REUSE, REDUCE & RECYCLE:

PLANNING FOR SUSTAINABLE SOLID WASTE MANAGEMENT IN STONE TOWN - ZANZIBAR

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PREFACE

This journey started for us with an entirely unknown topic. To experience how we gradually made it ours, as landscape architect, has been truly a pleasure. If ever doubted that landscape architecture and solid waste management are closely linked together, we wish that through this thesis has alleviated these doubts.

We hope that the reading of this thesis will be at least some of that learning experience we have gone through by making this project.

Cecilia Hellman & Emma Karlsson

Stockholm, March 2014

ABSTRACT

In the low-income countries of the world, rapid urbanization and decaying infrastructure results in an increasingly unsustainable situation when it comes to solid waste management. Often, the solution tends to focus on introducing technical advanced interventions based on the conditions of the high-income world. However, this thesis aims to find site-specific solutions on solid waste management at a local scale. By taking in consideration of local conditions a customized approach is possible where the solution is not dependent on expensive structural changes. The starting point has been to build a solid waste management strategy based on existing conditions and patterns. A case study has been performed in Stone Town, Zanzibar, which demonstrates how to analyze and create a solid waste management strategy based on local conditions. The result reveals that in order to improve the system of solid waste management the whole process must be taken into consideration. Separation of waste close to source proved to be the most effective way of reducing waste going for final disposal. Since the waste of Zanzibar Town consists of 85% organic material, composting is a suitable method of processing waste. In order to process waste close to source, and thereby reduce the transportation costs, the collection point was given a more prominent role. Two types of collection points were developed, a large and a small one. The large collection point facilitates waste processing at the same time as it serves as a public space, a social hub in the society. The social values are of large importance for making the citizens engaged in the process. Also aesthetical values affect the behavior of people. By raising the aesthetical appearance of decaying places, informal dumping may be prevented. In this field landscape architecture can contribute by linking green structure, social values and aesthetical aspects to solid waste management.

SAMMANDRAG

I låginkomstländer sätter den snabba urbaniseringen stor press på städernas infrastruktur. Tidigare fungerande system för avfallshantering bryter samman och försätter städer i en ohållbar situation där avfall informellt dumpas utan någon processering. Ofta riktas fokus på att implementera tekniskt avancerade lösningar som är anpassade för höginkomstländers förutsättningar. Denna uppsats syftar till att hitta platsspecifika lösningar som utgår från en lokal skala. Genom att se till de lokala förutsättningarna kan skräddarsydda lösningar utvecklas som inte kräver förändring av de storskaliga strukturerna. De befintliga förutsättningarna bör vara utgångspunkten för hur avfallshanteringen ska utformas. En fallstudie har utförts i Stone Town, Zanzibar, för att visa på hur en plats kan analyseras och resultera i en avfallshanteringsstrategi och ett designförslag. Eftersom avfallet i Stone Town består av 85% organiskt material är kompostering det mest effektiva sättet att processera materialet. Processning bör ske så nära källan som möjligt för att minska transportkostnaderna samt mängd avfall som går till deponi. För att möjliggöra detta krävs att det organiska materialet separeras tidigt i processen. För att lokalt kunna processa det separerade materialet har de lokala avfallsstationerna fått en mer framträdande roll i förslaget. Två olika typer av avfallsstationer, en liten och en stor, har utvecklats. Den stora avfallsstationen innefattar flera processeringsmetoder, varav den mest centrala är kompostering. Förutom avfallshanteringen fungerar platsen även som en social knutpunkt i staden. De sociala värdena är av stor betydelse för att engagera medborgare att delta i avfallshanteringsprocessen. Även platsernas estetiska värden påverkar medborgarna. Genom att förbättra platsers estetik kan förmodligen nedskräpning förhindras. I dessa frågor kan landskapsarkitektur bidra med nya infallsvinklar, som att koppla samman grönstruktur, sociala värden samt estetiska aspekter med avfallshantering.

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Our dearest thanks goes to Camilo Calderon, our main supervisor. Without his encouragement, inspiration and careful feedback, this thesis would not be realized. Thank you.

SUMMARY

The urgent topic of solid waste management is a global issue, particularly in developing countries. As cities grows faster, previously well-functioning systems collapse due to problems concerning especially collection and disposal of waste (Ogu 2000). The deficient solid waste management leads to serious problems such as environmental pollution, contaminated ground waste and public health issues (Vuai 2009). This thesis regards Stone Town, Zanzibar, which faces these challenges. The combination of poverty, rapid economical liberalisation and population growth in Zanzibar is putting a great pressure on its environment and nature resources. Zanzibar is particular vulnerable to environmental degradation due to its tropical Island ecosystem (The Government of Tanzania 2012).

AIM & LIMITATIONS

The aim is to find site-specific solutions on solid waste management at a local scale. To achieve out goal, the following research questions needed to be answered:

1. What are the challenges and opportunities in Stone Town – Zanzibar, in terms of solid waste management?
2.What would be a strategy and design of solid waste management that can respond to the problems and contextual conditions in Stone Town – Zanzibar?

The study has been limited geographically to Stone Town and thematically to solid waste produced from households and commercial establishments. The local scale has been chosen in order to achieve a solution not dependent on extensive infrastructural changes, which is infeasible in the current economical circumstances.

METHODOLGY

This thesis views solid waste management as process, which includes many actors with different interests. In order to address the complex situation a case study was chosen as the method. We chose to divide the case in three scales; a town, street and site scale, for understanding both the overall picture as well as the details of the solid waste management in Stone Town.

The case study included two literature studies, semi-structured interviews, direct and participant observations and mapping. The first literature study provided an understanding for the basics of solid waste management. As landscape architects we needed to get knowledge about the technical part of solid waste management that we were missing. The second literature study focused on the prerequisites of Zanzibar relating to waste composition and quantities, policies and regulations and finance concerning waste management.

Semi-structures interviews were conducted in order to understand the administrative structure of waste management. The interviews were performed with representatives from Zanzibar Municipal Council, the Department of Environment and private companies managing waste. To gain insight how the policies worked into practice on the street scale, residents, shop owners, formal and informal waste workers and non-governmental organizations were interviewed.

Observations, both direct and participant were done. Both gave comprehension of how people interact in the process of solid waste management. The observation was done of the waste management process from source to disposal on both local and municipal level. The participant observations gave a deeper insight of the daily work of solid waste management, which led to greater access to the realities of the procedure.

Mapping was performed to analyse how existing structures, such as flux, greenery, run-off, social patterns and spatially, is related to solid waste. This gave further insights of factors affecting the solid waste management, both in town and street scale.

A SWOT-analysis sums up and highlights the key issues of the waste management process in Stone Town. Together with summaries from the background, theoretical background and analysis of Stone Town, challenges and opportunities are identified in a synthesis of analysis.

SOLID WASTE MANAGEMNET IN GENERAL

Solid waste management can be defined differently. In this thesis solid waste refers to non-hazardous waste generated by households, and waste of similar nature generated by commercial establishments, schools and public spaces.

The process of solid waste management involves different actors. This thesis has based the classification of actors on Shübeler´s (1996) distinction. Service users, service providers, regulators and external actors all have different interests. Service users, such as residents and shop owners, want the service to run as smooth as possible without any inconvenience. Service providers, which refer to local government, non-governmental organizations, community-based organizations and

private sector enterprises, are managing the waste and can contribute with knowledge and labour. A functional system requires a set legal framework, which the regulator is responsible for. The external actors are international organisations or enterprises contributing to the solid waste management with capital or knowledge (Shübeler 1996).

Solid waste management refers to the material flow stream of solid waste from source to final disposal. Source, collection, storage, transportation, processing and disposal are included in the concept (Melaku 2010). This thesis explains all stages, but the analysis and the proposal only comprise the four first stages.

There are two major waste management models: the waste hierarchy and Integrated Solid Waste Management. The waste hierarchy focuses on waste reduction close to source (Adama 2007), while Integrated Solid Waste Management is concentrating on finding the most suitable solution for each situation (McDougall (red.) 2001). The latter is often mentioned as the most appropriate for developing countries (Melaku 2010).

It is important to be aware of the differences between high- and low-income counties when it comes to solid waste management. Otherwise, it is a risk of failure when trying to implement no customized solutions. Suitable strategies, according to UN-Habitat (2010), it is important to find simple, appropriate and affordable solutions when modernizing the system in low-income countries. The aim should be to reduce the amount of waste going for final disposal (UN Habitat 2010).

CURRENT SITUATION OF ZANZIBAR TOWN

The current situation of waste management is beneath contempt. According to our analysis, there are two important formal stages missing in the process of solid waste management, namely processing and disposal. This leads to untenable situation where waste is being dumped all over the Island. Zanzibar has difficulties to exit the situation on their own due to vague laws, poor economy and political reluctance. Therefore the solid waste management is dependent on aid.

Zanzibar Municipal Council is the authority responsible for waste management in Zanziabar Town. This is the only area on the Unguja Island where collection of waste is conducted by the municipality (Spitzbart et al. 2013). Stone Town is the old part of Zanzibar Town, and it is here 60 percent of the total workforce goes to when it comes to solid waste management. This due to that Stone Town is very labor intensive because of the door-to-door collection and the higher frequency of solid waste container removal (Juma, M. K. 2013). The municipal has the ambition to extend the door-to-door collection system to the rest of Zanzibar Town (Rajab 2013a).

The estimated solid waste generation in Zanzibar Town is 260 tons per day. Based on the expected population of 5% growth the forecast of waste generation in Zanzibar Town will be 320 tons per day in year 2015. 80-86% of the generated waste in Zanzibar Town is of organic matter. But there is no processing of organic waste occurs (Gauff Ingeniure 2005). Instead, all the waste is mixed at the collection points. Hence, there exist an informal sector, which separates and recycles material in a small scale. In Stone Town, informal waste workers are helping the door-to-door collectors at the collection point without any payment. There are also a number of non-governmental organisations that contribute to the solid waste management process by sweeping the streets. The working conditions for the door-to-door collectors, informal waste workers and non-governmental organisations are poor both economically and socially.

DESIGN PROPOSAL - TOWN, STREET & SITE

Based on this thesis theoretical background and the prerequisites of Stone Town, a solid waste management strategy and design was developed. The most prominent aspects in the proposal for improving the solid waste management are:

- The reduction of waste is necessary for minimizing the waste going for final disposal. Since 85% of the waste is organic, composting is the best alternative. The produced fertile soil should be used to improve the green structure of Stone Town.

- In order to process the organic material, a new network of collection points is proposed. It is a decentralize system including two types of collection points: a large and small one. The large collection point includes processing facilities of organic material. It also function as an information centre, social hotspot and community garden.

- The process of collecting waste is improved by adjusting time schedules and tasks. Street sweeping is done after door-to-door collecting and two new bins for organic material and mixed dry waste are introduced.

• The non-governmental organisations are given a new role as responsible for the large collection point and for collecting separated waste.

• Sites without function and meaning are redesigned and added aesthetical and social values. This will reduce the informal dumping of waste in Stone Town.

DISCUSSION

This thesis demonstrates that solid waste management should be viewed as process, which not only affect and interfere with, but is also built upon the landscape. Solid waste management is a basic facility, which needs to be included in the physical planning. This can be done in several ways. Often, this is done by engineers but we argue that an interdisciplinary approach could give a more holistic result. Landscape architects, for example, can contribute with linking solid waste management to green and blue infrastructure together with social aspects. In our proposal the new large collection point becomes a social hub where people can meet and learn about the process in a green lush environment. The social aspects are essential to get people interested and involved.

A major aspect to this thesis has been to make the result transferable to different areas of Stone Town. By choosing a typical street and representative's sites where waste is being accumulated, the result can be transferable to other similar contexts. But where differences of conditions are too diverse, a new strategy needs to be developed. Then our method can be used as a template to evaluate the solid waste management process of the area in questions. Thereby a new strategy can be adapted for those particular prerequisites.

SAMMANFATTNING

Avfallshantering är ett växande problem allt eftersom världens städer expanderar. Speciellt i utvecklingsländerna är problematiken stor. När städerna växer snabbare, kollapsar tidigare välfungerande avfallssystem på grund av svårigheter med insamling och omhändertagande av dessa stora mängderna avfall (Ogu 2000). Den bristfälliga hanteringen av avfall leder till allvarliga problem som miljöförstöring, förorenad mark och försämrad folkhälsa (Vuai 2009).

Denna uppsats analyserar Stone Town, Zanzibar, som handskas med ovanstående utmaningar. Kombinationen av fattigdom, snabb ekonomisk liberalisering och befolkningstillväxt påverkar öns naturresurser i hög grad. Zanzibar är dessutom särskilt sårbar för miljöförstöring på grund av den speciella ekologi som det tropiska klimatet och geografin skapar (The Government of Tanzania 2012).

SYFTE & BEGRÄNSNINGAR

Syftet med denna uppsats är att hitta platsspecifika lösningar för hantering av avfall på en lokal skala. För att uppnå detta mål, behöver följande frågeställningar besvaras:

1. Vilka är utmaningarna och möjligheterna i Stone Town - Zanzibar, i fråga om hantering av avfall?

2 . Hur ska en strategi och design utformas för hantering av avfall som svarar mot de problem och kontextuella förutsättningar som Stone Town - Zanzibar har?

Studien har begränsats geografiskt till Stone Town och tematiskt till avfall från hushåll och företag. Den lokala skalan har valts för att åstadkomma en lösning som inte är beroende av omfattande infrastrukturella förändringar, vilka är omöjliga i det nuvarande ekonomiska läget.

METOD

I denna uppsats ses avfallshantering som en process som omfattar många aktörer med olika intressen. För att hantera den komplexa situationen har en fallstudie valts som metod. Vi valde att dela upp studien i tre skalor, en stads-, en gatu- och platsskala, för att förstå både helheten och detaljerna i avfallshanteringen i Stone Town.

Fallstudien inkluderar två litteraturstudier, semistrukturerade intervjuer, direkta och deltagande

observationer samt mapping. Den första litteraturstudien gav förståelse för grunderna i avfallshantering. Som landskapsarkitekter behövde vi få kunskap om den tekniska delen av ämnet som vi saknade. Den andra litteraturstudien fokuserade på förutsättningarna i Zanzibar, som till exempel sammansättning och mängd av avfall, lagstiftning och finansiering avseende avfallshantering.

Semistrukturerade intervjuer har genomförts för att förstå den administrativa strukturen som behandlar avfallshanteringen. Intervjuerna genomfördes med representanter från Zanzibars kommunfullmäktige, Institutionen för miljö samt privata företag som hanterar avfall. För att få insikt om hur det i praktiken tillämpades intervjuades boende, butiksägare, formella och informella avfallsarbetare samt icke-statliga organisationer.

Observationer, både direkta och deltagande har utförts. Båda gav förståelse för hur människor interagerar i processen kring hantering av avfall. Observationerna gjordes i samtliga steg av avfallshanteringen, från källan som genererar avfall till den avslutliga deponin, på både lokal och kommunal nivå. De deltagande observationerna gav oss en djupare inblick i det dagliga arbetet, vilket har lett till en ökad tillgång till det verkliga förfarandet.

En kartläggning har utförts för att analysera hur befintliga strukturer såsom rörelsemönster, grönstruktur, avrinning, sociala mönster och rumslighet, är relaterade till avfall . Detta gav ytterligare insikt i vilka faktorer som påverkar avfallshantering, både i stads- och gatuskala.

En SWOT-analys sammanfattar och belyser de viktigaste frågorna i avfallshanteringsprocessen i Stone Town. Tillsammans med sammanfattningar från bakgrunden, är teoretisk bakgrund och analysen av Stone Town, sammansatta till en syntes där utmaningar och möjligheter i Stone Towns avfallshantering redogörs.

NUVARANDE SITUATION PÅ ZANZBAR

Avfall kan ha en mängd olika definitioner. I denna uppsats väljer vi att definiera avfall som fast avfall från hushåll eller av liknande slag som genererats av kommersiella verksamheter, skolor och offentliga miljöer. Processen för hantering av avfall involverar flera olika aktörer. Denna uppsats har baserat klassificeringen av aktörerna på Shübeler s (1996) distinktion. Mottagare av tjänsten, leverantör av tjänsten, reglerare och externa aktörer har alla olika intressen. Mottagare av tjänsten, till exempel boende och butiksinnehavare, vill att tjänsten ska löpa så smidigt som möjligt utan några besvär. Leverantören av tjänsten, som här syftar till lokala myndigheter, icke-statliga organisationer, lokala organisationer och företag inom den privata sektorn, hanterar avfall och kan bidra med både kunskap och arbetskraft. Ett välfungerande system kräver ett rättsligt ramverk, som regulatorn är ansvarig för. De externa aktörerna är internationella organisationer eller företag som bidrar till hanteringen avfall med kapital eller kunskap (Shübeler 1996).

Avfallshantering avser materialflödet av avfall från källan till slutförvaring på deponi. Källa, insamling av avfall, lagring på en avfallsstation, transportering, processering och deponering ingår i konceptet (Melaku 2010). Denna uppsats förklarar och analyserar alla stadier, men förslaget omfattar endast de fyra första etapperna.

Det finns två huvudmodeller för avfallshantering: avfallshierarkin och integrerad avfallshantering. Avfallshierarkin är inriktad på minskning av avfall nära källan (Adama 2007), medan integrerad avfallshantering koncentrerar sig på att hitta den lösningen som är bäst anpassad för varje situation (McDougall, (red.) 2001). Det senare nämns ofta som den mest lämpliga för utvecklingsländer (Melaku 2010).

Det är viktigt att vara medveten om att det finns skillnader mellan hög- och låginkomstländer när det gäller avfallshantering. Lösningar utvecklade efter höginkomstländernas förutsättningar riskerar att misslyckas när de implementeras i ett låginkomstland. Enligt UN-Habitat (2010) enkla, anpassade och prisvärda lösningar när avfallshanteringssystemet ska moderniseras i låginkomstländer. Målet bör vara att minska mängden avfall som går till slutdeponering (UN Habitat 2010).

NUVARANDE SITUATION I ZANZIBAR TOWN

Den nuvarande avfallshanteringen på Zanzibar fungerar mycket otillfredsställande. Enligt vår analys, saknas två steg i avfallshanteringskedjan, nämligen formell processering och sanitär deponering. Detta leder till en ohållbar situation där sopor informellt dumpas över hela ön. Zanzibar har svårt att hantera situationen på grund av ett svårt ekonomiskt läge, bristfälliga lagar samt politisk ovilja. Landets avfallshantering är helt beroende av bistånd.

Zanzibar Municipal Council är ansvariga för avfallshanteringen i Zanzibar Town. Zanzibar Town är det enda området på ön där avfallshantering utförs av kommunen (Spitzbart et al . 2013). Stone Town är den

gamla delen av Zanzibar Town, och tar emot 60-70 % av resurserna går när det gäller avfallshantering. Det beror främst på att Stone Town är mycket arbetskrävande på grund av sophämtning vid varje enskilt hushåll samt den högre frekvensen av hämtning av sopcontainrar (Juma , M. 2013). Kommunen planerar att utöka Stone Towns system med avfallshämtning vid varje enskilt hushåll till resten av Zanzibar Town (Rajab 2013).

Den beräknade mängden avfall som produceras varje dag i Zanzibar Town är cirka 260 ton. Baserat på den förväntade befolkningstillväxten på 5 % per år blir prognosen avfall i Zanzibar Town 320 ton per dag under år 2015. 80-86 % av det genererade avfallet består av organiskt material. Idag finns det ingen behandling av det organiska avfall (Gauff Ingeniure 2005), istället blandas allt avfall i sopcontainrarna. Dock finns det en informell sektor, som separerar och återvinner material i en liten skala. I Stone Town, hjälper dessa individer de formella avfallsarbetarna på sopstationen utan någon annan betalning än att de får sortera ut återvinningsbart material de kan sälja vidare. Det finns även ett antal icke-statliga organisationer som bidrar till avfallsprocessen genom att sopa gatorna för en låg lön. Arbetsförhållanden för både formella och icke-formella avfallsarbetare samt icke-statliga organisationer är svåra både ekonomiskt och socialt.

FÖRSLAG – STADS-, GATU & PLATSSKALA

Utifrån den teoretiska bakgrunden, bakgrunden samt analysen av Stone Town har en avfallshanteringsstrategi och design tagits fram. De mest betydande resultaten redovisas i följande punkter:

- En minskning av avfall som hamnar på deponering är nödvändig på Zanzibar. Eftersom 85 % av avfallet är organiskt är kompostering det bästa alternativet för att minska mängden sopor. Den komposterade jorden som produceras bör användas för att förbättra grönstrukturen i Stone Town.

- För att bearbeta det organiska materialet föreslås är ett nytt nätverk av avfallsstationer. Det är ett decentraliserat system med två typer av avfallsstationer: en stor och en liten. Den stora inkluderar kompostenheter som tar hand om organiskt material. Den fungerar även som ett informationscentrum, social knutpunkt och gemensam trädgård.

- Förändrat tidsschema och justerade arbetsuppgifter förbättrar processen för att hämta sopor. Genom att till exempel låta gatusopningen ske efter att sophämtarna har tömt sophinkarna blir förloppet mer effektivt. Nya hinkar föreslås införas för de som är villiga att vara med och sortera sina sopor.

- De icke-statliga organisationerna får en ny roll som ansvariga för den stora sopstationen samt för att samla in sorterat avfall från hushållen.

- Genom att tillföra estetiska och sociala värden till platser som idag saknar funktion kommer den informella dumpningen av avfall att minska på dessa platser.

DISKUSSION

Med denna uppsats hoppas vi påvisa att avfallshantering bör ses som en process som i allra högsta grad är sammankopplad med landskapet. Utformningen av avfallshanteringen påverkar landskapet både fysiskt och socialt.

Avfallshantering är en grundläggande infrastruktur i en stad, och behöver inkluderas i stadsplaneringen. Detta är något som vanligen är förbehållet ingenjörer, men vi menar att ett interdisciplinärt angreppssätt skulle gynna planeringen genom att ge ett mer holistiskt perspektiv. Till exempel kan landskapsarkitekter bidra med att koppla samman grön- och blåstruktur samt sociala aspekter med avfallshantering. I vårt förslag visar vi på hur en lokal avfallsstation kan fungera som en social knutpunkt där människor har möjlighet att träffas och lära sig mer om hur de kan bidra till en bättre sophantering.

En viktig poäng i denna uppsats har varit att göra avfallshanteringsstrategin överförbar till andra liknande miljöer i Stone Town eller regionen. Genom att välja ut representativa platser för vår analys kan resultatet överföras till andra liknande miljöer. Men där skillnaderna är alltför stora måste en ny strategi upprättas. Då kan metodiken som används i denna uppsats användas som en mall för att ta fram en ny strategi som passar den nya platsens förutsättningar.

ABBREVIATIONS

CBO	Community-Based Organization
DOE	Department of the Environment
NGO	Non-governmental organization
RGoZ	Revolutionary Government of Zanzibar
SIDA	Swedish International Development Agency
SMOLE	Sustainable Management of Land and the Environment
SW	Solid Waste
SWM	Solid Waste management
TZS	Tanzanian Shilling
USD	US dollar
ZMC	Zanzibar Municipal Council
ZUSP	Zanzibar Urban Services Project

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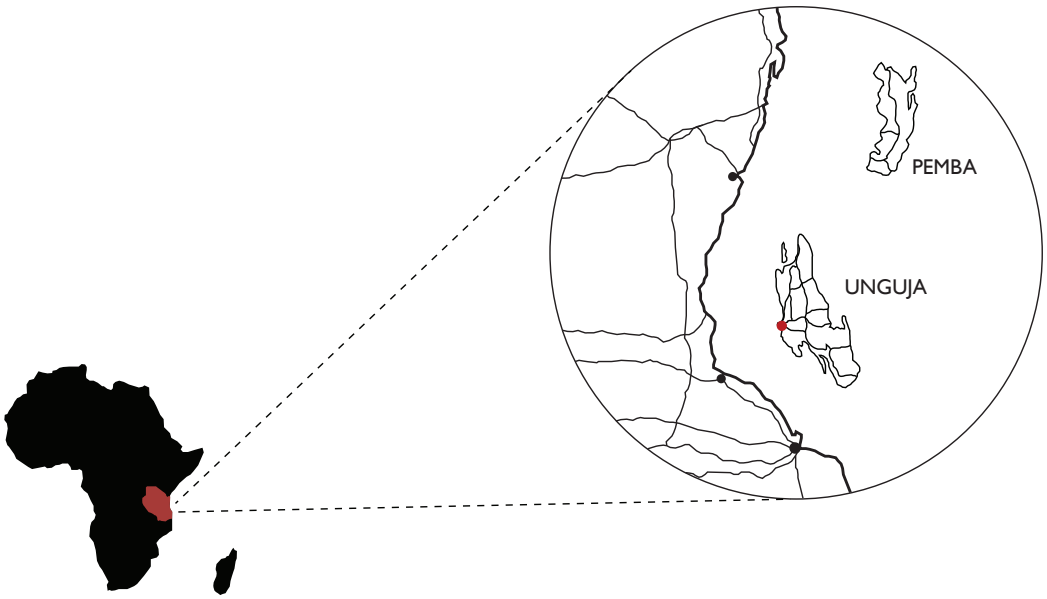
01

INTRODUCTION

THE URGENT TOPIC OF SOLID WASTE MANAGEMENT

Chapter one introduces the topic of solid waste management in a global context. It argues for the importance of solid waste management and introduces its problems on Zanzibar. The thesis problem statement is presented followed by the aim, research questions and limitations. Thereafter, the link between landscape architecture and waste management are discussed. The chapter ends with defining this thesis target group and finally reading instructions are presented.



1.1 A GLOBAL CONTEXT OF SOLID WASTE MANAGEMENT

Every citizen in the world, whatever the scale of his or her settlement, is dependent of the service of solid waste management. Yet, it is a topic receiving surprisingly little attention. According to UN-Habitat solid waste management is one of the largest challenges in the world (2010). Low-income countries are especially struggling with solid waste management due to financial, organizational and governance difficulties (World Bank 2012).

Urbanization and the increasing amount of waste go hand in hand. As cities grows faster, previously well-functioning system collapses due to problems concerning especially collection and disposal of waste (Ogu 2000). The deficient solid waste management leads to serious problems such as environmental pollution, contaminated ground water and public health issues (Vuai 2009). Insufficient solid waste collection affects all parts of the city. Uncollected waste in informal settlements is not only causing spreading of waterborne diseases in slum areas but also in wealthier areas (UN-Habitat 2010).

With today's budget constraints, political pressures and poor infrastructure developing countries must find unconventional solution for providing sustainable solid waste management systems in the cities (Kalungi Gyagenda 2010). Even though a substantial part of the cities budgets is spent on solid waste management, it is a little part of the amount that is being collected. However, many developing country cities have an active informal waste sector engaging in recycling and reusing material. The informal sector reduce the amount of waste that otherwise would have to be disposed by the city and thereby save as much as 15 to 20 percent of its waste management budget (UN-Habitat 2010). In the future, there are ample opportunities to embrace the informal waste workers in the management of solid waste and improve the process for everyone included.

