste stream into the different new waste streams. The effectiveness of a dirty MRF is that the facility can recover around 10 – 15% of waste as recyclables. This 10-15 % are the most of the time plastics, paper, glass, cardboard, metals and textiles. The rest of the waste will require further processing or will go for disposal to the landfill site. With a higher effective process you can achieve 70 % recyclables. The following features are applicable for a dirty MRF; the most of the current MRF are manual managed.

Strengths	Weakness
low capital costs	Low quality of recyclables output
Potential job opportunities	Health issues for staff during picking process
Extracts additional recyclables from residual waste stream	Low economic value

Table 4: Strengths and weakness of dirty MRF

Clean MRF

Basically, the main difference between a dirty and a clean MRF is that the incoming waste of clean MRF already is separated at the source. The waste producers separate the waste at the source. The effect of this is that the producer creates recyclable and non-recyclable waste. The recyclable material can be separated again in MRF, this will result a higher qualitative output. The process of separation at source create more waste streams, because every material gets it own waste stream like plastics and metals. A clean MRF is mostly (semi)automatically managed, which means the waste is carried over a conveyer belt and separated by machines or by hand. A clean MRF is able to recover around 80 – 97% of the amount of incoming waste. This high rate is generated because almost all the incoming waste is recyclable as a result of the separating at source. The following features are applicable for a clean MRF.

Strengths	Weakness
High processing efficiency	High depending on the waste producers
Able to bring the material fast to the market	Storage risks(security and thefts)
Potential job opportunities	Health issues for staff during picking process

Table 5: Strengths and weakness of clean MRF

3.2 External analyse

This chapter will analyse the external environment of a Material Recovery facility. The analyses have three levels the Macro, Meso and Micro level. The first analyse, the PESTEL model is on macro level. The second analyse the industry analyse with five forces model will analyse the Meso level. The last analyse the stakeholder analyse will analyse the micro level.

3.2.1 PESTEL model

Managers use the A 'PESTEL model' for analyzing the effect of the macro-environment on their decision in an organization. The PESTEL model is grouped in six factors. These factors can be barriers or opportunities. This model is showing whit which factors the municipality needs to deals with by the implementation of the MRF.

Political factors

The political factor is in this case an important factor. In the current situation the municipality owns all the landfills in the municipality area. This ownership means that all the waste of the area ends up by at the landfills of the municipality. When the municipality built a MRF they can safe landfill space at their own landfills. The objectives and the priorities of the City Council will determine the budget of the facility and the infrastructure for the waste collecting. A positive point is that the municipality can use the facility for education and awareness.

Economic factors

The economic factors have the highest influence on the waste amount. When companies receive more or less orders or they sale more products, the effect is that they will produce less or more waste. This economic situation has influence on the prices of the raw materials. The prices of the waste/ material are determined by demand and supply[26] in the material market.

Social factors

The social factors that have influence on building a MRF are the unemployment numbers of South Africa. South Africa has a population of 50 million people. The current unemployment number of South Africa is 24%[27] . The government and the local governments want to decrease the number of unemployment wit a job creation program[28]. With building a MRF you create jobs for the local population. By creating new jobs the City council can be more interested in the project. A conclusion of this situation is that the Municipality easily can find workers for the facility.

Technological factors

Research & development in the recycling and waste industry will have affect on the MRF during the building phase. During the development process new technologies in the recycling and waste market can be developed. The project organisation needs to be up to date of the developments. Developments can be new process of collecting waste, new technologies for MRF's and more efficient transport possibilities.

Environmental factors

The awareness about environmental factors and the influence of it has increased worldwide in the last decade. The current environmental hot topics are the demand to oil, emission of CO2, power generation and climate change. A lot of countries worldwide are now investing in sustainable management. With this investment they would earn value, improve the environment and safe energy. An example of new environmental concept is cradle-to-cradle[29] philosophy. The cradle-to-cradle concept is a philosophy of William McDonough & Michael Braungart. The main idea behind this concept is that all the used materials will end up in another new product. The difference between the normal recycling is that you don't have quality los of your material and you don't have rest products that go to the landfills. According to the book "Cradle to Cradle - Remaking the Way We Make Things" of William McDonough & Michael Braungart the motto of this circle is *waste equals food.*

Legal factors

The three legal factors that have influence on the project are the national waste bill[30], the Polokwane declaration and the national waste strategy[31]. With the legal factors you can see that the law force municipalities to start in recycling. In the current situation you can see that the law not yet is implemented.

National waste bill

The objective of the national waste bill is that health of people is protected and the environment with reasonable measures. The measures are focused on pollution ecological degradation and

[26] (Mosiya, 2011)
[27] (http://www.statssa.gov.za/keyindicators/keyindicators.asp)
[28] (http://www.jobcreation.org.za/)
[29] (http://www.duurzaamheid.nl/cradletocradle/boek/Cradle_to_Cradle_in_a_nutshell.asp)
[30] (MANAGEMENT, 2007)
[31] (NATIONAL WASTE MANAGEMENT STRATEGIES AND ACTION PLANS SOUTH AFRICA (1999) & National Environmental Management Act (NEMA, 1998)., 1998)

ecologically sustainable development. With the bill the government want to achieve national norms and standards for regulating the management of waste.

Polokwane declaration

The Polokwane is a national declaration of the year 2001. The goal of the declaration is stabilize waste generation and reduce the waste disposal by 50% by 2012 and develop a plan for zero waste production by 2022.

National waste strategy

The main objective of the national waste strategy is to reduce the generation and environmental impact of all forms of waste. The Department of Environmental Affairs are advising the local waste departments how they can operate their policies.

3.2.2 Industry analyse

To analyse the competition in the waste market in the City of Tshwane the five forces model[32] of Michael Porter will be used. The five forces model describes the influence from the players in the market on your new organisation. This model is analysing the market on Meso level. Whit this model you analyse the attractiveness (value) of an industry structure. To analyse the industry market this model use five competitive forces. All the forces have influence on strategy of the MRF. The forces are; threat of new entrants, bargaining power of suppliers, bargaining power of buyers, threats of substitute products or services and rivalry among existing competitors. The model is here reproduced in appendix V. All the forces of the model will be describes for the MRF in Rosslyn.

New entrants

When a new company wants to enter a market they always face entry barriers. In this case, the waste industry, the company face two entry barriers. The barriers are capital investments[33] and government legislation[34]. The entry barrier of capital investments occurs in that waste disposal and separation usually is a capital intensive and technical industry. When you want to operate a waste stream than you need to have transport facilities and locations where you can separate the waste. The second entry barrier is the legislation of the national government of South Africa for the waste industry. The government requires guidelines and bills for the waste industry. The companies and organization in the waste industry need to compliance this legislation.

Suppliers

The suppliers of the waste, in this case the companies in the Rosslyn industrial area; have different powers and influences on the waste stream. The companies were also mentioned in chapter 2.3 as waste producers. The companies are not bargaining with the waste companies for removal of the waste. All the companies have the objective of an efficient and a low cost waste removal. The power that waste the supplier has is that they can determine the amount of waste, the way of supplying, and the composition. The waste producers determine the flow and the frequency of the waste process. The waste suppliers of waste supply all different type of waste. Some types of waste have more financial value than orders and that the frequency is also different. You can see this in the waste composition (chapter 3.1.2). In the business environment the name of these two factors are the profit impact and the supply risk. Peter Kraljic[35] uses these two factors for analyzing the product that an organization purchases. The Kraljic matrix is showed in appendix VI. With these two factors you can divide products in different items. With the different you can create a purchase portfolio.

The MRF will be focused on one type of supplier. This is a high risk because you only can change to one other supplier and that is domestic area. This change will have effect on the profits. When a

[32] (Porter, 1987)
[33] (http://www.worldbank.org/urban/solid_wm/erm/Annexes/US%20Sizes/Annex%204B.3.pdf)
[34] (http://www.environment.gov.za//PolLeg/Legislation/2011Feb23/correction_notice.pdf)
[35] (http://www.12manage.com/methods_kraljic_model_nl.html)

material has a high frequency in the composition of waste than the supply risk is low, and this is the same of the opposite (chapter 3.1.2). When a recycle company give a high price for materials than the profit impact is high, when the companies give a low price for material than the profit impact is low (chapter 3.1.3). With this starting point the MRF in Rosslyn will have the following items.

Non-critical items: Cardboard, Wood
Bottleneck items: Mixed paper
Leverage items: Hard plastic
Strategic items: Mixed metals, White paper, PP plastic, PETE

Buyers

The South- African recycle market has three dominant players. These players have the most distribution channels and the financial capacity for recycling. These players are Sappi, Nampak and Mondi recycling[36]. These players are all looking for material for recycling. The main materials are paper, metals, glass and plastics. These companies produce new products of the recycle materials.
There exists is product differentiation between these dominant buyers in the recycling markets. Some buyers are looking for specific materials like paper or metals. The dominant players of the recycling market deals with this demand and supply in the market[37], for example when the demand of the paper is high, the companies focused than the most on paper collecting. Collecting paper is on that moment most profitable. The price of the material is determined by supply and demand. In every market situation buyers have different qualities and services. This is also the case in the recycling market. Recycling companies are specialized in a type of waste or material. The recycling companies have their core business (firm's most important activities).

Substitutes

At the current situation the dominant players in the waste market are the buyers that buy material of organization or informal pickers (chapter 3.1.4) that separate the waste. The buyers buy paper, metals, glass and plastics. Some of the buyers are specialized in collecting a specific material. The buyers are specialized, because the chosen material is the most profitable and the quality is the best. When a specific material is not profitable any more the buyer will start collecting another material. This is the moment when substitute of materials take place.

Competitive rivalry with in the industry

The biggest competition and rivalry in de waste market is between the big companies that have the activities of collecting, handling en recycling of the waste. You see in the description of waste supply chain (chapter 2.3) the activities of the collectors, handler's en recyclers. The big companies that I mentioned are determining the structure of the competition. The waste and recycling industry is an industry with high fixed costs. This is only for the private sector of the waste industry, because the municipalities do not recycle or separate the waste. The waste industry has product differentiation[38] in their services, but all the companies are searching for commodity products[39]. The services that the companies provide are different. The big dominant players in the recycling market use according to the Ansoff matrix[40] a market penetration strategy. All the companies want to collect more of the same type of waste. The recycling companies pays higher prices[41] for the waste if you separate the

[36] (http://www.sappi.com, http://www.nampak.com/, http://www.mondigroup.com/)
[37] (http://futures.tradingcharts.com/learning/supply_and_demand.html)
[38] Developing unique product differences with the intent to influence demand
[39] Commodity is a good for which there is demand, but which is supplied without qualitative differentiation across a market
[40] (http://www.12manage.com/methods_productmarketgrid.htm)
[41] (Mosiya, 2011)

waste by yourself and that you bring the waste directly to their facilities. With this strategy the recycling companies are trying to pull more the same waste types out of the providers of the waste.

3.2.3 Stakeholders analyse

A stakeholder analyse is used to identify individuals and groups that affected by achieving the project goals. The groups and individuals have different power, influence and interest on the project. A stakeholder analyse is important because the stakeholders determine the success of the project. The project organization needs to communicate with the stakeholder to achieve the success. Table 8 is the power/interest map of Gardner [42]1986. This map shows the relation between the stakeholders related between their powers and interests. The map illustrates how you need to handle with the different stakeholders.

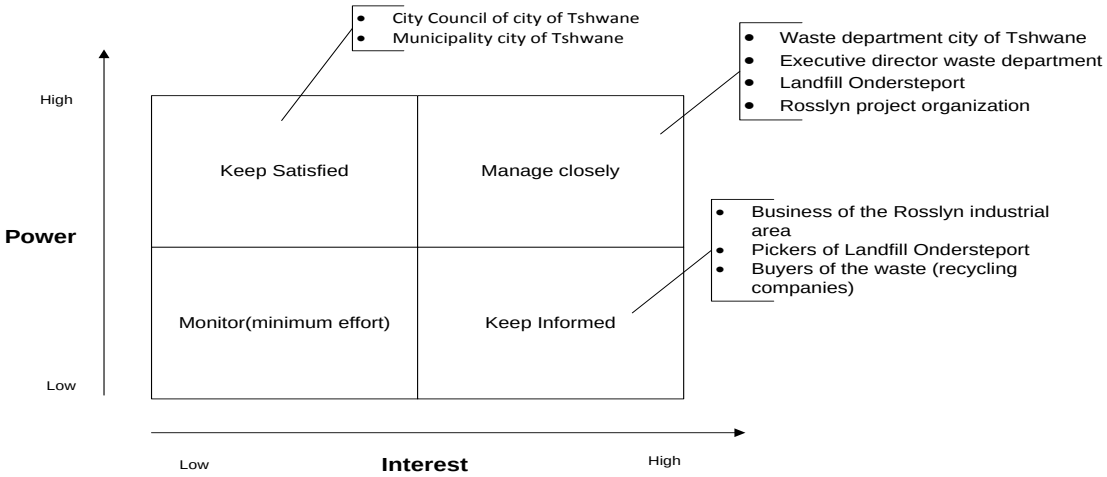


Figure 1: stakeholder analyse Gardner

The main interests of the stakeholders are financial interests. Examples of financial interests are the value of the waste, cost of the waste handling and fees of waste removal. The stakeholders are interested in the influences and effects on their waste financial situation. Besides the financial interests the stakeholders are also interested in sustainable waste handling. The power side of stakeholder map is about approval and financing the project. The stakeholders with highest power must approve the project set up.

