Waste management and production systems; The case of Zanzibar

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A Minor Field Study in Zanzibar, Tanzania

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Sammanfattning


Ögruppen Zanzibar genererar över 92,000 ton avfall varje år vilket är jämförbart med vikten av en Boeing 747 per dag. Avfallet kontaminerar miljön och påverkar såväl folkhälsan som Zanzibars ekonomi negativt. Mängden producerat avfall på en ö är begränsat liksom möjligheten för avfallet att transporteras fritt över landgränser. Traditionella avfallshanteringsföretag saknar ekonomiska incitament för att etablera sig på små marknader likt denna och därmed saknar många öar i utvecklingsländer ett hållbart system för avfallshantering.

Zanrec har identifierat detta som en affärsmöjlighet och har utvecklat en affärsmodell för att arbeta med avfallshantering i geografiskt begränsade landområden. Det främsta målet med denna studie var att undersöka hur Zanrec kan möta kundkrav genom en hållbar supply chain samt undersöka hur Zanrec kan öka värden i specifika avfallsfraktioner för att kunna skala upp verksamheten. För att uppnå ett tillfredsställande resultat grundades studien i att: (i) ge en inblick i avfallshantering i utvecklingsländer, (ii) kartlägga Zanrecs nuvarande supply chain, (iii) definiera vad som är värdeskapande aktiviteter enligt såväl hotell- som slutkunder, (iv) identifiera Zanrecs möjligheter och begränsningar baserat på nuvarande förutsättningar.

Slutresultaten av denna studie kommer att ligga till grund för effektivisering av Zanrecs berörda affärsområden och kan användas som riktlinjer i framtagandet av policys gällandes avfallshanteringssystem i andra utvecklingsländer.

Nyckelord: avfallshantering, utvecklingsländer, Zanzibar, supply chain, affärsmodell
Abstract
This study was performed as a bachelor thesis at the Royal Institute of Technology in Stockholm, Sweden, in the spring of 2014, and was carried out as a Minor Field Study funded by SIDA. It was conducted as a literature study complemented by a field study on Zanzibar, in collaboration with Zanrec.

Zanzibar as an archipelago, with its 495,000 inhabitants, generates over 92,000 metric tons of waste a year, which is equivalent of the weight of a Boeing 747 per day, contaminating the environment and causing implications to both public health and the island’s economy due to it’s effects on the important tourism industry. The amount of produced waste on an island is limited as well as the possibility for waste to be spread over island boundaries. Traditional waste management companies lack economical incentives to establish on such a small market, therefore many islands in developing countries lack a sustainable system for waste management.

Zanrec has identified this as a business opportunity and has developed a business model to deal with waste management on limited geographical areas. The main objective of this study was to investigate how Zanrec can meet customer demands by developing a sustainable supply chain, and to investigate how Zanrec can increase value of specific goods in order to scale the business. In order to achieve a satisfying result, the study was aimed to: (i) give insights into waste management in developing countries, (ii) map Zanrec’s supply chain of today, (iii) define what the value-adding activities are in the eyes of the customers, both hotels and plastic buyers, (iv) identify limitations/possibilities based on Zanrec’s prerequisites.

The results of this thesis will work as a foundation to make Zanrec’s business areas of concern more efficient and will work as a benchmark in policy making when working with waste management systems in other developing areas.

Keywords: Waste management, developing countries, Zanzibar, supply chain, business model
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1. Introduction

1.1 The Problem
One of the biggest issues of today is the climate change. Since the era of industrialization we have polluted our planet and littered our environment. During a long time the consequences from our way of living have been disputed, but with time it has become obvious that the human race really has affected the climate in a long-term perspective.

A country’s waste management system has a substantial effect on the environment but is not a primary concern for governments in developing countries. In developing countries, municipal solid waste is commonly disposed of by transporting and discharging in open dumps; the refuse is simply dumped in low lying areas on open land [1], [2]. One of the most significant problems associated with municipal dumps is the water contamination in the region of the landfill by leachate generated within the landfill [2].

Tanzania is one of the poorest economies in Africa in terms of per capita income, and also one of the countries most dependent on international aid. Almost nine out of ten development projects and close to half of government expenses are funded through aid money [3]. While Tanzania has accepted aid assistance for a long time, Zanzibar did not open up for aid workers until the 1970’s. Partly due to this, Zanzibar has remained relatively poor and the education sector lags behind that of mainland Tanzania [4].

One of Zanzibar’s biggest issues is that it struggles with a bad municipal solid waste management system. Zanzibar is today highly littered and polluted by waste and lacks a national plan regarding waste management. There is currently no formal landfill on Zanzibar and waste is dumped on uncontrolled dumpsites or in farm areas [5]. The efforts made so far have only been focused on city of Stone Town and the resources outside this area, where most of the population resides, have been limited [6]. The problem is also causing negative effects on the island’s economic development; during the last five years a negative trend has been seen in the most important industry on the island – the tourist sector. Four out of five visitors believe that the region is too polluted to visit again, causing tourism stakeholders to take action for a sustainable solution [5].

Currently, there is an increasing number of non-governmental organizations and community based organizations that have keen interest in environmental matters in Zanzibar [6]. Even the private sector’s involvement and contribution to improved environmental management is acknowledged and of importance. Zanrec is a green initiative and waste management company based in Stone Town, Tanzania. Zanrec’s main customers are hotels around the island from which Zanrec collects waste on a weekly basis. The contracted hotels pay for the waste collection service that Zanrec is providing. Zanrec currently sell the collected recyclables to a local buyer on the island. The company’s focus is to establish and manage an island extended infrastructure for waste management that should work as a full-time income for local residents at the bottom of the socioeconomic pyramid.

1.2 Research question and objectives
How do companies design waste management in a developing country to achieve environmental sustainability?
- What can be done to improve Zanrec’s supply chain of today?
- Which value adding activities are possible to perform for Zanrec meet plastic customer demands?
In order to create an environmental and sustainable waste management system on Zanzibar, Zanrec must ensure that its business strategy is economic sustainable. Focus in this project was to investigate how Zanrec can meet customer demands by developing a sustainable supply chain, and to investigate how Zanrec can increase value of specific goods in order to scale the business.

In order to achieve a satisfying result, the study was aimed to: (i) give insights into waste management in developing countries, (ii) map Zanrec’s supply chain of today, (iii) define what the value-adding activities are in the eyes of the customers, both hotels and plastic buyers, (iv) identify possible limitations/possibilities based on Zanrec’s prerequisites.

1.4 Limitations
To be able to extract deeper knowledge of how companies in developing countries design the waste management system we have chosen to conduct a field study with a case study approach, more can be read in section three. Our choice of case has created natural limitations as follows:
- We are only looking at how one company has decided to design its waste management system.
- This bachelor thesis focuses on waste management on Unguja, the biggest island of Zanzibar, and does not take waste management on the other islands into consideration.
- To be able to get a deeper insight of the supply chain we have chosen to limit the work to only look at PET. Also because of the fact that PET is the largest fraction of recyclables on Zanzibar.
- When looking at possible process methods for PET we have limited the research to methods that would be achievable for Zanrec in question of investment cost and technical complexity.
- The strategic suggestions were made with the coming years in mind, not with a ten or twenty year perspective.

1.5 Methodology
Since the focus of this thesis was to investigate how companies design waste management in developing countries to achieve environmental sustainability, we chose to conduct a field study. The case study approach was the main method in our field study. We approached the case by a literature review and by participating in the work of Zanrec to be able to map out the activities performed within the company. Data gathered consisted of a combination of observations, interviews and archival records. Together the literature review and a two-month field study provided the foundation for reaching the aims of this study.