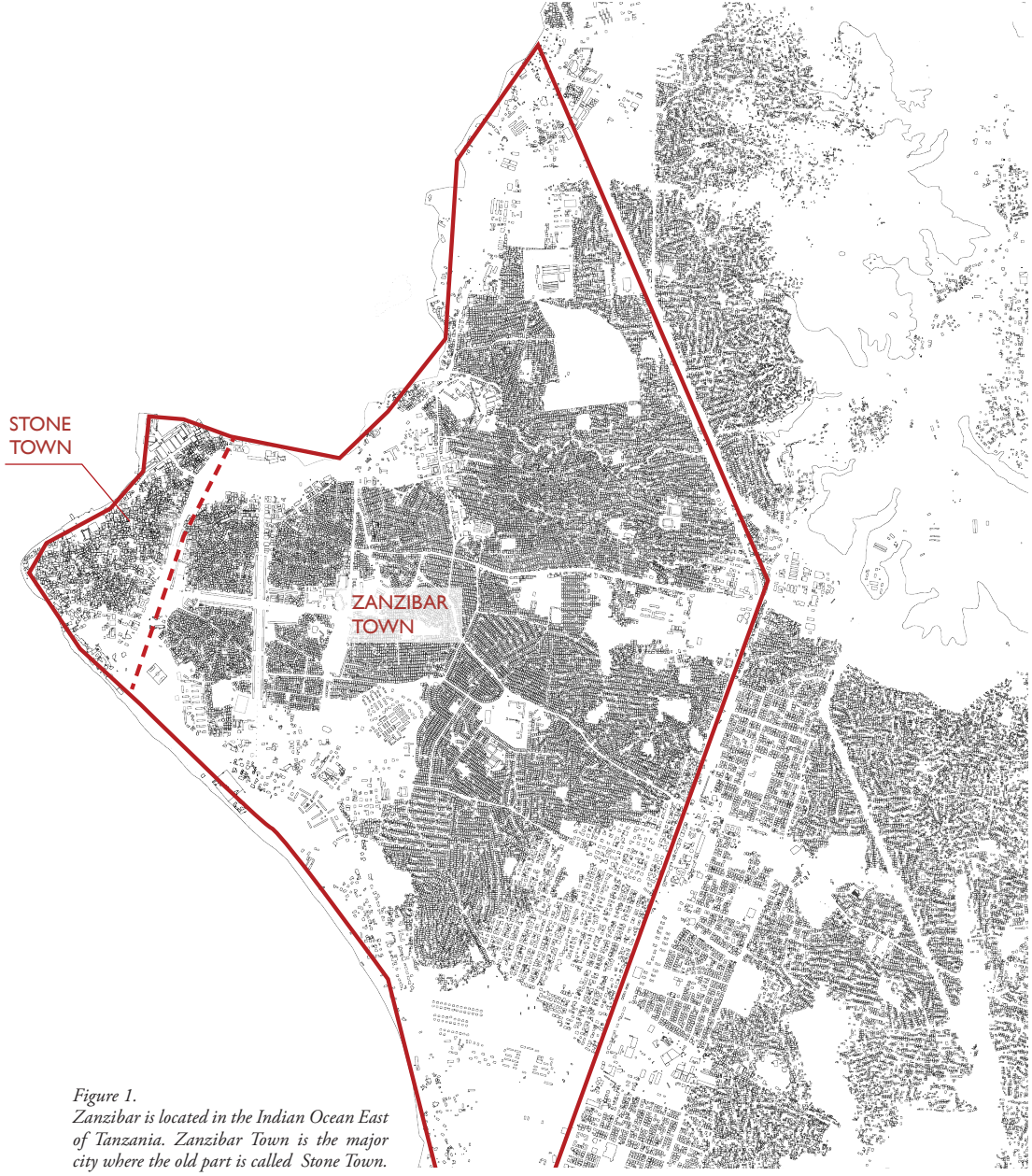


Figure 1.
Zanzibar is located in the Indian Ocean East of Tanzania. Zanzibar Town is the major city where the old part is called Stone Town.

1.2 SOLID WASTE MANAGEMENT IN STONE TOWN - ZANZIBAR

This thesis regards Stone Town, which is located in the south-western part of Unguja, one of the two main islands Zanzibar archipelago consists of. Stone Town is the old part of Zanzibar Town which is the major city of the islands. Stone Town is since year 2000 a World Heritage due to it is a high-class example of Swahili coastal trading towns of East Africa (UNESCO World Heritage Centre 2014). The classification as a World Heritage has lead to an increased tourism, which raise the pressure on the solid waste management system. Besides the increased tourism, Zanzibar Town has an estimated rate of growth of 5 % per year (Breeze 2012). This fast growing city is facing a very apparent problem with solid waste due to combination of several factors, e.g. managerial, social, financial and spatial, that leads to a lack of an organized waste management system on Zanzibar. Zanzibar Town is the only area where municipal solid waste management is conducted; the rest of the island is dependent on private initiatives. The lack of a systematic way of handling the waste leads to many significant issues for the Islands. Destruction of the landscape, bad smell, contaminated soils and leakage to ground water leads to health problems for humans and pose an obvious danger to many other species and organisms (Kalin & Skoog 2012).

This study intends to address the problematic solid waste management in Stone Town. A design proposal of a solid waste management strategy and a well-functioning solid waste collection point will be presented, which aims to give inhabitants a cleaner environment. The purpose is also to reflect how a sustainable solid waste management could be a benefit for the local economies as well as a contribution factor to a more sustainable environment in the future.

1.3 PROBLEM STATEMENT, AIM, OBJECTIVES & LIMITATIONS

The combination of poverty, rapid economical liberalisation and population growth in Zanzibar is putting great pressure on its environment and nature resources. Zanzibar is particular vulnerable to environmental degradation due to its tropical island ecosystem (The Government of Tanzania 2012).

Financial difficulties for Zanzibar Municipality Council could be considered as the prime issue concerning the poor solid waste management in Zanzibar, which leads to poor management, lack of health, education and advanced tools. Further problems are low local awareness of the consequences of solid waste and inability or unwillingness for some residents to pay for the waste management services (Vuai 2009).

The volume of municipality's solid waste has also increased steadily due to the rapid increase of urbanization in Zanzibar with a current daily production of 0.97 kg per capita. The challenges of relation between the population growth and waste management result in that only 45 per cent of the produced waste gets collected and transported to the dumping sites (Vuai 2009).

Everyday life is affected negatively by the solid waste management system which is not functioning in a satisfactory manner. Household waste that does not get emptied smells bad, spread diseases and contributes to an unpleasant surrounding. All together, the deficient solid waste management heavily affects the standard of life in Zanzibar.

1.3.1 AIM AND RESEARCH QUESTIONS

Solid waste management needs broad understanding from different perspectives and scales. As mention above, the large structure of solid waste management in Zanzibar have shortcomings in many ways. Infrastructure, technical facilities, laws and regulations and knowledge are inadequacies. These deficiencies are difficult to address due to mainly the economical situation the country finds it self-in.

This thesis aims to find site-specific solutions on solid waste management at a local scale. In this project, the local scale refers to a limited area where different features such as physical prerequisites, social cohesiveness, educational level and economic status create a particular character of the area in question. By taking in consideration of local conditions a customized approach is possible where the solution is not dependent on expensive structural changes, which is unfeasible in the current economical circumstances. To further circumvent the difficulties of structural character it may be wise to look at small-scale interventions and initiatives to find solutions that are likely to be implemented in the near future. Such interventions must be relatively cheap, contain simple intervention, be easily maintained, have a flexible construction and be profitable for the local users. A small-scale intervention on a local scale can generate change on a structural level, but is not dependent on the existing structure. This is desirable in a context where large structures do not operate properly, as in Stone Town.

To reach our aim for an effective waste management system from source to disposal, a holistic approach is necessary where the local scale interrelates to the municipality scale. Therefore, a strategy of solid waste management on a local scale will be presented, with a clear connection to the existing structures. The strategy will serve as a manual for local solid waste management in Zanzibar and other similar contexts. Design proposals will be presented based on the strategy and demonstrate how small-scale techniques can be adapted to different site-specific conditions. The proposals will further display how solid waste management can play a new role in the local community as an income generator, social platform and educational showground.

To achieve our goal, the following research questions need to be answered:

1. What are the challenges and opportunities in Stone Town – Zanzibar in terms of solid waste management?
2. What would be a strategy and design of solid waste management that can respond to the problems and contextual conditions in Stone Town - Zanzibar?

1.3.2 OBJECTIVES

To answer the research questions, this thesis serves to achieve three major objectives:

- To introduce the solid waste management process and involved actors in developing countries.
- To introduce strategies concerning solid waste management and possible technical solutions suitable for the context of Zanzibar.
- To present and analyze the current solid waste management process in Stone Town.
- To analyze the problem in context and present a solid waste management strategy on a local level that is applicable for different areas.
- To design site-specific proposals based on the local solid waste management strategy in order to show how the strategy can be implemented with precaution for the prerequisites of the site.

1.3.4 LIMITATIONS

This thesis concerns solid waste management as an important part of planning of the urban landscape. Solid waste, in this thesis, refers to materials rendered as useless to an individual. Thus, the definition is subjective and can vary from person to person. Solid waste is generated from households, commercial activities and other similar sources (Kalungi Gyagenda 2010). In this study solid waste produced from households, shops and commercial establishments. Obviously, other types of waste, for example industrial waste or liquid waste, are also of interest. But given that solid waste is the most extensive occurring and therefore most problematic waste in Stone town, it will be prioritized in this thesis.

Management of solid waste refers to the process of handling waste (Melaku 2010). In this thesis the process is described in six steps: source, collection, collection point, transportation, processing and disposal. Each step in the process involves several actors with different interests and agendas. Since the focus in this thesis is on a local scale, the proposals have been done on the steps where a local approach can be adapted. In the case of solid waste management, this is in the first three steps, namely; source, collection and collection point.

The thesis conducts a case study of Stone Town. Due to the fact that the solid waste management in Zanzibar Town, is the most challenging work for Zanzibar Municipal Council this topic is chosen. The technical solutions are limited to the degree of feasibility in a local scale, namely relative cheap, space-efficient, simple construction and easily maintained.

1.4 LANDSCAPE ARCHITECTURE & WASTE MANAGEMENT

Solid waste management is a process that highly affects the landscape. Regardless of how well planned and adapted the management is, the landscape will always be a part of the progression. In the light of that approach, where both the landscape and waste management is viewed as ongoing processes, it is motivated that the involvement by landscape architects in the planning of solid waste management is necessary.

Commonly, tasks concerning solid waste management have been limited to mainly engineers or similar professions. It is this thesis belief that the complex task of solid waste management needs to be addressed from several directions. Diverse professions have different aspects to add to the planning of solid waste management. Engineers could contribute with technical skills, physical planners with an overview planning perspective and landscape architects with an aesthetical, social and environmental knowledge. All discipline proposes solutions different from one each other, contributing with important aspects of solid waste management.

Landscape architecture is an interdisciplinary subject that derives its theories from different scientific disciplines. Spatial planning, design, ecology and sociology are all important aspects of the discipline and can contribute to the management of solid waste management in Zanzibar.

1.5 TARGET GROUP

The thesis serves as an example on how landscape architects can contribute to solid waste management. Therefore, the target group is foremost landscape architects. The thesis will also be of interest for other professions that are trying to find new approaches to the topic of waste management. Lastly, an obvious target group is stakeholders and officials responsible for solid waste management in Zanzibar, such as the Department of Urban and Rural Planning, Zanzibar Municipal Council, Stone Town Conservation and the Development Authority to name a few.

1.6 READING INSTRUCTIONS

Since the thesis is rather extensive following reading instructions will guide the reader through the work. The comprehensive work was needed in order to obtain an in-depth understanding of the topic, the context and the waste situation in Stone Town. Due to the high commitment of making a proposal which could actually be realized and put into practice, the extensive work was required. In addition, the way of representing the thesis with many graphs, figures and images also expands the number of pages. Yet, in order to make the thesis appealing to read and easy to understand all the illustrations and pictures are needed.

Following spread gives an overview of the chapters in the thesis which will help the reader to understand the structure of the thesis:

01 INTRODUCTION
THE URGENT TOPIC OF SOLID WASTE MANAGEMENT

Chapter 1 explain the aim of this thesis and argues that solid waste managemnet is an urgent topic thet needs to be dealth with.

02 METHODOLOGY
CASE STUDY OF STONE TOWN

Chapter 2 demonstrate the methodology of the thesis and how the case study was conducted. It also argues for the credibility of the thesis when combining different methods.

03 THEORETICAL BACKGROUND
AN OVERWIEW OF SOLID WASTE MANAGEMENT

04 BACKGROUND OF ZANZIBAR
CURRENT SITUATION IN ZANZIBAR

Chapter 3 and 4 serves as the background. The theoretical background provides knowledge of the topic while the background of Zanzibar exposes the prerequisites that affect the SWM on the Island. These chapters are important to fully understand the SWM compexity in Zanzibar, but since they are both ending with a summery it is possible to only read them.

05 ANALYSIS OF THE SWM PROCESS
FROM SOURCE TO DISPOSAL

06 ANALYSIS OF STONE TOWN
PHYSICAL CONDITIONS

Chapter 5 and 6 contains the analysis. In chapter 5 the SWM process, from source to disposal, is analysed stage by stage which gives a clear view on how the SWM works in Stone Town. Chapter 6 reveals features in Stone Town affecting the SWM process. These chapters are also ending with a summery of the most important facts revealed from the analysis.

07 DESIGN PROPOSAL
TOWN, STREET & SITE

Chapter 7 starts with a synthesis of analysis from chapter 3,4,5 and 6. Based on the synthesis of analysis, a SWM strategy is proposed. Thereafter, design proposals on different scales shows and explaines how the strategies are implemented on site.

08 DISCUSSION
REFLECTIONS OF THE PROJECT

Chapter 8 discusses the importence of SWM and reflects over the proposed solid waste management and its transferibility to other similar places.

02

METHOLOGY

A CASE STUDY OF STOWN TOWN

This chapter describes the methodology used for conducting this research. As the research is based on using case study as a method to examine solid waste management in Stone Town, an explanation of its benefits will be outlined, as well as a presentation on how case study was used in this particular case. Furthermore, the chapter reveals the various methods applied in the case study to collect data concerning solid waste management. The chapter also explains how the collected data was compiled and analyzed using a SWOT analysis to highlight the key issues of solid waste management in Zanzibar.

2.1 CASE STUDY

Solid waste management is a complex task since the issue is rooted in many factors. Politics, social customs, economy, habits and environmental issues all contributes to the situation of solid waste management in Stone Town. As the process of solid waste management is a practice that links different stakeholders on various stages, all elements must be fully elucidated. The case study is a fruitful approach when it comes to understanding such complex situations since it includes a variety of methods (Berg 2010). Therefore case study is chosen as the method for this thesis.

Case studies are generally considered as an overall strategy and can be combined with many different methods of data collection (Berg, 2010). Combining different methods is known as triangulation. By using a triangulation the validity of the data collection can be confirmed (Johansson 2007). In this thesis the following qualitative and quantitative methods will be used; literature study, observation, participant observation and interviews. These methods are further explained in the following sections.

In this thesis, the case study regards solid waste management in Stone Town. Stone Town is the old part of Zanzibar Town, which is located on the western part of Unguja, the main island of Zanzibar archipelago (McIntyre, C. & S, 2013). The specific case study was selected following an in depth discussion with the department of Urban and Rural Planning, Zanzibar. The department believe that solid waste management is one of the more urgent challenges for improving the quality of life in Zanzibar city.

The study has been done in three different scales: a town scale, a street scale and a site scale. Stone Town constitutes the town scale. It gave an understanding of larger structures, such as roads, greenery and other physical prerequisites important for the infrastructure of solid waste management. An additional focus turned to collection points, as they are crucial to the waste disposal system works in the city.

The street scale was represented by Sokomuhogo Street, an old bazar street with a mixture of shops and housing. The street was chosen because it represents a commonly found context in Stone Town. The street scale provided a detailed view of how the structures were contextualized on-site.

Three different sites comprised the smallest scale, the site scale. Two of them were chosen from the analysis of Sokomuhogo Street, as examples of sites as attract waste being dumped. The third site were a site suitable for a new collection point.

The selection of sites, for all three scales, was crucial for the result. The sites were selected through own observations and analysis, and in consensus with local officials, namely the Department of Urban and Rural Planning and the Zanzibar Municipal Council. The most important factor to consider when locations were chosen was that they represented common contexts of Stone Town. By doing that, the result is transferable to other areas of the city. To also include several sites led to that the strategy could be tested for various conditions and allowed for a wide range of factors could be included.

The case study provided knowledge and understanding of the different phases of the process of solid waste management, their prerequisites and details, which had not been documented before. This approach supplied a holistic view of all levels of the solid waste management and the interaction between them. Furthermore, to understand the actual situation and be able to make a proposal tailored for the circumstances, a detailed approach has been done throughout the thesis. It is this thesis opinion that it is essential to identify the details of the process for making a feasible and sustainable solution.

Based on the research and analysis performed, a local solid waste management strategy has been developed and constituted as a basis for the proposals. By having selected common contexts within the city the adaptaion of the strategy could be tested and evaluated.

In the following sections, a detailed description of the methods that were used and the information that was collected with them is presented.

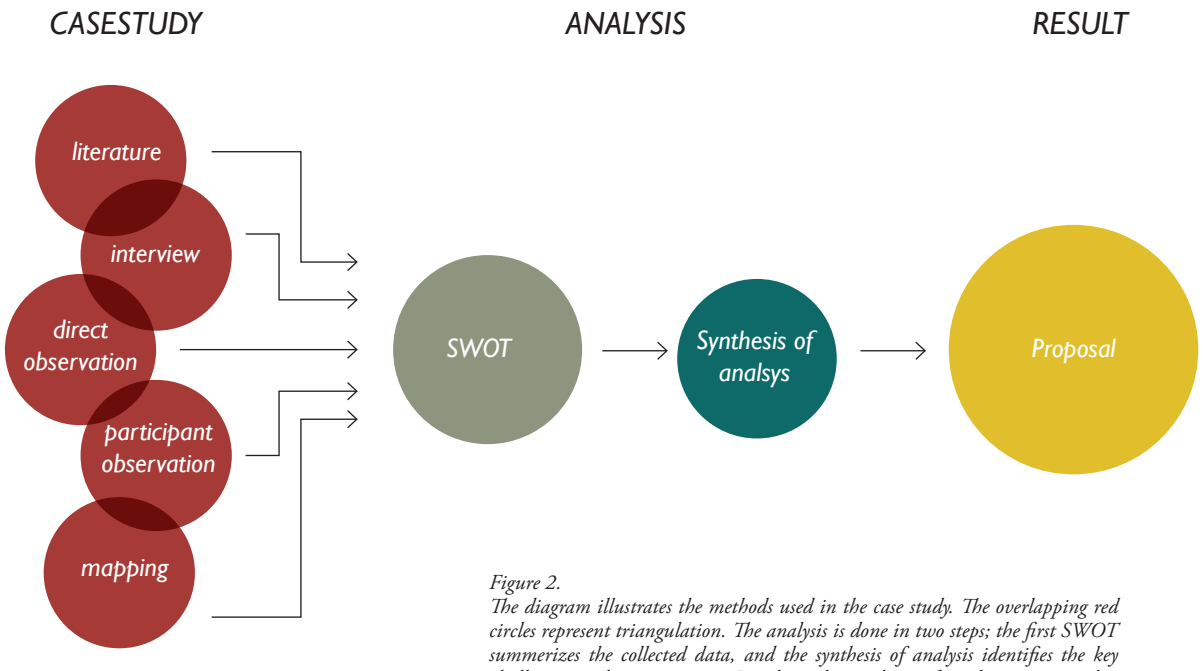


Figure 2.
The diagram illustrates the methods used in the case study. The overlapping red circles represent triangulation. The analysis is done in two steps; the first SWOT summerizes the collected data, and the synthesis of analysis identifies the key challanges and oppertunities. Based on the synthesis of analysis a proposal is developed.

2.1.1 LITERATURE STUDY

Two literature studies were conducted. The first literature study was made to collect the available knowledge of the subject. This literature study focused on the topic of waste treatment and possible technical solutions for processing solid waste in developing countries. The databases used for finding the relevant books, scientific articles, dissertations for the literature study were Web of knowledge and KTHB Primo. The main key words used to find the data were; SWM, SWM in developing countries, SWM in East Africa, ISWM, processing of solid waste in developing countries and recycling in developing countries. The literature study provided a foundation for understanding the basics of solid waste management and is presented in the theoretical background. Landscape architects commonly handle process-based situations, but the technical part of solid waste management therefore required further studies.

The second literature study was concentrated on the case of Zanzibar. Waste management, waste composition and quantities, policies and regulations and finance concerning solid waste management specific to Zanzibar was information searched for. Documents such as reports concerning solid waste management, legislative texts, Governmental policies and theses of the subject constituted the source of information. These documents were assigned in Zanzibar. The second literature study was necessary in order to relate to the existing situation and propose a sustainable solid waste management solution responding to the actual state of Stone Town. The gained information is presented in the background of this thesis.

2.1.2 SEMI-STRUCTURED INTERVIEWS

Interview is an important method when it comes to getting hold of people's opinions. The interviews were serving two different purposes. One was for understanding the administrative structure of the waste management in the town scale. The other purpose was to gain insight of how the policies works into practice on the street scale.

Concerning the town scale, semi-structured interviews were carried out with actors involved in solid waste management in Zanzibar Town. Four representatives from Zanzibar Municipal Council, two from the Department of Environment, two from Urban and Rural Planning and two from private companies were interviewed. The interviews took in between a half an hour to one and a half an hour each. Questions were asked about topics concerning how the solid waste management is carried out in Zanzibar Town (see appendix 2). The obtained knowledge from the interviews is included in the background.

To attain information of the street scale residents, shop owners, formal and informal waste workers and non-governmental organizations were interviewed. Concerning the residents and shop owners the main purpose was to document their opinions and attitude towards recycling and composting as well as their knowledge of solid waste management. Five residents and five shop owners, mostly men, from Sokomuhogo Street participated. Each interview took between a half an hour and two hours. The interviews were of informal character with questions open for different responses (see appendix 1). The responses provided not only a good understanding

of solid waste management, but also insight into current social issues, politics and everyday events.

Four different non-governmental organisations were also interviewed in order to understand their role in the SWM and hear their oppinions about the system (see appendix 2). These conversations gave comprehension of the everyday routine which was important when developing the proposal. Further, to involve all actors of the SWM, five semi-structured interviews were carried out with informal waste workers in Stone Town (see appendix 2). These interviews were of casual character and were time consuming since it required involvement in their environment.

All interviews provided knowledge of how waste management is performed in Stone Town in terms of working conditions, equality, income and expenditure relating to solid waste. The information gathered from the interviews provided different perspectives of the issues related to solid waste management, which in turn gave a comprehension of the situation. The result is presented in the analysis.

2.1.3 DIRECT OBSERVATION

Having an exploratory approach and making careful observations profound understanding of how people interact was gained. The observation was done of the waste management process from source to disposal on both local and municipal level. Especially informal waste workers and the interaction between informal and formal waste workers at the collection points and the disposal sites were obtained. How the separating was done, what was separated, whom was doing it and where it was done are examples of observed situations. The observations also helped to confirm or deny information obtained from interviews and literature.

The understanding that the observation gave is featured in the analysis of the thesis. When observing at the street scale, photo sessions were conducted to document the accumulation of solid waste on Sokomuhogo Street. This method was developed on site to meet the need for documenting the accumulation on the street scale. The photo method enabled comparison of different places at different times. The media in itself clarifies observations and has been used as a file bank. The outcome of the documentation and analysis was the identification of critical places, times and contexts concerning solid waste accumulation.

2.1.4 PARTICIPANT OBSERVATION

Participant observation is "the process of learning through exposure to or involvement in the day-to-day or routine activities of participants in the researcher setting" (Schensul, S., Schensul, J. & LeCompte 1999, p. 91). According to Halvorsen (1992) participant observation is an appropriate method when the researcher examines foreign cultures and do not know the answer they are looking for. The challenge is to listen and watch without preconceptions (Halvorsen, 1992).

To understand all the stages in the solid waste management process, formal waste workers have

been followed. Door-to-door collectors, street sweepers and a truck driver have been followed during their daily workday. As a positive consequence of participating in waste workers' daily duties, not only a deeper insight of their work was gained but also their trust. This has led to greater access to the realities of the procedure of solid waste management.

There have been different levels of participating in waste workers labour. When going with door-to-door collectors, a foreman supervised which may have affected the daily work of the collector. The foreman decided who should be followed and in what area. The work of the street sweepers, on the other hand, was transparent in a larger extent since it was without any monitoring of higher authorities. Participation of sweeping the streets allowed insight into their working conditions, daily procedure and how people view their work. When following the truck driver in his skip truck the field work was supervised by the municipality. This highly limited the insight of the truck drivers' daily routine.

The newfound knowledge obtained from the participant observation is mostly presented in the analysis of the town and street scale.

2.1.5 MAPPING

Thematic mapping has been performed to analyse how existing structures, such as flux, greenery, run off, social patterns and spatiality, is related to solid waste. By having collected a large range of information, related to solid waste management, intimate knowledge of the society of Stone Town has been gained. Physical prerequisites, architectural features, social and cultural patterns, greenery, run-off and the flux of Sokomuhogo Street have been mapped and are displayed in the analysis chapter.

The PEBOSCA framework was used as a guideline in the beginning of the project to map different physical and social elements of Sokomuhogo Street. PEBOSCA is a framework that facilitates the inventory of important elements and values within an area or a place. This inventory is useful in analysing and evaluating a place. The framework is derived from the UN HABITAT Agenda and classifies resources such as physical, economical, biological, organizational, social, cultural and aesthetic (Berg, 2010). However, this framework was further developed and adapted to meet the focus of this thesis. The categories have been adjusted to provide the necessary information related to solid waste management. Consequently the PEBOSCA is not a cohesive chapter and not further mentioned in the report.

2.2 SWOT ANALYSIS

The SWOT- analysis stands for strengths, weaknesses, opportunities and threats. The analysis is done by structuring all relevant material under four SWOT categories. This clarifies which strengths should be preserved, what weaknesses that should be reduced, the opportunities that should be developed and what possible threats should be handled (Sveriges Kommuner och Landsting, 2007).

In this thesis, the SWOT analysis served as a tool to sum up the gathered data and to

identify key questions of importance for further work with the design proposals. Gathered information concerning the waste management process and the prerequisites of Sokomuhogo Street were analyzed according to the method and is presented under each stage of the solid waste management process.

2.3 DISCUSSION OF METHODS

The case study, as previously mentioned, is useful when studying very complex situations or processes. Whether one can make a generalization from its outcome depends primarily on the case selected. For this project, Stone Town was selected as a case of study. This choice can be criticized on two main points. First and foremost, Stone Town is a heavily populated part of Zanzibar Town: the area exhibits a much more dense environment and is also more adapted for tourists than any other part of Zanzibar Town or parts of the Island. Therefore, one may ask whether it would have been better to choose a more representative environment, if the goal is to generalize from the findings of the case study. Secondly, as it is the part of Zanzibar Town where most of the resources are allocated, one should perhaps choose a part that does not enjoy the same focus and resources than Stone Town already possesses. However, since the municipality of Zanzibar Town is planning to extend the SWM system of Stone Town to other part of Zanzibar Town, it is an interesting case to study and evaluate. By doing this, other parts of the Island may benefit from the finding of the research.

The case study included several methods. The choice of methods has in and of themselves impacted in the result. For example, there was a big difference when we ourselves observed or participant observed in comparison to when we were accompanied by officials of the municipality. In the latter case time schedules was changed to speed up the process, which clouded the data collected. Obviously, this is something we had to take into consideration when making our analysis. If the same information could not be substantiated in other ways we were forced to remove it. Another circumstance to keep in mind for the validity of the thesis is that our documentation and analysis was conducted during the low season when less amount of solid waste is produced. Hence, our figures are modest. Further, the latest figures of quantities and composition are from 2005 which also needs to be taken in consideration.