3.3 SWOT analysis

The 'SWOT analysis' is a model where the internal and external analyse comes together for developing different strategies. With this analyse companies can identify the strengths, weaknesses, opportunities and threats of their organisation. This analyse tool support the companies by their strategic formulation. Strengths and weakness are part of the internal analyse (chapter 3.1). The internal analyse is focused on what happen inside a company. Opportunities and threats are part the external analyse (chapter 3.2). You create whit combining the internal analyse and the external analyse the confrontation matrix. The confrontation matrix creates four types of strategies. The types of strategies are.

0	Very negative or not applicable
1	Negative
2	Positive
3	Very positive

Table 6: Judge table confrontation matrix

Attack; with the strengths utilize the opportunities, the company need to make most of it. **Adjust;** with the strengths adjust the threats, the company need to restore the threat. **Defensive;** overcome

[42] (http://www.12manage.com/methods_stakeholder_mapping_nl.html)

the weaknesses to pursue the opportunities. **Survive;** with the weakness and threats try to survive in the market

In this SWOT analyze the combinations are judged with numbers. With the judgment of the combination you get a clear view of the important factors for the strategies. The combinations are judged with scale from 0 to 3(table 6). 0 is very negative or not applicable and 3 is very positive. The result of the judgment and the SWOT analyze are showed in table 7. Behind every strengths, weaknesses, opportunities and threats the chapter is described were the factor is linked to.

		SWOT analyse	**External analyse**								
			Opportunities				**Threats**				
			Few Strong buyers of materials (3.2.1)	Law force municipality for recycling (3.2.3)	Creation of new financial values(3.2.1)	High Rate of stakeholders (3.2.2)	Depending recycling companies (3.2.1)	Fluctuation material prices (3.2.1)	Fluctuation demand for materials (3.2.1)	Fluctuation in demand for materials (3.2.1)	**Total**
Internal analyse	**Strengths**	High volume of recyclable material(3.1.2)	2	1	3	0	1	3	3	0	13
		Waste composition useable for MRF (3.1.5)	1	0	3	1	1	0	1	0	7
		High prices for recyclables (3.1.3)	0	1	3	0	0	3	2	0	9
	Weaknesses	Low level of recycling (3.1.4)	1	0	1	0	0	0	0	2	4
		Low measurement of waste stream (3.1.4)	0	0	1	0	0	0	0	0	1
		High volume of waste dumping on landfills (3.1.4)	0	1	0	0	0	1	0	0	2
		Total	4	3	11	1	2	7	6	2	

Table 7: Confrontation matrix with score

Total score confrontation matrix		
	Opportunities	Threats
Strengths	15	14
Weakness	4	3

Table 8: Result of the judgment

The conclusion of this judgement is that combination between the strength and opportunities has the highest score, after that the combination between the opportunities and the threats. These sectors are the most important by formulating different strategies. The conclusion is that the waste stream needs to prefer an attack and adjust strategies. The strategies are formulated in short in the confrontation matrix table 13.

The outcome of the Confrontation matrix has resulted in four strategies. All the strategies have effect on the waste stream of the Rosslyn industrial area. The score table of the confrontation matrix made clear the order of implementation of the strategies.

Confrontation Matrix			Internal analyse	
			Opportunities	**Threats**
			Few strong buyers of materials (3.2.1)	Depending recycling companies (3.2.1)
			Law force municipality for recycling (3.2.3)	Fluctuation material prices (3.2.1)
			Creation of new financial values(3.2.1)	Fluctuation demand for materials (3.2.1)
			High Rate of stakeholders (3.2.2)	Fluctuation in demand for materials (3.2.1)
External analyse	**Strengths**	High volume of recyclable material (3.1.2)	**SO strategy (attack)** Get a MRF operational as soon as possible with a simple collection, separation and output process	**ST strategy (Adjust)** Store bailed waste on the MRF location and sale to the market in large amounts
		Waste composition useable for MRF (3.1.5)		
		High prices for recyclables (3.1.3)		
	Weaknesses	Low level of recycling (3.1.4)	**WO strategy (Defensive)** Awareness campaign for the companies for recycling and separation at source	**WT strategy (survive)** Research for new landfills in the Municipality of Tshwane
		Low measurement of waste stream (3.1.4)		
		High volume of waste dumping on landfills (3.1.4)		

Table 9: confrontation matrix with strategies

1. **SO strategy**

The first strategy that needs to be implemented is to get MRF operational as soon as possible. This is an attack strategy. In the starting phase the MRF needs to have a basic collecting, separation and output process. Basic means that the process needs to be labour intensive and need be low on IT.

2. **WO strategy**

The second strategy that needs to be implemented is a strategy of setting up an awareness campaign about recycling and separation at source. This is a defensive strategy. The campaign must be about recycling in general and separation at source. With the campaign the companies will be more aware about their waste and recycling. The result of the campaign is that the quality of the waste stream will increase

3. **ST strategy**

The third strategy that needs to be implemented is that the MRF needs to store bailed material (for example paper, cardboard and plastic) on their location. This strategy is an adjust strategy. Whit the stores and bailed material the MRF can sell the material, on the right moment with the right price to the recycle companies. Whit this strategy the MRF can reduce the risks of price fluctuation and they can adjust to the market.

4. **WT strategy**

This strategy is the worth case scenario. This strategy needs to implement when all other strategies fail, because than the municipality must use the survive strategy. The strategy is that the municipality needs to a do research about opening of new landfills. Whit this strategy change will not be realised.

4.0 Desirable situation

In this chapter the desirable situation will be described. The desirable situation comes from the SWOT analyse. The desirable situation is described with Critical Success Factors (CSF), business objectives, waste amount and best practices. This content of CSF descriptions of is founded by Ronald Daniel and Jack F. Rockart of McKinsey & Company in the 1960's. The technique is used for defining and measurement business objectives.

4.1 Critical Success Factors

Critical success factors are the factors that the MRF need to achieve for being successful in the future. The critical success factors have the foundation of the mission that is described in chapter 1.3. The MRF must focus on three critical success factors collection, separation and the output of waste. Every CSF has its own business objectives. The goals are shown in the following flow chart.

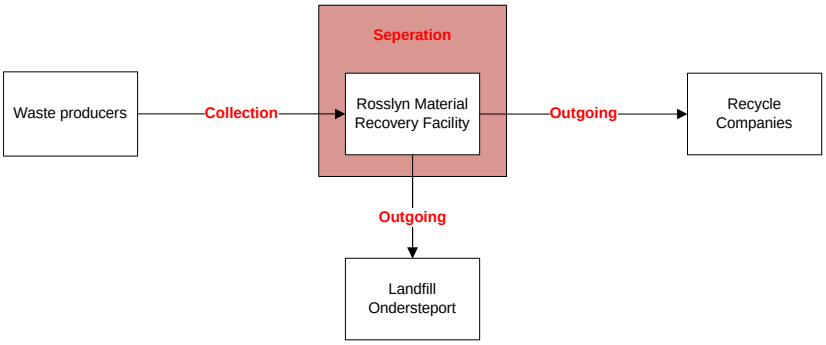


Figure 2: Critical success factors of MRF

The choice for these three strategic goals is based on the stages of reverse logistics (chapter 2.2). The incoming process is related to stage 1. The separation process is related to stage 2 and 3. The outgoing process is bases on stage 4 and 5. Beside the theory of reverse logistics the CSF are related to the value chain of Michael Porter[43]. The three CSF are here related to the inbound logistics, operation and outbound logistics. The value chain is showed in appendix XII.

Incoming process

The incoming process stands for the process from client to MRF. The main objective of the incoming process is that the incoming flow must supply the MRF constant with waste. The planning department and fleet management of the waste division are here responsible for. This incoming flow is crucial for the MRF, because without the waste the process of the MRF will come to a standstill.

The incoming waste must not come from a compacter waste truck, but the waste must come with a waste container with a volume of 6m3 or 11m3. When the waste is compacted it is much more difficult to separate, because the composition of the waste is broken or the waste is wet. Before the waste enters the MRF location it is important that a gatekeeper examine the composition of the waste container. The gatekeeper is in this case no security of the MRF, because the gatekeeper is part of the process of the MRF. The gatekeeper must determine of the waste container have enough recyclable materials. According to the result of the sample survey the waste stream can have waste containers with less than 10% recyclables. A gatekeeper must recognize these waste containers and send them straight to the landfill. Non-recyclable waste can influence the results of the process of the MRF. When the waste container has enough recyclable material, than the truck driver can dump the waste of container on the MRF location. When the container has got to less recyclable materials than the container can go directly to the landfill.

The business objectives of the collection are:

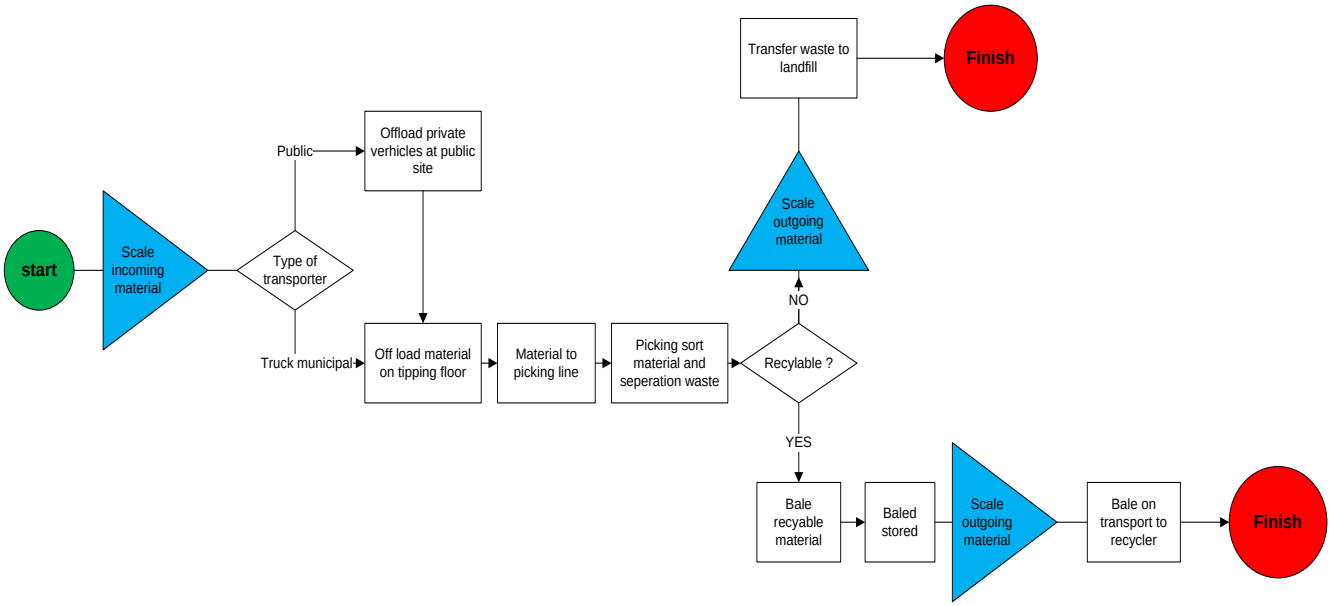
- Constant supplying of waste
- Only incoming dry waste

[43] (http://www.12manage.com/methods_porter_value_chain.html)

- Incoming waste containers controlled by gatekeeper

Separation

The second critical success factor is the separation of the waste. The separation takes place at the MRF. This process of separation is the key chain player in the waste stream, because it receives the waste from the collection process and hand out the waste to the recycle companies and to the landfills. The following flowchart shows the process of the new MRF in Rosslyn.



Flowchart 2: Separation process MRF

The process starts with that a truck from the municipality or private companies dumps the waste on the tipping floor of the facility. After the dumping a tractor pushes the waste on the conveyor belt. The waste is now going to the picking line/separation station. On the separation station pickers separate the waste by hand to different categories. After the separation the non recyclables will go to the landfill and the recyclable material will be bailed and sold to the recycling companies. At this stage of the project the turnaround time, wait time and time to market is not yet measurable. When the MRF is operational the supervisors are able to measure these factors.

In flowchart 3, three blue triangles are showed. These triangles are measure moments of the separation process. During these three moments the waste will be scaled. The reason for this is that you can measure your waste stream that is going through your facility and analyse the waste stream. The MRF separate the waste per category of material. The materials are

1. White paper
2. Mixed paper
3. Cardboard
4. Hard plastics
5. Soft plastics
6. Wood
7. Mixed metals
8. PET

After the separation the material must be scaled per category. After the scaling the material must be bailed with a baling machine. The baling machine is showed in the appendix XIII. With balling the waste you add value to the material. With the bails you are able to load a full truck. The materials that are recyclable must be bailed as much as possible with a bailing machine. With bailing the recyclable material you safe transport cost, you add value to the materials and low transport frequency compared with transport of loose materials. The common materials that are bailed by

current MRF's are white paper, mixed paper, cardboard and plastics and tins[44]. An average size of a cube that a compactor produces is 74cm (high), 110 cm (wide) and 100cm (deep). The content of this cube is 0,825 m3. Table 10 shows the average weights of the different materials with a bail of 0,825m3. The pickers that work in the separation station can't pick all the materials from the conveyor belt. My opinion is that a picker only can pick 1 out of 3 materials. This means that your level of recyclables will drop with 66 % and also the revenue. This picking margin is based on an assumption. Every picker is responsible for a specific type of material. Every pick has got its own location in the separation station.