1.6 Disposition
Apart from the introduction, this thesis consists of eight sections. In the subsequent section, the theoretical background is presented with a description of the problem in a global perspective, waste management in developing countries, the recycling process of PET, and Six Sigma. In section three the research methodology is presented. Section four presents a deeper introduction to the case consisting of information about the country, the company and the waste management system on Zanzibar today. Section five presents the results of the case, analysis of the findings, and which possibilities of improvement we have identified. Section six presents our conclusions with a summary of the findings, conclusions and implications of the case. References are presented under section seven and appendix can be found in the end.
2. Literature review

2.1 A global perspective
Since the early 19th century there has been a rapid increase in the global warming. Each of the last three decades has been warmer than all past decades [7]. Everything indicates that the global warming will continue, and that human spill of greenhouse gas emissions and its effects on the climate, with following consequences, will affect us all. Reduced ice cover, increased water levels and disturbances in rain patterns will distress all of us direct or indirect, and some of the most vulnerable areas of today will be the one affected the most. Even if it lacks unambiguous associations there is a unity about the fact that climate changes direct or indirect affects peoples’ life and that opposition and conflict risks increase [8], [9]. Many of the most troubled areas will be by the heavy populated coastal zones, and a lot of islands are at risk to be badly affected by the global warming [10].

One big environmental threat in the Indian Ocean is plastic. The material is popular due to its good properties of durability and lightness, but it is also those properties that makes it dangerous when spread over the boundaries of human societies, into the world’s ecosystems. Plastic is generally not biodegradable and if it decomposes, it takes several decades. Almost all types of plastic contain additives to give the plastic its specific qualities and some of these additives are hazardous for humans and the environment. If plastic is burned, harmful emissions are released. Plastic is a small fraction of municipal solid waste due to its low weight but is a large component by volume.

2.2 Municipal solid waste management in developing countries
The primary target of municipal solid waste management is to protect the health of the population, promote environmental quality, develop sustainability, and provide support to economic productivity [11]. Municipal solid waste management encompasses the functions of collection, transfer, resource recovery, recycling, and treatment. Developing countries often utilize the social sector known as scavengers to collect and sort wastes for recycling processing. Scavengers are citizens with low to no income that collect materials either dispersed throughout the city or concentrated at dumpsites [12]. The waste generated in the developing countries is similar in composition, the variation between regions being dictated by the climatic, cultural, and industrial, infrastructural and legal factor. Proper disposal of municipal solid waste is a necessity to minimize environmental health impacts and degradation of land resources.

Developing countries should develop area specific solutions to the problems in management of municipal solid waste. Technology is only a small part of the bigger picture of sustainable solid waste management. Rather, an integrated approach is necessary, which considers social, economic, institutional, legal, technical and environmental issues, and tries to balance these to obtain the best practicable means to manage waste [13]. Community involvement through neighborhood groups of people from middle and higher income groups and business individuals can provide the needed solution in mobilization of community-based efforts [11]. In general, the proper management of municipal solid waste is determined by the attitudes of people towards waste, such as the ability to refrain from indiscriminate dumping. Socio-economic characteristics may determine attitudes such as the ability/willingness to recycle municipal solid waste. These attitudes, however, may be positively influenced by awareness-building campaigns and educational measures [11].
The problems facing developing countries in handling municipal solid and liquid wastes are not impossible to solve but they need concerted effort from all sectors of society. Municipal solid waste management is the responsibility of every resident [11].

2.3 Recycling of PET bottles

Plastic packages have many advantages; one of them is being light which leads to reduced cost of transportation, while another is decreased risk of crushed packages [14]. Plastic packages contribute to the total transport weight with only one to three percentages. This leads to savings of 27 million ton of oil compared to if the packages would have been made of another material. By keeping perishable wrapped in plastic it is estimated that 10 percent of potential food losses are prevented which saves us 22 million ton of carbon dioxide emission [15]. But to produce 1 kg plastic, 2 kg of oil is needed [16]. When the oil prices increase, the interest for recycled plastic follows. Recycled plastic have less impact on the environment and the producer decrease the use of energy and carbon dioxide emission. Recycle a PET-bottle only consumes 24 % of kWh/piece and 6 % of CO2/piece compared to a new bottle [14].

The post consumer recycling industry started as a result of environmental pressure to improve waste management. The other aspect that acts as driving force for PET recycling is that PET products have a slow rate of natural decomposition [17]. Recycling processes are the best way to economically reduce PET waste [18]–[20]. The first effort to recycle post consumer PET was in 1977 [21], that began recycling PET bottles into plastic strapping and paint brush bristles. The recycling process was further developed during the 1980s and 1990s, and demand for post-consumer PET increased. It is now possible to recycle bottles and containers into new bottles [22].

To be able to reuse the plastic and guarantee a good quality there are certain steps the producer have to go through where each step adds value to the post consumer PET. The amount and type of sorting and processing required would depend upon purchaser specifications and the extent to which consumers separate recyclable materials of different types and remove contamination [22]. The first steps in the PET recycling process are showed in the flowchart below.

![Picture 1: The recycling process [23]](image)

The primary, and most harmful, contaminant to the PET recycling process is any source of polyvinyl chloride (PVC) [24], [25]. PVC can form acids when mixed with PET during processing. These acids break down the physical and chemical structure of PET. This will render the PET material unacceptable for many high-value end-use applications. With manually removal usually 90 % of the PVC contamination is removed [26]. The allowable levels of PVC are 8% of the weight. The color of PET affects the color of the recycled product and can be seen as a contamination.

PET are often baled into bundles and transported to a processing unit. There are essentially three generic types of PET bales that are purchased in the PET recycling industry. 1) Bales consisting solely of PET carbonated beverage bottles, “soda bales”, 2) Mixture of soda bottles and “custom” PET containers, referred to as “curbside bales” and 3) bales composed solely of custom-PET bottles, “custom bales” [22].
The size of the bale should be chosen after what allows the most efficient truck loading and unloading. Standard 48-foot trailers have an interior dimensions of 1.2 m long, 2.6 m wide and 2.4 - 2.7 m high. Usually it is preferable to stack a truck “row” with six bales, 2 bales wide and three bales high. This will result in a total of thirteen rows of bales, for a total of 78 bales/truck and a weight of 18 to 22 metric tons. A bale density of 240 - 290 kg/m³ should satisfy any purchasers minimum shipping weight requirements. Baled PET plastic should be stored in a fashion that keeps them clean and dry with limited exposure to sunlight. PET plastic regrind should be stored in clean cardboard boxes [22].

There are two types of sorting systems used at plastic recycling facilities; manual and automated. The manual sorting systems rely on plant personnel who visually identify and physically sort plastic bottled traveling over a conveyor belt system. The Automated system employs a detection system. Manual sorting systems are generally one of two types, positive or negative sorting system. In a positive sort system, PET bottles are removed. In a negative system the PET bottles stay and contaminants are removed. The positive sort systems are considered best in generating the highest quality materials, but they may not always be the most efficient system. The negative sorting system works well if materials have been presorted, and for PET bottles it can be easier to pick out the contamination than to grab a PET bottle [22].

After sorting, postconsumer-PET is ground into flakes in order to be easily reprocessed. PET flakes are washed following grinding [27]. Then follows drying, considered as an essential step in postconsumer recycling [28]. What happens thereafter is depending on what the end product shall be.

2.4 Six sigma
Process design or Design for Six Sigma is the appropriate process improvement strategy to employ in situations where it is determined that the process is fundamentally flawed or if there is too much variation in the process [29].