Many of the analyses can be improved when it comes to execution. Due to security reasons, we could not make observations after nightfall, hence a full analysis of the whole day proved impossible to achieve. Also, the preciseness of the data collecting can be improved. When analyzing on the street scale, we developed our own techniques for registering our observations. These new mapping techniques, referred to as photo sessions and mapping of street bins, may be further developed in the future. By utilizing a GPS for example, these techniques may be refined in order to produce a more precise result. However, we found our results accurate enough, for the level of this thesis, to make proficient conclusions.

The greatest strength of this thesis has been the combination of diverse method. While our multi-method approach has proven successful when it comes to the thesis reliability, it has been time consuming and resulted in an extensive master thesis.

03

THEORETICAL BACKGROUND

SWM IN GENERAL

Chapter 3 addresses the theoretical framework concerning solid waste management. It starts with a definition of solid waste and how this thesis relates to that definition. The designation is essential for the focus of the thesis and thereby important for the result. Following section describes the actors of solid waste management which are divided in subgroups along if they are service users, service providers, regulators or external support agencies of solid waste. To know which actors that are affecting and are affected by the process is important to be able to analyze and develop solutions that everyone benefits from. The actors are part of the process of solid waste management which is outlined further in this chapter. The section gives an idea of options available of solid waste management that are necessary for understanding its process. The second half of the chapter brings up existing models and guiding principles of modern waste management. It also explains differences of solid waste management in developed and developing countries. Both provide a basis, together with the analysis, for the forthcoming solid waste management strategy in chapter 7. Finally, a brief overview of technical solutions suitable for the conditions of Zanzibar is presented. The solutions give a hint of elements which can be implemented in the latter design proposal.

3. 1 DEFINITION OF SOLID WASTE

In this thesis, the working definition of solid waste refers to non-hazardous wastes generated by households, and wastes of similar nature generated by commercial establishments, schools and from public spaces.

Waste is a non-absolute term since it refers to material rendered useless to an individual. What is considered useless for one person may be of value for another (Gyangenda 2010). McDougall (red.) (2001) find that although waste consists of the same materials as useful products, it is considered useless. That is because the material is mixed and the content is unknown. The value of waste therefore normally rises when separated due to the quality of the waste is retained in a larger extent (McDougall (red.) 2001).

Solid waste is either solid or semi-solid form; the latter refers to liquid solid waste such as wastewater and sewage. Solid form of waste may consist of refuse from households, non-hazardous solid waste from industrial, commercial and institutional establishments, market waste, yard waste and street sweepings (Schübeler 1996). The sources of solid waste can be categorized into residential, commercial, institutional, construction and demolition, municipal services, treatment plant sites, industrial and agricultural (Technobanaglous et al. 1993). This thesis is focusing on, as mentioned above, the solid form of waste that is produced by residential, commercial and institutional actors.

3.2 ACTORS OF SOLID WASTE MANAGEMENT

Explaining the different actors and their interest of solid waste management is important for this thesis. It gives a comprehension of how the actors' interest affect the solid waste management process. A variety of individuals, groups and organizations are concerned with Municipal Solid Waste Management (MSWM). Service users, service providers, regulators and external actors all have different interests, agendas and roles. The following chapter gives a brief overview of the roles and interests of the actors based on Shübeler's (1996) distinction. All the information relates to the context of low income countries.

3.2.1 SERVICE USERS – THE GENERATORS OF WASTE

There are two types of service users; households and commercial establishments (Shübeler 1996). A household is a unit of people sharing residence (NE 2013), and a commercial establishment refers to marketable activities with the intention to provide revenue. According to Shübeler (1996), both types of service users desire effective and dependable waste collection services at affordable prices. Commercial establishments are particularly concerned with avoiding waste related pollution that could bother their customers. Further, Shübeler (1996) indicate that only informed and aware citizens are interested in having an environmentally sound disposal. Hence, it is of great importance to include educational solutions, latter to be used in the proposed solid waste management strategy (see chapter 7), to inform residents on how to reduce the amount of waste.

3.2.2 SERVICE PROVIDERS – MANAGING THE WASTE

Service providers refer to actors managing solid waste. Among these actors are Community-Based Organizations (CBO), Non-Governmental Organizations (NGO), local governments, private sector enterprises, informal private sector and external support agencies. A description of these is provided in the following sections. The section also highlights their importance for this thesis.

Community-based Organizations

CBOs are often formed by poorly served residents to upgrade local environmental conditions (Shübeler 1996). However, the interest of the CBOs is primarily to gain an income. When adequately organized, CBOs have substantial potential for managing and financing local collection services and operating waste recovery (Shübeler 1996).

Non-governmental Organizations

According to Shübeler (1996), non-governmental organizations (NGOs) organize between the governmental and private realms. NGOs are motivated by humanitarian and/or developmental concerns rather than an interest in improving the service for their own members. NGOs can help to enhance the community's capacity to manage waste collection. They can also support the informal sector by improving their working conditions. This may involve increasing the income, accessibility to social services such as health care and education (Shübeler 1996). By the actions mentioned the NGOs have a possibility to become a link between the informal sector and the society.

Local government

Shübeler (1996), describes local government authorities as responsible for the provision of solid waste collection and disposal services. Responsibility for waste management is customarily specified in bylaws and regulations. Further, local governments generally contract private enterprises to provide waste management services. In this case, local authorities remain responsible for regulating and controlling the activities of these enterprises. Lastly, Shübeler (1996) declares successful solid waste management depends upon the collaboration with the population. Local governments should take action to enhance public awareness of the importance of MSWM and promote active participation of users and community groups in local waste management (Shübeler 1996). In this thesis a major focus is put on the local government since they are responsible of providing the solid waste service. Every step of the service requires careful studies in order to understand the process and propose adjustments of it.

Private Sector Enterprises

The formal private sector includes a wide range from informal micro-enterprises to large business establishments. They are primarily interested in earning a return on their investment by selling waste collection, transfer, treatment, and recycling and/or disposal services. With a mixture of forms of partnership with the public sector, they may provide capital, management and organizational capacity, labor and/or technical skills (Shübeler 1996).

Due to their profit orientation, private enterprises can provide more efficient, lower cost MSWM services, under appropriate conditions. Nevertheless, private sector involvement does not guarantee effectiveness and low costs, especially when privatization is poorly conceived and regulated and when competition between suppliers is lacking (Shübeler 1996). It is this thesis position this sector must be carefully investigated in order to find any partners who can contribute to the waste management process.

Informal Private Sector

Informal activities carried out by individuals, families, groups or small enterprises comprise the informal private sector. The informal sector, such as waste collectors and scavengers, are often driven by poverty and the absence of more attractive employment possibilities (Shübeler 1996).

In some cases, belonging to religious, caste or ethnic minorities leads to social discrimination,

which obliges them to work under the informal private sector as waste collectors or sweepers. The working conditions for informal waste workers are usually very unstable and are often associated with homelessness (Shübeler 1996).

The waste management activities, such as collection, transfer, separation, recycling and/or disposal of informal waste provided by these workers constitute economically valuable services. The informal waste workers may be working on a self-employed basis or as informally organized groups. Normally, however, the informal waste workers contribution to the MSWM system is hard to integrate to the formal system due to their marginalized and unstable social and economic circumstances. Organizational and technical support is an initial step to promote their social rehabilitation and improve the conditions in which they live and work. By formation of co-operative societies or micro-enterprises, there is a significant chance to increase the job stability and earnings of informal sector workers, and to enhance the effectiveness of their contribution to waste management (Shübeler 1996).

It is important to find out how the existing informal private sector operates in order to propose how they can be formally included in the process for raising their standard of living and further contributing to the waste management.

3.2.3 REGULATOR – RESPONSIPLE FOR LEGISLATIVES

The regulator of solid waste management is, according to Shübeler (1996), the national government. They are accountable for the MSWM institutional and legal framework as well as ensuring that local governments have the necessary authority, powers and capacities for effective solid waste management. The national governments need to assist the local governments with guidelines and/or capacity-building procedures in the fields of administration, financial management, technical systems and environmental protection (Shübeler 1996). Thus, obviously the prioritizing of the topic from the national government is highly affecting the quality of solid waste management. This thesis requires the knowledge of laws and regulations that exist because they provide the prerequisites to give a design proposal (see chapter 7) that fits within the legal framework.

3.2.4 EXTERNAL ACTORS

For external actors, MSWM is often a component within a broader urban management program. The need of improving the cooperation between external actors dealing with MSWM is urgent. Because of lack of rationality in the technical and developmental concepts of successive external actors contributions, many cities of developing countries are burdened with incompatible and ineffective MSWM facilities and equipment. Coordination should also include external NGOs working with closely related areas to waste management (Shübeler 1996). In this thesis, the external actors need to be examined to see what their role are today and what they can contribute with in the future.

3.2.5 CONCLUSION

There are many actors with different interests involved in the solid waste management process. They all have to be considerate when making a solid waste management proposal.

Service users, such as residents and commercial establishments, are the generators of waste. If they are well informed, they can ease the process by for example separating the waste close to source. Service providers, such as CBOs, NGOs, local government and the private sector enterprises, refer to the actors managing waste. The service providers have the opportunity to contribute with knowledge and labor. Communication between the service providers is essential to facilitate the services. Also, a functional system requires a set legal framework, which the regulator is responsible for. This must be clear for everyone involved and supported by the citizens. The external actor can contribute with knowledge and capital. To maximize their utility, they must evaluate the solid waste management as a whole before contributing with resources.

3.3 SOLID WASTE MANAGEMENT – FROM SOURCE TO DISPOSAL

Solid waste management (SWM) refers to the material flow stream of waste from source to final disposal. Source, collection, storage, transportation, processing and disposal are included in the concept (Melaku 2010). In the following section each step of the concept is described to provide knowledge about the process of solid waste management. This knowledge serves as a platform of information, latter to be used in the analysis of the case study in Stone Town.

3.3.1 SOURCE

Source is the generator of solid waste such as households and commercial establishments (see section 3.2.1). Waste generation is highly dependent on individual preferences. Further more people's attitude and awareness of environmental impact of waste influence the individual waste generation and -managing (Ermias 2011).

Avoidance and minimization of waste require the least effort and yet present the greatest returns. Therefore the highest priority should be to prevent waste generation at the source (Gyagenda 2010).

To achieve reduction of waste at a source level, one needs to have knowledge about the source and types of solid waste produces, together with composition and rate of generation. This information is basic to the design and operation of the functional elements with the management of waste (Technobanaglous et al. 1993).

3.3.2 COLLECTION

Collection refers to removing accumulated waste from generating sources. It may imply collection from a centralized location where the solid waste has been delivered by the generator of waste, or by going from individual generator to another, i.e. door-to-door collection (Melaku, 2010). The choice of collection system determinate the cost for the community in effort and money. The amount of labor, level of community participation and transport systems used are factors that regulate the design of primary and secondary collection systems (*Solid waste management in low-income housing projects: the scope for community participation* 1989). Since the type of collection system highly affects the process, it is one of the most important steps of solid waste management to have knowledge about for further analysis of the case study in Stone Town. There are a number of different collection systems; no collection system, primary collection system and secondary collection system, each explained below.

No collection

No collection is a common system in developing countries where waste is thrown a short distance from the house. Most of the waste is eaten by animals, dried in the sun and occasionally burnt. No collection has especially negative impact on the environment in wet seasons: the humidity turns the waste into a hazardous risk with breeding ground for insects and the waste will emit a bad smell from the rotting process (*Solid waste management in low-income housing projects: the scope for community participation* 1989).

Primary collection

Primary collection refers to the collection from generators to a collection point or a depot. Community waste disposal mostly concerns primary collection. There are different types of primary collection systems such as door-to-door collection, curbside collection, block collection and communal depot.

Door-to-door collection implies collection by the door of the generator of waste (see fig. 3). The collector stops as close as possible and households or shops are only required to put waste in a small container or bin. In dense areas where vehicles cannot enter, a handcart is usually used as equipment instead of a truck. The waste is transported to a waste collecting site within the

neighborhood (*Solid waste management in low-income housing projects: the scope for community participation* 1989).

A similar version of door-to-door collection is the curbside collection (see fig. 4). The only difference is that standardized refuse bins, designed to fit the lifting devices of the truck, is required (*Solid waste management in low-income housing projects: the scope for community participation* 1989). The homeowner is responsible for placing the containers to be emptied at the curb on the collection day and for returning the empty containers to their storage location until the next collection (Techobanolous et al. 1993). In this method, it is the collector of the waste who has the responsibility to collect the waste separately, which is very convenient for the householder. However, it requires cooperation and scheduled service between homeowner and collector. (Bachamanda & Ramachandra 2007)

Block collection comprises of a block system where collection vehicles arrive at a particular place or a set day and time to collect waste from the households (see fig. 5). People living within a residential block bring their waste bins and empty them directly into the vehicle (Bachamanda & Ramachandra 2007). Benefits with this structure are reduced collection staff members and no steeling of bins. Proper coordination between the people and the collection service is required (*Solid waste management in low-income housing projects: the scope for community participation* 1989).

Centralized collection is the same principle as block collection but there is no fixed collection point for each household (see fig. 6). People go with their own waste to the collection point. The centralized collection reduces the number of stops for the collecting vehicle and eases the route of collecting. Hence, the risk of people not throwing their waste in the collection point is increased with the distance from the source (*Solid waste management in low-income housing projects: the scope for community participation* 1989).

As it will be shown in chapter 7, the door-to-door collection will be used as the method of primary collecting as it is the existing system that residents and municipality are content with and what the physical street structure allows (see chapter 6).

Secondary collection

Secondary collection refers to the collection of waste from the collection point to a communal depot or recycling facility. This procedure is usually the responsibility of the municipality and is depending on the choice of the primary collection system and available equipment (*Solid waste management in low-income housing projects: the scope for community participation* 1989).

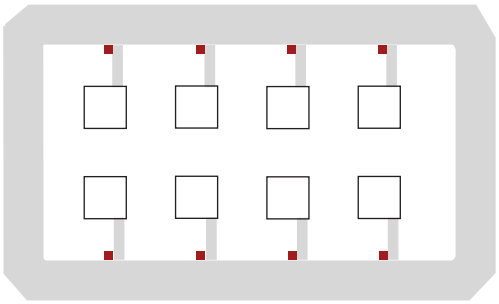


Figure 3.
Kerbside collection demands roads accessible for waste trucks and standarized bins designed to fit the lifting devices of the truck.

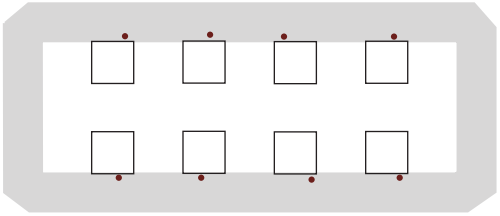


Figure 4.
Door-to-door collection implies collection by the door of the generator of waste.

3.3.3 STORAGE

Storage is referred to when waste is put in a temporary reservoir before transported to final disposal. Storage can be done at different levels, at source (often household) and at the community level are two examples among others. Household storage is when every household has it own container, with a lid. The size depends on how much waste is being generated and the collection frequency. The household storage is very time-consuming and costly for a truck. Community storage is when a collection point is used. This type can be used to make the process more efficient (*Solid waste management in low-income housing projects: the scope for community participation* 1989). The most suitable type of storage is determined by the type of waste, generation rate and the size of the premises. The storage must be durable enough to withstand solid waste collection. It must also be animal and insect proof (Melaku 2010).

The design of the community depot affects its use and maintenance. For example, an open depot is unprotected against rain, insects and rodents which make it hard to keep the container clean. Loading and unloading can be unpleasant and tiring for the collectors. However, it is a cheap solution and scavengers have free access to the depot and can reduce the amount of waste by collecting material for their own purposes. By using a closed depot, fly breeding, rapid decay and leachate are being reduced. This improves environmental control (*Solid waste management in low-income housing projects: the scope for community participation* 1989).

3.3.4 TRANSPORTATION

Transportation refers to the transfer of solid waste from a (central) point to a more (distant) final management facility (Gerald 1997, in Melaku 2010). There are various types of vehicles used for primary collection and secondary collecting. For primary collection, different kinds of handcarts, pedicarts or animal-operated carts are used. An array of trucks and equipment are used for secondary collection, such as trailers and containers, flat containers with tractor, waste collection trucks, and compaction refuse collection trucks (Schübeler 1996). It is essential that the system of transportation and equipment used, must match the existing situation of the local waste management. In the design of solid waste management, the selection of vehicles, including the operational cost, should be carefully chosen and not exceed the planned budget.

3.3.5 PROCESSING

In this thesis processing is referred to when solid waste is treated and transformed, into the same product or another creation, with the purpose of using the material again. Processing can be divided into recycle, reuse, anaerobic- and aerobic process and incineration. It is a crucial to have knowledge of this part of the solid waste management process in order to propose solutions

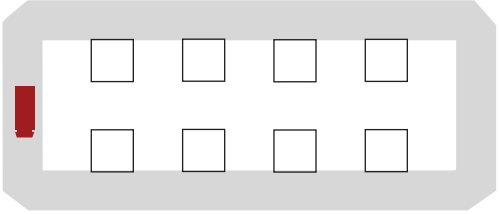


Figure 5.
Block collection comprises of a block system where collection vehicles arrive at a particular place or a set day and time to collect waste from the households.

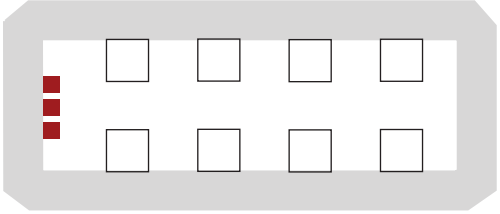


Figure 6.
Centralized collection is when people go with their own waste to a centralized collection point.

for reducing the amount of waste going for final disposal. The different types of processing are presented below followed by a conclusion.

Recycling

Recycling is the removal or separation of material, discarded as useless, and then re-used. Either the reused item have the same original purpose or it is processed into raw material and then developed into something else (Gerald 1997, in Melaku 2010). The less processing needed before the reclaimed material can be re-used, the more economically beneficial it is. Examples of recyclable materials are paper, plastic and metal. Private enterprises, individuals, communities and municipal can run the recycling, depending on the context (*Solid waste management in low-income housing projects: the scope for community participation* 1989).

Reuse

Melaku (2010) defines reuse as solid waste materials used again for the same purpose or used in the same form but in another situation. This form of recycling is common in developing countries where no recycling facilities are available (Melaku 2010). In this thesis reuse is included in processing despite of the fact that no actual transformation of material occurs. But, since reuse also reduces the volume of waste going for final disposal it can be considerate as a processing activity.

Anaerobic processing

Anaerobic processes occur in oxygen-free environments. Biogas is an example of such process and is produced when organic material is digested into simple organics and dissolved nutrients. The organic substrate typically consists of household waste, human excreta, cattle manure, wastewater and agriculture residues (Wargert 2009). Basic biogas systems consist of a digestion tank with pipes for waste input and an output for the produced "slurry" and a gas collection reservoir (Amigun et al. 2007, in McInerney 2011). There is a wide range of uses for biogas such as cooking, lightning, water heating, and conversion into electricity in a generator. The biogas slurry can be used for fertilizer, feedstock for fish and pigs and earthworm farming (Chang et al. 2011 in McInerney 2011).

Aerobic processing

Aerobic processes occur in environments with access to oxygen. Composting is an example of an aerobic process where biological degradation transforms into stabile organic material (*Solid waste management in low-income housing projects: the scope for community participation* 1989). It is viewed as permanently removing the organic material from the waste stream in an economical viable way (Adama 2007). Consequently the process needs air, water, microorganism and organic substrate. Compost can be done in small quantities at the neighborhood level or at the transfer depot site. It may be a profitable business for nurseries and vegetable plots. The process might take a month, or less in humid and warm countries. It needs to be turned regularly to get air to reach the microorganisms and minimize the smell (*Solid waste management in low-income housing projects: the scope for community participation* 1989).

Incineration

Incineration refers to controlled burning of waste materials. The temperatures need to be extremely high to destroy chemical compounds and disease-causing bacteria. Uncontrolled burning can damage personal health and the environment, whilst controlled burning can both decrease volume and recover energy from the waste burning processes (Melaku 2010). However, pollution technologies, such as filters, are needed to reduce the gases into the air (Zurbrugg 2003, in Melaku 2010).

Conclusion of processing of waste

Both recycle and reuse is environmental friendly methods of processing waste. While recycled material needs some energy to be processed and then used again, reused material is used again without any energy demanding process. Therefore reuse is the preferable option. Aerobic processing, in this case composting, is also a good option of processing waste due to the low energy input. Anaerobic processing and incineration, on the other hand, demands a high-energy supply and are relatively expensive. However, there are different models that can suit the context of a developing country. If investing in a biogas plant or a proper incineration oven, benefits can be obtained in form of energy and income.

3.3.6 DISPOSAL

Final disposal is often synonym with landfill. There will always be waste that cannot be recycled, incinerated or composted, and therefore must be transported to landfill (Melaku 2010).

The design of the landfill is important to prevent leachate from polluting near by surface or aquifers. Properly managed as a sanitary landfill, the landfill should be covered with a layer of earth daily after disposal to promote storm water runoff, reduce odors and protect human health and environment. Sanitary landfills are expensive and often cause complaints from surrounding neighborhoods (Adama 2007).

When not properly managed, landfill-gas with high contents of methane can migrate off-site and cause problems to the surrounding environment (Gerald 1997, in Melaku 2010). The type of landfill affects the planning of the solid waste management process. Especially if it is an unsanitary landfill, the focus of waste reduction is urgent to prevent environmental pollution.

3.4. MODELS OF WASTE MANAGEMENT

This section introduces two models, *The waste hierarchy* and *Integrated Solid Waste Wanagement*, with different approaches of how to handle waste. *The waste hierarchy* focuses on waste reduction close to source, while *Integrated Solid Waste Management* is concentrating on finding the most suitable solution for each situation. The two approaches are representing important models in the field of solid waste management and are therefore described and evaluated in the section below.

3.4.1 WASTE HIERARCHY

The waste hierarchy is a global guiding principle for municipal solid waste management, which emergence from the need of a healthier environment. The aim is to reduce waste that goes for final disposal (Adama 2007).

The waste hierarchy ranks the waste in six levels, namely: prevention, minimization, reuse, recycling, energy recover and disposal. The least desirable components occupy the lowest position of the model (see fig. 7), while the preferred waste composition sits at the top (Adama 2007). As seen in the figure, the model clearly illustrates the alternatives of how to manage waste. But, the methods are ranked in a specific order which does not give any room for adaptation to local conditions. Further, the model does not consider the cost of implementing waste reducing facilities, for example recycling, which makes it difficult to use in a developing country (McDougall (red.) 2001). Having that said, this thesis takes the principle of reducing waste that goes for final disposal into account, but is leaving out the idea of a hierarchy of handling waste.

3.4.2 INTEGRATED SOLID WASTE MANAGEMENT

Unlike the waste hierarchy model, integrated solid waste management (ISWM) does not define the "best" system (see fig. 8). Instead, ISWM involves evaluating local conditions and adapting a strategy with a combination of the most suitable waste management activities for that context (EPA 2013). ISWM view waste as a resource and only in a negative association if it cannot be a resource used to its fully potential.

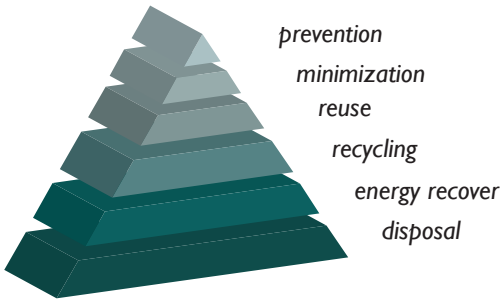


Figure 7.
The waste hierarchy model ranks the methods of processing waste.

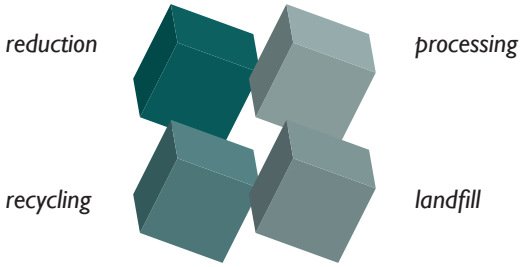


Figure 8.
The Integrated Solid Waste Management combines different processing methods to find a suitable solution to manage waste.

ISWM is the current model used in developed countries (McDougall (red.) 2001). Developing countries are still on the stage of trying to manage the basic task of collection the waste but the trend is to introduce ISWM system for a sustainable waste management (Melaku 2010).

According to McDougall (red.)(2001) the establishments of ISWM systems in developing countries, where poor collection services, little or no processing and massive informal dumping occurs, has four requirements. The first requirement is data collection on waste composition. Waste characteristics are, in combination with cultural, political and social aspects, important factors to be evaluated for selecting and combining the most appropriate waste management activities. The second requirement is to develop a simple sanitary landfill instead of the existing informal dumping. The third requirement is to separate organic waste from municipal solid waste (McDougall (red.) 2001). This should be done as close to source as possible to remain the quality of the material (Oduro-Appiah & Aggrey 2013). The organics can be composted and then used as fertilizer or as an income generator. The last requirement is to involve and formalize the informal sector. They can be a great resource for the municipality in the collection of recyclable materials (McDougall (red.) 2001).

Further McDougall (red.) (2001) states public acceptance and participation in planning and implementation stages are equally important as the technical and economic aspects of the waste management. However, it has been hard to fully integrate public involvement and stakeholders since the existing SWM systems have often been shaped by technical-driven experts instead of the citizens that are using them (McDougall (red.) 2001).

The ISWM model is a holistic approach where all methods of waste management can play a role in the solid waste management process (McDougall (red.) 2001). McDougall (red.) (2001) argues that major system changes needs to be done in order to improve the entire system. Instead of small and constant changes of the existing system, ISWM suggests redesigning of the whole system (McDougall (red.) 2001). The holistic approach is desirable in a processed-based context, which this thesis seizes on, but to rebuild an entire structure is difficult in developing countries when the economy does not allow large investments. Therefore, this thesis disagrees when it comes to changing the entire organization of SWM. The ISWM model is therefore used as a base for the strategy, but since this thesis has a local approach, the proposal will be built on the existing SWM structures.

3.5 DIFFERENCES OF SOLID WASTE MANAGEMENT IN DEVELOPING AND DEVELOPED COUNTRIES

This chapter exposes the difference between developed and developing countries in the context of solid waste management. It is important to be aware of the different problematic in developed and developing countries. Otherwise, there is a risk of failure if implementing high-income countries' solution without adaption to local prerequisites in low-income countries (George 2003, Adama n.d.).

3.5.1 DENSITIES, QUALITIES & SERVICE COVERAGE OF WASTE

Waste generation is lower but the waste density is higher in developing countries, due to the moisture content (Haile 2003, in Melaku 2010). Even though the generation of waste is higher in developing countries the quality is poorer due to the lack of separating. This is important to know when treatment and recycling program are considerate as an economical option (George 2003, in Melaku 2010).

The level of services for waste collection also has large differences between industrialized and developing countries. While industrialized countries have a service coverage of 100 per cent of the urban population, in developing countries less than 50 per cent of the population is served with waste collection (World Bank 2006, see Melaku). When developing a new SWM strategy, it is important to include the part not receiving the service. Otherwise half of the waste is going to be illegally dumped which will degrade the result of the whole SWM process.

3.5.2 ACTORS OF PROCESSING

In developing countries, informal actors largely drive the development of solid waste management, which gives a waste hierarchy from below. A lot of waste is not ending up at disposal site due to inefficient solid waste management. However, a high percentage is recovered informally, like scrap metal, plastic and rubber. This reuse, also referred to as informal recycling, in developing countries is usually done by informal private sector/waste workers (Adama y.u, Schübeler 1996). Since this thesis regards a developing country, it is important to look at the conditions of the informal waste workers to see how they can be included in the SWM process.