Materials	KG per bail	Monthly material KG	Bails monthly	Earning per ton	Revenue monthly
Cardboard	439,6	21184,0	48	R 400,00	R 8.473
Soft plastic	244,2	16497,8	68	R 14.252,20	R 235.130
HDPE (plastic)	219,8	29021,8	132	R 3.569,40	R 103.590
White Paper	732,7	4000,9	5	R 800,00	R 3.200
Mixed paper	427,4	43131,8	101	R 150,00	R 6.469
Totals			354		R 356.865

Table 10: Bails production monthly bases

Not all the materials will be bailed. The material of hard plastics and metals will not be bailed. These materials will be transported loose in waste containers to the recycle companies. The composition of the not bailed waste will be transported loose to the recycle companies. The revenue for the materials of mixed metal and hard plastics is in the table 12.

	Monthly receive in tons	Price per ton	Revenue Monthly
Hard Plastics	29	R 3.596,40	R 104.374
Mixed Metals	0,9	R 17.815,00	R 17.454
total	30	R 21.411,40	R 121.829

Table 11: Non recyclables

The revenue of the MRF on a yearly basis is R 356.865 + R 121.829 = R 478.694 * 12 months = R 5.744.333

The business objectives of the separation are:

- Scaling of the incoming waste and waste trucks
- Separate waste per category
- Bailing the waste per category

Output process

The output process is the point where the MRF will generate revenue with the financial value of the materials. The recyclable material will be sold to the recycle companies. The revenues were calculated in this chapter. The waste that is not recyclable must be dumped on a landfill with a container of 11m3 or 30m3 containers. With this type of container you achieve low transport cost and a low frequency of transport, when you compare it with a 6m3 container. During the separation process the recyclable materials will be bailed per category. After this process an inventory of bailed materials will arise. The different recycle companies will pick the bails up from the MRF location. The recycle companies only will come when they can achieve a Full Truck Load (FTL). This way of distributing your materials called *'manufacturer storage with customer pickup'*[45]. The flowchart of the distribution is in the appendix XIV. The major advantage of this type of distribution network is

[44] (http://www.wastecare.com/Products-Services/Balers/aboutbalers.htm)

[45] (Sunsil Chopra)

that it can lower the delivery costs and that you have flexibility for the variety of materials. The waste stream is whit this type distribution network a push stream.

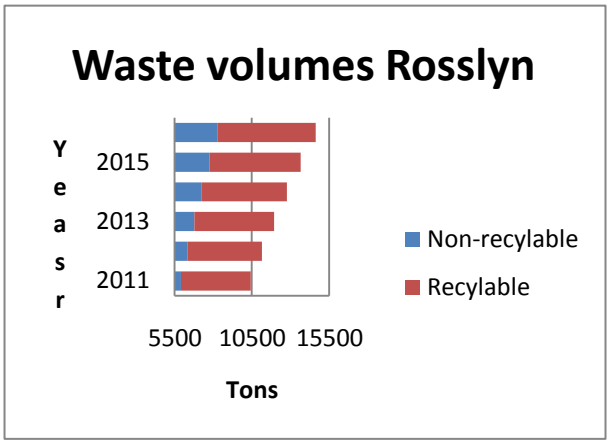
The business objectives of output process are:

- Store bailed waste on MRF site
- Pick up bailed material by recycle companies
- Waste to Landfill Ondersteport

4.2 Waste amount

4.2.1 Amount

It´s difficult to make estimations about the waste production figures of the future. The volume of the waste production is very depended on economical development. The waste management in Cape Town is very similar to waste management in Pretoria. Cape Town has the same problem situation; they also run out landfill capacity. The estimation of Cape Town is that waste production will increase every year with 7 %. When the Rosslyn area has the same increase ratio as Cape Town, than it will produce the following waste volumes. The Rosslyn area produces at the moment op a yearly basis 9708 Tons. Bar chart 1 shows the developments in the future. The amount of recyclable materials will increase. The research of the composition was not focused on which of recyclable will increase of decrease. With this situation the municipality will safe a landfill space of 32231 Tons



Bar chart 1: Waste volume with recyclable and non recyclables

4.2.2 Composition

It is also difficult to make estimation for the future of the composition. Factor of the PESTEL analyse have a lot influence on the composition. For example when the industry develops a substitute for plastics, than the number of the plastic will decrease and another material will increase. When the situation of the composition will stay the same than the future will have the following numbers. The weights of the materials are in tons. The calculation is based on increase rate of 7 % (chapter 4.2.1)

Material	Average KG of container	2011	2012	2013	2014	2015	2016
Wood	31	635	679	727	778	832	890
Hard Plastics	48	983	1051	1125	1204	1288	1378
Soft Plastics	27	559	598	639	684	732	783
Cardboard	35	717	767	821	879	940	1006
White paper	7	135	145	155	166	178	190
Mixed paper	8	153	164	175	188	201	215
PET	2	50	54	57	61	66	70
Mixed Metals	11	224	239	256	274	293	314
PP plastics	7	135	144	154	165	176	189
Other recyclables	30	610	652	698	747	799	855
Non recyclable	270	5511	5897	6310	6752	7224	7730

Table 12: composition figures of the future

4.3 Best practice MRF

A MRF is worldwide known concept. The most MRF are standing in Europe and in North-America. These are the continents with the most knowledge of MRF's. For example the Veolia group [46] have worldwide 219 MRF's. This is a worldwide best practice[47]. A local best practice is the Weltevreden Material Recovery Facility, outside Johannesburg. Pictures of this MRF are in appendix X. The MRF only separates domestic waste. The MRF is located on a landfill. This means that MRF in Weltevreden has same similar process and that operates in the same industry. The financial and process information of this facility were not available. The process of the MRF in Weltevreden is that the incoming waste is mixed. This means all type of waste are in the same stream. There is no separation at source. The incoming truck dumps the waste on the floor before the conveyor belt. The pickers start now with picking the big pieces of scrap out of the waste. When this activity is ended the waste tractor will start pushing the waste to the conveyor belt. The waste on the conveyor belt goes to the separation station.

On a daily basis 16 pickers are working on the separation station. All the pickers are responsible for picking a specific type of material. After the picking the material is dropped in to a big bin. The bin is located under the conveyor belt and the separation station. Every bin has its own type of material. The MRF has 9 bins with materials. When the bins are full with materials, the bins will be emptied. The process of emptying is that the employees of the MRF will open the doors of the bins. The waste that is in the bins falls automatically on a conveyor belt. The conveyor belt goes to packing machine/compactor. The bailer machine compact the waste in bales. The material that is packed with a high frequency is plastics, cardboard, white paper en mixed paper. The materials of glass and tins are not packed, but they are collected in a 6m3 waste container. When the waste is compacted in bails or collected in waste containers the waste is ready for transport to recycling companies. The waste that is not recyclable ends up in a waste container. The waste container is located at the end of the separation station. The waste of the containers goes to the landfill.

5.0 Implementation

In this chapter the implementation of the MRF will be described. First the phases of the change of the current situation to the desirable situation will be described. After that the way of monitoring this change will be discussed. Behind that the implementation of the MRF in the waste stream will be described.

5.1 Phases

According to the colour thinking theory of change of Professor L.I.A. de Caluwé (see appendix XI) the change must be realised on a blue colour manner, this means in phases. These phases must be controllable, less complexity, and with a clear objective. With these factors a project organisation can realize the change of the waste treatment. The objective of the change is to realize a working MRF and to save landfill space. The change has four phases.

Phase 1: Introduction of the MRF

The first phase of the change is to introduce the MRF in the waste stream. With this introduction the waste stream can adjust to the MRF, but also the mindset of the people change in this phase. The change in the process of collection the waste is that process will not finish any more on the landfill but it will finish by the MRF Facility. The MRF will be in this phase a dirty MRF (3.1.5), because the incoming waste stream is mixed.

[46] (www.veolia.com)

Phase 2: Working separation processes
The second phase of the change is that the MRF will operate efficient and use all his capacity. This phase is an important phase because during this phase the stakeholders will see the MRF working and the results. The critical success factors must succeed in this phase.

Phase 3: Separations at source of non-critical items and leverage items
The third phase is about improving the quality of the waste stream. In this report I have mentioned a few time the concept of separation at source. Separation at source is a long term objective that's why in start in phase 3. The first starting of separation at source is to separate the non-critical items and leverage items. These items are from the Kraljic purchase portfolio (chapter 3.2.3). These items have a low supply risk so that means that items have high frequency in the composition of the waste. With separation at the source the level of the non-recyclable waste will drop. The reason for this is that the non-critical items and leverage items are collected separate. This results in that the pickers on the conveyor belt of the MRF now easier can pick the materials, because the materials are now more spreader. The error margins will now drop. The MRF will change in this phase to dirty MRF with dual stream (chapter 3.1.6)

Phase 4: Full separation at source
The last phase is that the waste producers separate almost all their waste at the source. This is a big logistic challenge because the collection process frequency will change. With the full separation at source you get the best output of a MRF, because you separate the two big categories dry and wet waste, this also happen at phase 3. In this phase the MRF is changed in a clean MRF (chapter 3.1.5).

5.2 Monitoring

According to blue thinking of change the change must be monitored and controllable. The first step in monitoring is that waste stream must monitor frequently. The key factors of the waste stream are

1. Volume of the waste
2. Amount of recyclables in the waste composition
3. The waste producers
4. The situation of the landfills

These four factors have taken part in the sample survey (appendix II). These factors must also be monitored before built of the MRF and when the MRF is operational. The first two factors must be scaled frequently by a sample survey. In the current situation now waste is scaled at the landfills, so the current data is not really reliable. The development of the third factor has a link with the first two factors. The waste producers must be monitored about what of type of waste they produce and what the volumes are. These three factors have the most influence on the waste stream, so that is why they need to be monitored. The last factor, the situation of the landfill, must be monitored because this is current situation of the waste treatment and this will be the location where you will see the consequences of a MRF.

5.3 Implementation MRF in the waste stream

5.3.1 Waste stream

The SWOT analyses and the confrontation matrix gave different type of strategies (chapter 3.3). The outcome was that the best strategy is to get a MRF operational as soon as possible. The desirable situation (chapter 4.0) has described the business objectives of this strategy for succeeding success. Chapter 5.1 and 5.2 described how the current the situation need to change in the desirable and how

the is change need to be manage. The question is now 'how need the MRF need to be implemented in the waste stream?" and what will be plan of running a MRF?

The implementation of the new waste stream must be realized with a bottom up approach[48] and bottom down approach. The bottom down approach must come from the City Council and from the directors of the waste department (chapter 3.2.1). These parties are important for the support and urgency of the implementation. The bottom approach is aimed on the practical side and on the operational level. The practical and operational factors are related to the CSF and the business objectives (chapter 4.3) and to the current situation of the waste stream (chapter 3.1). These people that work in the current waste own the process and the power of the process. With the bottom up approach the support of these people are important in succeeding the Critical Success Factors and the business objectives.

The starting point of the strategy is that the MRF need to act like an 'analyser' according to the scenario's strategies of Raymond Miles and Charles Snow. The scenarios are in the appendix XIII. The MRF is going to operate in a stable and changing market, with low risks and a formulized structure. With these three factors the MRF will be able to structure a mix between his service and the selling the materials and to create stable job opportunities for the local people. With the bottom down and up and the starting point of Raymond Miles and Charles Snow the MRF need to carry out the following plan for the critical success factors.

Collecting process
The factor that municipality needs to implement is a new planning schedule for the waste collecting. The new planning schedule needs to be focused on that the MRF will have a constant supply of waste containers. This means that the planning of the pickup schedule of the waste truck needs to be connected so that the MRF will constant flow of incoming waste. The pickup of the waste must be done with 6m3 of 11m3 containers. The frequency and volumes of the waste are mentioned in chapter 3.1.1. Change only occurs for the truck drivers. The truck driver must bring the waste container to the MRF and take a full container with non recyclables back and bring it to the landfill. Before the waste container enters the MRF location it needs to be controlled by a gatekeeper. This job of gatekeeper needs to be implemented. The gatekeeper judges the waste container about enough recyclables, and to judge if the waste is dry (chapter 4.1). Whit this two steps you can analyse the waste container about his profitability. The collection process will change incrementally in phase 3 and 4 were the separation at source will be implemented.