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Picture 2: Choice of process improvement method [29].
The Six Sigma concept was developed by Bill Smith, a senior engineer at Motorola in 1986 as a way to standardize the way defects were tallied. At Motorola, Six Sigma is defined as “a business improvement process that focuses an organization on costumer requirements, process alignment, analytical rigor, and timely execution”. Six Sigma projects generally follow a well-defined process consisting of five phases; define, measure, analyze, improve, and control which are collectively referred to as DMAIC.

The define phase of a DMAIC project focus on clearly specifying the problem or opportunity, what the goals are for the process improvement project, and identifying the scope of the project. Identifying who the customers are and their requirements is also critical given that the overarching goal for all Six Sigma projects is improving the organization’s ability to meet the needs of its customers.

The measure phase typically begins with the identification of the key process performance metrics. Correctly choosing process performance metrics is critical in order to have an accurate picture of how the process is actually performing in terms of meeting customer requirements.

In the analyze phase the objective is to utilize the data that have been collected to develop and test theories related to the root causes of existing gaps between the process current and desired performance. Ultimately the goal is to identify key cause and effect relationships that can be leveraged to improve the overall performance of the process.

The improve phase consists of identifying and test options to improving the process. Usually the technique of Design of Experiments (DOE) is used in this phase. Some major considerations associated with DOE include; Determining which factors to include in the experiment, Specifying the levels for each factor, Determining how much data to collect, Determining the type of experimental design.

As the Six Sigma project nears completion, the focus in the final phase shifts to the development of procedures to again monitor the process. Here the purpose is to ensure that the process’s new higher level of performance is maintained and that previous problems do not resurface[29].

3. Methodology

3.1 The field study
Since the focus of this thesis was to investigate how companies design waste management in developing countries to achieve environmental sustainability, we chose to conduct a field study. It is mainly a qualitative method, supplemented by quantitative parts. For our purpose it is suitable to make informal interviews, direct and participant observations, analyses of documents produced within the group, hear collective discussions and participate in the life of Zanrec [30][31].

An advantage of our field study was the fact that we are students; it was easy for us to follow the employees of Zanrec in their daily work when they visited business partners without people being stressed out by our presence. As students we were also able to both be a part of
the case of study, and to observe from a distance. A daily example was that we were able to conduct the study on both the office of Zanrec and on other locations not related to the case.

The field study method also allowed us to be more flexible during our work. During our study, knowledge about the subject deepened and the company rapidly expanded during our stay. Our choice of method allowed us to adapt our research to the new situations that occurred.

The method’s strength is that it has greater validity than a survey. A weakness is that it is qualitative and not quantitative and has no statistical description. Another problem is the reliability; we were affected of our own knowledge and mainly the courses we have studied in our education[30]. Courses as Automation Technology, Manufacturing Technology, Industrial Management Control, Operations Strategy, Industrial Marketing and Industrial Project Management naturally affect what issues we took notice of and what solutions we suggested for Zanrec’s future development.

3.2 The case study approach
We decided on the case study approach as the main method in our field study. The case is a solid waste management company in a developing country that works within a limited geographical area. The case is of interest because the conditions that exist on Zanzibar are similar to other places that need to develop their waste management. It is a small “paradise” island where tourism is of great importance for the economy and where the government at the moment is not able to develop a sustainable waste management system, leaving waste management to be managed by minor local players of different qualities. The findings can therefore be generalized and used in other places [30], [32].

The case was chosen because of its uniqueness; the development of a new business model to handle waste management on minor islands. The amount of produced waste on an island is limited as well as the possibility for waste to be spread over island boundaries. When discussing waste management difficulties in developing countries players are often private companies with profit as their aim or non-governmental organizations (NGOs) that only can finance their work with temporary funding. Our case is of interest because it combines the social factors from the NGOs and the economical sustainability perspective from the companies. Final results can work as a benchmark for other limited geographical areas in developing countries where proper waste management is lacking.

We approached the case by a literature review and by participating in the work of Zanrec to be able to map out activities performed within the company. From that we were able to make an issue tree in order to break down the research question into smaller sub questions. Stated below are six sources of evidence that we had at our disposal [30], [32]:

1) Documents
2) Archival records
3) Interviews
4) Direct observations
5) Participant observation
6) Physical artifacts

To be able to retrieve as good data as possible we used the method of triangulation[31]. The validity of the data improves when retrieving information about the same thing from multiple
sources. That consisted of a combination of observations, interviews and archival records. Next chapter addresses further how we used the different sources.

3.3 Data sources

3.3.1 Documents and archival records
Primary we retrieved secondary data from employees of Zanrec which consisted of management meeting agendas, data of collected waste from every hotel since the 17\textsuperscript{th} of December 2012, Zanrec’s business strategy for 2014, flowcharts of the business model and customer contracts.

Management meetings were held at the Zanrec office every Friday. Meeting participants were managing director, head of logistics, financial accountant, sales managers and administration. The agenda covered accomplishments of last week for all departments, possibilities and limitations, deep dive questions, accomplishments of following week and individual goals. Both short-term and long-term goals were up for discussion.

A customer contract is a document which states what duties Zanrec need to fulfill during the collections, and also fee amount, method of payment and duties the customer agrees to fulfill to simplify waste collection.

3.3.2 Interviews
The collection of data through interviews was shown to be more difficult than we first thought. If you approach a seller or customer you seldom get the information you want. That is mainly because of two reasons; data is merchandise on Zanzibar and traded for other information or money, and it is a strong tradition that you must be polite and deliver what people want. Therefore, people give an answer they think that you want, not their real thoughts about a subject. The way we worked around this was by getting information through local contacts we got to know while staying on the island. These people could use their network to retrieve some of the information that we needed. Information has also been gained through interviews with local people and through taking part in every day life on Zanzibar. The method was chosen since it was considered the best way to get insight to a society where reliable data is not easily accessed. The persons hardest to get in touch with and derive data from were the regional players in Dar es Salam.

Employees of Zanrec were a useful resource in our work. Dynamic conversations with open questions were held with managing director, financial accountant who also is a former plastic dealer, head of logistics, project manager and responsible for sales and customer relations. The aim of the conducted interviews were to cover different topics critical to our research, but were also extended with sub-questions as the interview progressed; questions concerned areas of what the interviewee works with, the interviewee’s general opinions of Zanrec’s strategic development, and what issues the interviewee can see in the organization today.

We conducted interviews with two hotel managers, both relatively new customers to Zanrec. Semi-structured interviews with open questions were used with the aim to get information about what the hotels value in their relationship with Zanrec. Questions covered areas of what the hotels consider to be value- and none value-adding to the service and how they like to inform their guest about their social work and their partnership with Zanrec.

We interviewed five plastic dealers with an aim to identify what price Zanrec can get from post consumer PET scrap depending on how the material is processed. We interviewed local,
regional and global dealers. The local dealers were chosen from established contacts of Zanrec due to their good knowledge of the local market; one of the interview objects was an ex-dealer and the other one a current dealer on the market. The two interviewed regional dealers were chosen based on recommendations from people working in the area of waste management in East Africa. Both of the interview objects were managing directors and involved in the regional market at a high extent. The last interview object was used as a reference source for us to get more insight into the plastic industry; a production manager at a Swedish company, which only deals with post consumer PET in the area of Scandinavia.

To choose the global dealers we screened existing webpages for buyers and sellers of plastic, primary from China, and deselected based on their interest in Zanrec’s type of material and quantity. From the collected information we found 66 companies that were of interest. Selection was made based on which companies had phone numbers available to facilitate interviews in English. A lot of the business-to-business companies in China lacked a homepage and a functional phone number. Potential buyers’ lack of English speaking skills was also a big struggle [33].