3.5.3 VIEW ON WASTE

A person's view of waste is dependent on their economic status. In countries where people struggle with the basic needs of getting food, waste management is not prioritized among the citizens. In developed countries, where most of the citizens have a high standard of living, recycling is mostly done to lessen the environmental impact. In developing countries, on the other hand, informal recycling can generate an income (Melaku 2010). Therefore it is important to find strategies that can be economical beneficial for the residents. This will attract more people to participate in the solid waste management process and change the view on waste from useless to something valuable.

3.6 STRATEGIES OF SOLID WASTE MANAGEMENT IN DEVELOPING COUNTRIES

There is a need for local authorities to develop and improve strategies for solid waste management in developing countries. As mentioned in the introduction (in chapter 1), transportation, infrastructure, technologies, administration and policies need planning and considerable investments. In this chapter different strategies of solid waste management in developing countries are reviewed and followed by a conclusion.

3.6.1 GENERAL STRATEGIES OF SOLID WASTE MANAGEMENT

According to UN-Habitat (2010) it is important to find simple, appropriate and affordable solutions when modernizing the SWM system in developing countries. To find the appropriate solution, a progressive approach is necessary until the best system is tested. The aim should be to reduce the amount of waste going to final disposal, as this is an expensive activity. Therefore an ISWM system is necessary to extend recycling rates and minimize the waste stream ending up at landfills or informal dumpsites. (UN-Habitat 2010) "This is particularly important, as every ton of waste reduced, reused or recycled is a ton of waste for which the city does not have to pay for its transport and safe disposal. " (UN-Habitat 2010, p. 212). UN-Habitat (2010) also highlights the importance of identifying simple, appropriate and affordable solutions.

To accomplish a well-functioning ISWM system, win–win solutions are recommended, where

the city and the informal/micro-enterprise sectors work together for reduction, reuse, and recycle of the waste (UN-Habitat 2010). Furthermore, UN-habitat points out that there exists no universal waste management program. In every new city the waste management needs to be adapted to its local context. It is important to have a critical and creative approach to be able to evaluate the cities' strength and then built a strategy upon them. The system should also be created in cooperation with all stakeholders to find and then adapt solutions that will work in that specific situation (UN-Habitat 2010).

Another aspect of importance is knowledge about the solid waste management. This regards both the public, who generate the waste, and the politicians and officials who are responsible for managing the waste. The responsible stakeholders need to understand what they are doing to be able to make good decisions based on sound local knowledge (UN-Habitat 2010).

In short terms, UN-habitat considers that developing countries has to develop their own models of solid waste management, inspired by the modern waste management but adapted to their own local conditions.

3.6.2 HANDS ON STRATEGIES OF SOLID WASTE MANAGEMENT

While the UN-Habitat recommendations for developing countries are of general character, Fitsum Melaku (2010) presents hands-on strategies for improving solid waste management.

The collections points must be available for an efficient solid waste management. The right amount of numbers of containers is essential to increase availability for the residents. Containers should be placed in the centre of the user population. Market places, or along roads or rivers are not suitable locations for containers due to the risk of pollution (Melaku 2010).

Further hands-on strategies recommended by Melaku (2010) are to introduce composting to reduce the amount of waste going to final disposal. When planning for composting, the area should not be far from the residential house and it should be accessible for trucks.

Information and education concerning solid waste management is of significant importance to change the attitude towards waste. An attitude change is needed to involve people in recycling and reduction of waste. Once people are involved with waste management, it is of big importance to give feedback on what happens with recycled waste to keep their interest (Melaku 2010).

3.7 TECHNICAL SOLUTIONS

There are a number of solutions available for processing waste to reduce the amount of waste going to landfill areas. This chapter evaluates biogas, composting and incineration and their suitability for Zanzibar. Hence, recycling will not be mentioned in this section since it is not an economical feasible solution in Zanzibar at the moment. This reason for this will be explained in section 4.1.5.

3.7.1 BIOGAS

As mentioned in section 3.3.5 biogas is an example of anaerobic processing. It is produced when organic material, such as kitchen waste, human excreta, cattle manure or waste water is digested in an anaerobic environment. According to the biogas entrepreneur Salim Abubakar, there exists a variety of biogas systems which can be used in different kind of environments. It comes in both small scale inventions which can provide one family with energy to large scale industries providing a whole city's consumption of energy (Abubakar 2013). However, in developing countries the most commonly used biogas plant is small dome models (McInerney 2011).

A simple biogas system consists of a digestion tank with pipes for waste input and effluent slurry output. There is also a reservoir collecting the produced gas. On a daily basis organic waste should be loaded in the input. The system produces more gas if the waste material in the tank agitates (Abubakar 2013).

There are many benefits of using biogas. The most prominent benefit is the generation of renewable energy. Other benefits are the potential of income from selling the slurry as a fertilizer, reduction of organic waste and the improved domestic hygiene. Hence, the biogas plant needs certain precautions such as monitoring of pH, carbon to nitrogen ratio and organic loading rate (McInerney 2011).

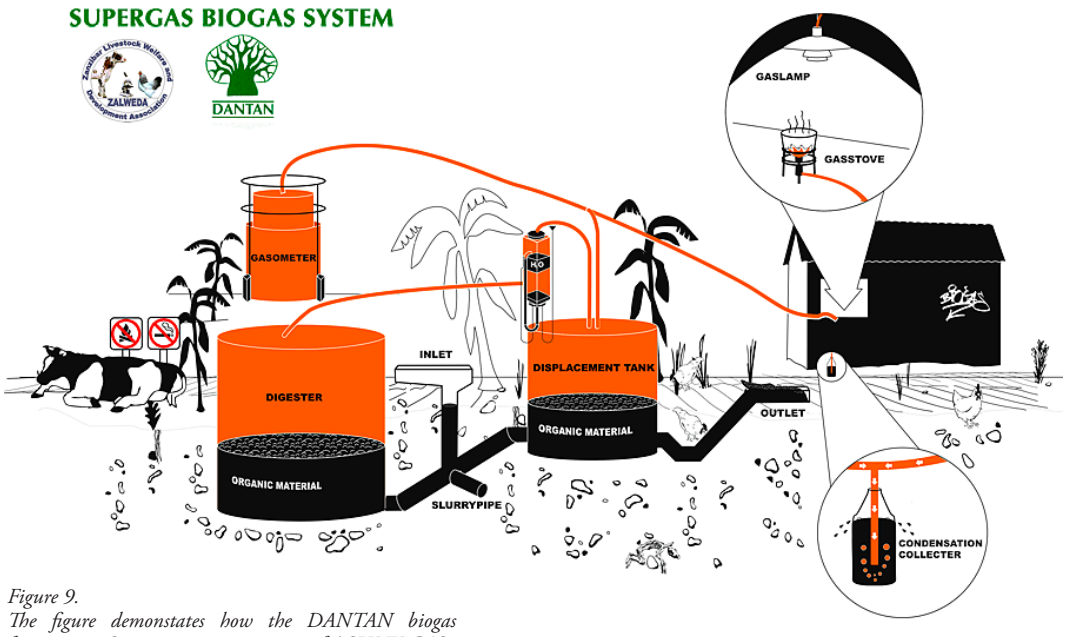


Figure 9.
The figure demonstates how the DANTAN biogas functions. Source: www.supergas.info/?SUPERGAS_Biogas_System

3.7.2 COMPOSTING

There are many different kind of composting technics available. One of them is windrow composting. This technic is commonly used when producing large volume of organics. The organic material is put in long rows which needs turning frequently to promote aeration(Richard 2000). Windrow composting has the potential of handling large volumes of organics which can generate income in form of fertile compost. The volume consequently demands a large area which could be problematic if short of space (Allee, D., Fabian, E., Kay, D., Regenstein, J. Richard, T. 1993).

Another technic is vermicomposting where domestic worms are used to accelerate the decomposition. The worms can also be used as stock feed for animals. According to Vinnerås (2013) the vermicomposting system is a cheap and simple solution made of local materials suitable in small-scale urban animal agriculture. Beneficial effects of the vermicomposting is low-maintenance, economically viable production of animal feed protein in the form of worm biomass, good compost, reduction of waste amount and poor waste management is alleviated (Vinnerås 2013).

Simple composting units for households can be built anywhere with local materials. This is a suitable solution when smaller amount of organics is produced. This simple composting technic only demands a small amount of space and is easy to monitor (Hamilton 2013). However, Vinnerås claims that in all small scale, local, treatment systems it is important to keep rodents away from the compost. Most efficient is by having a well sealed system and metal mesh over openings for keeping the rodents out (Vinnerås 2013).

3.7.3 INCINERATION

As mentioned in section 3.3.5, incineration refers to controlled burning of waste materials. Zhu (Red.) (2007) claims temperatures need to be extremely high to destroy chemical compounds and disease-causing bacteria which demands proper filters to get rid of the air pollution. Such technical solutions are capital intensive and need well-trained operators and are therefore very expensive. Further, Zhu states incineration as unsuitable for developing counties due to high level of organic waste moisture in the waste (Zhu (Red.) 2007).

There exists a type of simple incineration oven called *The community cooker* in Kenya. It is a cheap solution created to suit in a slum environment where people normally cook on charcoal. *The community cooker* is a system where garbage and household waste is dried and then burned in a firebox for generating of heat. On top of the firebox, the eight cooking plates heats up and are available to use for cooking. Other facilities like toilets and bathrooms can be combined with *The community cooker* (Kang'ong'oi 2013).

3.7.4 CONCLUSION OF TECHNIQUES

Section 3.7 evaluates the suitability of biogas, composting and incineration for the context of Zanzibar. Composting is the most interesting technique due to waste composition (see section 4.4) and economical situation of Zanzibar (see section 4.1.5).

Biogas plants are a considerable solution since it generates energy. Due to expensive and poor functioning electricity supply from the mainland (see section 4.1.5), biogas could be a good complementary energy source. However, biogas plants should be tested in small scale before extending the system.

Incineration is not suitable in Zanzibar due to the high cost. Nevertheless *The community cooker* is an affordable option which could be used in Zanzibar. But it is this thesis opinion the technique is not appropriate until an affordable filter have been developed to protect against air pollution.

3.8 SUMMARY OF THEORETICAL BACKGROUND

- Integrated solid waste management aims to find the most suitable solution for each situation. The waste hierarchy model, on the other hand, focuses on waste reduction close to source. The first is often mentioned as the most suitable for developing countries.

- It is important to find simple, appropriate and affordable soultions when modernizing the waste management system in low-income countries.

- Composting is the most interesting technique due to waste composition and economical situation of Zanzibar.

- Biogas could be a good complementary energy source. However, biogas plants should be tested in small scale before extending the system.

- Incineration is not suitable in Zanzibar due to the high cost.

- There are many actors with different interests involved in the solid waste management process. They all have to be considerate when making a solid waste management proposal.


AON

04

CURRENT SITUATION OF ZANZIBAR TOWN

Chapter four gives an overview of solid waste in Zanzibar. It starts with an introduction where short facts about the Island are reveled. The existing law, policy and strategy concerning solid waste management are thereafter explained and discussed. Following section introduces the different actors working with solid waste and identifies their obligations in the process. The chapter ends with waste quantities and composition followed by an overview of waste management in Zanzibar Town.

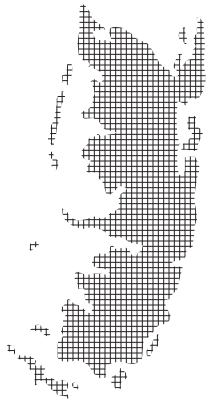
4.1 INTRODUCTION TO ZANZIBAR

This spread shows geographical information about Zanzibar and facts about the solid waste management.

FACTS ABOUT ZANZIBAR

Country: Tanzania
Islands: Zanzibar/Unguja & Pemba
Capital: Zanzibar Town
Area: 2.460 km2
Population: 1.100 000
President: Ali Muhammaed Shein
Religion: Muslim (95%)
Avarge income: 700 USD (1.100 060 TSH)

TANZANIA



PEMBA

ADMINISTRATIVE STRUCTURE

- **North Region**
- **South Region**

INDIAN OCEAN

UNGUJA

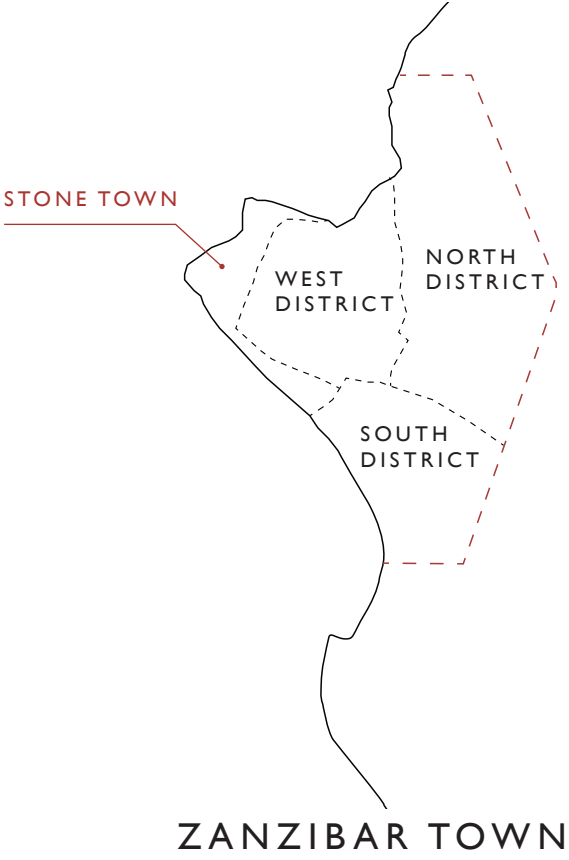
ADMINISTRATIVE STRUCTURE

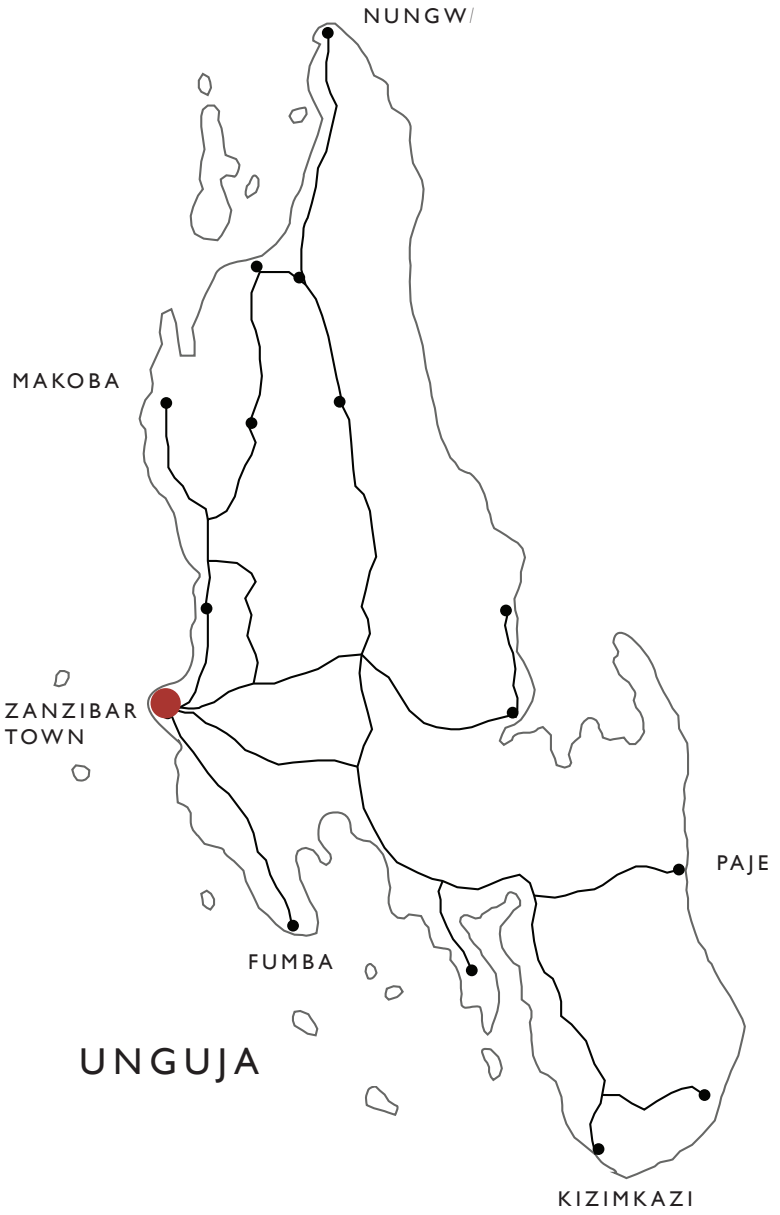
- **Urban West Region**
  - Zanzibar Municipality Council
  - West District Council
- **North Region**
  - North A District Council
  - North B District Council
- **South Region**
  - CentralDistrict Council
  - South District Council

Shahias

DAR ES SALAAM

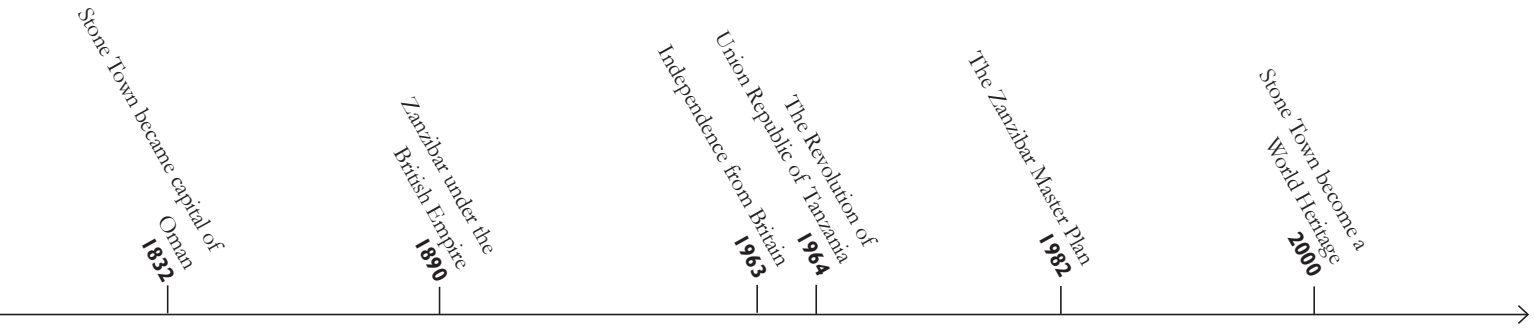
- First visitors from Arabia, Persian Gulf and West India! **100th**
- Traders from the Persien Gulf began to settle **1100-1200**
- Portugese governance **1505**
- Arabic governance, with a omansic sultan. The portugese were expelled. **1698**





WASTE IN ZANZIBAR TOWN

0,52 kg/person/day is generated
45% of the generated waste is collected by ZMC
70 % og the resources goes to Stone Town
85% of the waste is organic
232 ton/per day will be generated 2015
3000 TSH/month is the fee for a household
8000 households are paying the fee



Timeline of the history of Zanzibar

4.1.2 LOCATION & ADMINISTRATIVE STRUCTURE

Zanzibar is situated in the Indian Ocean, East Africa, and consists of approximately 50 scattered islands. It is part of the United Republic of Tanzania, but has its own Government, which is a legislative assembly known as the House of Representatives. The Government is headed by the president, Ali Mohamed Shein, and has its own juridical system (RGoZ 2007).

The main islands are Pemba and Unguja, which are divided in five administrative regions. Each region has two districts administrated by the district councils. Zanzibar Town, the capital of Zanzibar, belongs to the Urban West Region on Unguja and has its own council, Zanzibar Municipal Council (ZMC). ZMC is the organ in charge of solid waste management in Zanzibar Town where the Division of Sewage, Drainage and Solid Waste (DSDSW) is included (Spitzbart et al. 2013). DSDSW is responsible for implementing the practice of SWM. The district of Zanzibar municipality is divided in different administrative units called shahias. A shahia consists of one or several villages. The municipality has started to involve some of the shahias in Zanzibar Town to manage the solid waste in their community. The aim is to extend the cooperation between ZMC and shahia throughout all areas in Zanzibar Town (Rajab 2013a). This requires a substantial amount of resources to be transferred to the shahia for them to cope with the task.

4.1.3 POPULATION

There are no certain numbers of the population in Zanzibar. In the year of 2008 the population was estimated to 1.100 000 people. Approximately two thirds were living on Unguja Island and 460.000 of them in Zanzibar Town (Breeze 2012). The population growth is estimated to 5.0 % per year (Breeze 2012) and more than 60 % of the population on Unguja is living in Zanzibar Town (Spitzbart et al. 2013). The fast growing rate of Zanzibar is highly affecting the amount of waste being generated. Since the waste management is struggling today, with only 40 percent of the waste being collected, these are alarming figures.

4.1.4 HISTORY

During the age of Exploration, the Portuguese Empire gained control of Zanzibar, and kept it for nearly 200 years (RGoZ 2013). In 1698, Zanzibar fell under the control of the Sultanate of Oman, where Zanzibar became an important base for sea trade routes between Arabia, India and Africa. The monsoon wind made it a perfect center for trading spices, slaves and ivory. Zanzibar's strategic place led to that the Sultan moved his capital from Muscat in Oman to Zanzibar Town in 1840 (RGoZ 2013). This required major changes in the unhygienic Town including collection of solid waste, sewage drainage (Haji H., Azzan R., Ufuzo S. 2006). At the time, a large part of East Africa's coast was controlled by the Sultan of Zanzibar. The expansion made the empire vulnerable and the Sultan lost many of his assets to Great Britain, Germany and Italy. The British Empire gradually took over and Zanzibar became a British protectorate in 1890. The British primary contribution to Zanzibar was the abolishment of slave trade and

slavery (RGoZ 2013). Year 1923 they performed the first master plan of Stone Town where problems of sanitation and open spaces were addressed (Haji H., Azzan R., Ufuzo S. 2006). Hence, sanitation issues has been an ongoing topic since the 1800-century.

Through the Zanzibar revolution in 1964, the Island became a semi-autonomous part of Tanzania. Today, the relationship with the mainland is tense due to Zanzibar's dissatisfaction with their low influence over political and economic issues. Therefore, political voices are risen for the independence from Tanzania mainland (African Press International 2010).

The history is still viable today through the Swahili culture with a mixture of ethnic groups, cultures and architecture. Stone Town got scripted as World Heritage in year 2000 by UNESCO for its unique townscape of a Swahili coastal trading town (UNESCO World Heritage Centre 2014.). The architecture manifests the cultures of Africa, The Arab region, India and Europe in one homogenized Swahili tradition (see fig. 10, 11 & 12). The world Heritage status means that precautions must be taken when it comes to development of Stone Town. Stone Town meets the following criterias to be classified as a World Heritage:

> Criterion ii : The Stone Town of Zanzibar is an outstanding material manifestation of cultural fusion and harmonization.
> Criterion iii : For many centuries there was intense seaborne trading activity between Asia and Africa, and this is illustrated in an exceptional manner by the architecture and urban structure of the Stone Town.
> Criterion vi : Zanzibar has great symbolic importance in the suppression of slavery, since it was one of the main slave-trading ports in East Africa and also the base from which its opponents such as David Livingstone conducted their campaign. (UNESCO World Heritage Centre 2014).

Figure 10.
Indian housing is characterized by extrovert architecture. With large balconies and windows a lot of natural light enters the building. Other features such as carved doors with rounded tops are typical for Indian influenced architecture. Source for sketch: (LaNier & McQuillan 1983)

Figure 11.
Arabic housing is characterized by introvert architecture to keep a comfortable indoor temperature. Small windows and flat roofs surrounded by a characteristic wall border. Another common feature is beautifully rectangular carved doors which communicates the social status of the owner. Source for sketch: (LaNier & McQuillan 1983)

Figure 12.
European colonial architecture is characterized by decorative features on the facade. External staircases, window shutters and balconies are adorned with carved wood and painted in pastel colours. Source for sketch: Cecilia Hellman

According to own observations there are many neglected buildings and ruins which attract informal waste dumping in Stone Town. If this issue is not properly taken care of, the overall experience of the city will deteriorate and in the worst case jeopardize the classification of a World Heritage which would be devastating for the tourism industry.

4.1.5 ECONOMY

Tanzania, including Zanzibar, is rated as a low-income country in the World Bank's (2012) Country Classification According to Income. This means all larger investments, such as infrastructure, are dependent on funding from abroad, which also includes development of solid waste management.

The economy of Zanzibar is agro-based, but within the last decade the tourism sector has grown significantly. In 2012, approximately 200.000 tourists visited Zanzibar. The tourism industry is not only contributing to economic growth, but is also one of the main generators of solid waste (Spitzbart et al. 2013). A tourist use more than 15 times more water than the average daily demand of a local resident. The same ratio concerns generation of solid waste (Mohammed 2002).

Concerning the budget for DSDSW, which are responsible for the SWM in Zanzibar Town, it is difficult to get hold of accurate figures. According to own research there exist no separate statistics for the division which makes it impossible to plan for future revenue and expenditure. On top of that, all the SWM revenue goes to another state body namely the Ministry of Finance. In this case, this means that all SWM revenues are not proclaimed for the DSDSW.

Under the year of 2010 the number of billed costumer shifted from 3500 – 4500 per month which gives an estimated income of 14000 - 20000 USD per month (Juma 2012). The income only covers three per cent of the solid waste management cost and the municipality pays for the rest (Juma 2012). According to Hija Abdalla Makame, the head accountant of DSDSW, a total amount of 88 300 USD (143.000.000 TSH) needs to be topped up for the SWM budget every month (Makame 2013). This means that proposed solid waste management solutions need to be simple, inexpensive and take advantage of the materials and skills that are in place.

4.1.6 ENVIRONMENT & POLLUTION

Zanzibar's ecosystem is particularly sensitive due to its Island ecology. The small and densely populated archipelago provides habitat for many endangered and rare species of coral, fish, sea grass, mangrove and other flora and fauna (Lange & Jiddawi 2009). The Island ecology is also dependent on the tropical climate Zanzibar possess. Between year 2005-2008, the maximum and minimum temperature of Unguja Island was estimated to 23.3 C - 30.7 C and the mean relative humidity was 78.9 (RGoZ 2013b). The humidity accelerates the deterioration of the stone houses in Stone Town (Ngoma 2009) and probably creates favorable conditions for fungus that discolor the facades.

With 120 tons of solid waste generated every day from Zanzibar Town a massive strain is put on the environment. Via surface water runoff and leaching the waste is polluting the coastal zones and harming the marine life. In addition, untreated sewage is discharged straight into nearby coastal waters, containing high levels of Nitrogen and Phosphorus. A number of water borne diseases has been reported related to the contamination, such as diarrhoea, gastroenteritis, cholera and dysentery with gastroenteritis. These diseases, especially big outbreaks of cholera, claim many life on the Island (Mohammed 2002).

4.2. LAW, POLICY & STRATEGY

There is no formal law concerning solid waste management. The existing law only includes obligations concerning handling of hazardous waste. However, in February 2013, a new environmental policy for Zanzibar was adopted. The new Zanzibar Environmental Policy includes specific policy statements and strategies for waste management (RGoZ 2013). The following section gives an overview of the framework of laws and policies.

4.2.1 AN INOPERATIVE LAW REGARDING WASTE MANAGEMENT

The government of Zanzibar introduced The Environmental Management for Sustainable development Act, 1996 (1996), which is the current environmental law in Zanzibar. It includes 9 chapters and 124 sections concerning rights and obligations for individuals, companies and institutions.