Separation process
For the separation process the municipality need to build a Material Recovery Facility in Rosslyn. I highlighted in chapter 4.4 and 4.2 the best practice of a MRF and the separation process of a MRF. The two chapters discussed the objective of the MRF and what type of material the MRF will separate. The implementation of the MRF will cost round 5.6 million Rand according to the best practice. The municipality have at the moment a plot of land of 4 hectares in Rosslyn. The location is on Hendrick van Eckstreet. This location is ideal for a MRF it close by the waste producers and the Landfill and the area has a good infrastructure for the transport of waste. Figure 3 shows what the municipality need to built. This is a separation process, the core business of a MRF. Number 1 shows in figure 3 the conveyor belt of the MRF (number 1), the pickers (number 2), the bins of the recyclable materials (number 3), the bailer machine (number 4) and the conveyor belt where the waste will be dropped on before separation (number 5) and the waste container where the non recyclables will end up in (number 6)

[48] (http://123management.nl/0/020_structuur/a223_structuur_01_operationeel_procesimplementatie.html)

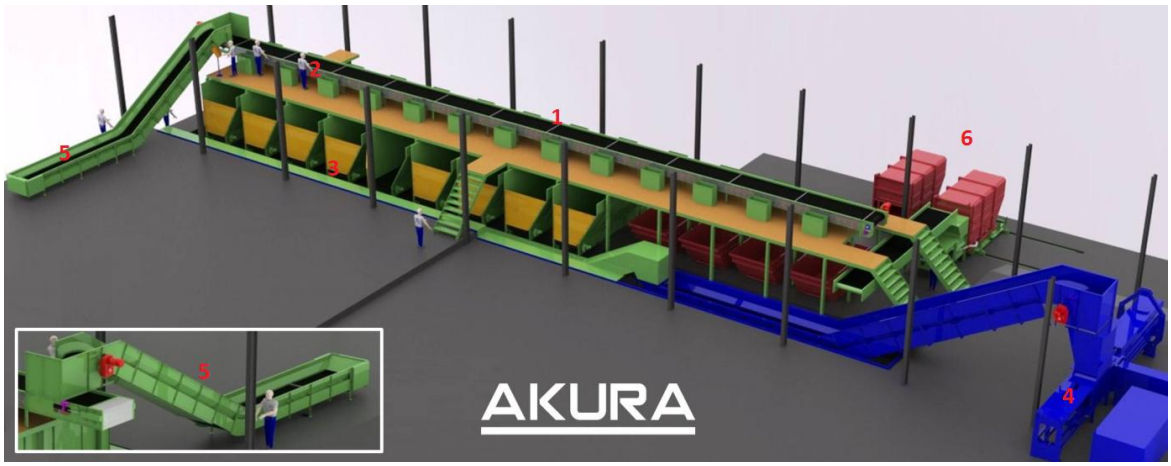


Figure 3: Separation station of a MRF

All these factors together are forming the separation process of the MRF facility. The simulation picture is from Akura. Akura is a company who built MRF's in South Africa.

Outgoing process

The implementation of the output process is that the MRF must make contract with recycling companies for picking up the recyclable materials (chapter 4.2). An important factor of this contract is the communication between the MRF and the companies. The MRF and the recycling companies need to make a planning for the pickup. The best situation for the companies is that they transport the waste with Full truck loads. The municipality must organize the transport of the non-recyclables from the MRF to landfill Ondersteport.

5.3.2 Cost

The implementation of a MRF starts with an investment for the facility. The investment is for building the facility and for tools for running the process. After the investment the running costs will appear. The important factor in the running costs are the cost drivers of process. These are the factors that create costs. The cost drivers of the MRF are cost of the staff, building, transport costs and cost for the machines. The transport costs are based on fuel costs and the maintenance costs of the luggers. Appendix XII shows the formulas of the fuel cost and the maintenance is discussed.

Investment	
Construction costs	R 3.800.000,00
Bailer machine	R 1.300.000,00
Waste tractor	R 270.000,00
Waste tools	R 5.000,00
Truck scale	R 300.000,00
Total investment	**R 5.675.000,00**
Total Investment €	*€ 567.500,00*

Table 13: Investment

The investment and the running cost are based on assumptions,best practices and comparable processes. The reason why the investment and the running cost are assumptions is that there is not a clear current situation of the cost and investments.

5.3.3 Benefits

The revenue that MRF will receive will come from the recycling companies who are paying for the materials. The calculation of the revenue is based on the amount materials that will be sold to the recycling companies and on the error margin (chapter 4.2) of the pickers. The grow rate of the

Year	**2011**	**2012**	**2013**	**2014**	**2015**
Revenue	R 5.744.333	R 6.146.437	R 6.576.687	R 7.037.055	R 7.529.649
Costs	R 6.399.359	R 6.399.359	R 6.399.359	R 6.399.359	R 6.399.359
Profit	R -655.026	R -252.923	R 177.328	R 637.696	R 1.130.290
ROI	-11,54%	-4,46%	3,12%	11,24%	19,92%

Table 14: Revenue, costs, profit and ROI per year

revenue is base of the increase of the waste production of 7% (chapter 4.3.1).
Table 14 also highlighted the Return On Investment (ROI). The ROI is a ratio between the revenue and the investment. For example in the year 2012 the ROI calculation is R -252.923: R 5.765.000, 00 (total investment chapter 7.3.2) = -4.46 %. During the two first years the ROI is negative, that means that there is no return of the investment. In the year 2013 the ROI is positive so there is a positive return of your income. In the year 2015 34, 28% of the investment is recovered The MRF is in first two years not profitable, because the costs are higher than the revenue. After the first two years the revenue is higher than the cost. This MRF is now profitable; this point from changing from not profit to profit is the breakeven point. The breakeven point is in the year 2013. The line chart of the breakeven point is showed in the appendix XII. The main question of the research shows that the MRF will start after three years. The calculation start in 2011, this is done because the data of the waste is from 2011 and to show urgency of the waste situation.

5.4 Key Performance Indicators

Key performance indicators (KPI) are indicators with a manager can analyse the performances of his organisation. KPI is not same as Critical Success Factors (CSF) from chapter 4.2. The CSF are factors that have crucial interest for the success of the strategy, KPI's is a measurement tool for to quantify your business objectives. The relation between the CSF, objective and the KPI is that the KPI makes the CSF and objective measurable. The MRF will have the following KPI. The KPI's are predictive KPI's, because the KPI's are for an organisation that needs to be built.

CSF's	Objectives	KPI's
Incoming process	Constant supplying of waste	MRF must receive 63 containers per day of 6m3 or bigger.
	Only incoming dry waste	100% of the waste must be dry
	Incoming process controlled by gatekeeper	Gatekeeper must inspect a minimum of 90 % of the incoming coming trucks
Separation process	Scaling incoming waste	100 % Incoming waste truck must be scaled
	Separate per category waste Balling recyclable waste	Separate station must separate a minimum of 8 categories
		Bailer must produce a minimum of 354 bales per month
Outgoing process	Store bailed waste on MRF site	MRF must store bails on a weekly basis
	Pick up bailed material by recycle companies	Minimum of 40% must go the recycle companies
	Waste to landfill Ondersteport	Maximum 60 % of the waste stream can go to the landfill

Table 15: Key performance indicators

6.0 Conclusion: answer sub- and main question

In this chapter the main-and sub question (chapter 1.4) of this thesis will be answered. The answers are the conclusions of this research.

Sub questions

1. *What is the current waste stream of the Rosslyn industrial area?*

The current waste stream of the Rosslyn industrial area starts by the companies of the area and finished by the landfill Ondersteport (chapter 3.1.4). The transport of the current waste stream is organised with waste trucks (luggers). In the current waste stream there is not an organised separation process. The separation is done by informal pickers on the landfill. The informal pickers only pick the most value material. The current turnover is realised by the price of waste removal that the companies pays. The current turnover per year R 5.783.400 and the costs are R 6.944.003 this means that there is no profit, but a loss of R 1.160.603.

2. *What amount of waste is currently produced in the Rosslyn industrial area?*

The Rosslyn industrial are producing currently 9708 ton per year (chapter 3.1.1). Of this 9708 ton 43.2 % is recyclable and 56.8% is not recyclable (chapter 3.1.2) these number have effect on the waste stream of the MRF. According to the setting of the sample research (chapter 1.6) the amount of waste has a deviation 5%. The results are for 45% reliable; this means that the real amount of waste is different.

3. *What is the influence of the theory of reverse logistic on the waste stream of a material recovery facility?*

The influence of the theory of reverse logistic is that MRF must recover the value of the material, add value to the material and safe pollution in the logistics processes (chapter 2.4). The MRF must run and implement the stage of reverse logistics to achieve an efficient waste stream (chapter 2.2). With the stages the MRF better connect with the waste supply chain (chapter 2.3).The MRF will add value to the material with baling the materials with a baling machine(chapter 4.1).

4. *How can you create support by the shareholders and stakeholders for getting a MRF operational in the future?*

The project needs to create support per stakeholder and shareholder on different manners (chapter 3.2.3). Some stakeholders need to keep satisfied, manage closely monitor or keep in formed. For creating support by the companies of Rosslyn the municipality should create an awareness campaign (chapter 3.3). This campaign should focus on the advantages of separation at source. The effect of the separation source is that the quality of the waste stream will increase, because the waste stream will receive more recyclable materials. Beside the companies the most support need be created by the politician. The politician need be convinced about the advantages of a MRF and the sustainable waste treatment.

5. *What will be the collecting process of waste in the starting phase of the new MRF?*

In the staring phase of the MRF the way of collecting the waste will stay the same. This means no separation at the source, because there is no awareness by the waste suppliers. Separation at source is a long term objective when there is awareness. The municipality need to implement a new collection schedule. The schedule is that the waste pickups are connected with each other. On this way the MRF will have a constant supply of waste. The waste of the waste suppliers must be dry, because dry waste is best recyclable. The transport of the waste will be done by luggers (waste truck) with 6m3 containers or 11m3.

6. *What will be the separation process of waste in the starting phase of the new MRF?*

The best separation process in the starting phase of the MRF is that the MRF will separate eight types of materials (chapter 4.2). These materials have the highest frequency in the composition (3.1.2). The separation process should take place in the separation station of the MRF (chapter 7.3.1). The separation will be done by hand from a conveyor belt by pickers (figure 1). After the separation the material of cardboard, soft plastic, hard plastic, mixed paper and white paper need to be bailed with a bailer machine. With bailing process you added value to the material and you create transport efficiency (chapter 4.2).

7. *What will be the output stream of waste in the starting phase of the new MRF?*

The output process is the moment where the MRF will generate his income, because the recycle companies will pay at this moment for the materials. In the starting phase of the MRF the most efficient output process is that the recycle companies will pick up the material at the MRF site. This is called ‘manufacture storage with customer pick up’ (chapter 4.2). The companies will pick mostly the

bails, beside they also will pick up the loose material. The non-recyclable materials will go from the MRF to the landfill by 11m3 waste containers.

8. *What are the investments, running costs and benefits of the waste stream?*

The investment for building a MRF is 5.675.000 Rand (chapter 7.3.1).The running cost per year will be 6.399.359 Rand. After two years in 2012 the MRF will achieve the break-even point with a profit of 177.328 Rand. In the same year the MRF will have a positive Return Of Investment of 3, 12 % (chapter 7.3.2)

9. *How should the new waste stream of material recovery facility needs to be implemented after the research of three years?*

The total MRF and his objective must be implemented in four phases (chapter 5.1). The phases have the objective of improving the process and the waste quality. During the implementation change must be the blue colour thinking of change management of Professor L.I.A. de Caluwé. The MRF must have the starting point of analyse of the Miles and snow strategies (chapter 5.3.1). To measure and to manage the process of the implementation the MRF needs to work with KPI's for each CSF (chapter 5.4)

Main question

The main question of this research was the following question.

What will be the waste stream strategy for the new material recovery facility in Rosslyn Pretoria that needs to be built within after a research of three years, for creating support by the waste suppliers, and the by recycling companies?

The MRF will be after a research of three years, a new chain in the waste stream between the producers and the landfill. The focus of the waste stream strategy of the new MRF must be on creating new values and adding values. The new values will be created during the separation process of the MRF. This new value is the creation of recyclable material from waste. The new values are financial value and social new values. The financial value comes from the value of the waste that will be separated and sold to the recycling companies. The social value come form that the MRF will create new jobs for the local population. When the MRF is operational the support of the waste suppliers can grown when they start with separation the waste at the source. This separation at source will increase the financial value of the waste. The support of the recycling companies must come from that they easily can buy the waste from MRF, on this way the MRF will have fact efficient process.

7.0 Recommendation

In this chapter the recommendations of the research will be described and the subjects for further research

My research about the waste stream of the new Material Recovery Facility in the Rosslyn industrial area has me brought me to the following ten recommendations for the waste department of the municipality of Tshwane.

1. Invest 5.675.000 Rand for building a dirty type of Material Recovery Facility (MRF) with a separation station in the Rosslyn industrial area on the Hendrick van Eckstreet after a research of three years,
2. Invest in a bailing machine for MRF. The bailing machine will add value to the recyclable material and will generate transport advantages.
3. The MRF needs to work with gatekeepers who inspect the waste quality of the content waste container. This will generate a higher quality of materials in the output stream of the MRF.
4. The separation station of the MRF need to separate a minimum of 8 type materials in the starting phase according to the composition of the waste.
5. The municipality must implement a new collection schedule for the waste truck, so that the MRF will have a constant supply of waste.
6. Implement the five stages of reverse logistic in the waste stream of the MRF.
7. Measure the incoming amount and outgoing of waste of the MRF with a scale.
8. The municipality need set up awareness campaign about separation at source by the business in Rosslyn. This will improve the quality of the waste stream.
9. The MRF need to make contracts with recycling companies about selling the recyclable materials and picking up the recyclable materials.
10. The waste department needs to invest in political support by the city council and the departments for sustainable waste removal and recycling.

When the waste department of the municipality of Tshwane will accept and implement these recommendations the municipality will create new jobs, a sustainable waste process and save landfill space.

<u>Further research</u>

This research had a scope; the scope was described in the objective on the research. This scope had the focus on the waste stream of an MRF and on setting up a material recovery facility. The following researchers can focus on the following subject. These were not part of this research.