3.3.3 Observations
To be able to get a good understanding of the current supply chain we followed the waste collecting team during two routes, on a total of 24 hours. We chose the longest route both times to be able to see as much as possible. Due to low season and because some of the hotels were closed, we were not able to visit all the contracted hotels but could make observations in 11 out of 55 contracted hotels. We visited a local buyer for two hours and had the opportunity to inspect both a shredding machine and a bundling machine.

We followed the work of four people in the management team of Zanrec: managing director, head of logistics, project manager and the one responsible for sales and customer relations. To be able to understand their part in the business we attended sales meetings, management meetings, joined the collection team, watched and observed the social work with local schools and watched introductions of new customers. The estimated time for the observations is 100 hours.

The quality of results obtained from field research depends on how thorough the field worker is. To be able to get as good results as possible we have spent approximately 125 hours (per person) in making observations from various persons and situations. To be able to remember our observations in the field, and try to minimize the risk of observer bias, we have been taking notes and photos during these observations [31]. The challenge with the method is to separate what you “know” have happened with what you “think” have happened. We tried to minimize our own misinterpretations by reading about Tanzania and Zanzibar to enrich our understanding about the cultural context. Another strategy that we chose was to discuss the same things with both Swedes and Tanzanians in order to make the cultural differences visible of the knowledge we gathered.

4. Zanzibar and waste management

4.1 Tanzania and Zanzibar
The United Republic of Tanzania is a result of two East African sovereign states of Tanganyika and Zanzibar that united in 1964 to form one country [34], shortly after achieving independence from Britain in the early 1960’s. The first democratic election since the 1970s
were held in 1995, when one-party rule ended. Tanzania is the largest nation in East Africa both in land area and population; land area of 947,300 sq km, which includes the islands of Mafia, Pemba, and Zanzibar, and a population of 49.6 million people (July 2014 est.). Population growth rate of Tanzania is 2.8 % (2014 est.) and the annual rate of change in urbanization is 4.77 % (2010-2015 est.) [35].

Zanzibar archipelago is located in the Indian Ocean off the eastern coastline of Tanzania. It contains three large islands: Mafia island, Pemba and Unguja (often referred to as Zanzibar), and a number of smaller ones. Together, the two main islands Unguja and Pemba almost compare to the size of the Swedish island Gotland [5]. Unguja and Pemba together consists of ten districts and each district is divided into Shehias. A shehia is a small administrative unit, which in urban areas is a demarcated area and in the countryside consists of one or several villages and usually represents between 1,000 – 21,000 people [5]. The shehias have decision power in some questions concerning their geographic region.

Stone Town is the capital of Zanzibar and is rich in history, situated on the western part of the island. Stone Town has a particular culture with disparate elements of the cultures of Africa, the Arab region, India, and Europe. The role of tourism in the contribution of national income for Zanzibar is irreplaceable, and due to its physical features, Stone Town is a major tourist attraction [6], [36].

A large portion of Zanzibar’s gross domestic product (GDP) is associated with climate sensitivity activities, either directly such as with agriculture or tourism, or indirectly for example from the use of natural resources [37]. The coastal zones of Zanzibar contain high populations and significant economic activity. These areas are at risk from future sea level rise and storm surge, as well as from coastal erosion. Coastal and marine ecosystems are the backbone of Zanzibar’s economy, and support a very large number of livelihoods on the island. The economic value provided by fisheries, seaweed farming and tourism make up over 30 % of Zanzibar’s GDP [37].

4.2 Solid waste management on Zanzibar

The Zanzibar archipelago, with its 495 000 inhabitants, generates over 92,000 metric tons of waste a year, which is equivalent to the weight of a Boeing 747 per day, contaminating the environment and causing implications to both public health and the islands economy [5]. The contamination has a close relationship with eruption of diarrhea, cholera and typhoid, which claim the lives of residents, affect the labor force and causes substantial economic losses to Zanzibar. The efforts made so far have only focused on Stone Town; resources outside this area, where most of the population resides, have been limited [6]. Most of the waste are of domestic and market origin and have potential for compost production; a study of 2005 showed that the major domestic waste fraction in Stone Town was organic waste (85.6wt%) and the second largest fraction was plastic (4.4wt%) [5], [36].

Zanzibar Municipal Council handles about 30 % of the total amount of waste generated on the island. The remaining 70 % is randomly disposed on streets and beaches or burned in backyards [5]. Cattle and other animals are frequently seen walking around in waste, eating from it, and children are often observed playing in the waste. There are some minor players on the island that offer waste disposal for restaurants and hotels, but quality of the services is very varying. Some players dispose the waste by digging a hole in the ground to put it in, or by dumping it in the nature. Other players collect waste and sell the most valuable to mainland of Tanzania. The potential market of waste management is too small to interest the
traditional waste management companies, and they would not be able to build an economical sustainable business with traditionally used methods.

Picture 3: Unofficial dumpsite Stone Town

4.3 Description of Zanrec

4.3.1 Zanrec’s core competence and supply chain in short
Zanrec is a company in the business of waste management, and is today trying to develop an economical sustainable business model to deal with waste management on smaller islands, with start on Zanzibar. Compared to the traditional waste management companies Zanrec’s core competences are in the field of servitization [38] by corporate social responsibility work (CSR-work) and social impact. Compared to the NGOs, Zanrec’s strengths are in the field of customer relations and the ability of long-term financial commitment.

Picture 4: Flow chart of Zanrec’s business chain
Zanrec’s customers are both the hotels and the waste dealer, therefore Zanrec has a double income opportunity; to sell the waste handling service on side of the business chain, and a possibility to sell collected waste material on the other side. Below we will describe Zanrecs supply chain of today, starting with supply, through production and ending with demand.

4.3.1 Supply
Most of the development has taken place during the last half-year. What started as a pilot project in the end of 2012 together with a few hotels, where only plastic was collected, developed during the end of 2013 to full service waste management for hotels around the island. The decision of which service provider the hotel use is often taken by the hotel manager, a person employed by the hotel owner that works on a commission fee for three years before moving to another job. The price of the service Zanrec is providing is more than twice as expensive for the hotels compared to other service providers, and the increased waste management cost is taken from the profit. Today Zanrec have 55 contracted hotels, with a total of 564 rooms, where each hotel has about 5-15 rooms. 11 of the contracted hotels have full service. In the initial phase, hotel customers sign a waste management contract where they agree with Zanrec to collect their waste. A full service contract states that the hotel is responsible for continuous separation of all waste in labeled bags and barrels, and is effectual even if a hotel decides to close during low season. Education in how to separate waste is held with hotel staff and is an important part of the agreement, and a key to an effective collection.

Each hotel assets one bag for each type of material: plastic, organic waste, glass, metal and other non-organic waste. Zanrec is responsible for collection of the waste, which should be picked-up three times a week, if nothing else is stated in the contract. The collection route is disposed dependent on hotel location, total time of collection route and on how many times waste collection is supposed to take place at each hotel. Currently Zanrec collects approximately 100 kg of PET from the hotels per week but the amount of waste fluctuates depending on the tourist season. The quality of PET derived from the hotels is often very good, without polluting materials or sand. The hotels are a potential major source of PET because of all the tourists whom consume a lot of water, juice i.e., but as a matter of fact, only 9 % of the PET originates in the hotels. This results from staff taking a lot of bottles with them home for personal use.