Due to the fact there is no specific section for managing solid waste, new regulations are put under the chapter IX Miscellaneous Provision. The prohibition of plastic bags is an example of a regulation put under this chapter. It was introduced year 2011 and defines penalties for any person who manufactures, imports, store or sell any plastic bag in Zanzibar. Even though the amount of plastic bags has reduced significantly according to Mzee Khamis Juma (2013), head of labor of construction and environment at the ZMC, plastic bags are still scattered on formal and informal dumpsites. According to own observations shops are seen handing out small plastic bags despite the law which could be one reason why plastic bags are still dumped. Another reason could be that tourists are unaware of the prohibition and therefore brings plastic bags from abroad.

Other regulations are the Environmental Impact Assessment (EIA) of 2012 and the Sustainable Utilization of Non-renewable Natural Resouces of 2011. The law also defines the responsibilities of Department of Sewerage, Drainage and Solid waste, (DSDSW) to provide solid waste management services in Zanzibar municipality (Spitzbart et al. 2013).

4.2.2 POLICY

Except the law, The Environmental Management for Sustainable development Act, 1996, there is a policy document providing a framework for environmental issues. The Environmental Policy of Zanzibar serves as a national environmental response framework and strategy. The objective of the policy is to reduce negative environmental and health impacts. The document is devided in 15 Policy Statements where the seventh concerns waste management. The policy states: "The Government in collaboration with private sectors and other stakeholders will improve waste management practices at all levels" (RGoZ 2013).

The policy analyzes the current environmental situation and point out the major concerns. Environmental pollution caused by lack of solid waste management, unsustainable tourism development and lack of scientific research of environmental conservation and management are some of the current environmental issues (Spitzbart et al. 2013). All key actors in the public, private, and community domains should implement the strategies between 2013 and 2018 (RGoZ 2013).

In order to concretize these objectives in The Zanzibar Environmental Policy, a National Environmental Action Plan (NEAP) has been conducted. The Action Plan aims to support the Government to meet its commitments for sustainable planning (RGoZ 2013b). The document includes log-frames of activities on waste management, which describes what are the outputs, main indicators and coordinating institutions. The implementing strategies for Policy Statement 7 are:

7.1 *Promote proper and appropriate infrastructure services required for waste management (handling, reduction, collection, disposal, recycling, reuses and treatment).*

7.2 *Promote proper and appropriate environmental sanitation facilities.*

7.3 *Promote public private partnership and community involvement and participation in waste management.*

7.4 *Promote public awareness on proper waste management practices.*

7.5 *Develop and implement environmental standards and guidelines for waste management.*

7.6 *Promote cleaner production techniques to reduce waste at sources.*

7.7 *Promote polluter pays principle (RGoZ 2013b, pp. 77-79).*

According to Aboud Jumbe (2013), environmental scientist at the Department of Environment, the most urgent action is to develop a National Solid Waste Management Strategy which response to implementation strategy 7.1. This is the prerequisite for all other activities. A National Solid Waste Management Strategy is crucial to nationally achieve consensus on how to manage the waste management (Jumbe 2013). The strategy will serve as an official baseline policy for waste management on Zanzibar. According to Mr. Aboud Jumbe, Environmental Scientist at the Department of Environment, it will be a clear-cut principle including the whole process about solid waste management. A new dumpsite will be proposed as well as strategies on how to involve the communities and the private sector. One of the main purposes is also to define responsibilities among all stakeholders (Jumbe 2013). Since the work with the new strategy has not started yet, it is uncertain of what it is going to be included.

Implementation strategy 7.1, 7.2 and 7.6 are in need of finance, which the Government currently does not possess (Juma, M. K 2013). Regarding the third strategy, about promoting public private partnerships and community involvement, ZMC is contracting community based organizations (CBOs) and non-governmental organizations (NGOs) to work with waste management (Rajab 2013c). Private partnerships, however, is rare. Strategy 7.4 is implemented through public awareness campaigns displayed on television and radio together with monthly cleaning up days. Despite the ongoing promotion there is much left to do (Rajab 2013c). Implementation strategy 7.7, Promote polluter pay principle, has not been implemented yet. There is likely a resistance to impose such fees because companies, that are significant for Zanzibar's economy or have connections to the government, dumps large amounts of waste on the Island. The strategy number 7.5, Promote environmental standards and guidelines for waste management, is mostly concerning the Hotel Resort Industry and less about what is hapening in Stone Town, because ZMC have their own regulations on waste collection and disposal (Jumbe 2013).

Another important strategy in *The Environmental Policy of Zanzibar* is the policy statement 12 which stresses the importance of mainstreaming women, poor and other vulnerable groups in the environmental management practices (RGoZ 2013). According to the ZMC, gender equality thinking is put in the recruiting of workers since most of the street sweepers are women (Rajab 2013c).

The policy of Land Use Planning is an additional document which the Department of Urban and Rural planning has developed (DoURP 2013). The basic need of planning for a proper solid waste management is not mentioned in this document. It is this thesis belief that SWM needs to be a part of the initial stage of physical planning in order to build a consistent and well operating town.

4.3 ACTORS OF SOLID WASTE MANAGEMENT IN ZANZIBAR TOWN

This chapter introduces the different actors in Zanzibar Town based on own observations, interviews and literature review. As shown in the section "Actors of solid waste management" (see section 3.2), it is important to identify all actors since they all play an important role in the waste management system.

4.3.1 HOUSEHOLDS

The average household in Zanzibar Town consists of 5.6 members (ZMC, 2013). The households are required to pay 1.89 USD (3000 TZS) per month for the waste management services (Rajab 2013b). Approximately 38 % of the domestic costomers (households) are paying the fee in Zanzibar Town which gives an average household revenue of 15 120 USD (24 000 000 TZS) (Juma, M. K. 2013) per month and 181 440 USD per year.

4.3.2 COMMERCIAL ESTABLISHMENTS

Commercial establishments refer to shops, hotel, restaurants and institutions. Virtually all commercial establishments' revenues (98,2 %) derive from shops which are paying 3.78 – 7.57 USD (6 000 – 12 000 TZS) per month (Rajab 2013b). Under the year of 2013 an amount of 84 022 USD (133 242 500 TZS) were collected from shops (Makame 2013). Hotels are paying a monthly fee of 6.31 – 75.75 USD (10 000 - 120 000 TZS) depending on the size while luxury hotels, such as the Serena, are paying 107.31 USD (170 000 TZS) per month (Rajab 2013b). The Serena hotel has a special chamber for waste which is emptied once per day (Rajab 2013b). 1,1 % of the revenues from commercial establishments derives from hotels (see figure 13) which gives an approximately revenue of 941.18 USD (1 491 026 TZS) from hotels under the year of 2013.

In 2009, large dustbins were given from the municipality to shop- and hotel owners in Stone Town. These bins were however used as storage of food supplies instead of the original purpose in many cases. The solution from the municipality was to pierce the bins to prevent the alternative usage. Today many of the bins are missing and not replaced by new ones (Rajab 2013b).

4.3.3 COMMUNITY BASED ORGANIZATIONS

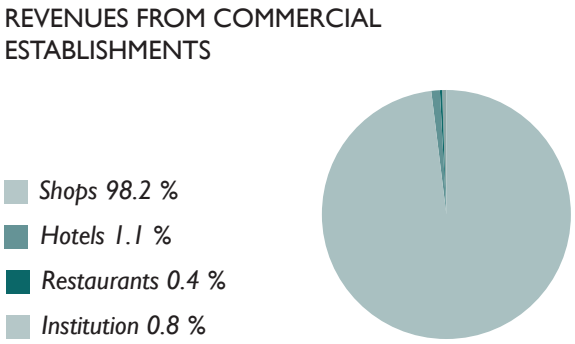


Figure 13.
Numbers are derived from ZMC (Juma, M. K. 2012). Assuming that the relationship between these numbers from 2012 are still correct, the total amount of revenues from commersial activities under the year 2013 should be 85 562 USD (135 548 176 TSH).

The municipality plans to extend the door-to-door collection to areas outside Stone Town. The collection will be outsourced to CBOs in each district. For now, there exist 45 Shahia in the municipality, where 17 are registered as CBOs, waiting for permission to start. The aim is to have one contracted CBO in each Shihia (Rajab 2013a).

4.3.4 NON-GOVERNMENTAL ORGANISATIONS

There are a number of NGOs spread over the Islands. Selected NGOs are yearly contracted by the municipality for street sweeping in Stone Town. Normally NGOs has to show commitment by working for free in seven months before getting the contract (Rajab 2013a).

In general, the NGOs are struggling to manage financially and therefore involves in secondary activities to finance their organization. The municipality does not properly provide equipment and gear, which is a health risk for the workers (Juma, J. 2013). According to interviews, many NGOs have dropped in number of members due to the hard economic circumstances, which leads to difficulties to pay wages.

There is a wide range of seriousity among the NGOs in Stone Town. Many are committed to their work, but some organizations are mainly looking for money. That makes it difficult to determine which organization that have sincere pretenses and should be invested in (Hamilton 2013).

Based on interviews with NGOs, the attitude among the NGOs working in Stone Town is that it is possible to separate waste and recycle. However, the technical know-how is very low, and might just exist in some of the leading positions within the groups. Also, there is a lack of communication between the groups, which hampers the exchange of knowledge.

The organizations have a major focus on education. The low educational status is viewed as one of the main reason of littering. TV- and radio campaigns, posters and clean-up days are promoted as ways of raising the knowledge and awareness of environmental issues (Juma, J. 2013).

The following section will describe the tasks and activities of three large NGOs active in Stone Town.

Sustainable East Africa

Nell Hamilton has started the organization to support existing NGOs involved with environmental issues. She plays an important role to coordinate and inform the NGOs within Stone Town.

The approach of Sustainable East Africa is to create network and partnership between researchers, volunteers and community groups. The organization has knowledge about both sustainable technical solutions as well as application of funding. They help communities to identify initiatives that protect the environment but also generate an income (Hamilton 2013).

Zanzibar Cleaning of the Environment and the development of youth, ZACEDY

ZACEDY is a NGO consisting of young people dedicated to environmental issues. The NGO is ambitious and driven, but lacks a deeper knowledge of solid waste management.

Zacedy group is located outside Stone Town in Kwikwajuni. A subgroup of Zacedy, called the City Group, is contracted by the municipality for street sweeping in Stone Town. There are 50 people working in the City Group, and 85 percent is women. The group is responsible for sweeping seven of the municipality areas of Stone Town. According to the City Group workers they have to receive a new contract every three month (Juma, J. 2013).

A street sweeper earns 1000 TSH per day or 40000 TSH per month, which barely covers the cost of transportation to work. Working hours are between six and eleven o'clock every day of the week. When finished sweeping all workers meets and gets their daily salary. The work is hard

with poor equipment and harsh working conditions. Sometimes it is an absence of salary due to late payment from the municipality (Juma, J. 2013).

The Glitters Volunteer Group, GLIVOG

The vision of GLIVOG is to become a strong reliable organization in claiming environmental development in municipals of Zanzibar. However, the organization is involved in many projects improving the society, such as health, education, women and children issues. There is a variety of tasks for members; street sweeping, sharing ideas or working with education (Ramadhan 2013).

The main task, when it comes to waste management, is to sweep the streets around Darajani market in early morning. This task is contracted by the municipality for a trial period of one year.

Muhammed Said Ramadham, chairman of the GLIVOG, stresses the importance to finance the organization with own means. If too dependent of the ZMC, the organization would operate very insufficient (Ramadhan 2013).

Figure 14.
Members from GLIVOG have been sweeping the streets around Darajani Market and are waiting for the compactor truck.

UWAMWIMA

UWAMWIMA is a farmers' association working to promote the sustainable production of organic crops and vegetables in Zanzibar (Rehani 2013). In October 2013, 265 of the 1022 existing farmers in Zanzibar were registered as organic farmers. Salum Rehani, project coordinator of the organization, states there is a high demand for fertilizer among the farmers. Organic fertilizer such as compost cost 3.10 USD (5000 TSH) / 30 kilo while cow dung is half the price (Rehani 2013).

In line with the increasing interest for organic farming, the demand for organic fertilizer will rice at the same pace. This means composting could be lucrative business.

4.3.5 LOCAL GOVERNMENT

The Zanzibar Municipality Council (ZMC) is responsible for accomplish laws and regulations set by the Department of Environment. Issues concerning solid waste management fall under the Division of Sewerage, Drainage and Solid Waste (DSDSW) at ZMC.

DSDSW (2010) has established a Business plan 2010/2011 on how to manage the municipal waste. The Business plan addresses challenges, needs and proposes solutions with sewerage, drainage and solid waste in the Zanzibar municipality. In order to achieve these goals DSDSW has established several objectives listed in the Business plan. However, according to DSDSW (2010), every goal will be impossible to achieve due to limited financial resources. The activities are therefore minimalized to some specific focus areas. The main focus areas concerning solid waste management are:

- Closure of Jumbi dumping site and construction of a new sanitary landfill site at Kisakasaka
- Implementation of Zanzibar Urban service Project (ZUSP) by 2011. The

project is financed by the World Bank and includes; institutional strengthening of ZMC by revenue collection, collection and transportation of solid wastes in Zanzibar Municipality and installation of street lights in Zanzibar Town.

- Addition on door-to-door services with extension to the West Zone and maintenance plans for vehicles, tools and equipment
- To design a customer billing software for implementation of a new tariff structure and to increase domestic customers, well trained fee collectors with new routes for domestic collectors (DSDSW 2010).

According to the municipality a new landfill has not yet been developed (Rajab 2013b). This has affected the second objective, the ZUSP project, since the World Bank has a requirement of a sanitary landfill before sending the rest of the founding (Rajab 2013b). The third objective is in an initial stage with signing different CBOs for the door-to-door service (Rajab 2013b). However, no analyses or evaluations have been done concerning how the existing system of door-to-door collection functions in Stone Town today. This gives an uncertainty whether the system is beneficial outside Stone Town. The last objective of designing a new software program is accomplished. But, according to own experience, it is difficult to receive compiled statistics on revenues.

4.3.6 PRIVATE SECTOR ENTERPRICES

The private sector in Zanzibar comprises of micro- to middle sized enterprises. According to own research, no larger companies concerning solid waste management, such as recycling industries, are established.

Zanrec Plastics Ltd

Zanrec is a widely recognized waste and recycling company on Zanzibar. The company is partly funded by Swedish International Development Cooperation Agency (SIDA) and private impact investors. According to Tim Woolven, the Project manager for Zanrec, the company is currently collecting plastics, metal, glass and cardboard for selling or processing both locally and further afield. They are focusing on the private sector since it is more profitable and produces the most waste, but are also buying recyclable materials from NGOs around Zanzibar (Woolven 2013).

Woolven continues with explaining that Zanrec is planning to expand the services but for now they are at their maximum capacity. At the end of 2013 they are going to start a pilot project of recycling organic materials in a semi open windrow composting system. They want to work with the municipality and tender for the public solid waste management provision on the island, but currently ZMC is unwilling or not ready to start that process (Woolven 2013).

Dantan – supergas

Dantan is a project which introduces pilot biogas plants in Zanzibar (Kirknæs 2009). Salim Abubakar is a local technician installing biogas plant for the Dantan prodject. According to Abubakar there exist a large potential in Zanzibar for biogas plants, but they need to be properly monitored. Unfortunately, many plants have broken down due to a lack of knowledge of how they should be properly managed (Abubakar 2013). If the biogas plant shall be developed into their full potential, the monitory staff needs accurate training for the project to succeed.

4.3.7 INFORMAL PRIVATE SECTOR

The informal private sector refers to different groups at the lowest part of society looking for recyclable waste material for selling. According to own observations, they are mostly young and unpaid men with unspoken, yet expected, working duties. Further, they play a very important role at the collection point by assisting the municipality workers. Through their work the amount of waste is reduced which is beneficial for the municipality.

Figure 15.
One of the informal dumpsites in use by the ZMC, October2013.

4.3.8 EXTERNAL ACTORS

External support agencies are important for Zanzibar in terms of founding and contributing with knowledge. Two external actors involved in SWM are introduced below.

The finnish government

The finnish government is founding the Sustainable Management Of Land and Environment (SMOLE) in Zanzibar. The objective is to reduce the absolute poverty through land management and socioeconomic development. Physical planning is one important focus of the project (SMOLE 2012). During 2014, the first waste management strategy of Zanzibar will be developed (Møller 2013). Since there has not been any strategy for managing solid waste before, this document has the potential of becoming an important tool for the physical planning of Zanzibar.

World Bank

The United Republic of Tanzania considers ZMC to have a weak overall local government system with vague responsibilities, limited resources and lack of appropriately trained personnel. Therefore they have requested the World Bank for assistance in the Zanzibar Urban Service Project (ZUSP) (RGoZ 2009). ZUSP aims to develop selected urban infrastructure within the municipality, enhance the physical environment and strengthen institutional capacity for urban management in Zanzibar. The project started year 2011 and will be implemented over five years (RGoZ2009).

Through the ZUSP project World Bank is currently financing all equipment concerning solid waste management. Compactor trucks, skip trucks and waste bins have already been sent. However, the World Bank has the requirement of a proper landfill before they are allowed to be put in use. Consequently, the brand new equipment is stored outside Stone Town (Rajab 2013b).

4.4 WASTE QUANTITIES AND COMPOSITION

Waste characteristics are, in combination with cultural, political and social aspects, important factors to be evaluated. The evaluation need to be done in order to select and combining the most appropriate waste management activities of prevention, reduction, recovery and disposal (McDougall (red.) 2001).

The waste composition of Zanzibar Town is similar to that of other developing countries. Approximately 80 - 86 % of the total amount of the generated solid waste is organic (Gauff Ingenieure 2005). Hence, the waste analysis data is from 2005 and will need to be updated since increased tourism and standard of living impacts the composition.

According to the Division for Sewerage, Drainage and Solid waste (2010), municipal solid waste is dominated by household waste with an addition of institutional and industrial waste. Households generate about 50 % of the solid waste: the remainder is mostly from shops. The solid waste from households consist of 85.6 % organics, while the remaining 14.4 % are evenly spread amongst plastic and bottles, paper, textiles, metal, cardboard and diapers (Gauff Ingenieure 2005).

The estimated solid waste generation in Zanzibar Municipality is 0.45 kg per person and day, with a density of 0.33 kg per liters. It is estimated that in Zanzibar municipality, 260 tons per day of solid waste is produced, but only 40 % is collected and transported to various dump-sites (Gauff Ingenieure 2005). Most of the waste is haphazardly disposed in different areas of the city (ZMC 2013).

Based on an expected population growth of approximately 5%, the forecast of waste generation in Zanzibar town will be 320 tons per day in year 2015. Approximately 165 ton of these are generated only by households (Gauff Ingenieure 2005). Nevertheless, as this forecast is based on relatively old data, the accuracy of the prediction is uncertain. Still, we can expect there to be a rapidly growing amount of waste in the future.

WASTE COMPOSITION FROM HOUSHOLDS

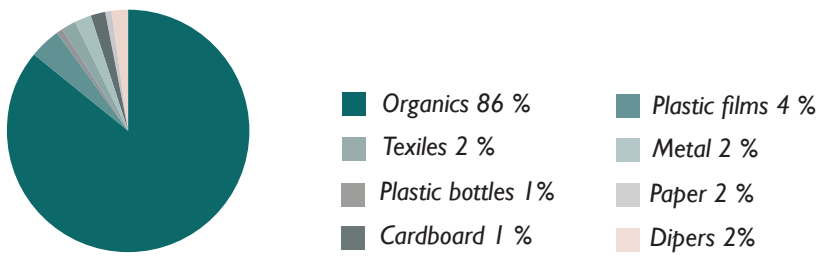
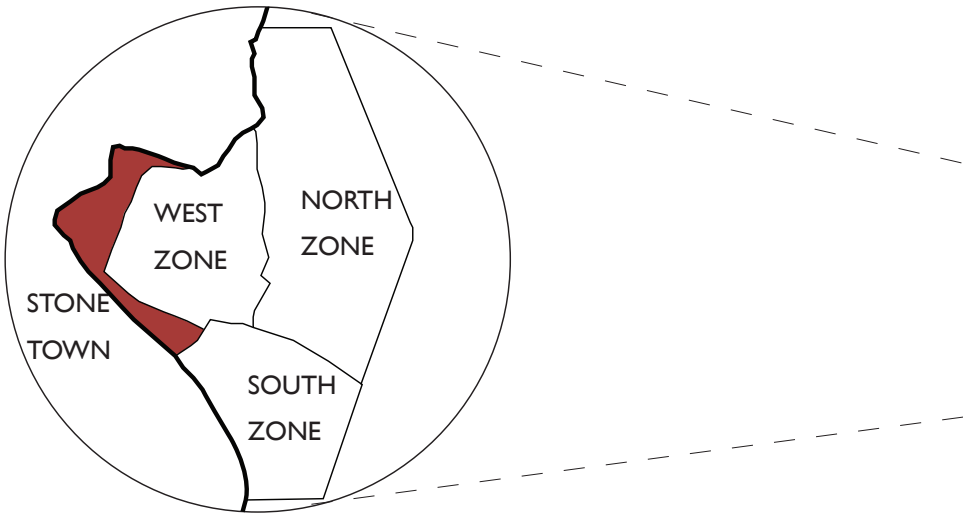


Figure 16.
Numbers are derived from ZMC (Juma, M. K. 2012).



4.5 AN OVERVIEW OF WASTE MANAGEMENT IN ZANZIBAR TOWN

Except Zanzibar Town and some parts of Pemba, there exists no formal waste management system on Zanzibar (Spitzbart et al. 2013). The DSDSW, Department of Drainage, Sewage and Solid Waste, is the authority responsible for waste management in Zanzibar Town.

The Solid Waste services are divided in four zones in Zanzibar Town: Stone Town, North-Zone, West-Zone and South-Zone (see fig. 17). These services should be provided on a daily basis within the boundaries of the municipality (DSDSW 2010). According to DSDSW (2010), collecting and transporting of solid waste to dumpsite is challange. Hence, there is no formal dumpsite on Zanzibar instead the ZMC is using crude dumpsites (Juma, M. K. 2013). (Juma, M. K. 2013).

Observation reveals that the location of the informal dumpsites varies as the open surfaces are filled up with solid waste. Further, most commonly used dumpsites are illegal quarries, swamps and other open or green spaces. Several disposal sites are directly connected to the residences, which in turn causes complaints from the residents. However, some farmers are willing to allow solid waste being dumped at their farmland to access the nutrients in the organic material, in exchange for payment (Rehani 2013).

It is apparent that there is an uneven distribution of resources between the four zones. A large focus, around 60 - 70 % of the resources and services, is placed on Stone Town (Juma, M. 2013). This is because Stone Town is very labor intensive due to the existing door-to-

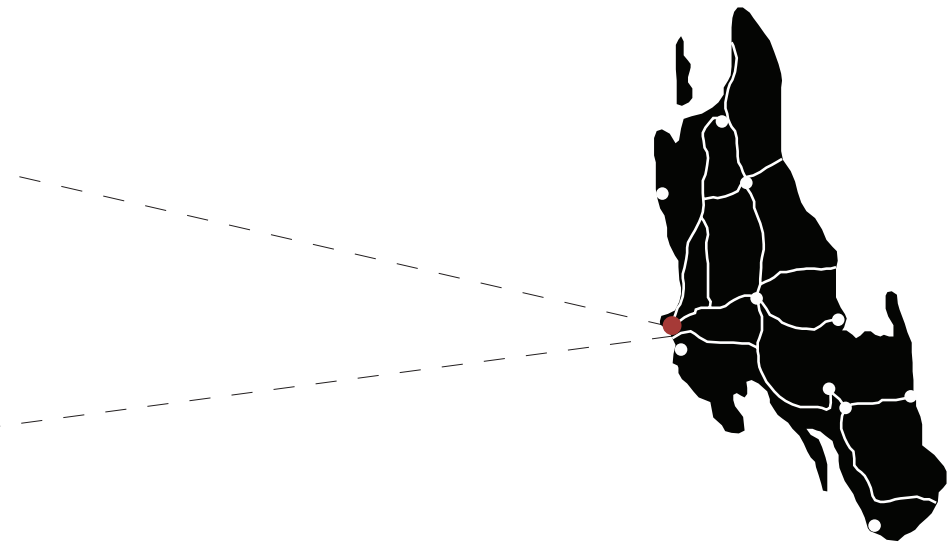


Figure 17.
Illustration of the four administrative zones of Zanzibar Town.

door collection and the higher frequency of solid waste container removal. To maintain the tourism industry, the municipality is putting a lot of effort on keeping Stone Town clean (Juma, M. 2013).

Except the formal door-to-door collection of waste, informal dumping occurs all around Zanzibar. In the north, south and west district of Zanzibar Town, residential should bring their waste to certain collection points. However, the collection points are few and not properly managed which leads to massive informal dumping and burning of solid waste.

Outside of Stone Town, the residents in the other three zones are required to bring their waste to collection points operated by ZMC. There are fewer collection points than in Stone Town and accordingly longer distance to the container. This results in individuals and commercial proprietors choosing to informally dump their waste in open, often flooded, areas rather than to carry them to the collection point (Breeze 2012).

ZMC is regarding the existing system of door-to door collection in Stone Town as well functioning. They perceive Stone Town as a role model and have the ambition to extend the door-to-door collection into the other three zones (Rajab 2013a). As it is the objective of the municipality to apply this collection system to other districts, examining the existing system of Stone Town is essential to comprehend the whole waste management process from source to disposal. ZMC is also planning to reduce the amount of collection points to one site.

4.6 AN OVERVIEW OF WASTE MANAGEMENT IN STONE TOWN

Stone Town has, as mentioned before, door-to-door collection. The SWM service is divided into three districts and 16 working areas in Stone Town. There exist one additional district East of Creek Road. Each district has two door-to-door-collectors and two street sweepers. Three team leaders and the same amount of foremen lead the work in each district. Approximately there are 150 individuals NGO sweeping the streets (Abdulraman 2013).

MUNICIPAL WORKERS

NGO WORKERS

Figure 18.
The map over Stone Town shows the division of the sixteen ZMC working areas.

4.7 SUMMARY OF BACKGROUND

- ZMC is not able to finance the solid waste management. In addition, ZMC does not receive all the revenues from the customers.
- There is a unclear legislative system concerning waste management.
- The first waste management strategy will be developed in 2014.
- The collecting system in Stone Town is door-to-door collection which the municipality plan to extend to the rest of Zanzibar Town.
- The waste consist of 85% organic material.

05

ANALYSIS OF THE SWM PROCESS

FROM SOURCE TO DISPOSAL

This chapter reveals the waste management process based on own interviews and observations. An overview is given of the whole solid waste management process followed by a summarized process diagram. Every step of the process is examined in detail and then analyzed through a SWOT. The chapter is concluded with a summery.

5.1 THE PROCESS OF SOLID WASTE MANAGEMENT IN STONE TOWN

Due to the objective of the municipality, to spread the waste management system to other districts of Zanzibar Town (see chapter 1), this chapter will examine the existing system of Stone Town to give a comprehensive overview of the whole waste management process from source to disposal. The goal is to get an understanding both of the system itself as well as the conditions necessary for it to function. The following analysis examines each step together with the involved actors and also the equipment used.