- Transporting waste by rail to landfills
- Turnaround time of a material recovery facility.
- Training of workers of a material recovery facility

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Drs. Paul Postmes	First supervising lecturer
Drs. Herman van Tongerloo	Second supervising lecturer

Tshwane University of technology

Jacques Snyman	Professor Civil engineering

Municipality of Tswhane

Andre Beselaar	Director Collection, Waste department
Frans Dekker	Director Landfills, Waste Department
Jacco de Vijver	Area manager, Waste department
Adriaan Fleming	Fleet management, Waste department

WaMaSa foundation

Frits van Aggelen	Chairman Foundation WAMASA
Jur Jonges	Teacher Architecture and Living of the Utrecht University
Frits Steenhuisen	Executive manager CREM - working on sustainability
Joop van Tubergen	Waste specialist
Mr. van Tubergen	Waste specialist

Recycle companies

Kevin Matthews	Sales manager, Akura Manufacturing Engineering company
Meshack Mosiya	National procurement manager, Nampak Recycling
Desmond L. Moloisi	Location manager, Mondi Packaging South Africa
Collen Kgaladi	Regional development officer, The class recycling company
George Madula	Development officier, Consol

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Appendix

I Waste supply chain

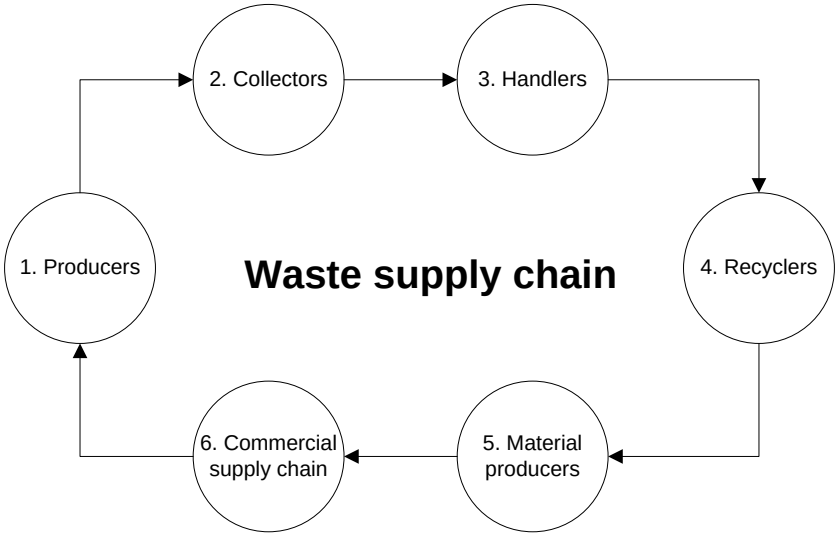


Figure 4 waste supply chain (chapter 2.3)

II Results sample research

The sample research was set up for analyzing the amount and composition of the waste stream. During the sample research waste containers of a content of 6m3 were separated by hand and per category material. After the separation the materials have been weight with a scale. The process of sample had three steps.

Step 1: Contact with waste truck drivers

The first step of the sample research was that I had contact with waste truck drivers. The contact was about which waste container form which companies the driver will pick up on a specific day. When the driver had a container of 6m3 the driver gave a call. After that the driver drove the waste container to a location where we start separating the waste container. The conclusion is that the driver selected the waste container, so it was totally random.

Picture 1: The truck driver drive on luggers (waste truck)

Picture 2: A Lugger put two waste containers of a content of 6m3 down on the location of the sample research

Step 2: separate the waste per category

The second step was to separate the content of waste per category. Every type of materials had it own bin, on this way the materials has been separated per category. The separation was done by hand. The separation by hand of a 6m3 waste container took 3-4 hours per container.

Picture 3: The content of the waste container is separated by hand

Picture 4: The content of the waste container is separate per category in waste bins

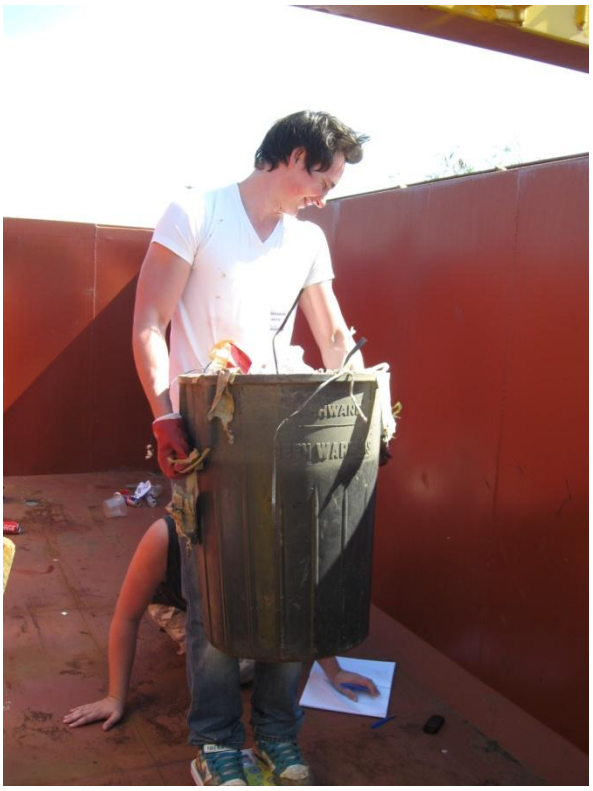
The following pictures are examples of materials that have been separated.

Picture 5: Cardboard

Picture 6: White paper

Step 3: Scale the waste

After the separation the waste bins of the specific materials has been scaled with a bathroom scale. The results of this scaling are in table 16 & 17.



Picture 7: waste is weighed on a bathroom Scales, another person is reading the amount kilograms

The first table is a summary of the result of the sample research. The results show how much kilogram of a waste container is recyclable and how much is not recyclables. The table also shows the percentages of the recyclables.

Waste Container details							
Skip number	Company	Date	Total weight KG	Recyclable	Recyclable in %	Non Recyclable	Non recyclable %
1	HI-Q	12-mei	734	132	18%	602	82%
2	Nissan	13-mei	558	474,5	85%	84	15%
3	Nissan	14-mei	536	375	70%	161	30%
6	Tubecon	16-mei	495	233	47,07%	262	52,93%
7	ALC	17-mei	552	237	42,95%	315	57,05%
8	ALC	18-mei	561	235,5	42,00%	325	58,00%
9	Feltex	19-mei	482	378,5	78,61%	103	21,39%
10	Cummins	23-mei	206	132	64,23%	74	35,77%
11	Pioneer plastics	24-mei	438	184	42,01%	254	57,99%
12	Lion Matches	25-mei	307	61,5	20,07%	254	82,87%
13	Bumbo	25-mei	594	54	9,09%	540	90,91%

Table 16: The results of the sample survey of 12 May to 25 May 2011. In total 13 waste containers of 6m3 have taken part in the sample survey

These tables are the details results of the sample survey. The results are reproduced per materials.

Company	**Wood**	% bin	% Recyclable	**Hard plastic**	% bin	% Recyclable
HI-Q	31	4,22%	5,15%	28	3,81%	21,21%
Nissan	30	5,37%	6,32%	164	29,38%	34,56%
Nissan	218	40,69%	58,13%	58	10,83%	15,47%
Tubecon	9	1,82%	3,86%	8,5	1,72%	3,65%
ALC	13	2,36%	5,49%	0	0,00%	0,00%
ALC	12	2,14%	5,10%	0	0,00%	0,00%
Feltex	6	1,25%	1,59%	157	32,61%	41,48%
Cummins	7	3,41%	5,30%	13	6,33%	9,85%
Pioneer plastics	9	2,05%	4,89%	65,5	14,95%	35,60%
Lion Matches	3	0,98%	4,88%	0	0,00%	0,00%
Bumbo	3	0,51%	5,56%	35,5	5,98%	65,74%

Company	**Soft plastic**	% bin	% Recyclable	**Cardboard**	% bin	% Recyclable
HI-Q	16	2,18%	12,12%	21	2,86%	15,91%
Nissan	9	1,61%	1,90%	20	3,58%	4,21%
Nissan	5	0,93%	1,33%	25	4,67%	6,67%
Tubecon	57,5	11,62%	24,68%	71,5	14,44%	30,69%
ALC	33	5,98%	13,92%	24	4,35%	10,13%
ALC	52,5	9,36%	22,29%	6	1,07%	2,55%
Feltex	15	3,12%	3,96%	156,5	32,50%	41,35%
Cummins	64	31,14%	48,48%	21	10,22%	15,91%
Pioneer plastics	30,5	6,96%	16,58%	1	0,23%	0,54%
Lion Matches	13,5	4,40%	21,95%	33,5	10,93%	54,47%
Bumbo	5	0,84%	9,26%	7	0,59%	6,48%

Company	**White Paper**	% bin	% Recyclable	**Mixed Paper**	% bin	% Recyclable
HI-Q	0	0,00%	0,00%	7	0,95%	5,30%
Nissan	0	0,00%	0,00%	1	0,18%	0,21%
Nissan	4	0,75%	1,07%	0	0,00%	0,00%
Tubecon	18	3,64%	7,73%	6	1,21%	2,58%
ALC	2	0,36%	0,84%	15,5	2,81%	6,54%
ALC	1	0,18%	0,42%	18	3,21%	7,64%
Feltex	40	8,31%	10,57%	2	0,42%	0,53%
Cummins	6	2,92%	4,55%	16	7,79%	12,12%
Pioneer plastics	2	0,46%	1,09%	2	0,46%	1,09%
Lion Matches	0	0,00%	0,00%	11,5	3,75%	18,70%
Bumbo	0	0,00%	0,00%	3,5	1,18%	12,96%

Company	**Glass**	% bin	% Recyclable	**PET**	% bin	% Recyclable
HI-Q	17	2,32%	12,88%	5	0,68%	3,79%
Nissan	0	0,00%	0,00%	2	0,36%	0,42%

Nissan	0	0,00%	0,00%	3	0,56%	0,80%
Tubecon	0	0,00%	0,00%	11	2,22%	4,72%
ALC	0	0,00%	0,00%	1	0,18%	0,42%
ALC	0	0,00%	0,00%	1	0,18%	0,42%
Feltex	0	0,00%	0,00%	1	0,21%	0,26%
Cummins	0	0,00%	0,00%	1	0,49%	0,76%
Pioneer plastics	0	0,00%	0,00%	2	0,46%	1,09%
Lion Matches	0	0,00%	0,00%	0	0,00%	0,00%
Bumbo	0	0,00%	0,00%	0	0,00%	0,00%

Company	**Tins**	% bin	% Recyclable	**Mixed metals**	% bin	% Recyclable
HI-Q	0	0,00%	0,00%	7	0,95%	5,30%
Nissan	0	0,00%	0,00%	6,5	1,16%	1,37%
Nissan	0	0,00%	0,00%	53	9,89%	14,13%
Tubecon	5	1,01%	2,15%	34	6,87%	14,59%
ALC	1	0,18%	0,42%	0	0,00%	0,00%
ALC	0	0,00%	0,00%	0	0,00%	0,00%
Feltex	0	0,00%	0,00%	0	0,00%	0,00%
Cummins	1	0,49%	0,76%	2	0,97%	1,52%
Pioneer plastics	1	0,23%	0,54%	10	2,28%	5,43%
Lion Matches	0	0,00%	0,00%	0	0,00%	0,00%
Bumbo	0	0,00%	0,00%	0	0,00%	0,00%

Company	**PP bag**	% bin	% Recyclable	**Rubber**	% bin	% Recyclable
HI-Q	0	0,00%	0,00%	0	0,00%	0,00%
Nissan	0	0,00%	0,00%	25	4,48%	5,27%
Nissan	0	0,00%	0,00%	9	1,68%	2,40%
Tubecon	12,5	2,53%	5,36%	0	0,00%	0,00%
ALC	0	0,00%	0,00%	0	0,00%	0,00%
ALC	0	0,00%	0,00%	0	0,00%	0,00%
Feltex	0	0,00%	0,00%	0	0,00%	0,00%
Cummins	0	0,00%	0,00%	1	0,49%	0,76%
Pioneer plastics	60	13,70%	32,61%	1	0,23%	0,54%
Lion Matches	0	0,00%	0,00%	0	0,00%	0,00%
Bumbo	0	0,00%	0,00%	0	0,00%	0,00%

Company	**Textile**	% bin	% Recyclable	**EPS**	% bin	% Recyclable
HI-Q	0	0,00%	0,00%	0	0,00%	0,00%
Nissan	0	0,00%	0,00%	0	0,00%	0,00%
Nissan	0	0,00%	0,00%	0	0,00%	0,00%
Tubecon	0	0,00%	0,00%	0	0,00%	0,00%
ALC	128,5	23,29%	54,22%	19	3,44%	8,02%
ALC	128	22,83%	54,35%	17	3,03%	7,22%
Feltex	0	0,00%	0,00%	0	0,00%	0,00%

Cummins	0	0,00%	0,00%	0	0,00%	0,00%
Pioneer plastics	0	0,00%	0,00%	0	0,00%	0,00%
Lion Matches	0	0,00%	0,00%	0	0,00%	0,00%
Bumbo	0	0,00%	0,00%	0	0,00%	0,00%

Table 17: the results of the sample survey of 12 May to 25 May 2011. The results are per type of materials of the waste containers