To be able to reach the plastic that gets out in the nature among local communities Zanrec has another type of PET supplier. Through community work, Zanrec has activated 15 so-called collection points; local community agents whom are collecting waste in their local villages. The shehia decides who gets the opportunity to become an agent, which is an advantage for Zanrec and decreases the risk involved in setting up a new collection point. The agent’s home is then rebuilt to also work as a collection point; house walls are painted white with Zanrec’s logo viewable to the public, the agent gets education and a set of tools to be able to preform their task in a proper way. It is the local agent who is responsible for keeping the village as clean as possible and also the one who decides how the PET should be collected. Some collect all the material by them selves, others make the villagers to bring their PET to the collection point in exchange for money. An agent is approximately collecting one metric ton per week and is not affected by season fluctuations. The agent is paid when Zanrec collects the material. Depending on how much material the agent has collected, Zanrec makes the decision on when to come and pick up the waste. Zanrec’s waste truck has a separate transportation route to pick up waste from agents. Because most of the PET from collecting points is collected out of sand, mud or from a backyard, it is often very polluted.
4.3.2 Production
Zanrec does not have a processing unit where material can be separated and where value-adding activities can be performed. The degree of automation is low due to high investment cost and low labor costs. Instead, when Zanrec collects waste from hotels and agents some separation needs to be done on the truck during the collection route and before storage. This value-adding activity depends on how well hotels and agents separate the material before pick-up, and is often very time consuming.

![Picture 5: Manual separation of organic waste](image)

Zanrec tries to limit the waste that is needed to go to the dumpsite by gathering the recyclable material and sell it, as well as disposing organic waste to farmers to be used as fertilizer [39]. The organic waste is transported to a contracted farming area where a careful inspection and separation of the organic waste is done to decrease the risk of contamination.

The collected plastic, which is the second largest waste fraction, is currently stored in bags of 100 kg per bag at the company’s office as well as at the home of head of logistics. Approximately 190 bags of plastics can be stored which is approximately 185 m$^3$ of PET. A baling machine is ordered and about to be installed for further use in production.

4.3.3 Demand
The one buyer of PET that Zanrec is conducting business with today is located in the Stone Town area. The delivery of the material is induced when Zanrec starts to run out of storage space. Zanrec is given the same price regardless the quality or quantity of the material, and after the transaction of PET the local dealer processes the material in a simple facility by shredding and cleaning it. When the local buyer accumulates 15 ton of PET, the material is sold to a Chinese buyer in Dar es Salam or straight to China. The local dealer is buying at a higher price than other local buyers because of a willingness to increase cash flow. The local dealer has also understated its eagerness to buy more post consumer PET from Zanrec if the volumes where to increase. The local dealer has a history of bad liquidity and has sometimes not been able to pay for the PET.
Notable is that even if Zanrec sells all collected plastic, the income from this is minor and the main income for Zanrec derives from the hotels.

5. Results and analysis of the results

5.1 Supply
As stated above, the cost of Zanrec’s service is taken from the hotel’s business margin and is much higher than other waste management companies on Zanzibar. We detected four aspects that have an impact of how willing the hotel managers are to invest in their waste management: profit margin, size of hotel, origin of the manager and branding strategy. Zanzibarian managers that have been informed about recycling and people that origins from countries that focus on recycling tend to be keener to use Zanrec as their waste manager. The Zanzibarians because of their pride of the island combined with a long-term perspective on the development of businesses on the island. Others because they understand the importance of a recycling service and that its a “must-have” rather than an optional service.

In the big compound hotels the guests often stay with all-inclusive and only move within the boundaries of the hotel. Guests only witness lack of waste management on their trip to and from the hotels, and degree of pollution by the road differs a lot between different areas. Guests on smaller hotels see more of the surrounding areas when they take a walk, have dinner outside the hotel area or going to the beach. For these hotels the waste situation affects how the guests experience their stay. We encountered that the reaction from some of these guest are that they believe that the island is polluted due to tourism and the hotels, and not that it is the villages themselves that pollute the community. In addition, some hotels are also branding themselves as social responsible, and for them it is easy to motivate a higher cost for waste management if they believe in Zanrec as a company and what Zanrec can achieve.

The customers we interviewed that already have or are about to join Zanrec have not pointed out any activity that they think is not value adding in the service. When they talk about the value of the service they stress that it is the whole service package that is of most interest to them. Two things they emphasize is the credibility of Zanrec and the social impact. This probably derives from that the hotels have seen many good initiatives on the island considering waste management. Many of these initiatives have been lead by NGOs or smaller companies, but after some time the funds have run out or the company have disappeared. Because of the reason that Zanrec is a profit-oriented company with an interest of economic sustainability, they are more willing to conduct business with Zanrec than any other player on the market. The hotels want to build a long-term partnership and not just get a short-term solution. They also consider Zanrec to be honest and a reliable business partner.

The hotels also stress the possibility to improve their CSR-work. They are attracted by the story that Zanrec sells. One hotel expressed that the customers expect good food and service, but will not go home and tell people about those types of experiences. Thus, if the hotel can show how to take responsibility for the surrounding areas, be a part in cleaning the community, educate and train school kids in recycling and empowering the local businesses, the guests will return home and advocate the hotel. The hotels appreciate cleaned communities, reused products and marketing material, which Zanrec can provide.

The hotels’ collection points are very varied in design; they differs a lot from each other where some of the collection points are poorly attended by the hotel and have an illogic
structure. When a process have too much variation a Six Sigma DIMAC project is preferable [29]. The standardization should meet the voice of the customer, but cannot be too expensive. Another aspect to take into consideration is what possibilities Zanrec will have of removing contamination when a future processing unit is built. According to Meredith [29] the problem should be defined from the customer perspective. From observations and interviews in our fieldwork the voice of customer is:
- The solution cannot take too much time from the staff
- The recycling process must be easy to understand and preform
- The solution must contribute to the CSR-work
- The solution must make a difference in the local community
- The solution must be a long time partnership between Zanrec, the hotel and the local community
- The waste collection should be preformed in the same frequency and at the same time each week
- The staff should get proper education to be able to preform the service

Technical requirements:
- Zanrec has to set up the waste area with standardized waste bins.
- Every bin should have a specific spot.
- Every bin should have a simple sign concerning what goes in the bin.
- The bins should stay close to each other in order to minimize the risk of throwing in the wrong bin.
- Every collection point should have a picture of how it should look like. A copy should also be kept in a truck-manual where new employees can have a look at how the collection point looks like, and which condition it should be in when leaving the hotel.
- Bins of the same color as in the waste area should be implemented in the kitchen area so that waste can be sorted properly from the beginning.
- Zanrec should have a report system so that errors can be detected and transmitted to the right person within the company.

A way to measure how well Zanrec meets the goals could be:
- Store data on how often a hotel is complaining about the service.
- Random samples of comparison between the picture of how the collection point should look like and the real outcome.
- Call some of the hotels continuously in order to gather thoughts about the cooperation.

When this is implemented Zanrec has to analyze, improve and complete the process. An important step to succeed is to develop internal report and information structures.

It is of importance that customers notice a difference when they sign a contract with Zanrec compared with the other companies on the waste management market. Zanrec is already performing better after collecting the waste, but needs to improve the collecting routine at the contracted hotels. This can otherwise generate implications for Zanrec when expanding; the goal is to recruit an additional 25-60 employees during 2014, which is an increase of 450 percentages since the beginning of 2014. Today management is concerned if the new employees will be able to preform at the specified levels. When the business expands Zanrec must be able to introduce new employees and make it easy for them to understand and work at the desired level of performance. Current conditions at the hotels differ were some have asphalt and air-condition in at the waste area, and some have the waste collection point in a distant area straight on the ground. Standardization costs cannot be too high, and in the near
future Zanrec will have a process facility that will be able to manage the hotels’ lack of separation skills. Zanrec should focus on how bins and bags are arrayed and how instructions for sorting are attached in an intuitive way in the waste collection area.