5.1.1 PROCESSING – A MISSING LINK IN THE CHAIN

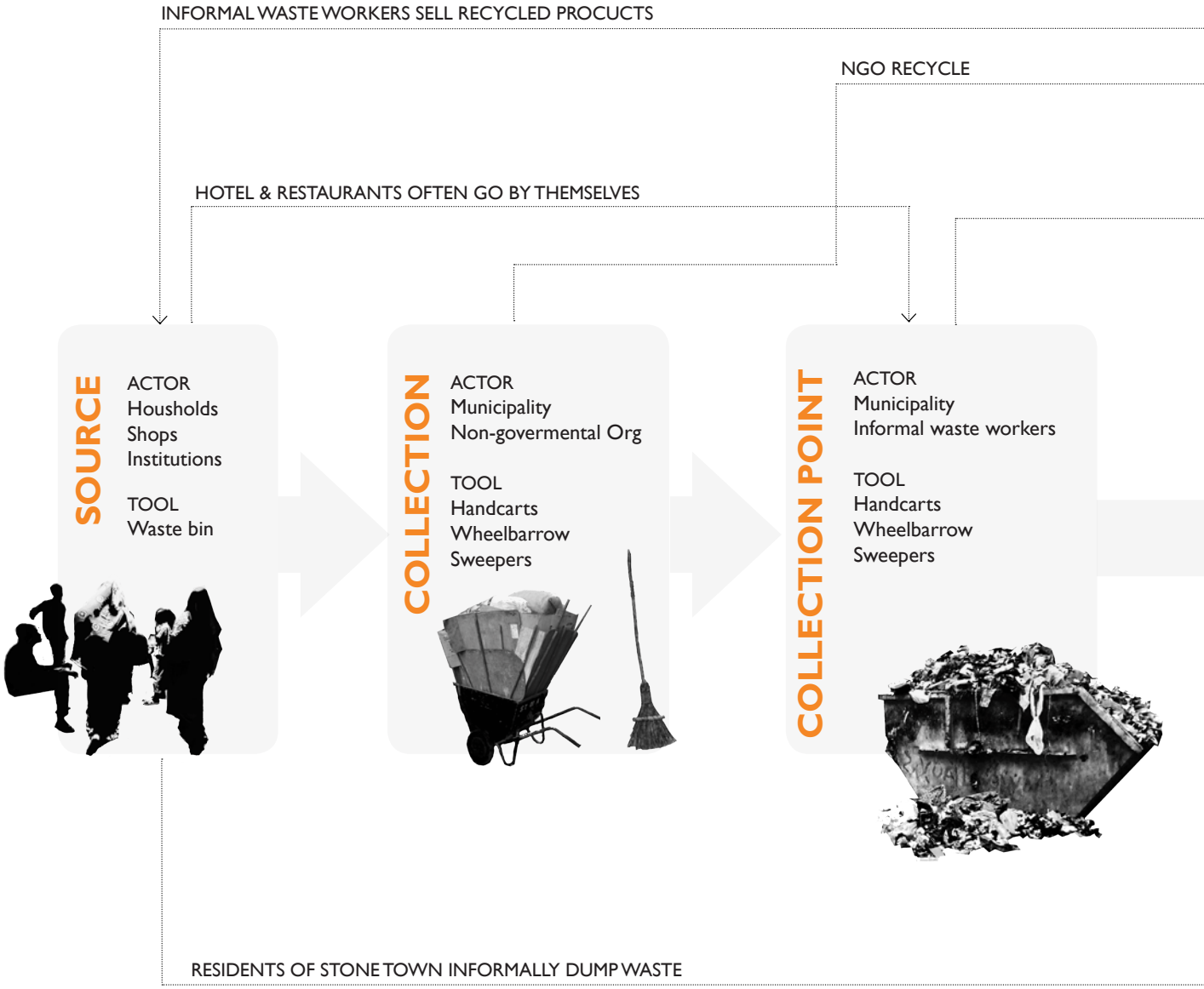
The process of solid waste management in Stone Town is a dynamic flow with different stakeholders involved. Each step; source, collection, collection point, transport, processing and disposal are creating a chain of events that together constitutes the process of solid waste management.

However, processing of solid waste has no formal practice on Zanzibar, which has resulted in informal activities only. The informal waste workers represent a large part of the labor force dealing with procedures concerning recycling, reusing, and others ways of minimizing waste. Also, a formal disposal site is missing. This leads to a troubling situation, where massive informal dumping takes place in an abundance of different, more or less suitable locations.

The municipality, ZMC, is responsible for managing the door-to-door collection and in some extent the street sweeping in Stone Town. The majority of the street sweeping is managed by the four non-governmental organizations contracted by the municipality (see chapter 4). The communication between the municipality workers and the NGO workers is poor and there exists a general confusion of how and where the different workers are employed.

Lack of funding complicates the process drastically and leads to disruption when technological equipment breaks or malfunctions. Residents and business owners are affected by the reduced service and find it inconsistent and unreliable.

Figure 19.
The digram reveals the current process of solid waste management in Stone Town.



INFORMAL PROCESSING

ACTOR
Informal waste workers

TOOL
-

INFORMAL WASTE WORKERS RECYCLE

TRANSPORT

ACTOR
Municipality

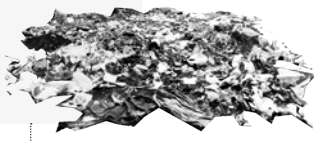
TOOL
Skip truck
Compactor truck

PROCESSING

DISPOSAL

ACTOR
Municipality

ACTOR
Waste truck



SINCE THERE IS NO PROPER LANDFILL, WASTE IS INFORMALLY DUMPED

INFORMAL DUMPING

SOURCE

ACTOR
Housholds
Shops
Institutions

TOOL
Waste bin

5.1.2 SOURCE

Households, shop owners and institutions act as generators of solid waste in Stone Town. In order to get their opinion on the SWM system semi-structured interviews were conducted on Sokomuhogo street with five shop owners and five residents (see section 2.1.2 and appendix 1). The interviews revealed that they put their solid waste outside their door normally at night or early morning. However, many of the bins are left outside all day. Each household is supposed to have one bin outside their own door, but many resident shares bin and put them in clusters. The waste bins are made of different types of materials, from plastic buckets to bags, and are often placed in an unstructured manner. Despite waste bins being left outside during the day, waste is accumulated on the street.

Observations show how all parts of the population are participating in the littering of the streets. Children are often seen throwing paper from wrapped food and adults engaged in cooking on the street are leaving leftovers such as potatoes or fruit peels on the ground.

No formal separation of solid waste occurs but the interviews showed that most of the people have the knowledge and are willing to participate in such activities if proper services are provided. According to a field survey in 2011, 74 per cent of the households in ZMC are willing to carry out separation at source (Juma, M. 2012).

Further, the interviews indicated there exist an uncertainty among the residents and shop owners whom is collecting waste, sweeping the street and when it is done. They also express dissatisfaction with how the waste management is handled by the municipality.

Figure 20.
From left: plastic buckets used as waste bins by households, shop with foodstand, foodstand and a tourist shop on Sokomuhogo Street.

SWOT

STRENGTHS
There exists a lot of knowledge of how to handle waste in a proper manner.

WEAKNESSES
People don't feel responsible for their waste as soon as it's put outside the door.

There is no formal separating of waste.

No uniformity of waste bins and they are put on different places.

OPPORTUNITIES
People know how to separate.

THREATS
Residents are frustrated with the solid waste management run by the ZMC.

5.1.3 COLLECTION

There are two types of collection of waste in Stone Town; door-to-door collection of household waste (or similar) and street sweeping of waste that has been generated on the streets. Both are done on a daily basis early in the morning.

Door-to-collection collection

Door-to-door collection is a process where a municipality worker collects household waste placed in a bucket outside the door of the houshold or shop. The municipality waste workers obtain the equipment at 05:30 am at the headquarters located in the northeast part of Stone Town. After a five to fifteen minutes' walk, depending on where in Stone Town the collector works, the collector arrives to his area. He starts with arranging the cart by using wooden boards to build up walls to be able to fit a larger volume of waste in the cart (pic. 1). Collecting is done by taking every bucket from both sides of the street and put it into the cart, and sometimes saving valuables in separate bags (pic 2).

Two types of handcarts, a large and a small model, are used for the collection. There is only one large cart available at the moment (pic 3). Since there are not enough handcarts for every worker, the collector must keep a fast speed along the route to deliver the cart to the next worker after finishing his area. The stressed situation and poor equipment result in solid waste dropped outside the cart. In low season, usually one round to the collection point is sufficient for a route when using the large handcart. During high season, two till three rounds are necessary.

The collector prefers buckets being clustered in small groups since it eases his work by reducing stops (pic. 3). Along the route the wooden boards are arranged to hold a larger amount of waste in the cart (pic. 4).

The door-to-door collector has a fixed route and is familiar with the residents in his area. Some residents know the exact time when he arrives, and keep the waste bin inside until he passes by, to prevent the bin from being stolen (pic. 5 & 6).

1 2

9 10

It is prohibited to throw waste: nevertheless piles of waste are scattered all around Stone Town. The door-to-door collector does not collect scattered waste as it is not part of his daily tasks, and even if it was, he could not fit the extra waste in the hand cart (pic. 7 & 8).

The working conditions of the door-to-door collector are extremely hard, with physically demanding work (pic. 9) combined with a low salary, only 0.75 USD (1200 TSH) per day. The collecting ends by the container at the collection point after approximately 45 minutes (pic. 10).

In order to properly implement the door-to-door collection paved roads, sustainable material and equipment and proximity to collection points are needed.

SWOT

STRENGTHS
Skilled waste workers with a lot of local knowledge.

WEAKNESSES
Lack of equipment. Existing gear in poor condition.

Time consuming.

OPPORTUNITIES
Bins are often clustered.

THREATS
The waste collector is the only one knowing where people keep their waste on his route.


ZMC

Figure 21.
From left: a women from Zacedy group is sweeping in Stone Town, sweepers at Ngome Kongwe collection point, the last two photographs shows how piles of solid waste are picked up in wheelbarrows and brought to the collection point.

Street sweeping

There are four actors sweeping the streets of Stone Town; the municipality workers and three NGOs called The Glitters Volunteer Group, Zacedy and The Community Police. The majority is women due to a combination of the view of street sweeping as traditional women's task and the fact that they don't have many other options of work.

Participant observations shows that the activity of the street sweepers occurs simultaneously with the door-to-door collection. The task is basically to sweep the waste of the street into piles and collect it on a wheelbarrow or in a sack, and empty it at the collection point. Many times the workers have to reposition fallen waste bins and clean up around them. The equipment used is a handmade broom, which last approximately three days, and a half plastic canister to use as a dustpan.

The working conditions are very difficult. Street sweepers are paid 0.63 USD (1000 TSH) per day, a salary that barely covers the cost of travel to and from work. Lack of uniforms and other equipment poses a threat to the health and well-being of the workers. Due to the difficult working conditions and the poor encouragement the NGO workers are decreasing in numbers which is going to be devastating for the cleanliness of the city.

SWOT

STRENGTHS
Committed workers.

WEAKNESSES
Unreasonable working conditions with no uniforms or other protective clothes.

Poor communication.

OPPORTUNITIES
Willingness to take responsibility.

THREATS
Illness from pollutions.

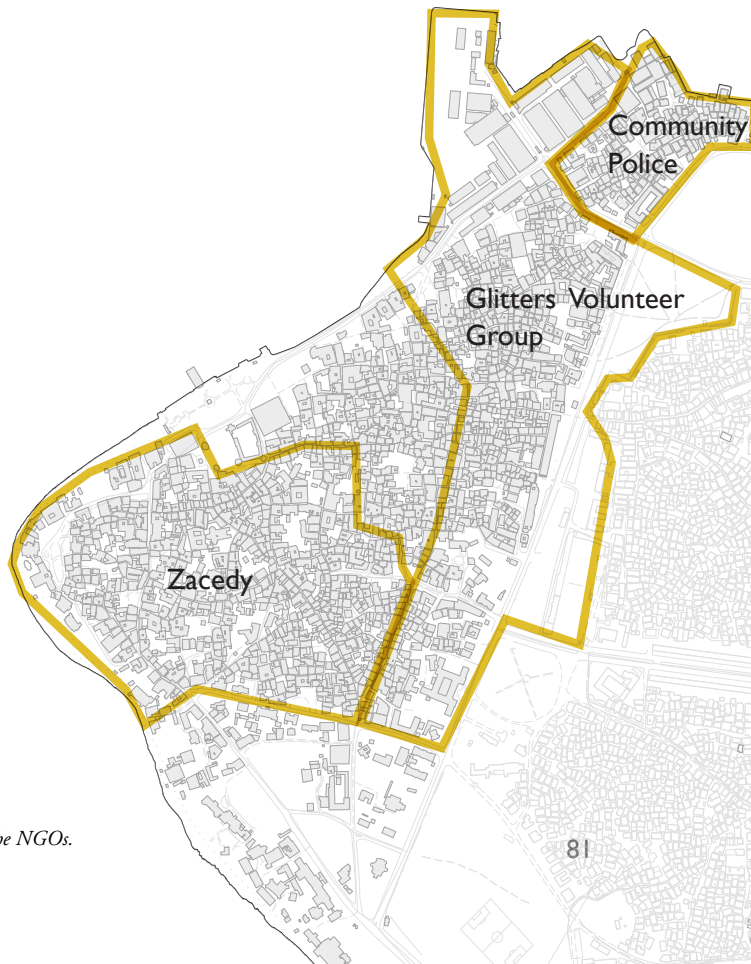


Figure 22.
The map show the different areas of the NGOs.

COLLECTION POINT

ACTOR
Municipality
Informal waste workers

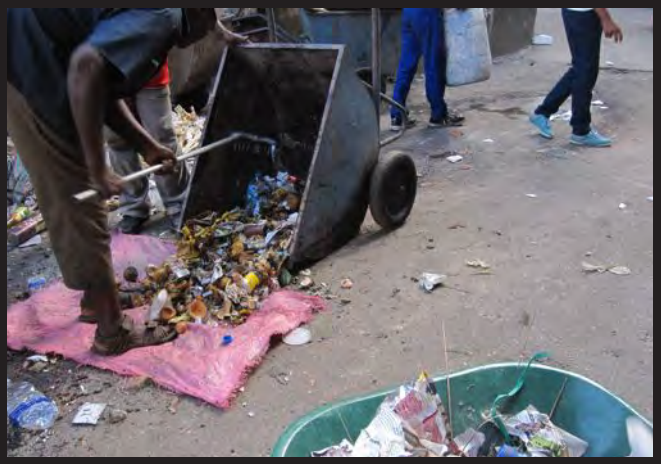
TOOL
Handcarts
Wheelbarrow
Sweepers

5.1.4 COLLECTION POINT

There are six formal collection points used for generated solid waste in Stone Town. Hence, many informal dumping sites exist; especially in parking lots, green areas and narrow alleys.

The collection points normally comprise of an open 9m³ container, often in poor condition and hard to find. The container is placed on a concrete slab, large enough for two containers, which makes it easy to collect the full container and replace it with a new one. In low season the containers are emptied once a day in the morning, while in high season they are emptied two or three times a day.

Collectors, street sweepers and informal waste workers are all working together in a structural way at the collection point. The informal waste workers are assisting the waste collectors by emptying the handcarts and swinging waste into the container (pic 1 to 5). In return they are allowed to take recycling materials from the collected waste. Even though some of the waste is sorted out for recycling, the container gets overfilled and the waste collectors needs to compact the volume by jumping on top of it (pic. 6). Still, a considerable amount of waste is ending up outside the container, which is swept into piles by the street sweepers (pic. 7) and then put directly into a compactor truck (pic. 8). After approximately 45 minutes, all the excessive waste is tidied up and the supervisor calls the skip-truck driver. When the skip-truck arrives an empty container is put besides the filled container and the filled container is removed (pic. 9 & 10).



1 2

10

Following pictures show how waste is being accumulated at Ngome Kongwe during a day in low season (october 2013).

05:00 AM

08:00 AM

13:00 PM

16:00 PM

SWOT

STRENGTHS

Waste collectors, informal waste workers and street sweepers are working together in a structural manner.
Informal waste workers are reducing the waste.

WEAKNESSES

Few collection points - overfilled.

They are almost invisible and placed on back streets.

Collection points are in poor condition, smelly, non-hygienic which creates an accumulation of rats and cats.

People throw waste outside the container and scavengers are making a mess while looking for recyclables.

No formal separation occurs.

OPPORTUNITIES

There is often free space around the collection point which makes it possible to do something more with the space.

THREATS

Health risk and contamination from unsanitary collection point.

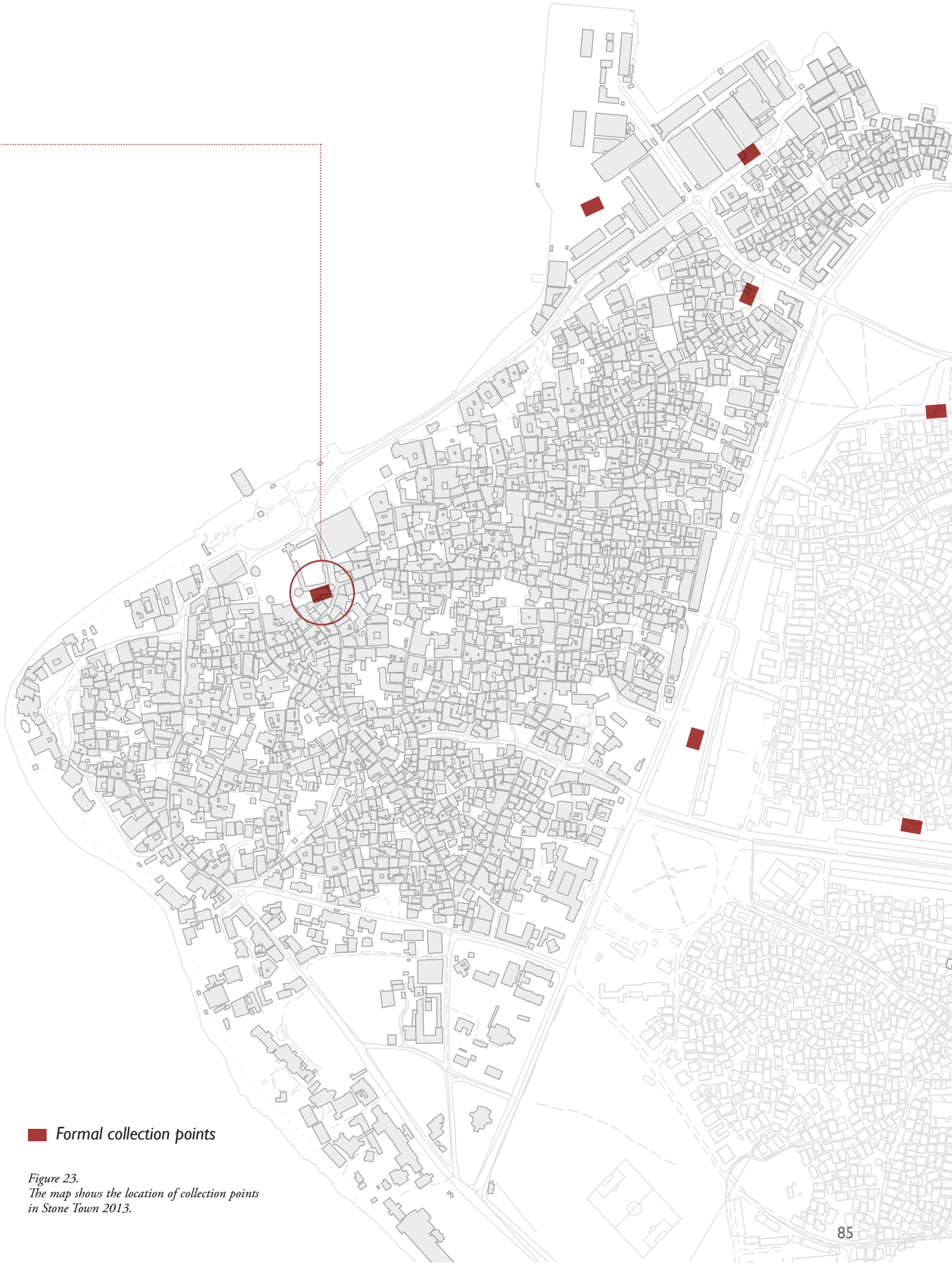


Figure 23.
The map shows the location of collection points in Stone Town 2013.

TRANSPORT

ACTOR
Municipality

TOOL
Skip truck
Compactor truck

5.1.5 TRANSPORT

There are two types of secondary collection vehicles used for collecting waste in Stone Town: a compactor truck and a skip-truck. Both types are of poor condition due to age and high wear. According to interviews and observations, frequent breakdowns create disturbances in work productivity, which results in containers that are not emptied for days becoming a hygienic inconvenience.

Observations shows that the compactor truck (pic. 1 &2) reduces the volume of waste by compacting it, which allows a larger amount of transported waste. Further, in Stone Town the compactor truck mostly takes care of all waste that does not fit into the containers and ends up on the ground beside the collection point.

The compactor truck starts its route at the Darajani market where shop owners and street sweepers put the collected waste straight into the truck. The route continues to the harbor and further on to Ngome Kongwe – the Old Fortress (see fig. 12). When the practice of collecting all excessive waste from the collection point is finished, the foreman calls the skip truck driver. Although there are no set times for the skip truck to come, it is a well functioning system based on good communication.

There are three skip trucks in Stone Town, but at the moment one is out of order. The two remaining trucks prioritize Ngome Kongwe and the Darajani market (see fig. 13). Thereafter the order of collection of the remaining containers is decided in cooperation with the foremen.

The skip truck collects the filled container and replaces it with empty one (pic 3 to 5). When the container is placed on the truck bed the driver puts on a tarp (pic 6 & 7), which often is defective, to prevent waste fly off during the transport. The whole procedure with collecting the container is very efficient and only takes five minutes.

Thereafter the container is driven to the current informal disposal site (pic. 8 & 9).

5 6 7

8

3 4

9

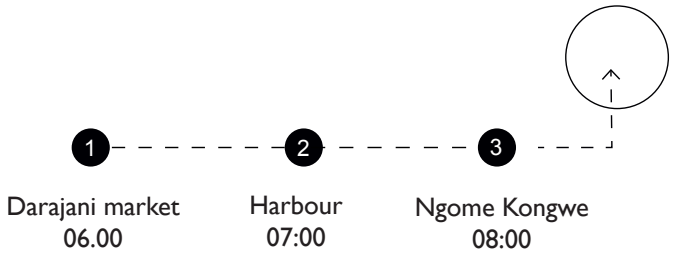


Figure 24.
Routes and time schedule for the compactor truck in Stone Town.

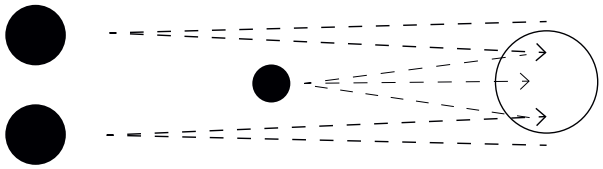


Figure 25.
The two skip trucks running in Stone Town priority Nagome Kongwe and Darajani Market.

SWOT

STRENGTHS
The skip-truck only takes 5 minutes.

WEAKNESSES
The compactor truck takes 45 minutes.

Trucks brake down easily.

OPPORTUNITIES
Good communication between waste collectors and truck drivers.

THREATS
A lot of focus on techniques in the waste management process.

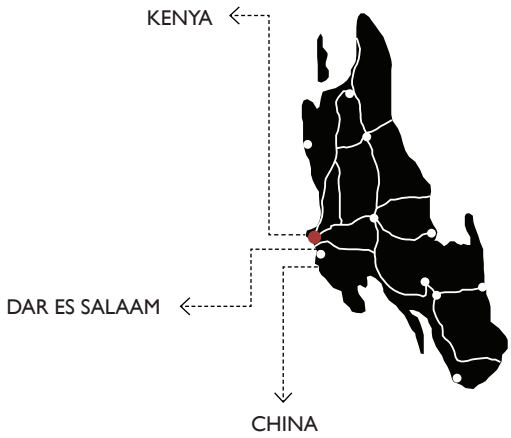

2
3
1
START

5.1.6 PROCESSING

There exist no formal processing of waste in Stone Town. Despite this, there is a lot of informal processing, such as reuse and recycling. Mostly of the recyclable material is collected by individuals, in this thesis referred to as informal waste workers, at the collection point or disposal site. Most of the material is sold to agents at the harbor, which in their turn ship the items to the mainland.

Plastic, metal and glass has approximately the same value per kilogram, about 0.12 USD (200 TSH), but weighs naturally very different. A rice bag is about 0.31 USD (500 TSH) each. Especially plastic bottles are sought after because they are re-used for juice, oil or water. Metal bins are converted to lamps and rubber is used to make shoes. Organic waste in good condition is sorted out and given as feed to animals.

The informal waste workers contribute to reduction of the waste volume that otherwise would go to disposal. They are not organized; instead they work each one for themselves. The working conditions are obviously very tough which leads to that mostly young men are coping with the circumstances.



SWOT

STRENGTHS
There exists informal processing.

There is an interest of recycling.

There are recyclable materials.

WEAKNESSES
Only informal processing.

Waste lose value due to destruction.

OPPORTUNITIES
The informal waste workers are skilled at separating.

Figure 26.
From left: Reuse of big water bottles, recyclable material at Ngome Kongwe collection point, collected water bottles for selling, a scrap trade shop in Stone Town, recyclable material at Ngome Kongwe collection point.



DISPOSAL

ACTOR
Municipality

5.1.7 DISPOSAL SITES

There are no formal disposal sites on Zanzibar. The current disposal site in Mwanakwerekwe is an open landfill which has been in use by the municipality for two months when observed in October 2013. The site is a former illegal sand quarry just next to and owned by a Christian community. The municipality and the community split the cost of compacting the landfill with bulldozers and other expenses (Rajab 2013a).

No precautionary measures have been taken at the Mwanakwerekwe disposal site. The area is not fenced or covered which causes vast environmental contamination and security vulnerability. Moreover, the plan is to cover the landfill with sand from the harbor of Zanzibar (Rajab 2013a). One can assume that this sand is highly polluted from the harbor activity and the sewage drainage straight into the ocean.

The skip truck arrives at the disposal site and unloads its contents in the container (pic. 1). A crowd of approximately ten boys looks through the waste and collects materials of value (pic. 2). On the edge of the landfill, collected waste is stored under a simple shelter (pic. 3), where some of them live.

SWOT

WEAKNESSES

There exist no formal dump site.

The informal dump site is unhygienic and has inadequate security.