Companies Rosslyn industrial Area		**Date: 1 & 2 March 2011**	
Number	**Company**	**Address**	**Size company**
1	SNS Engineering and Construction	Hendrix van Extract	Medium
2	Caway metal Fabrication	Hendrik van Eckstraat	Small
3	Petretake	Hendrik van Eckstraat	Large
4	CPM	Hendrik van Eckstraat	Small
5	GAS	Hendrik van Eckstraat	Small
6	NISSAN	Hendrik van Eckstraat	International
7	Nampak	Hendrik van Eckstraat	International
8	Feltex	Martinusras	Large
9	BMW	Martinusras	International
10	MA stamprug Plant	Martinusras	Large
11	Tensile Rubber antrusion div	Martinusras	Medium
12	SC Johnson	Martinusras	Large
13	Office complex	Martinusras	Small
14	IVECO AFS commercial	Van Niekerkstraat	Small
15	Rosslyn Ice	Van Niekerkstraat	Small
16	HI-Q	Van Niekerkstraat	Small
17	Nick Bester promotions	Van Niekerkstraat	Small
18	Mariano precision Patternmakers	Van Niekerkstraat	Small
19	Copies for Africa	Van Niekerkstraat	Small
20	Multiloads	Van Niekerkstraat	Medium
21	ABN Akasia Bolt & Nut	Van Niekerkstraat	Small
22	Preweld	Van Niekerkstraat	Small
23	Own mark	Van Niekerkstraat	Small
24	TDS Labour broking	Van Niekerkstraat	Small
25	North West Carglass	Van Niekerkstraat	Small
26	Speddick industrial Tyres	Van Niekerkstraat	Small
27	Galaxcy Pipelines	Van Niekerkstraat	Small
28	Van celle supliers CC	Van Niekerkstraat	
29	Jetvest 1160 cc projects	Van Niekerkstraat	Small
30	WMB engineering Service	Fairwood	Small
31	Furnique	Fairwood	Small
32	Elben kombuise	Fairwood	Small
33	Deutech Cabinets	Fairwood	Small
34	KMP System engineering	Fairwood	Small
35	AWT Welding and Tools	Fairwood	Small
36	O'Graby's paints	Fairwood	Small

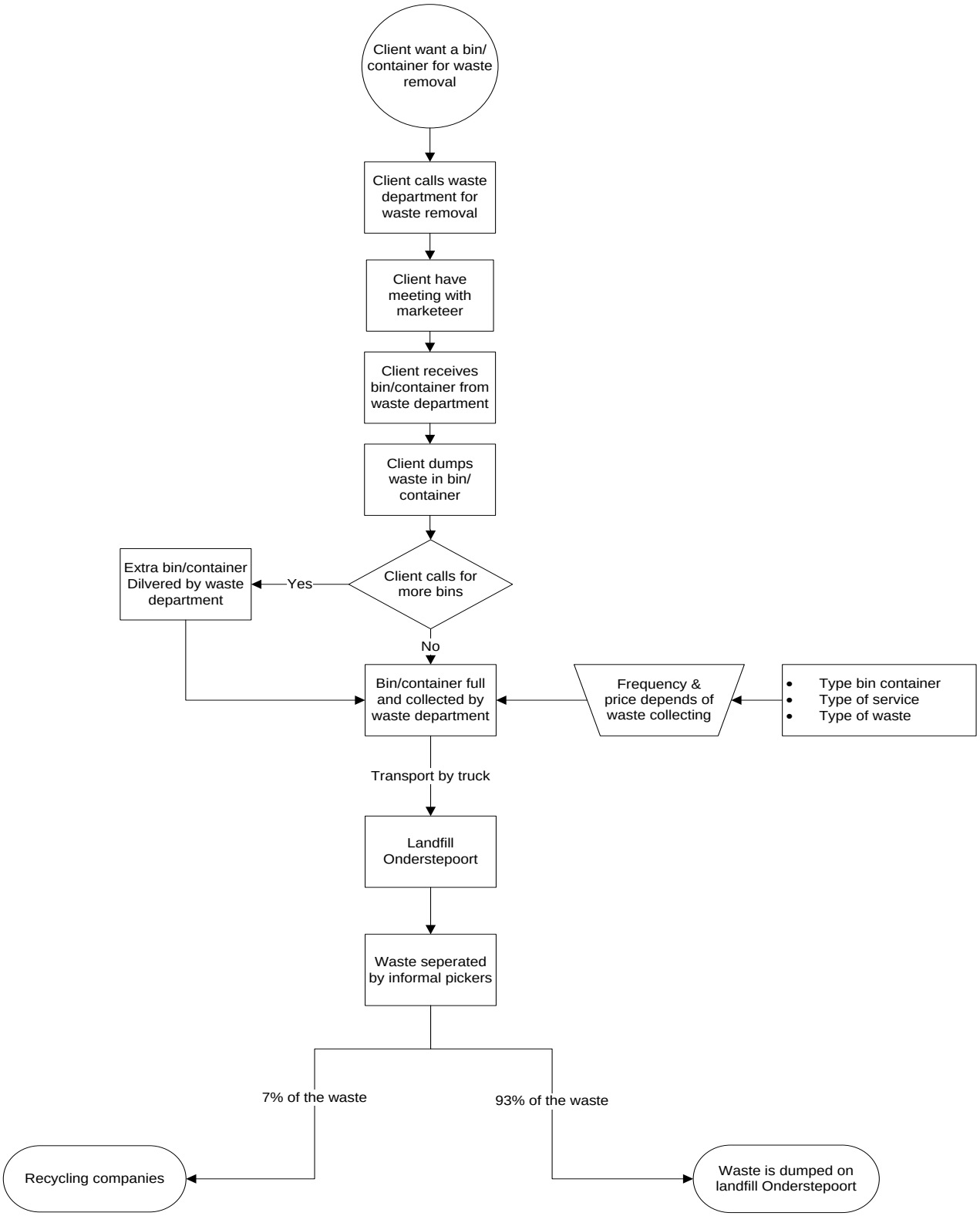
37	SGE Boiler and maintenance	Frans du toit straat	Medium
38	WBHO roads and earth knorts	Fairwood	Small
39	Gentec Canopies	Orchard	Medium
40	Andre Shopfitters	Orange avenue	Small
41	Solway Precion Engineering	Orange avenue	Small
42	E & N Laser Plasma & profile cut	Fairwood	Small
43	Pallet Makers	Fairwood	Medium
44	Stong	Hendrick van Eckstraat	Small
45	Maisto auto body	Hendrick van Eckstraat	Small
46	De Molen	Hendrick van Eckstraat	Small
47	SDD Engineering	Hendrick van Eckstraat	Small
48	JR kopano engineering	Hendrick van Eckstraat	Small
49	Rosslyn Endowres	Hendrick van Eckstraat	Small
50	Saligna Meubels	Hendrick van Eckstraat	Small
51	TI Group Automotive Systems	Hendrick van Eckstraat	Medium
52	TE	Hendrick van Eckstraat	Small
53	JDA Metals(recycling)	Hendrick van Eckstraat	
54	Muto Matic	Hendrick van Eckstraat	Small
55	Freight Link	Hendrick van Eckstraat	Medium
56	Polytec interior	Hardy Muller	Large
57	Blue Pointer	Hendrick van Eckstraat	Large
58	ATC	Hendrick van Eckstraat	Medium
59	Thebe Packaging	Hendrick van Eckstraat	Medium
60	Hide & Skin Pro	Hendrick van Eckstraat	Small
61	BM Networks	Hendrick van Eckstraat	Medium
62	S.A. Truckmetals	Hendrick van Eckstraat	Small
63	Mix Instruments	Hendrick van Eckstraat	Small
64	Apache manufacturing	Hendrick van Eckstraat	Small
65	Wubbeleing Engineering	Hendrick van Eckstraat	Small
66	Precision Rubber Mouldres	Hendrick van Eckstraat	Medium
67	Cloud nine	Lore Delfish	Small
68	Rest assward	Lore Delfish	Medium
69	Strand Foam	Lore Delfish	Medium
70	Latex Park	Frans du toit straat	Large
71	Warior	Frans du toit straat	Medium
72	IPM	Frans du toit straat	Medium
73	Volenbo	Frans du toit straat	Medium
74	Ebersoacher	Frans du toit straat	Large
75	Ouwurf	Van Eeden	Small
76	Westher Westarc	Van Eeden	Small
77	CBI Electric	Van Eeden	Medium
78	SKF Distributor	Van Eeden	Small
79	Jakopoints	Van Eeden	Small
80	Vacuform	Van Eeden	Small

81	Rhino Kinings	Potgieter	Medium
82	Pioneer plastics	Potgieter	Medium
83	Sequre	Potgieter	Medium
84	Vehicle Control Systems	Potgieter	Small
85	Hospi sterilizers CC	Potgieter	Small
86	Topline Steel systems	Lever	Medium
87	Babelegi Workwear	Lever	Medium
88	Tshukundu steel houses	Lever	Small
89	AF Hydraulics	Lever	Small
90	union Tech	Van Eeden	Medium
91	Duromax	Van Eeden	Medium
92	Emerald Steel Electrical construction	Van Eeden	Small
93	Nyati paints	Greyling	Small
94	Geared Up	Greyling	Small
95	Strasa Services	Greyling	Small
96	CMT	Greyling	Small
97	Industrial Bat	Greyling	Medium
98	Lomel Construction	Greyling	Medium
99	Dint Doctor	Greyling	Small
100	Hydraulics	Henrico	Small
101	Afrit	Henrico	Small
102	Granite	Henrico	Small
103	Engineering services CC	Henrico	Small
104	Grounil kontrakteurs	Henrico	Small
105	FTB Engineering	Henrico	Small
106	MC Barn	Henrico	Small
107	Martiq 1008 CC	Greyling	Small
108	J&H Auto spray	Greyling	Small
109	Cectah Exhause	Greyling	Small
110	Swringers Marine services	Greyling	Small
111	Bumbo	Hardy Muller	Large
112	N.N. metals		Large
113	RTS Cupboard & Granite	Stefan viljoen	Small
114	Bise Engineering	William Hoydt	Medium
115	Power Petrolium Distributor	Hardy Muller	Medium
116	Lastafilm	Piet Prutorius	Small
117	The Irovy co	Piet Prutorius	Small
118	Masak Home	Piet Prutorius	Large
119	Apple plastic	Piet Prutorius	Medium
120	Akasia	Piet Prutorius	Small
121	Fornits	Piet Prutorius	Small
122	Alu Wood projects	Piet Prutorius	Medium
123	Bandag	Piet Prutorius	Medium
124	ISO bodius	Piet Prutorius	Small

125	Venture	Piet Prutorius	Large
126	Tubecon	Piet Raubach	Large
127	Afrisom	Piet Raubach	Large
128	Pioneer	Sloan	Large
129	Stalpac	Gaigher	Medium
130	Euor-plastifoam	Aluminium	Large
131	Chep	Aluminium	Medium
132	Value logistics	Gaigher	Large
133	Lion	Gaigher	Large
134	Trident steel	Kitshof	Large
135	Furniture wholesalers	Ma Du Pessis	Large
136	Grippen CC	Kotzenberg	Medium
137	Wasteman	Johan Uys	Medium
138	MetPro	Kotzenberg	Medium
139	Marcom Plastics	Pepler	Medium

Table 18: the population of the sample survey (the 139 companies of the Rosslyn industrial area)

III Flowchart current waste stream



Flow chart 3: current waste stream (chapter 3.1.4)

IV Geographic location of clients and landfill current situation

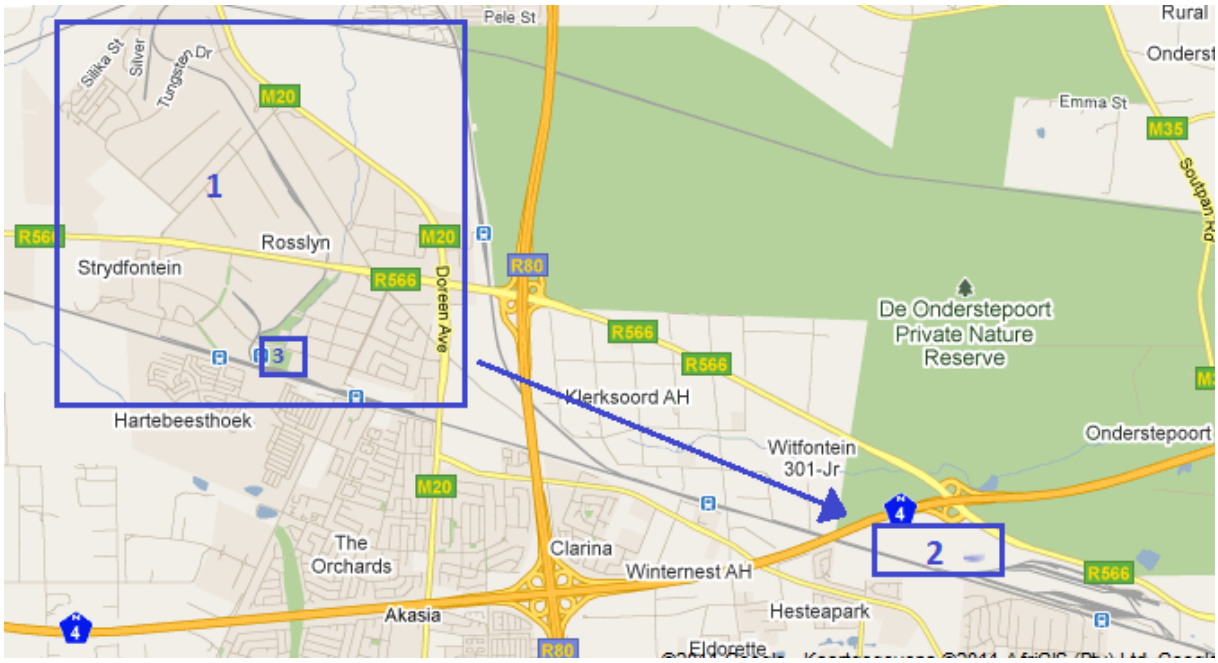


Figure 5: Geographic map of the project area (chapter 3.1.4)

Current situation

Sector 1 is the Rosslyn industrial area. This is the area where all the population is located. Sector 2 is the Landfill Ondersteport. This is the landfill where the waste from the Rosslyn area is dumped. The waste is transported by truck from sector 1 to sector 2.