To be able to handle all costs and finance a future expansion, Zanrec needs to reach approximately 50% of the existing hotel market. Number of rooms depends on which price Zanrec can take for the service. Collection rates depend on number of agents and contracted hotels. Zanrec will and should no longer focus on non-full service and instead focus only on full service contracts. Zanrec currently focuses on getting new customers and is approaching three new segments: i) bigger hotels with approximately 100 rooms each ii) groups of hotels that are located in the same area, iii) restaurants. To be able to reach the bigger hotels and restaurants the strategy is similar; the aim is to initially contract one customer, or a group of customers, in each segment, develop and build the routines that suit this type of customer, and then use these as reference customers when approaching others. The strategy to reach hotels in the same area is to have a jointed campaign towards them were Zanrec assembles all hotel managers in order to discuss waste management issues in the area, how it affects tourists, and what they together could achieve by joining Zanrec.

Table 1: Data collected from a waste collection route [40]
Resources should also be focused on how to make the transportation of waste most efficient. Each collection stop affects the route and has a big standard deviation. A significant cost driver is long transportation distances; many hotels are situated near the coast and far from the main road. Average time of transportation from main road is nine minutes. Average time of collection is four minutes during low season. Only 45 minutes of an eight hour route were spent at the hotels [40].

5.2 Production
As the business expands, a bottleneck will occur concerning material processing; separation of and cleaning all incoming material will be unsustainable if it is conducted in the same way as today. With a processing unit, Zanrec will be able to handle incoming material in an easier manner [22].

The first step in the refining process will be the sorting of material and removal of contamination. Because of low labor costs and lack of technically advanced resources, the processing unit should consist of austere equipment and separation work should be handled manually. According to D. J. Hurd [22] either negative or positive separation should be adopted to divorce PET from other materials. Due to the fact that the PET bottles are considered voluminous compared to the size of the contamination, we suggest positive separation. Then it is also possible to color sort the material in the same process step. 57% of the buyers have demand for color sorted material, and the price for colored material is 473 USD/MT compared to 358 USD/MT for unsorted material [41].

After sorting the material, different approaches are possible for Zanrec to consider for its processing unit. The first approach is to only color sort the material, bale it into secure bundles for storage and shipment. Lack of storage space is one major bottleneck in production and with bundles of PET instead of big bags of unprocessed loose PET, it is possible to increase the storage capacity from today’s 19 ton to approximately 30 ton, an increase of 58 percent. To assure the most efficient transportation of the material, and optimal price suggestion from buyers, the bundles should be made according to industry standards according to D. J. Hurd [22].

![Flow chart of first approach](image)

Picture 7: Flow chart of first approach

The other approach is a process of refining the material to a higher extent, but also to a higher cost; a processing unit with the capability to color sort, remove lids, cold wash and bale before storage and shipment. Additionally, warm wash with label removal and shredding could be of interest in the long run. To go further downstream in the process requires more investment in knowledge and machinery than what would be advisable for Zanrec in its current situation [27], [28].

![Flow chart of second approach](image)
If Zanrec shall do one of the approaches stated above, it is most cost efficient to do the first mentioned. If Zanrec decides to remove lids to sell separately, the second approach should be adapted to the process since just taking off the lids is not cost efficient. The material is easier to clean with the lids off, and if the material is properly washed (warm and cold), labels can be removed at the same time. The removal of lids only has a limited effect on the value of post consumer PET. The lids are made of HDPE/PP and according to our interviewees, the market for this type of plastic is better than the market for PET. Calculations show that the average price of HDPE/PP on the current market is 567 USD/MT, but the approximated cost for retrieving the material is 1678 USD/MT [42], [43].

The labels on PET bottles are sometimes difficult to remove depending on which type of glue that is used. This is highly regulated in most developed countries but not as regulated in developing countries. However, the most common way to remove glue from PET bottles is to use hot water and sodium hydroxide (NaOH). For future development of the business, a hot water wash with NaOH added to the process should therefore also be taken into consideration.

An evaluation of Zanrec using a shredding machine has been made, and the conclusion is that sand is the most critical factor; sand has a tendency to destroy the cutting edges in shredding machines and therefore generates big operating cost. A shredding machine is also more energy consumptive than a baling machine. Because of relative high degree of sand contamination in post consumer PET on Zanzibar it is not advisable for Zanrec to shred the material in this stage, according to Olofsson [44].

All of the value-adding activities stated above will strengthen Zanrec’s role on the plastic scrap market and also bring more value to the company. Due to high sand contamination and the limitations in processing space and technology, and taking into consideration the demand from the market, the suggestion is that Zanrec initially only color sort and bale the material.

5.3 Demand
Changes in the quality of the material affects the price and a pattern concerning quality demands has been shown on the overall market for post consumer PET; the material should be separated by color, washed and without any contamination, and baled into secure bundles with a minimum weight density of 160 kg/m³ [41]. The most important step is to remove as much sand as possible. Buyers stress the fact that clean material with a minimum of sand and no lids or labels gives Zanrec a higher price range. Therefore, the more Zanrec can do in terms of cleaning and separating the material, the higher price suggestion of the processed material [22], [45]. Overall, potential buyers of post consuming PET also value efficient transportation solutions, and good and solid business relations.

We made SWOT analyses of three different market segments: the local, regional, and global market[46]. The analysis points out that since the local dealer has a history of bad liquidity and has sometimes not been able to pay for the PET, an important step in Zanrec’s further development is to build a partnership with a new buyer.
There are approximately twelve companies dealing with plastics in Dar es Salaam. Most companies are Chinese owned trading companies, which sell all supplied material directly to China. The business situation in Dar es Salaam, which is the capital of commerce in Tanzania, is rough with a lot of competition where a poor attitude towards dissemination of information is effective due to the risk of revealing business strategies. Actors on the PET market in Dar es Salaam often offer low prices and the market is very uncertain where buyers often stop buying altogether because of low market prices [45]. This leaves suppliers with a lot of material no longer possible to sell. A recommendation from two of the interviewees; a former plastic dealer and a current actor on the regional PET market, is for Zanrec to set up a long-term agreement with one buyer which is consistent with the price setting and is interested in a long lasting cooperation [45], [47]. The price suggestions between actors in Dar es Salaam do not differ much, approximately between 210-270 USD/ton [45], [48].

The market for PET is growing with an expanding middle class in developing countries such as China. Demand in developed countries such as the U.S. is starting to flatten, largely attributable to an ongoing decline in soda, juice and sweetened beverage consumption as more Americans associate weight gain with sugary, and more recently, low calorie drinks [49], [50]. As polyester textile production in North America and Europe was being lost to Asia, those regions experienced rapidly growing PET packaging markets for beverage bottles and thermoforms. There are several reasons to focus on the Asian market for recycled PET, and the Chinese market in particular. China has 83% of the export market share of PET [51]. Another aspect to take in to consideration is the trade imbalance in China; as a result of Chinas massive export, as much as 40-60% of the containers come back empty, a major lost in profit for the shipping companies [52]. Due to the huge demand for recycled plastic in Chinese industries, and the beneficial shipping conditions the focus of the work related to the global arena has been focused on mainly Chinese companies. Based on extensive research we have identified the average price on the global market as 517 USD/MT and the average quantity as 160 MT/month.