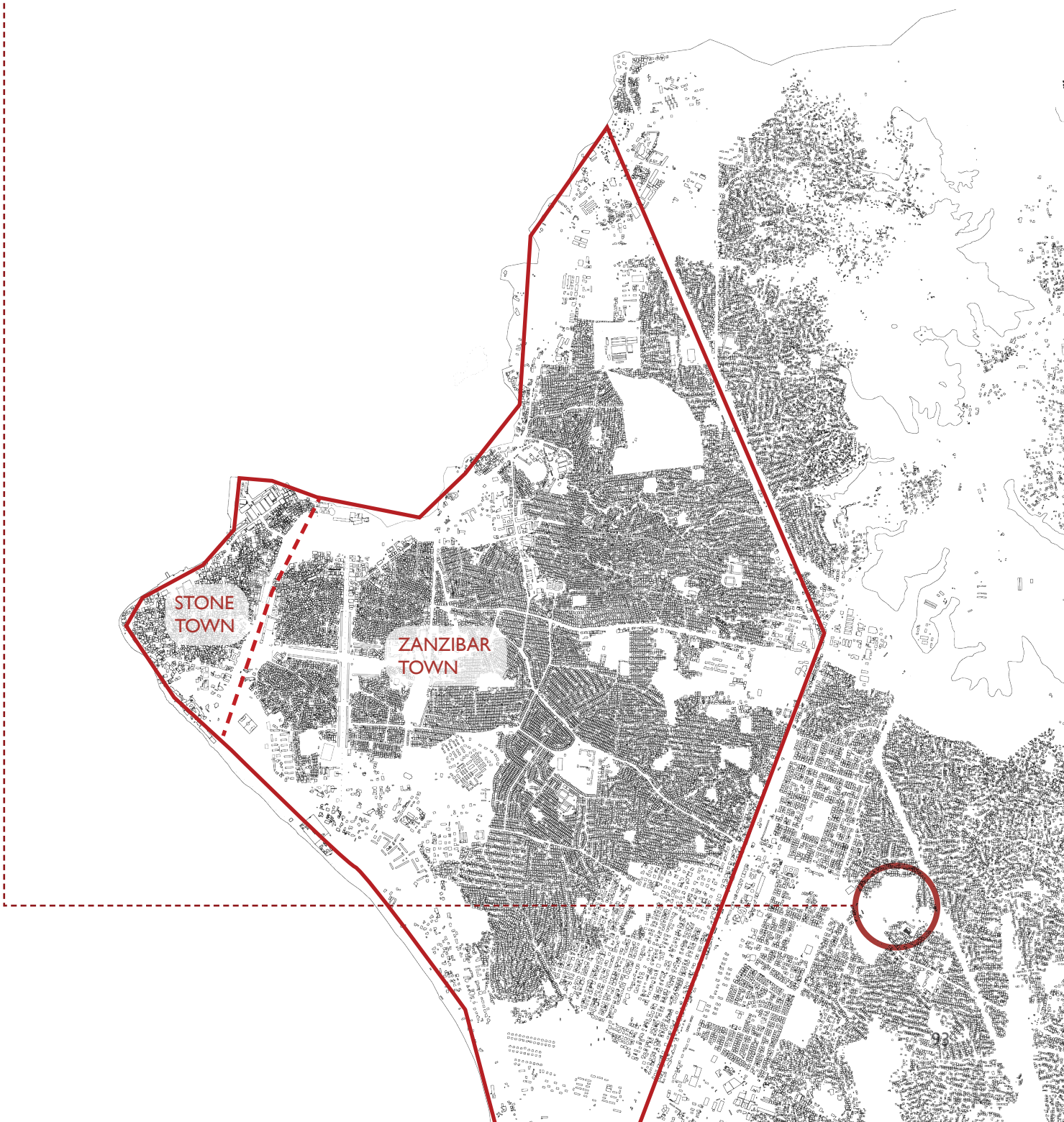
OPPORTUNITIES

Reduced disposal by separating and recycling.

THREATS

Contamination of groundwater is potentially a huge health risk for people and the environment.

1 2 3



5.2 SUMMARY OF ANALYSIS

- Residents don't feel responsible for the produced waste but they have the knowledge of how to separate the material.

- The door-to-door collectors are skilled and have a lot of local knowledge. The collection is time consuming since there is not enough equipment avalible and waste bins are scattered along the streets.

- There exist several committed NGO:s but they are not properly acknowledged in the process which leads to a reduction of people participating.

- Informal waste workers contributes at the collection point and reduces the waste by selling recycleables. Yet, they are not officially included in the process.

- Collection points are few and unevenly spread over the city which makes them hard to find and overfilled with unsanitary waste.

- There exist a lot of focus on techniques in the waste management process which demands a lot of resourses.

- There exist no formal separation or processing of solid waste which leads to heavy transportation of waste to the informal dump sites.

06

ANALYSIS OF STONE TOWN

THE PHYSICAL CONDITIONS

Chapter 6 contains analysis of Stone Town in two scales. The first section analyzes the town as a whole to get an overview of the situation. The second section shows a typical street to demonstrate ordinary circumstances within the town. Solid waste, as a topic, is used as a filter to sort out relevant information. The chapter is concluded with a summery.

6.1 ANALYSIS OF STONE TOWN IN THREE SCALES

To understand the complexity of Stone Town concerning solid waste management different scales needs to be investigated. This thesis has divided the analysis in three scales in order to reveal different levels of details affecting solid waste management.

The analysis of the town scale exposes large structures such as roads, greenery and other physical prerequisites important for the infrastructure of solid waste management. The street scale involves the same analysis as mentioned above but in a smaller scale, and also more people-oriented like how people move and where people socialize. There is also a focus on how waste is handled on the street.

Analysis of the site scale includes critical places concerning solid waste management. Such sites either needs to be improved or changed to develop the system. This minor analysis will be presented in chapter 8, directly related to the proposals.

Figure 27. The figure illustrates the relation between the three scales. The site scale analysis will be presented in chapter 7 together with the proposals.

6.2 INTRODUCTION OF THE TOWN SCALE

The town scale gives a general description of the prerequisites that effects the solid waste management in Stone Town. Factors like infrastructure, social nodes, green areas, run off, ruins, garden, graveyards and mosques are analyzed. Existing collection points are also described and analyzed.

Figure 28. The figure shows a map over Stone Town. Creek Road is dividing Stone Town from Zanzibar Town.

6.2.1 THEMATIC MAPPING OF STONE TOWN

This section consist of eight thematic maps of Stone Town. Each map is described with a text and shows important factors that effect the solid waste management at the town scale.

INFRASTRUCTURE FOR WASTE

Stone Town is only accessible by car from the West due to its location by the Indian Ocean. Concerning the solid waste management, there are three roads accessing Stone Town that can be used by waste trucks. Recyclable material is shipped from the harbor to the mainland.

Figure 29. shows a compactor truck sharing the space with pedestrian cyclists and taxis at the Darajani market.

ACCUMULATION OF WASTE BY SOCIAL NODES

Large gathering places, such as markets, the harbor and sport fields attract a lot of people and thereby also waste. At social events and holidays the sport fields are used as celebrating areas where all the waste material is left on the ground after the event.

Darajani market is the most important node in Stone Town where food, household supplies and clothes can be bought. The local transport is stationed at the market area which increases the crowding.

1. The Harbor
2. Mbuyuni
3. Forodhani Market
4. Darajani Market
5. Mnazi Mmoja

Figure 30. Darajani market

Figure 31. The large green areas are often open grass fields with some trees around the borders.

LARGE GREEN AREAS IN NEED OF SOIL IMPROVEMENT

There exist a few larger green areas in Stone Town. Although, most of them are in poor condition and are in need of restoration. To get a lush green city these areas need new fertile soil and reinforced with new plants.

1. Mbuyuni
2. Forodhani Market
3. Kisiwandui Garden
4. Zanzibar State House Garden
5. People's Garden and Victoria Garden
6. Mnazi Mmoja

TRIANGULAR RUN OFF

Due to Zanzibar's location close to the equator, rain season occurs twice a year. The elevation of Stone Town is shaped as a triangle with St. Joseph's cathedral on the top, which forces the water in three directions. When heavy rain occurs littering is flushed to wells and clogs the system.

Figure 32. shows a rain fall where water are flushed down the streets in Stone Town.

WASTE DUMPED IN RUINS

Due to deferred maintenance of most of the buildings in Stone Town there exist a large number of ruins. The remains give an unfortunate character, which attracts waste dumping. People throw and burn their waste in the ruins that gives an unsanitary environment in the city. Instead, the ruins can be seen as opportunities to create a new network of public green spaces in Stone Town.

Figure 33. Burning of informally dumped waste is common in Stone Town.

GRAVEYARDS ARE CONTRIBUTING TO THE GREEN STRUCTURE

There are a large number of graveyards in Stone Town. They are often green but lack maintenance to form a high quality of green space. Since a wall surrounds most of them they are hard to find and usually used as dumpsites for waste. However, they have the potential of reinforcing the green structure and raising the biodiversity in town.

Figure 34. A previously beautiful and green graveyard is destroyed by informal dumping.

SCHOOL GARDENS EDUCATE CHILDREN

Schools within Stone Town are spread evenly over the city. Some of them have a relatively large schoolyard with cultivations. Even though there exist some cultivations, none of the schools have composts. Instead, organics together with other waste materials are put straight on the soil as fertilizer. For educational purpose there could be a prospect of making a more efficient degrading process by using composting.

Figure 35.
School gardens are contributing to the grees structure of Sone Town as well as educating the children.

MOSQUES ARE IMPORTANT SOCIAL NODES

As 95 % of the population of Zanzibar is Muslims, there are a large number of mosques in Stone Town. They serve as important social nodes, especially for men. Currently there are no information or activities provided by the mosques concerning waste or solid waste management.

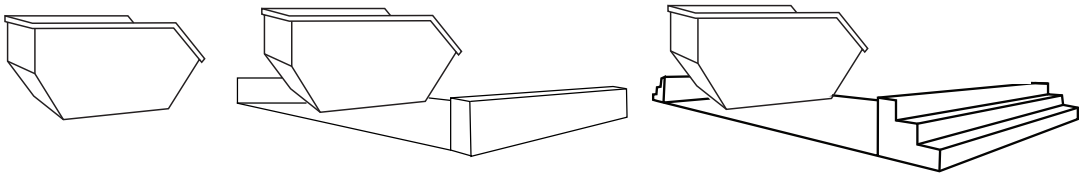
6.2.2 COLLECTION POINTS

Collection points are anonymous in Stone Town. Except for the container, there is nothing indicating that the place is a collection point. There are currently five public formal collecting points in Stone Town; Ngome Kongwe, Mbuyuni, Passing Show, Harbour facility and Darajani market.

Harbour facility and Ngome Kongwe (see fig. 36, nr. II and IV) consists of one container each placed straight on the asphalt. Due to the fact that the lowest part of the container is facing the facade, it hampers the work of swinging waste into the container.

Passing Show (see fig. 36 nr I) consists of a concrete slab, with raised edges, fitting two containers relatively hidden on a parking area.

The collection points Mbuyuni and Darajani (see fig. 36, nr III and V) both have new concrete slabs fitting two containers. These slabs are provided with stairs which makes it easier to reach the container.

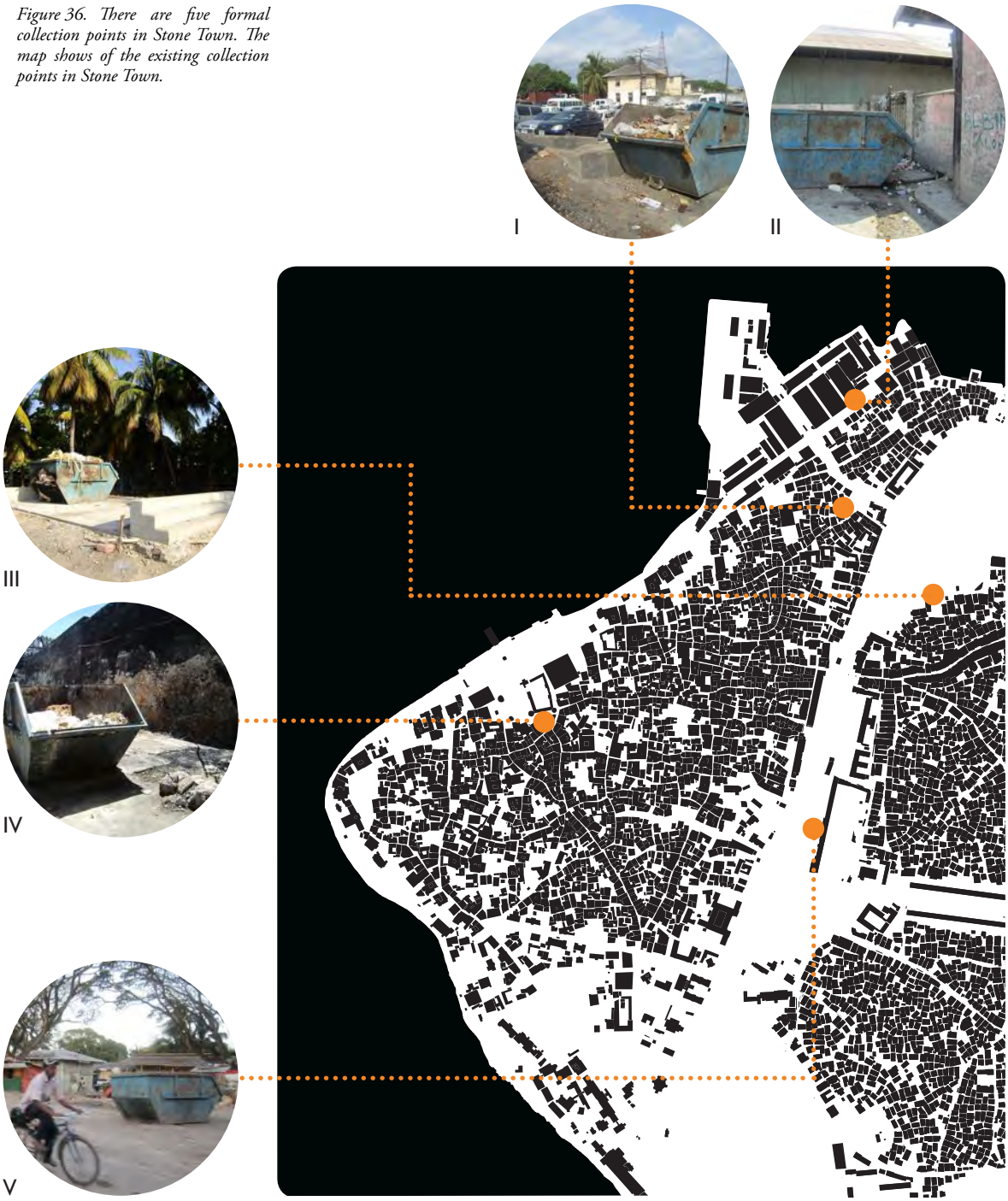


II Harbour facility
IV Ngome Kongwe

I Passing Show

III Mbuyuni
V Darajani

Figure 36. There are five formal collection points in Stone Town. The map shows of the existing collection points in Stone Town.



6.3 INTRODUCTION OF THE STREET SCALE

The street scale reveals more detailed prerequisites affecting the solid waste management in Stone Town. Sokomuhogo Street was chosen for the analysis because of its varied contents of shops and housing, junctions forming small squares and narrow alleys which represent a commonly found street in the town.

Sokomuhogo Street is crossing the very heart of Stone Town, from the fortress in the north to Vuga road in the south. The street is approximately a half of a kilometer long and run through the districts of Baghani, Sokomuhogo and Vuga. The street is located South East of Darajani market where the local transport station also is situated. Jaws corner, located in the middle of the street, is the most striking and important gathering node in Sokomuhogo district.

Figure 37.
Map over Sokomuhogo Street.

Figure 38.
Picture of shoe shop on Sokomuhogo Street.

6.3.1 PHYSICAL PREREQUISITES

This section shows the physical prerequisites, of a commonly found street in Stone Town, affecting the solid waste management. Characteristics are winding and narrow streets where sight lines are constantly broken. Desolate small alleys are interspersed with crowded barazas outside residential housing or intriguing shops. Junctions open up narrow streets with its spatial volume and forms small squares which are commonly used for socialization.

Households & commercials establishment

There is a mix of residential and commercial establishments. However, it is a concentration of commercial establishments at the north part from Jaws Corner. The south part is mainly occupied by households. The commercial establishments are usually tourist shops located at the ground floor with households on top. This area tends to be cleaner from solid waste, especially during the daytime when shops are open. Most of the shop owners live outside Stone Town and commute into town.

There are two restaurants with direct contact to the street and one restaurant in a backyard located north east. Except from the restaurants there are ten food stands with takeaway food and a large amount of women cooking on the barazas. People tend to through wrappings on the ground after eating takeaway food why these areas often are littered.

Spatial volume

The broadest parts of the street occurrs where roads are crossing Sokomuhogo Street. The experience of the spatial volume increases in these areas. The broadest parts are between 5-10 meters, while the narrowest part of the street is 2 meters. Narrow alleys, with a small amount of light reaching the ground a short time during the day, are highly littered.

Street structure

The street is winding through tightly seated houses, framed by solid barazas. Narrow alleys exaggerate the dense character while junctions of roads open up for a more airy experience. The junctions are often used as social squares while the alleys are used for waste dumping. This variety in the street structure makes it difficult to have a consistent approach to waste management.

The experience of public and private zones on the street varies. The actual street is of public character. On side of the street, the barazas have a semi-private to public character depending on height and distance to private residence. Backyards are often of private character but there exist some public places hidden behind the houses.

Households & commercials

residential *commercial establishments* *institution*

Spatial volume

Broad parts *Narrow parts*

6.3.2 ARCHITECTURAL FEATURES

Sokomuhogo Street has the typical architecture of what makes Stone Town a World Heritage town. Most of the buildings date back to the 19th century, with a mix of Arab, Persian, Indian and European elements (LaNier & McQuillan 1983). Sokomuhogo Street is an old Bazar street (Pitcher, see McIntyre, C. & S, 2013) which today serve as a main pedestrian thoroughfare. The street still has much of its old character well-kept although the shops are mostly located at the north part and are of touristic appeal. The architectural features are important to recognize for keeping the character of Stone Town (LaNier & McQuillan 1983).

Bulidings & facades

Sokomuhogo Street is highly influenced by the Indian housing but modified by the Swahili culture (LaNier & McQuillan 1983). The Indian houses have a more extrovert appearance with large open windows and balconies which allows natural light to come in. There also exist some influences of Arabic housing, which has an introvert appearance on Sokomuhogo street. These houses were not constructed for the heavy raining seasons appearing on Zanzibar which moisture damaged the houses. In order to protect the houses corrugated tin roofs were added (LaNier & McQuillan 1983).

Details

There are a variety of doors with different styles along Sokomuhogo Street. Especially the massive carved doors stand out with their delicate decorations. The symbolic patterns and quotations from the Koran give identity to the often-plain facades (Pitcher, see McIntyre, C. & S, 2013).

Different patterns decorate security bars for windows and doors. These patterns are Arabic influenced and give a modern touch to the street.

Barazas

Baraza benches, simply called barazas, are thick benches of solid stone built into the walls around courtyards and outside buildings. The barazas evolved as a way for Islamic men to welcome visitors without compromising the privacy of their womenfolk (Pitcher, see McIntyre, C. & S, 2013). They align almost along the whole stretch of Sokomuhogo Street and create a prominent architectural feature.

During rainy season, when water flushes the street, the barazas provide a practical elevated pavement, and pedestrians jump from one baraza to another in an attempt to keep their feet dry (Pitcher, see McIntyre, C. & S, 2013). Waste bins are commonly kept on the barazas which is practical, especially during rain seasons.

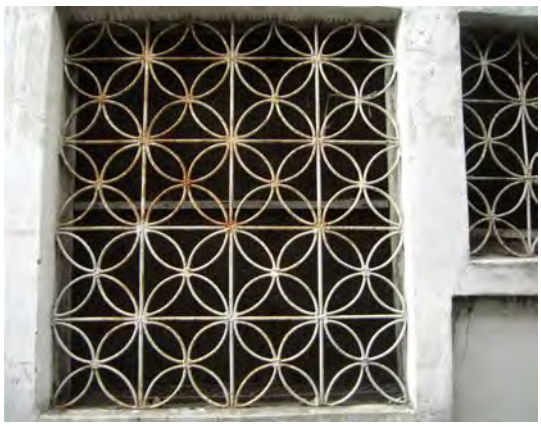


Figure 39. The pictures show a variety of architectual features from Sokomuhogo Street.

6.3.3 SOCIAL & CULTURAL

There is a rich and vivid social life on Sokomuhogo Street. People are often sitting and socializing in small groups on the baraza benches along the street. A concentration of social life occurs around and south of Jaws Corner where there are more residential houses.

Social pattern of men and women

Men are dominating the public spaces. They are often seen hanging out while women are mostly seen one by one cooking, handcrafting or sitting outside shops on the barazas. Women are also seen taking care of their children or just passing by.

Jaws corner

Jaws corner is one of the dominant social sites in Stone Town. During the morning hour, before work, the place is crowded with men discussing politics and news over a cup of coffee. At approximately two o'clock men are occupying the square again. At this time they are playing board games such as domino and bao or drinking coffee and discussing different subjects. Jaws Corner is then crowded all until the evening. Sometimes at night men are watching football on a TV which is temporary arranged for the occasion.

Children

Wider parts of the street are used as playgrounds by the children. They are running around on the street playing with tires or chasing each other. At the south of Sokomuhogo Street children are often seen playing football. In the morning and around two o'clock they are passing by on their way to or from school.

Children are a large contributing factor to the littering on the street. They throw wrappings on the ground and play around by kicking plastic bottles.

Figure 40.
From left: "Bao" game board usually played by men on the street, the vivid social life on Jaws Corner, two children are playing on the baraza and several children are playing at a wider part of Sokomuhogo Street.

Social nodes

Social hotspots

Jaws Corner

Playground for children

6.3.4 GREENERY

There exist no larger green structures directly on Sokomuhogo Street, only two trees exist along the whole street. However, there is one green backyard in close connection to the street. This backyard is a private banana plantation next to a restaurant. The area is hard to locate for non-residential. Potted plants, outside some commercial establishments, are the only well taken care of green feature on the street.

There are two forgotten green areas trapped between houses. These areas are similar to ruderal grounds and are used as latrines and informal dumping areas.

6.3.5 RUNOFF

The runoff is poor on Sokomuhogo Street. The street gets flooded during heavy rainfall and a lot of water is gathering in low-lying areas. Waste is transported by the runoff and clogging the existing well. The heavy rains also create mudslides, from ruins and forgotten-areas that slope down to the street, which contributes to the clogged wells. This makes the street sweeping impossible and all the accumulated waste and mud on the street is ending up by the well.

Figure 41. Heavy rain causes temporary floodings on Sokomuhogo Street.

GREEN TYPOLOGIES

Figure 42. The figure shows four typologies of greenary occuring on Sokomuhogo Street: a green backyard, a plantage, potted plants and plants growing in cracks.

6.3.6 THE FLUX OF SOKOMUHOGO STREET

Sokomuhogo Street is especially crowded during the morning time when residents are crossing the street on their way to work, and in the afternoon when they are coming back. Nevertheless, tourists are strolling the street all day.

Except the many pedestrians, several kinds of vehicles keep the street busy. Motorcycles, mopeds, bicycles, bicycle charts and handcarts add to the flux of the street. Many times conflicts of interest occur when the narrow street cannot provide room for everyone.

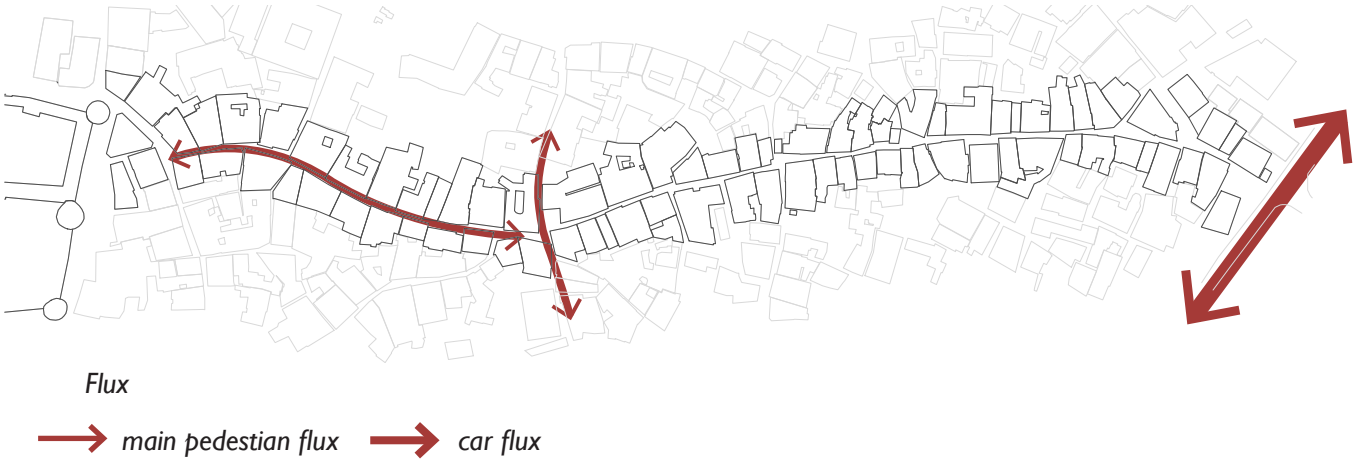


Figure 43. Bicycles, ice cream vendours and motorcycles all keep the street busy.

6.3.7 WASTE ACCUMULATION DOCUMENTATION

To document the accumulation of solid waste on Sokomuhogo Street, picture series has been taken at different times during the day. The point of times has carefully been chosen dependent on critical hours during the day concerning the waste. Before the door-to-door collection and street sweeping to document the most amount of waste, and after their work to see the reset of the waste on the street. The next sessions shows the waste accumulation throughout the rest of the day. Hence, the last session occurs at 18.00 PM due to safety aspects and darkness. Unfortunately, the pictures does not reflekt the real scenery on site. In reality the street looks more littered.

Factors such as activity in the buildings, time during the day and the prerequisites of the surroundings determine the accumulation of the waste along the street. Obviously, the street is the most littered before collecting and sweeping, and thereby the most clean after their work. Another factor could be the distance to the collection point.

Cleaner Street close to shops

At the north part of Sokomuhogo Street where most of the shops are located, the street is cleaner in general, at least during the daytime. Shop owners' keep the areas outside their shop clean for attracting customers. When night comes, and the shop owners close, the accumulation starts rising. Early in the morning, before the collection and sweeping has started, the street is in a poor state with a lot of littered waste.

In the South part on the other hand, the documentation shows a higher amount of solid waste on the street. This could be because residentials might have other priorities than the shop owners. Another important fact is that the collection point is located further away. Also, a higher amount of waste from households cooking on the barazas litters the street.

Littering at night

Obviously, the street is cleaner in the morning after the door-to-door collection and the street sweeping. Thereafter it is a relatively even accumulation of solid waste on Sokomuhogo Street. Nevertheless, the amount slightly rises after noon and continues until late night. 13:00 AM is a critical time when the solid waste starts to get visible on the street, probably because of littering after lunch.

Waste accumulates in dark narrow areas

The spatial prerequisites is highly affecting where people tend to dump their waste. The narrow parts of the street, and accordingly darker, tend to attract waste accumulation. It could be the same amount of waste scattered over less space, or the fact that ruff aesthetic places tend to signalize approve of littering.

Plenty of narrow alleys are connected to the South part of the street; these create non-used places where waste is accumulated.

Social places are kept cleaner

In open areas where people tend to socialize the littering is less. However, there seems to be a higher amount of waste littered in a circled area around these open areas. As an example, Jaws Corner look tidy but the streets next to the square are highly littered.