Suitable situation

The suitable situation is that the waste is transported from sector 1 to sector 3. Sector 3 is the location where the MRF will be built. After the separation process the waste will transported from sector 3 to sector 2.

V Five forces model

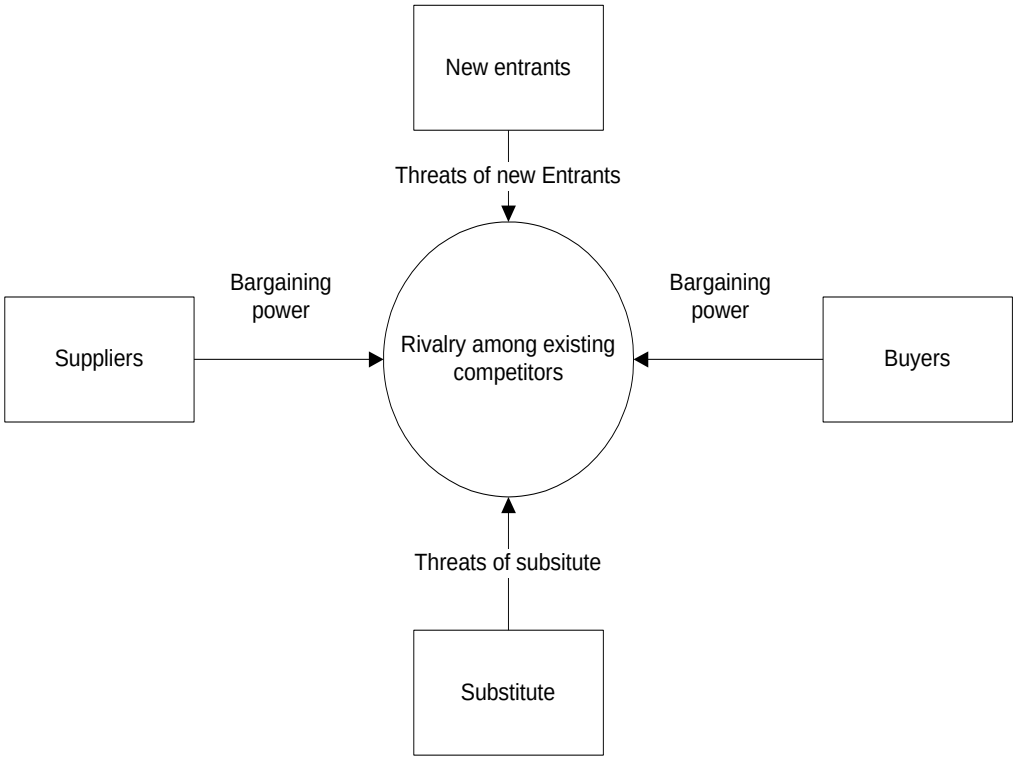


Figure 6: Five forces model Michael Porter (chapter 3.2.2)

VI Kraljic purchase portfolio

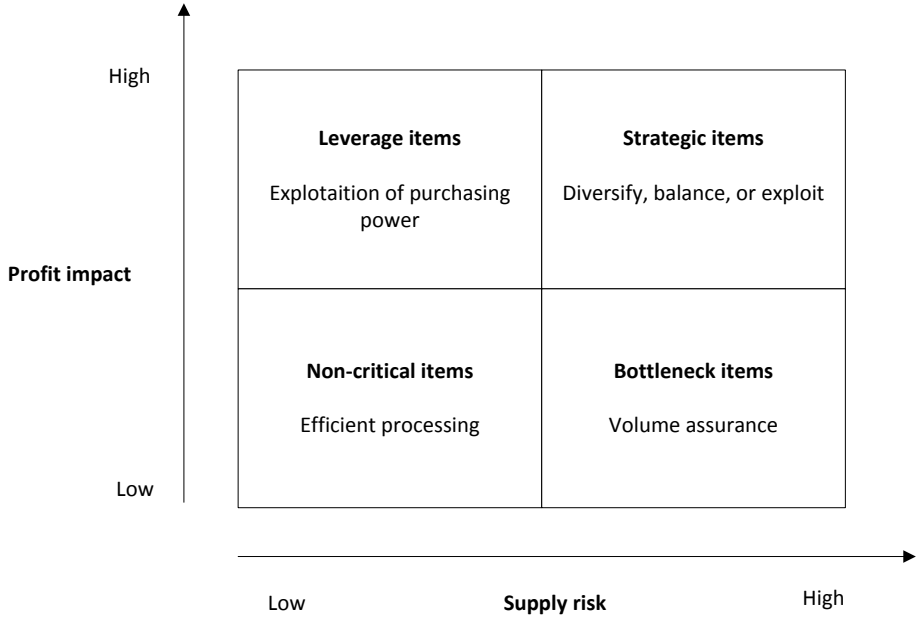


Figure 7: Kraljic purchase portfolio (chapter 3.2.2)

VII Value chain

The value chain of Michael Porter[49] is splits in support activities and in primary activities

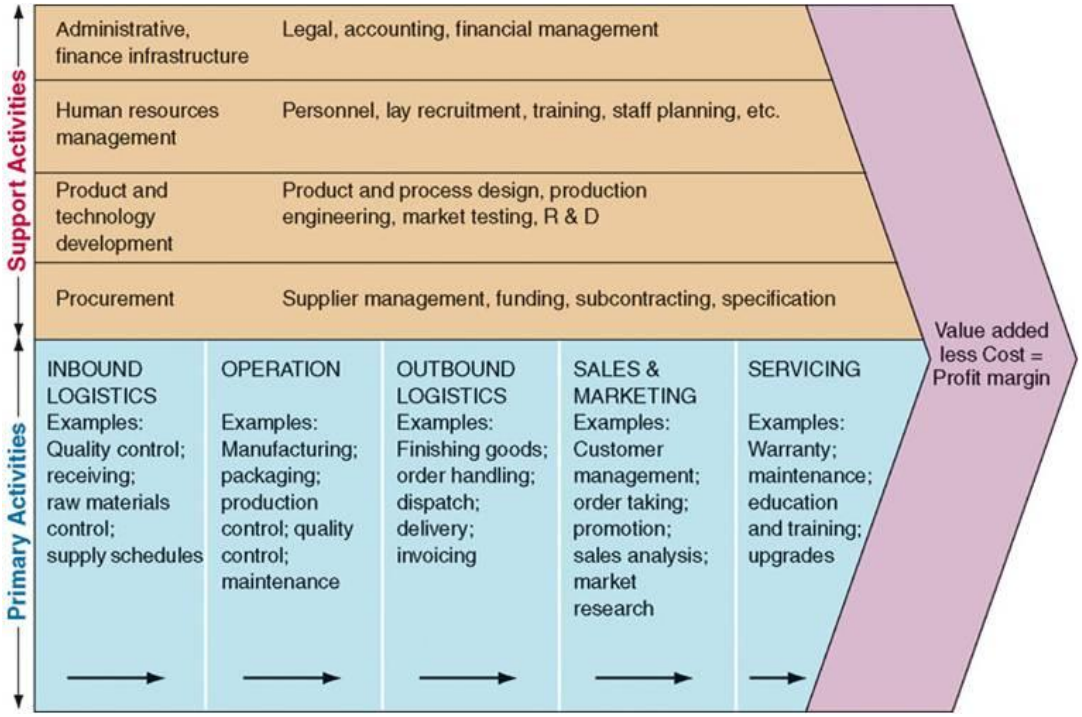


Figure 8: Value chain of Michael Porter (chapter 4.1)

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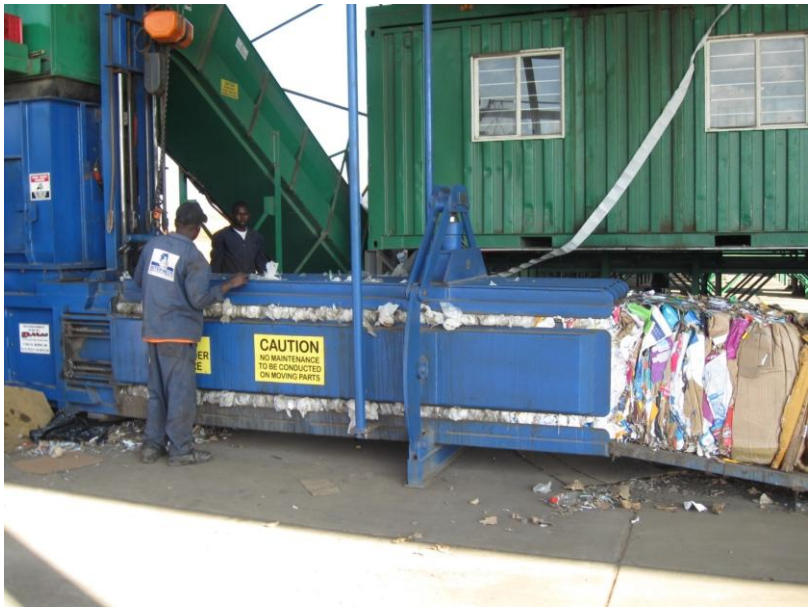
VIII Baling machine



Picture 8: Baler machine with bails (chapter 4.1)

[49] http://www.data2dollars.com/Value_Chain

IX Distribution Network

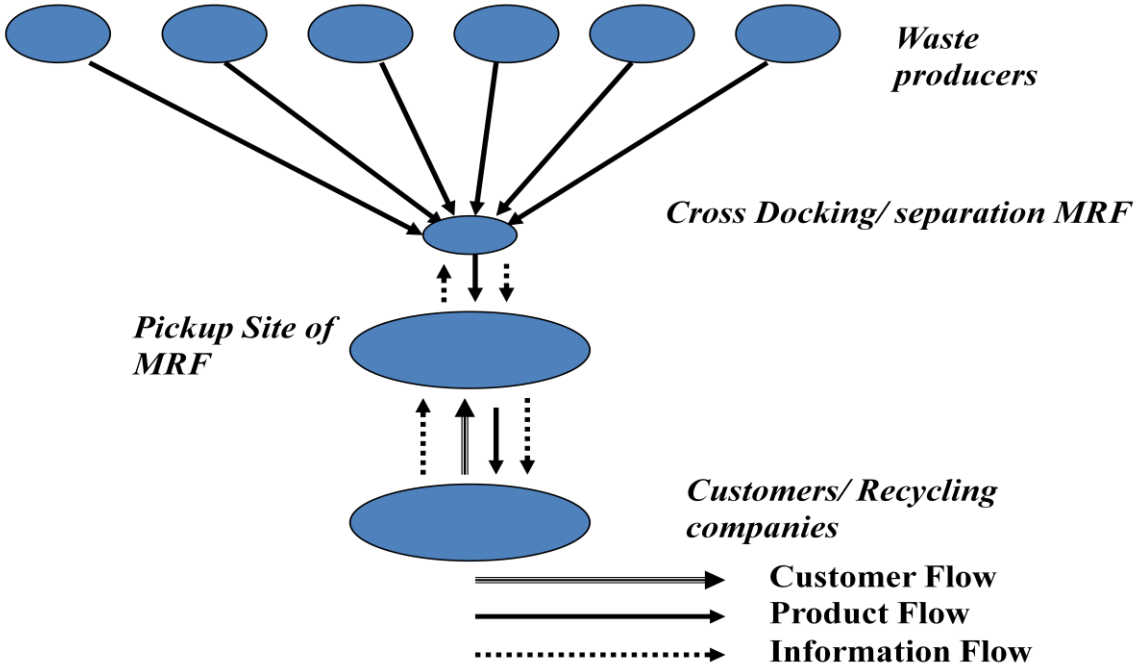


Figure 9: Distribution network (manufacturer storage with customer pick up) of output process (chapter 4.1)

X Pictures of MRF Weltevreden

Picture 9: Incoming waste of MRF

Picture 10: Separation station MRF

Picture 9: Empty waste bin after separation. The waste goes on the conveyor belt. the conveyor belt goes to the bailing machine

Picture 12: bails from the bailing machine

XI Color thinking of change

There are five colors of change according Professor L.I.A. de Caluwé. The colors are blue, yellow, red, green and white. Every color of change has its own objectives, way thinking and activities to achieve the change.

	Objectives for change	Thinking	Things/people will change if you
Blue thinking	Result is fixed on for hand Clear description of the result	Rational	Formulate a clear result/objective in advance Make a good phased plan from A to B Properly monitor the phases and steer accordingly Keep everything as stable and controlled as possible Reduce the complexity as much as possible
Red thinking	People are the objective The people need to be influence, seduced and provoked	Reward	Stimulate people in the right way, for example by punishment or use advanced HRM instruments for reward, motivation and promotion status Give people something back for what they give you
Green thinking	Motivation of the people Learning of the people Growing potential	Own motivation	Can make them to see/learn/know new things Can create joint learning situations
White thinking	Everything is possible Innovation Enterprising	Chaos	Assume that the will and wishes and the 'natural way' of the allow people Own dynamic energy to emerge will see the dynamics/complexity Take away any barriers Use symbols and rituals
Yellow thinking	Symbolize of power of people high influences	Politics	Can bring interests together Can force them to take standpoints/opinions Can create win-win situations/form coalitions Can show the advantages of certain ideas Can point them in the right direction

Table 19: colour thinking of change

My point of view is that the waste activities of the municipality must change on a blue thinking. The objective of blue thinking is that the result is fixed on for hand and that here is a clear description of the result. By a blue thinking of think on a rational so you think step by step. In this case it is clear that the municipality must build a MRF to safe landfill space, so the result of the change is fixed. To achieve this long term objective the municipality needs to think and managed the change step-by-step. The five actions that the waste department must undertake to realize a changing situation is.