![SWOT-analysis of local buyer](attachment6)

**Strengths**
- Low transportation cost
- Good price compared to other local and By all the material, no matter of condition
- Zanrec can deliver continuously when needed
- High price consistency

**Weaknesses**
- Low liquidity
- Same price amount no matter of how refined the material is

**Opportunities**
- If continue to sell direct to China the buyers will demand a lot of material continuously

**Threats**
- Sensitive of market demand

Picture 9: SWOT-analysis from attachment 6, local dealer.
6. Conclusions and recommendations

The research question of this thesis was: how do companies design waste management in a developing country to achieve environmental sustainability?
- What can be done to improve Zanrec’s supply chain of today?
- Which value adding activities are possible to perform for Zanrec to meet customer demands?

The waste management system is poor in many developing countries. And on small areas, such as islands, there are few economical benefits for traditional waste management companies to establish. In order to solve the problem a new business model must be developed.

We have applied the method of a case study given the research question and we conducted a field study where the empirical setting was Zanzibar, an island out of the coast from Tanzania, with a poorly developed waste management system. Focus in this project was to investigate how the case of Zanrec works today to set a benchmark for other areas with the same problem. Focus was also to investigate how Zanrec can develop the supply chain to enable further development and increase economical sustainability.

In order to achieve a satisfying result, the study was aimed to: (i) give insights into waste management in developing countries (ii) map Zanrec’s supply chain of today, (iii) define what the value-adding activities are in the eyes of the customers, both hotels and plastic buyers, (iv) identify possible limitations/possibilities based on Zanrec’s prerequisites.

The findings of the thesis could be summarized as follows:
- Inflow of material is continuous and does not depend of a fluctuating tourist season.
- The collection points lack standardization.
- One major cost driver is transportation distances between collection points during the collection routes.
- Increased social impact and cleaner communities are key arguments for customers to join a Zanrec agreement.
- Sand contamination is a big problem for post consumer PET recycling. It is difficult to get rid off and causes problems further downstream in the refining process.
- One major bottleneck in production is lack of storage space.
- 57 % of the buyers demand color sorted material, and the price for sorted material is 532 USD/MT compared to 239 USD/MT for unsorted material.
- The current local buyer is not a sustainable business partner.
- Average price for HDPE/PP on today’s market is 567 USD/MT, but approximated cost for retrieving the material is 1678 USD/MT.
- China is a big market for PET with the possibility of beneficial transportation agreements.

Based on this thesis the following conclusions may be drawn considering how Zanrec can improve its business model:
- Standardize the collection points in order to strengthen the branding of Zanrec and to simplify sorting and staff training. It should be easy for both the customers and Zanrec to work with the collection points, and there should be a visual difference between pre- and post-signing of a contract with Zanrec. The design of waste management sites, for example provider of composting solutions, could be a possible add-on service. Cost is a limiting factor.
- Minimize transportation distances by updating collection routes. This should be done in combination of maintaining the sell strategy towards costumers in neighboring areas.
- Develop a partnership with a new buyer of plastics. Zanrec should take following factors into consideration: price, capability of buying different types of material, time consumption for managing transportation, and possibility to deliver when reaching certain storage levels and not on a ongoing contract.
- Develop production with color sorting and baling of the material in order to get highest return compared to process cost. Do not remove lids of HDPE/PP if the action can’t be combined with another value-adding activity that covers the cost.
- Increase storage space, and have storage space in consideration when planning a new processing facility. Do also investigate the possibility to cold wash and remove lids when expanding the processing facility.
- Continue to develop tools for customers to use when they want to communicate about the social impact they accomplish by taking part in Zanrec’s joint solution. It should be easy to sell the story of waste management engagement and local community work. A key factor in the selling process is to involve many customers in the same area in a joint mission of cleaning the village.
- Investigate and develop good incentives for waste collection and how Zanrec can maintain high motivation in local communities, organizations and among agents. They are all keystones in collecting the major part of plastics and in keeping the villages clean. Co-working with these types of groups must be more strategic.
- Continue to develop a relationship with potential buyers with the aim to choose a new business partner. Both regional and global partners can be of interest but is dependent on the amount of material. In the initial phase we recommend to start with a regional player until Zanrec knows more about the total amount of collected material due to business expansion.
- Continue to develop the internal structures for report and communication between employees. To be able to preform on a high level even when the workload increases new and improved routines must be set into place.

The results of this thesis will work as a foundation to make Zanrec’s business areas of concern more efficient and will work as a benchmark in policy making when working with waste management systems in other developing areas as Zanzibar.

There are many questions left to answer regarding how to design waste management systems in developing countries to achieve environmental sustainability. A continuation of the bachelor thesis could include how companies should work with the local communities, organizations and collectors in the best way to maintain and motivate them in the long run. Other subjects of interest would be to investigate how Zanrec’s business model could be implemented on other islands with similar conditions or how Zanrec can develop its work regarding CSR. A more detailed investigation of how Zanrec’s process unit should be design in order to meet customer demands would also be of interest.

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Appendix 1 Interview templates

1.1 Interview template - hotel customer

Hotel name:
Time of being a customer:

The service today
- What do you think of the service of Zanrec?
- How come you became a customer?
- How come you are still a customer?
- Do you think the price is reasonable?
- Is there something Zanrec can do to make it easier for you to sort your material? (more staff education, extra bin in the kitchen, better signs etc)

Evaluation of the service
- Do you miss anything in the service?
- Is there something you think is unnecessary in the service?
- Would you like to change anything?

Other values
- Can you see any added value to your business by using Zanrec instead of an other company?
- How do you show your customers that you use the service of Zanrec? How would you like to show them (movie, fb, marketing material)? How would you feel to be on Zanrecs webpage or facebook page?
- Should you be interested in buying back recycled material as in glasses, lamps, recycled paper etc?

1.2 Interview template – plastic buyer

Hi,

My name is X and I’m a student at the Royal Institute of Technology in Sweden. I am writing my bachelor thesis about waste management and PET recycling on Zanzibar. At the moment I investigate which opportunities the Zanzibarian Waste Management companies have to sell their PET and wonder if I can ask you some questions?

Interesting materials

Is your company interested in buying PET?
Sorted or mixed?
Other materials except from PET?

How do you want the material to be processed?
Bundled with lid?
Bundled without lid?
Bundled with/without label?
Cold washed?

What size of the bundles do you want the material to be in?
- density? (standard minimum weight density of 10 lb./cubic foot)

What other quality demands do you have on bundled PET?

Interesting amount

What quantities are you interested in?
Zanrec have between 10-150 tons/month
19000 ton
27000 ton/år
80 ton/dygn

Delivery agreements

How does the relationship with your suppliers look like? How does the order process work?

- Do you come with an order or can an actor approach you when they have an interesting amount to sell?
- Is there any price differences if you have a continuous delivery contract or a more seldom shipment agreement?
- How often do you need to ship if you want to have a continuous agreement?

Price

How much would you approximately pay for:
Loose/bundled with/without lid?
Loose/bundled with/without label?
Cold washed or not?
Svårt att tvätta PET, väldigt skrymmande. Bala och se till att få den så ren som möjligt. Då får man bäst betalt härifrån.