1. Formulate clear how the municipality want to built a MRF and the objectives of the process
2. A planning with phases for project of building a MRF
3. Develop a clear project organization that can monitor the progress of the project
4. The project organization needs the able to control the progress of the phases of project
5. The project organization must reduce the complexity of the project, so they are able to achieve the goals

XII Financial

Fuel costs

Fuel usage	**Luggers**
Km p/m	117.973
Litre p/m	52.357,62
Km p/l	2,25
Diesel costs in R per litre	6,55
Costs p/km in R	2,91
Costs p/km in €	0,29

Table 20: Fuel cost (chapter 3.1.4 & chapter 5.3.2)

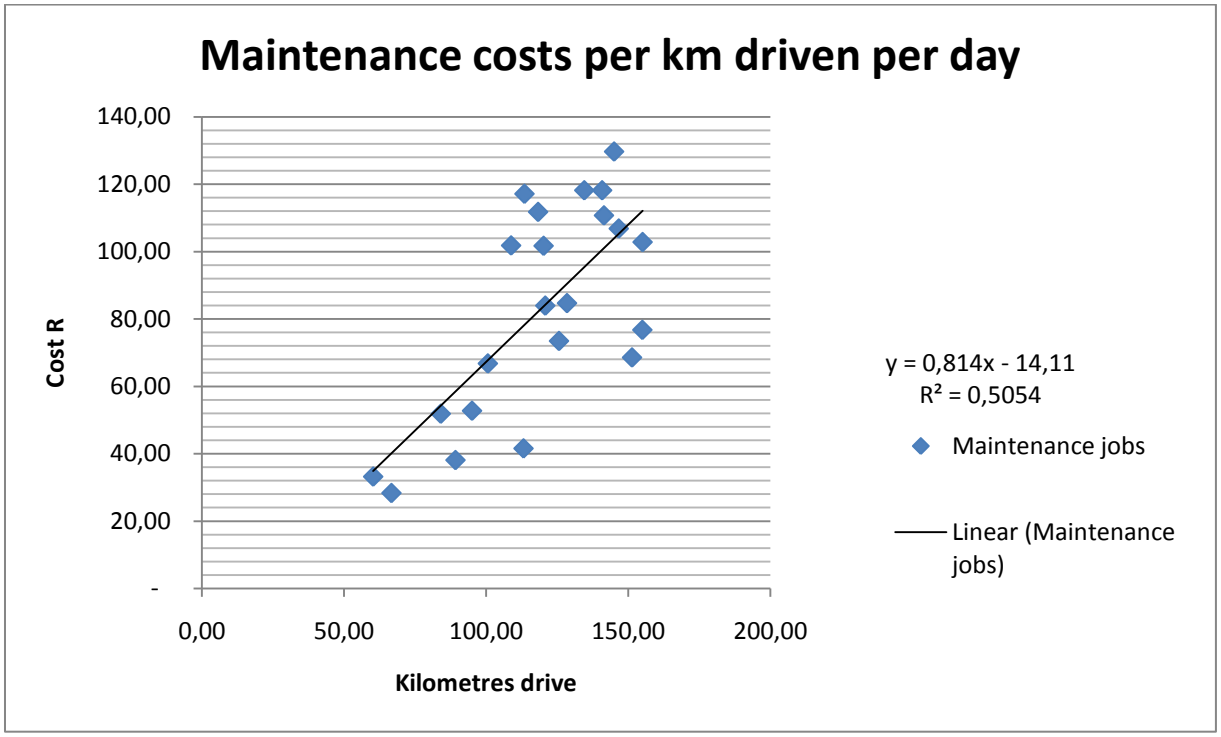
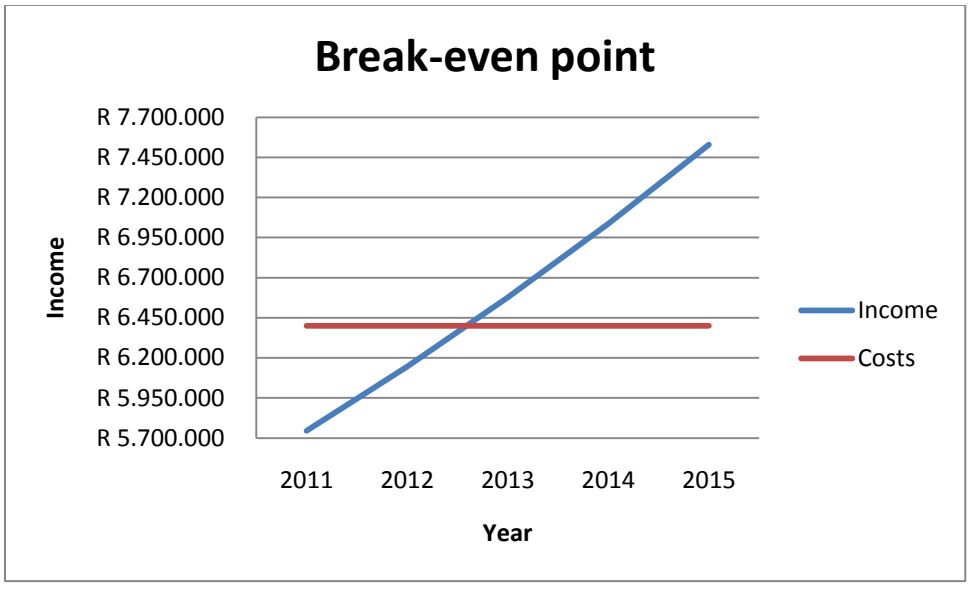


Table 21: Maintenance costs (chapter 3.1.4 & chapter 5.3.2)

Running costs				
Fixed costs	*Staff*	*Amount*	*Costs yearly*	
	Manager	1	R	133.923
	Operator	3	R	460.860
	Workers	20	R	905.904
	truck drivers	1	R	45.295
	Lugger drivers	14	R	3.249.333
	Clothes		R	20.000
	Depreciation		R	200.000
	Insurance		R	6.000
	Security		R	20.000
Variable costs	**Building**			
	Maintenance		R	30.000
	Electricity		R	19.200
	Transport costs			
	Maintenance		R	723.418
	Fuel costs		R	565.424
	Machines			
	Maintenance		R	20.000
	Total Costs		R	6.399.359

Table 22: Running costs of MRF facility in Rosslyn, Pretoria (chapter 5.3.2)



Line chart: 2 breakeven analyse (chapter 5.3.3)

XIII Scenario's for strategies Raymond Miles and Charles Snow

Every strategy needs to have a starting point. A lot of professors worldwide have different visions about this starting point. Raymond Miles and Charles Snow argue in their book Organisation Strategy, Structure and Process´(1978)[50] argued that different companies strategies arise from the way companies address the three fundamental problems. The problems are Entrepreneurial, Engineering and Administrative problems. Raymond Miles and Charles Snow describe four forms of strategies for solving these problems. Every form is a type of role/ strategy an organisation can choose. The roles are defenders, prospectors, analyzers and reactors. The characteristics of these organisations and strategic sets are.

Strategies	Organisations	Strategic set
Defender	Narrow product-market domains	Aggressively prominence in chosen segment
	Managers are experts	Ignore developments outside of this domain
	Not look for opportunities	not search for new opportunities
Prospector	Continually search for market opportunities	Ignore developments outside of this domain
	Responses to emerging environmental trends.	Penetrate deeper into current markets
Analyser	Operate in stable and changing markets	Successful imitation through marketing surveillance
	Operate with formalized structures	A mixture of products and markets
	Operate with low risks	Structure is matrix, functional and product
Reactor	Not a systematic strategy	Management fails to find a viable strategy
	Little control over the external environment	

Picture 10: Miles and Snow strategies

The best situation for the MRF in Rosslyn is to be analyzer. The reason for this is that waste management is very stable, because the waste treatment is for years the same. When a MRF will be built the market will start changing because the supply will increase. So the MRF will operate in a stable and changing market. The analyzer strategies also match very well with the municipality, because the municipality has a formalized structure. With the role of analyzer, and the processes the MRF must have the strategic set of successfully imitation of the MRF concept. Beside that the MRF must find a mixture between the value of his materials and the market situations. The organization will have a structure that is functional and per product. This will happen in that supervisor managed the three CSF (chapter 4.2) and product site is that pickers are responsible per material. These three points are the strategic starting point of the MRF in Rosslyn.

[50] http://www.12manage.com/methods_miles_snow_four_strategic_types.html

XIV Minutes Akura manufacturing Engineering Company (Pty) Ltd

Date:	16 March 2011
Place:	Boksburg, South Africa
Time:	14:00-15:00
Attendance:	Kevin Matthews (sales manager Akura), Remco Silvius (student Business engineering HU), Ward Dilven(student Business engineering HU), Derk Jan Krijnen (student Logistics & Economics HU)
Subject:	Material Recovery Facility (MRF)
Company:	Akura manufacturing Engineering Company (Pty) Ltd
Website:	www.akura.co.za

Goal of interview
The main goal of this interview is to get a clear view of the requirements for a MRF. This includes the total costs of building and maintaining the facility.

The company
Akura is a manufacturer of baling equipment and a major manufacturer/supplier of waste handling equipment. The company is able to handle project of all sizes and are always custom made. Akura is focused on projects that reduce the volume of waste materials and/or to extract the recyclables.

Summary of meeting

Waste collecting process
The collection of waste influences the whole waste process and the value of the waste. The majority of the municipalities are still collecting waste by a mixed waste stream. This means that the recyclable and non-recyclable materials are in the same stream. This mixed stream is difficult to process and expensive.

According to Kevin Matthews, one of the most valuable waste streams is a stream where the recyclable and non-recyclable materials are separated before transport. This type of collecting needs dedicated trucks that are responsible for the recyclable and the non recyclable waste. By using this method the value of the waste will increase significantly.

Requirements for MRF
Kevin Matthews was not able to give information about the requirements for building a MRF. This was because the composition of the waste has not been researched yet at this stage. When the composition is clear Kevin Matthews can give a quotation of costs of a MRF. The composition of the waste is essential in determining the set-up of a MRF. Kevin Matthews emphasized to us the importance of knowing the composition of the waste.

Important factors for building MRF
The following factors need to be considered when building a MRF:

- Volume of the incoming waste
- The composition of the incoming waste
- The value of the incoming waste
- Demand of the recycling companies

XV Minutes Nampak

Date: 18 March 2011
Place: Sandton, South Africa
Time: 10:00-10:45
Attendance: Meshack Mosiya (national procurement manager), Remco Silvius (student Business engineering HU), Ward Dilven (student Business engineering HU), Derk Jan Krijnen (student Logistics & Economics HU)
Subject: Economic value of waste
Company: Nampak
Website: www.nampak.com

Goal of interview
The main goal of this interview is to get a clear view about the economic value of waste.

The company
Nampak is a packaging company that uses recyclable material for their production. Besides packaging Nampak also produce tissues. Nampak works with paper, plastics, glass and metals. These materials are coming from banks, printers, retailers, small business and agents from Nampak.

Summary of meeting

Nampak process
Nampak owns six factories in South Africa. The incoming waste of these factories is sourced by Nampak itself or by agents from Nampak. Beside the factories Nampak also owns three tissue mills, one cardboard mill and one glass mill. Companies are selling directly to these mills or through agents.

Value of waste
There are factors that influence the economic value of the waste. Factors are the demand and supply of the waste and the competitions in different areas. Other factor that influences the value is the manner of how the waste is supplied to Nampak and the waste being baled or not.

Prices of waste

All these materials are bailed or crushed for transport.

Cardboard	**Per Ton**
Collected by Nampak	R400
Delivered by client	R650
Straight to mill	R1000

Glass	**Per Ton**
Collected by Nampak	R250
Delivered by Client	R500

White paper	**Per Ton**
Collected by Nampak	R800
Delivered by client	R1500
Straight to mill	R2500

Tins	**Per Ton**
Standard price	R400

XVI Glossary

The following terms will be used in thesis.

- *€:* Euro, Currency of specific countries in the European union
- *City Council of Tshwane*: Governmental division in the area of Tshwane which governed on local level.
- *City of Tshwane:* Governmental division in the area of Tshwane which governed on local level.
- *Domestic waste*: Waste which is produced by household, mostly existing out of paper, plastics, glass and organic disposed. Synonym to residential waste
- *Industrial waste:* Waste which is produced by businesses and can consist out of every type of material or substance
- *Informal pickers*: Person who works on landfill and separate the waste for a personal profit
- *Landfill:* Legal dumping site controlled by the government.
- *Lugger:* Type of waste truck
- *MRF:* Material Recovery Facility
- *Municipality of Tshwane:* Governmental division in the area of Tshwane which governed on local level.
- *R:* South- African currency
- *Rand:* South- African currency
- *Recycle companies*: Companies who can make new materials of waste
- *Recycling:* re-using waste
- *Rosslyn:* The area of the municipality of Tshwane
- *Tshwane:* South- African name for Pretoria
- *Waste:* A material that is not any more useful, according to waste producers