Would it be any price differences if the company would have an Eco social focus?
The company could trace their plastic in the whole supply chain and guarantee to be eco social?
Appendix 2 Plastic dealers

2.1 SWOT – plastic dealers

**Strengths**
- Low transportation costs
- Good price compared to other local and regional dealers
- Low transportation costs
- By all the material, no matter of condition
- We can deliver continuously when it fits us
- High price consistency

**Weaknesses**
- Low liquidity
- Pay the same amount no matter of refined the material are

**Opportunities**
- If continue selling direct to China the dealer will need a lot of material continuously

**Threats**
- Sensitive of market demand

---

**Strengths**
- Pay a higher price
- Able to buy a larger amount of material
- Able to buy various types of recyclable material
- Able to adapt their price depending on quality of material
- Bigger player on the global market

**Weaknesses**
- Low price consistency

**Opportunities**
- Easy to find transportation solutions
- Relative cheap transport solutions
- Many different dealers on the market
- Both traders and manufacturers
- Develop a partnership and get a good price over time

**Threats**
- Zanrec is a very small player on this market
- Sensitive of market demand
2.2 Compilation customers of HDPE on 2014-05-15

Average price on market (USD/MT): 567
Average quantity (MT): 70
Demand of sorted HDPE (%): 63%
Average price sorted HDPE (USD/MT): 518
Average price of mixed HDPE (USD/MT): 652
<table>
<thead>
<tr>
<th>Customer</th>
<th>Quantity</th>
<th>Units</th>
<th>Frequency</th>
<th>Price</th>
<th>Funds</th>
<th>Per unit</th>
<th>Location</th>
<th>Sorted/mixed</th>
</tr>
</thead>
<tbody>
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<td>Recycler's world</td>
<td></td>
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<td></td>
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<td></td>
<td></td>
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<td>USD</td>
<td>lbs</td>
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<td>Mixed</td>
</tr>
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<td>week</td>
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<td>USD</td>
<td>lbs</td>
<td>CAN</td>
<td>Mixed</td>
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</table>

2.3 Compilation customers of PET on 2014-05-06
Average price on market (USD/MT): 438
Average quantity (MT): 638
Demand of sorted PET (%): 69%
Average price sorted PET (USD/MT): 473
Average price of mixed PET (USD/MT): 358
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<th>Funds Per unit</th>
<th>Location</th>
<th>Sorted/mixed</th>
</tr>
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<td></td>
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<td>USD MT</td>
<td>USA</td>
<td>mixed</td>
</tr>
<tr>
<td>LW1087757</td>
<td>20</td>
<td>MT</td>
<td>ongoing</td>
<td>595,25</td>
<td>USD MT</td>
<td>USA</td>
<td>sorted</td>
</tr>
<tr>
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<td>MT</td>
<td>ongoing</td>
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<td>USD MT</td>
<td>USA</td>
<td>sorted</td>
</tr>
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<td>USD MT</td>
<td>USA</td>
<td>sorted</td>
</tr>
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<td>month</td>
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<td>CAN</td>
<td>sorted</td>
</tr>
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<td>ongoing</td>
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<td>USD MT</td>
<td>IND</td>
<td>mixed</td>
</tr>
<tr>
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<td>MT</td>
<td>ongoing</td>
<td>200,00</td>
<td>USD MT</td>
<td>IND</td>
<td>mixed</td>
</tr>
</tbody>
</table>
Appendix 3 – Data from observations of Zanrec

3.1 Enquiry of lid removal, HDPE-test on 2014-05-09
Date of information collection: 2014-05-09

Mission
To calculate the cost for retaining HDPE plastic from the PET-bottles.

Method
Two Zanrec employees got ten minutes to take of the lid from PET-bottles. The bottles came from a bag of PET that was kept in the storage space. The bag was picked at random and represents an average bag of Zanrec PET. They picked up the bottles, turned the lids of and placed the lids in one bag and the PET in an other. After then minuts were both the bag of HDPE and the bag of PET weighted.

Observations, data and estimations

<table>
<thead>
<tr>
<th>Data</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>10 min</td>
</tr>
<tr>
<td>Nr of employees</td>
<td>2</td>
</tr>
<tr>
<td>Total weigh PET</td>
<td>13 kg</td>
</tr>
<tr>
<td>Bag weigh</td>
<td>3 kg</td>
</tr>
<tr>
<td>Estimated weight of the contamination</td>
<td>3 kg</td>
</tr>
<tr>
<td>Estimated nr of PET missing lids</td>
<td>50 %</td>
</tr>
<tr>
<td>Total weigh HDPE</td>
<td>1 kg</td>
</tr>
<tr>
<td>Estimated decreased efficiency of full day work</td>
<td>50-75%</td>
</tr>
<tr>
<td>Total amount of PET /month</td>
<td>20 ton</td>
</tr>
</tbody>
</table>

Calculations
20 ton of PET gives 10 ton of PET with lid. We are able to get 1/7 kg HDPE per kg PET. 10 ton PET gives us 1428 kg HDPE, 1,43 HDPE/month.

With respect to the decreased efficiency (by 25 %) when doing the task for a longer time, and that it is preformed by one person we calculate that 1 kg*0,5*0,75=0,375 kg HDPE on ten minutes and 2,25 kg on an hour.

1428 kg/ 2,25 kg/h= 635 h to remove all HDPE.

635 * 3,8 USD/h= 2411 USD/month, approximately 2400 USD/month.
1 MT 2400 USD/1,43= 1678 USD/MT.

Result
Zanrec can extract 1,43 ton of HDPE/month to a cost of 1678 USD/MT.
Data from Waste collection – observations from route 2014-05-05

- Total time of route: 7h 48min
- Total time of collection: 45 min 6 s
- Average time of collection: 4 min 6 s
- Total time of transportation from main road: 1 h 42 min
- Average time of transportation from main road: 9 min 15 s

**Waste collection - monday route**

![Graph showing waste collection times and transportation times for Hotel 1 to 11.]
<table>
<thead>
<tr>
<th>Hotel</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
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</thead>
<tbody>
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<td>Fukushani</td>
<td>Michamwi</td>
<td>Michamwi</td>
<td>Michamwi</td>
<td>Paje</td>
<td>Paje</td>
<td>Jambiani</td>
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<td>SE</td>
<td>SE</td>
<td>SE</td>
<td>SE</td>
<td>SE</td>
<td>SE</td>
<td>SE</td>
<td>SE</td>
<td>SE</td>
<td>SE</td>
</tr>
<tr>
<td>Number of rooms</td>
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<td>5</td>
<td>24</td>
<td>4</td>
<td>5</td>
<td>13</td>
<td>11</td>
<td>34</td>
<td>13</td>
<td>12</td>
<td>66</td>
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<tr>
<td>Type of service (full, semi, other)?</td>
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<td>Full</td>
<td>Pilot</td>
<td>Full</td>
<td>Full</td>
<td>Pilot</td>
<td>Pilot</td>
<td>Pilot</td>
<td>Pilot</td>
<td>Pilot</td>
<td>Semi</td>
</tr>
<tr>
<td>How good at separation (not good, good, very good)?</td>
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<td>Very good</td>
<td>Very good</td>
<td>Very good</td>
<td>Not good</td>
<td>Very good</td>
<td>Not good</td>
<td>Not good</td>
<td>Very good</td>
<td>Good</td>
<td>Very good</td>
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<td>2,43</td>
<td>6,07</td>
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<td>4,49</td>
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<td>2,19</td>
<td>-2,07</td>
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<td>4,6</td>
<td>4,6</td>
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</tr>
<tr>
<td>Average time of transportation from main road</td>
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<td>9,15</td>
<td>9,15</td>
<td>9,15</td>
<td>9,15</td>
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<td>9,15</td>
</tr>
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<td>Approximate distance truck to bins (no steps)</td>
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<td>30</td>
<td>5</td>
<td>2</td>
<td>15</td>
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<td>5</td>
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<td>No</td>
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