Figure 44. The figure shows a photo session of how waste is being accumulated on the street. Unfortunately, the pictures does not reflekt the real scenery on site. In reality the street looks more littered.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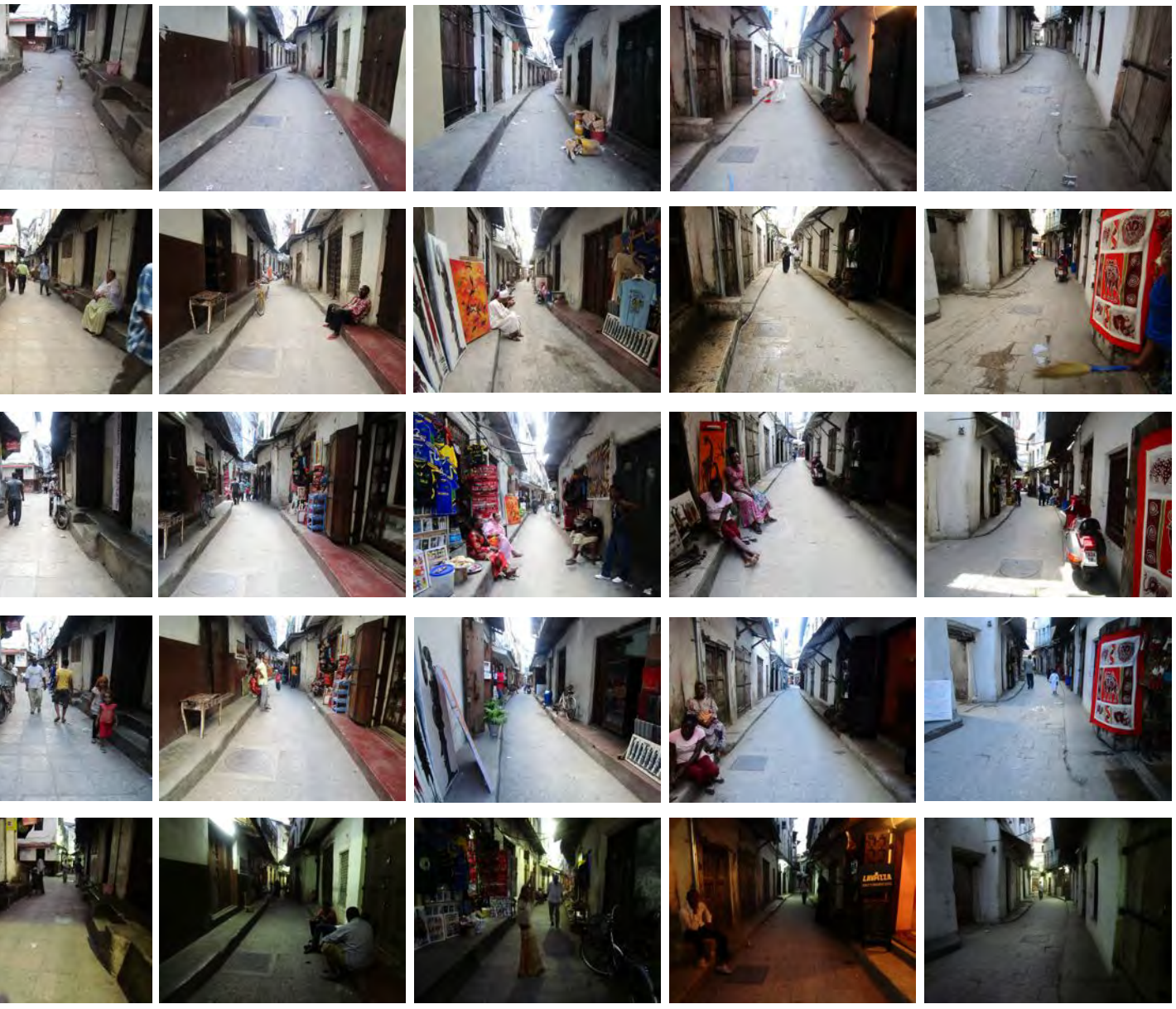


6.3.8 WASTE BINS ON SOKOMUHOGO STREET

Following section describes how the formal waste bins are moved and where the informal dumping accumulates during a day. The mapping has been done three times during one day; early in the morning, before the door-to-door-collectors comes and after the door-to-door collecting is done. By mapping one complimentary session in the afternoon, it reveals how many waste bins are staying outside throughout the whole day.

According to the mapping, the movement of the waste bins and the accumulation of the informal waste piles are depending on what kind of activity there is in the houses, status of the area and the time during the day. Obviously, the highest amount of waste bins and waste piles occurs on the street before the door-to-door collector has arrived.

Waste bins in systematic order close to tourist shops

At the North part of Jaws Corner, where the most tourist shops are located, the waste bins are put in a systematic order throughout the day. Early in the morning the documentation shows a slightly higher amount of waste bins, often clustered together. This indicates that more waste bins are put out after the shops have closed and then taken in during the day.

In the South part of Jaws Corner waste bins are spread out on the street. Yet, there are also many places on the street where waste bins and informal dumping are clustered together. The difference from the North part of the street is that the South part has a larger amount of small bins in a poor condition.

Fewer amounts of informal waste piles close to shops during the day

There is less informal dumping on the North part of the street, probably because shop owners are keeping the street clean. Hence, close to Jaws Corner, informal dumping accumulates during the day, due to the selling of peeled fruits on the square.

South of Jaws Corner, where more residential houses are located, informal dumping is accumulated throughout the day.

Rundown places accumulates waste

Informal dumping often get scattered in areas that does not have a proper cause. These areas are often dark and narrow alleys, left out areas in between houses or planting areas. The mapping shows how the informal dumping accumulates in such critical places. This is more commonly found in the South part of Sukomuhogo Street.

There is one specific critical area where a high amount of waste gets accumulated throughout the day. Waste bins and informal dumping occurs unregularly around the area. Littered waste also piles up in the planting surface and the space in between the houses. The littered waste does not get collected, partly because the waste is neither in bins nor on the street and also because the door-to-door collecting route switches collector at this area.

Figure 45. The figure shows different typologies of waste bins from Sokomuhogo Street.

MAPPING OF WASTE BINS AND INFORMAL DUMPING

Figure 46. The North part of the street is constituted of mostly commercial establishments. The shop owners takes responsibility for cleaning their part of the street.

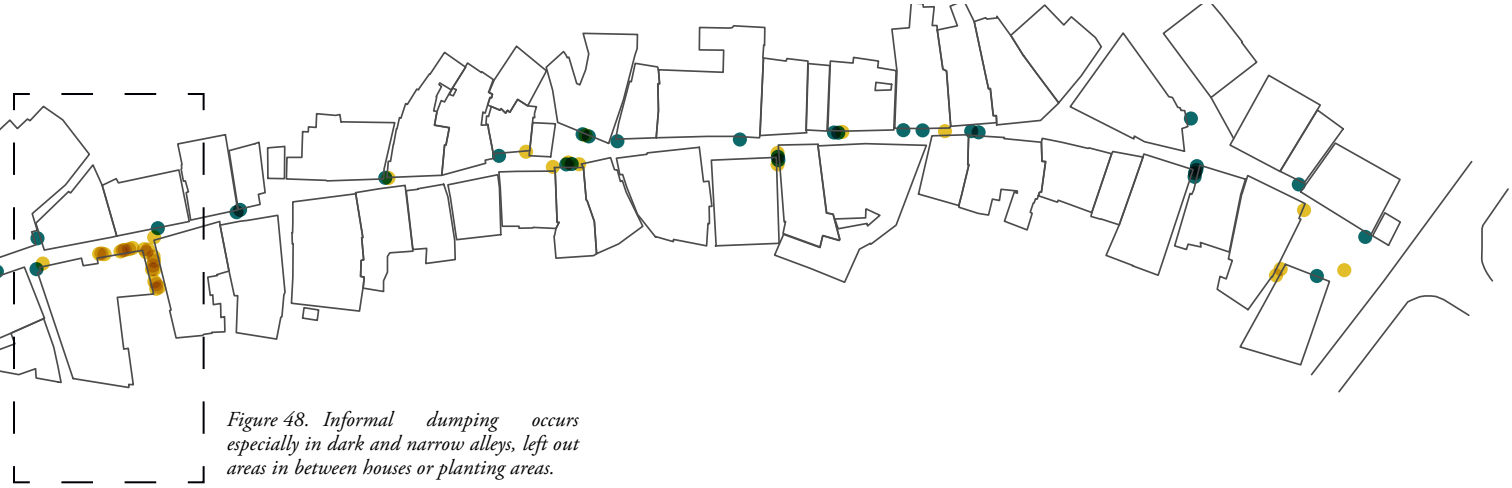


Figure 48. Informal dumping occurs especially in dark and narrow alleys, left out areas in between houses or planting areas.

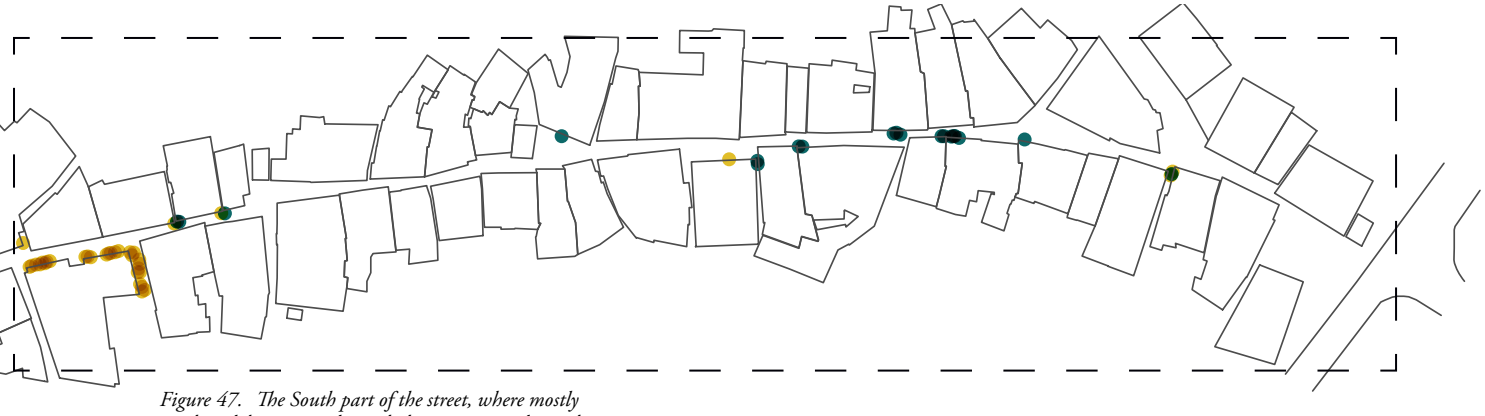


Figure 47. The South part of the street, where mostly residental houses are located, becomes more littered during the day compared to the North part. The longer distance to the collection point combined with the fact that residentals does not take responsibility of their waste are two factors affecting the littering.

waste bin informal dumping

6.3.9 WASTE MANAGEMENT ON SOKOMUHOGO STREET

This section describes the waste management on Sokomuhogo Street from source to collection point. The section also defines peoples opinion of waste management on the street, based on own observations and interviews.

Source

According to interviews with residential of Sokomuhogo Street, people are not satisfied with the municipal door-to-door collection. Since they regard the service as poor, with default of collection especially on weekends, they sometimes decide not to pay the fee. Even though the fee for residents is fixed at USD (3000 TSH)/month, it seems to vary what people are actually paying.

The attitude of the majority of the residents is, since they are paying for the waste management service, that they don't have any further responsibility than putting out the dustbin. It varies between households when they put it out, some do it at late evening or early in the morning; others have it out all day. Also the amount of waste generated per day varies, but normally it is one bin a day. A more frequent waste collection, with 2 or 3 collections a day, is mentioned of several residents as a suggestion to improve the waste management.

All residents interviewed said that they are willing to take more responsibility, but only if the waste management system was improved and well-functioning. According to interviews people would consider to separate organics from dry waste. They would also consider to bringing the household dustbin to the collection point if bins were provided and more collections points was available and closer to home.

Collection

Sokomuhogo Street is running through four different ZMC working areas. The door-to-door collector in each working area is familiar with many of the residents living on the street. This makes every route specific and personal for its collector. Places on the street occurring in between the routes seem to be more littered. The ununiformed door-to-door collecting affects the manner of waste collection. At some houses the collection is done by knocking on the door where the bin is handed, at other places residents knows exactly when the collector arrives and waits by the door with their waste bin. All in all, the waste collector alone possesses the information about how the residents behave with their waste on his route.

The street sweeping on Sokomuhogo Street is done by the NGO:s from the Zacedy group. It occurs simultaneously or before the door-to-door collection which sometimes results in that waste dropped from the door-to-door collectors handcart remaining on the street.

6.4 SUMMARY - ANALYSIS OF STONE TOWN

- There is a need for soil improvement for green areas in order to develope the green structure in Stone Town. Forgotten green areas and run down places are used as latrines or for informal dumping.

- Social meeting points play a major role for the inhabitants of Stone Town. Social areas, such as Jaws Corner, are kept clean from waste.

- There are no places dedicated for children to play on Sokomuhogo Street. Children are one of the major sources for littering.

- Solid waste accumulates in dark and narrow areas on the street. Also the spaces in between door-to-door collecting routes are littered. Littering rises at night.

- Waste and mud are clogging wells in rainy seasons which leads to flooding and poor working conditions for the waste workers.

- Shop owners keep the street clean outside their entrance by sweeping and having their waste bins in order. Residents, on the other hand, do not take full responsibility for their waste. But if facilities were properly arranged, residents are willing to separate their waste.

- Stone Town is surrounded by three major roads which are accessible for waste trucks.

- Collection points are concentrated to the North part of the town. Two of the five collection points around Stone Town are provided with new concrete slabs which easens the workload, but the rest of them are in poor condition.

07

DESIGN PROPOSAL

TOWN, STREET & SITE

This chapter describes and illustrates the proposal for solid waste management in Stone Town. The first section gives an overview of the proposal, followed by its keynotes. Thereafter, the chapter continues with the strategy. The strategy is implemented in three scales; town-, street and site scale. All the scales are illustrated in their own separate sections.

7.1 SYNTHESIS OF ANALYSIS

SUMMARY OF BACKGROUND

- ZMC is not able to finance the solid waste management. In addition, ZMC does not receive all the revenues from the customers.
- There is a unclear legislative system concerning waste management.
- The first waste management strategy will be developed in 2014.
- The collecting system in Stone Town is door-to-door collection which the municipality plan to extend to the rest of Zanzibar Town.
- The waste consist of 85% organic material.

SUMMARY OF THEORETHICAL BACKGROUND

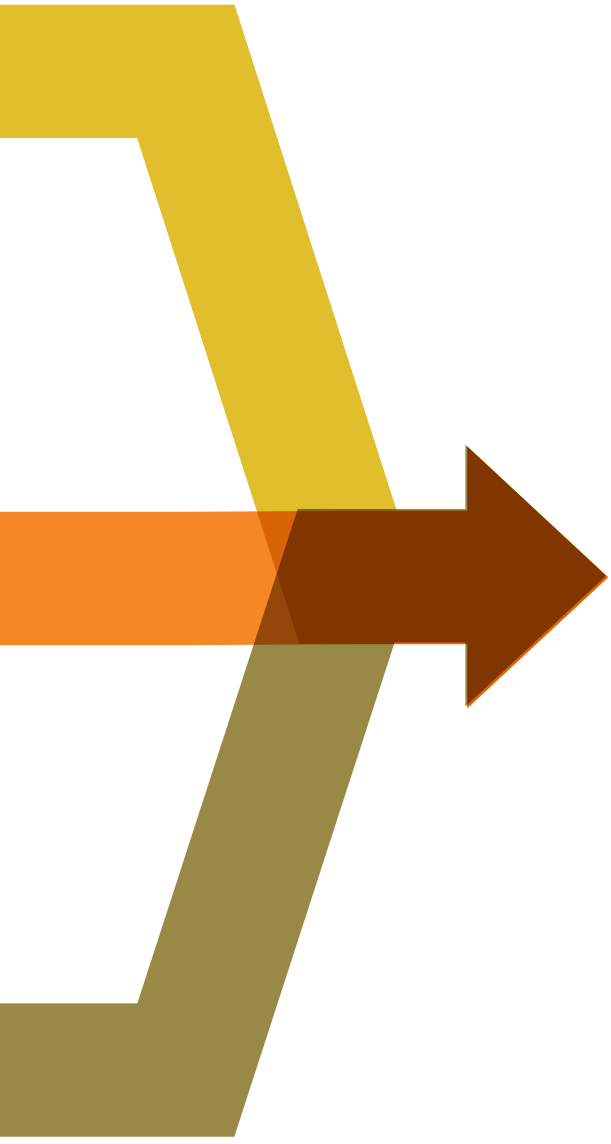
- Integrated solid waste management aims to find the most suitable solution for each situation. The waste hierarchy model, on the other hand, focuses on waste reduction close to source. The first is often mentioned as the most suitable for developing countries.
- It is important to find simple, appropriate and affordable soultions when modernizing the waste management system in low-income countries.
- Composting is the most interesting technique due to waste composition and economical situation of Zanzibar.
- Biogas could be a good complementary energy source. However, biogas plants should be tested in small scale before extending the system.
- Incineration is not suitable in Zanzibar due to the high cost.
- There are many actors with different interests involved in the solid waste management process. They all have to be considerate when making a solid waste management proposal.

SUMMARY - ANALYSIS OF THE SWM PROCESS IN STONE TOWN

- Residents don't feel responsible for the produced waste but they have the knowledge of how to separate the material.
- The door-to-door collectors are skilled with a lot of local knowledge but the collection is time consuming since there is not enough equipment avalible and waste bins are scattered along the streets.
- There exist several committed NGO:s but they are not properly acknowledged in the process which leads to a reduction of people participating.
- Informal waste workers contributes at the collection point and reduces the waste by selling recycleables yet they are not officially included in the process.
- Collection points are few and unevenly spread over the city which makes them hard to find and overfilled with unsanitary waste.
- There exist a lot of focus on techniques in the waste management process which demands a lot of resourses.
- There exist no formal separation or processing of solid waste which leads to heavy transportation of waste to the informal dump sites.

SUMMARY - ANALYSIS OF STONE TOWN

- There is a need for soil improvement for green areas in order to develope the green structure in Stone Town. Forgotten green areas and run down places are used as latrines or for informal dumping.
- Social meeting points play a major role for the inhabitants of Stone Town. Social areas, such as Jaws Corner, are kept clean from waste. .
- There are no places dedicated for children to play on Sokomuhogo Street. Children are one of the major sources for littering.
- Solid waste accumulates in dark and narrow areas on the street. Also the spaces in between door-to-door collecting routes are littered. Littering rises at night.
- Waste and mud are clogging wells in rainy seasons which leads to flooding and poor working conditions for the waste workers.
- Shop owners keep the street clean outside their entrance by sweeping and having their waste bins in order. Residents, on the other hand, do not take full responsibility for their waste. But if facilities were properly arranged, residents are willing to separate their waste.
- Stone Town is surrounded by three major roads which are accessible for waste trucks.
- Collection points are concentrated to the North part of the town. Two of the five collection points around Stone Town are provided with new concrete slabs which easens the workload, but the rest of them are in poor condition.



OPPORTUNITIES

Organic material is avaliable and can be processed by composting or biogas plants.

Informal waste workers can be integrated in the formal waste management system.

Potential for residents to contribute in the SWM process.

Social areas are kept clean.

CHALLENGES

SWM is not seen as a process as the planning does not have any legal frames and does not include all actors.

The municipality is dependent on individuals which has poor working conditions. By not acknowledge their work, the ZMC risk to loose them as a working force.

Waste is not seen as a resource since no formal processing occurs.

7.2 OVERVIEW OF THE PROPOSAL

The proposal contained in this chapter shows the new solid waste management system for Stone town. The proposal is based on a general set of keynotes which demonstrates this thesis vision of a new solid waste system and points out important factors which can be improved. The keynotes are then concretized in a solid waste management strategy, which is embodied in fifteen principles. The solid waste management strategy is implemented on three scales; town, street and site. The scales are used to explain the principles for the solid waste management process on different sizes of areas in Stone Town. The town scale proposal reveals the larger structures of the updated solid waste management process. Different actors and stages of the process are thereafter explained at the street scale proposal. Following site scale which consists of three example areas, shows how the proposal works on site. This section also includes a brief analysis for each example area.

Since this thesis aims to find site-specific solutions on solid waste management at a local scale (see chapter 1), the site scale proposal is much more developed than the street- and town scale proposals.

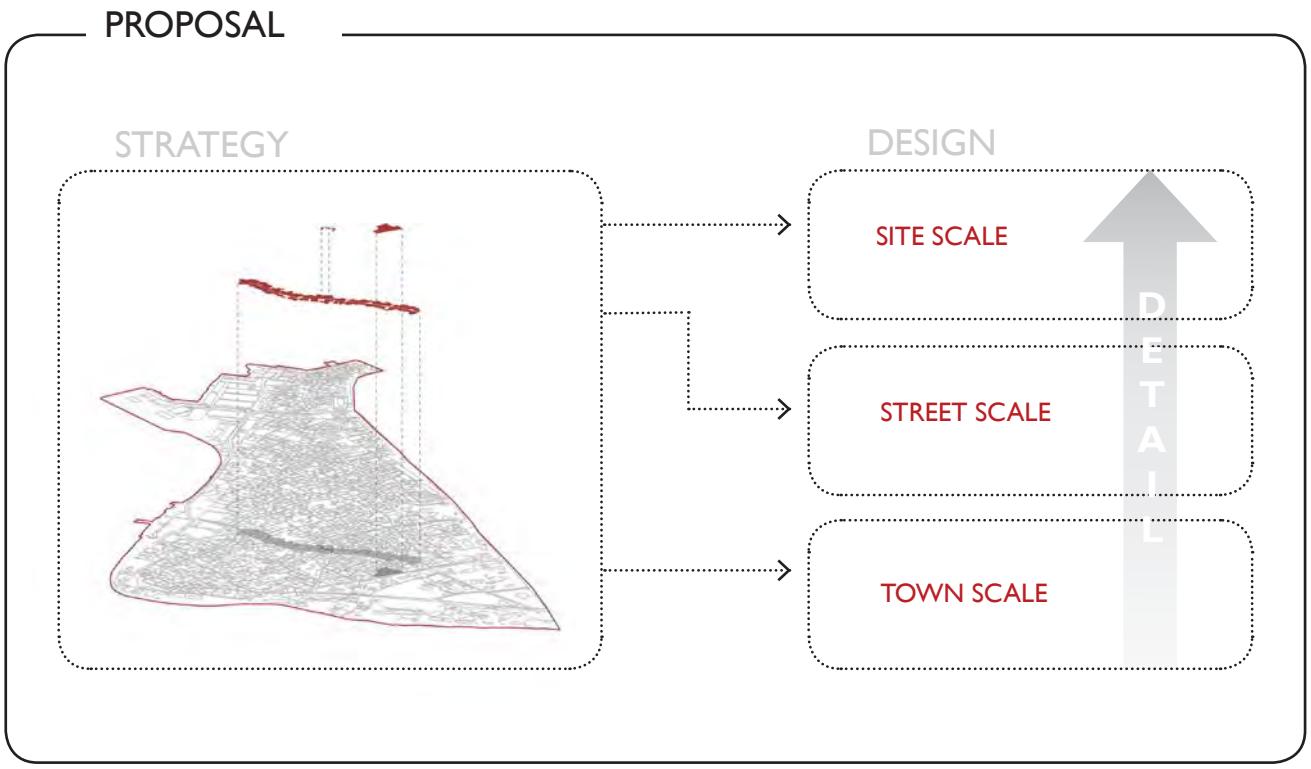


Figure 49. The figure shows how the strategy is implemented in the design proposal of three scales. The level of detail increases with reduced scale.

7.3 VISION OF THE PROPOSAL

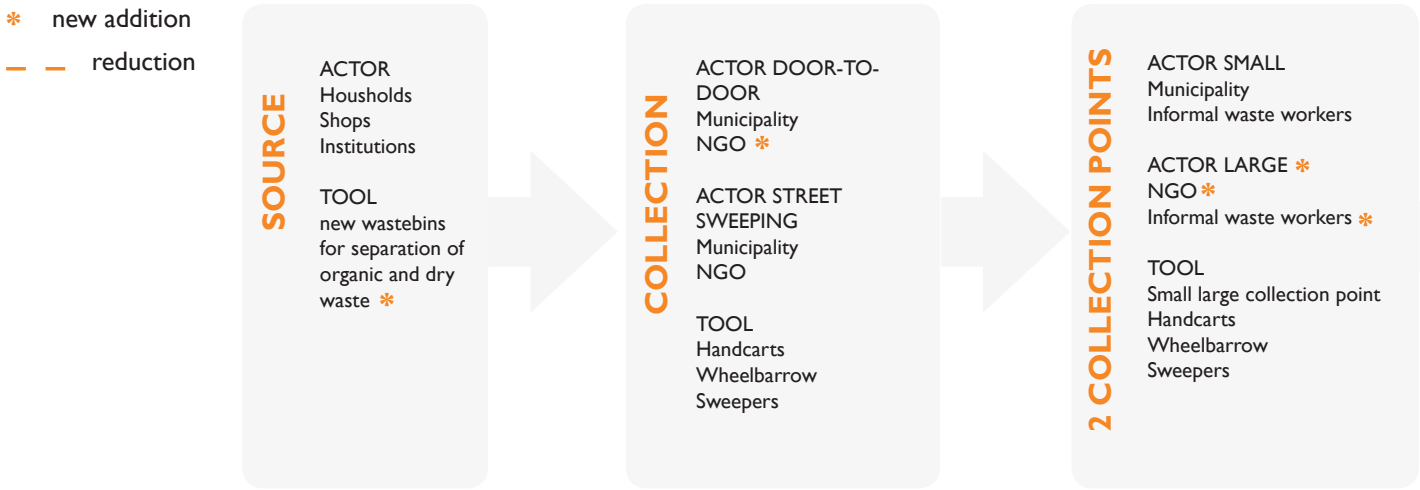
Stone Town, with its unique settings and World Heritage-status, is dependent on a well-functioning solid waste management system. While it is important to preserve the characteristics of Stone Town, the waste management system needs to be modernized. As discussed in section 3.6.1, a modernized solid waste management system does not equal expensive techniques; rather it employs new creative ways of thinking. It is this thesis firm belief that a design of solid waste management must be built on strong awareness of the process of solid waste management. Both of the actual process of degrading/recycling/reusing the waste, but also the process of how/by whom/at what time it is done. This should all be taken in consideration when developing the design.

Besides viewing solid waste management as a process, this thesis proposes to treat waste as a resource instead of a problem. This is based on the theory of integrated solid waste management (see section 3.4.2). There exists no universal solution of solid waste management, which ISWM points out (see section 3.4.2). Each and every city has to look at its own conditions and see what is suitable for that context. The solution must build upon the existing structures and patterns, whether it is physical, economical or social prerequisites.

Stone Town has a great amount of local initiatives, such as several ambitious NGOs (see section 4.3.4) and informal waste workers (see section 4.3.7), which should be viewed as a resource. By letting the local initiatives lead the way, a lot of knowledge can be won and also money saved for the municipality. In this proposal, the NGOs are given more responsibility when it comes to collecting and processing the solid waste. This obviously requires that they receive something in return, in this case a larger influence in the town and the possibility to add to their income. By also including the informal waste workers, the proposal seizes all opportunities to maximize the capacity of local assets and raises the working conditions for the workers.

As shown in section 5.1.2, the people of Stone Town care and are willing to take responsibility of their surrounding. By giving people the proper tools and training they can create a platform for their own initiatives. Working together towards a common goal creates social coherence and a feeling of empowerment. In the proposal, people are given the opportunity to participating by signing up for separating their household waste. This personal involvement opens up advantages, both economically and socially.

Separation of waste, as close to source as possible, is vital for a sustainable solid waste management as shown in section 3.4.2. If the quality of waste rises, and thereby the value of waste, it will make the waste more profitable. In the long term, a proper solid waste management



can finance or support other project within the city.

As seen in section 4.4, organic waste constitutes a substantial part of the waste composition in Zanzibar Town. This proposal places great emphasis on handling the organic matter by separating it from the rest of the household waste and turning it into fertile compost. The compost is not only useful for community gardens and small cultivations, but also have the potential to form a foundation for a new green structure in Stone Town. The analysis of Stone Town show different areas of various size and function: large green areas, ruins, graveyards and school gardens are all existing structures that can be improved by fertile soil processed from organic waste.

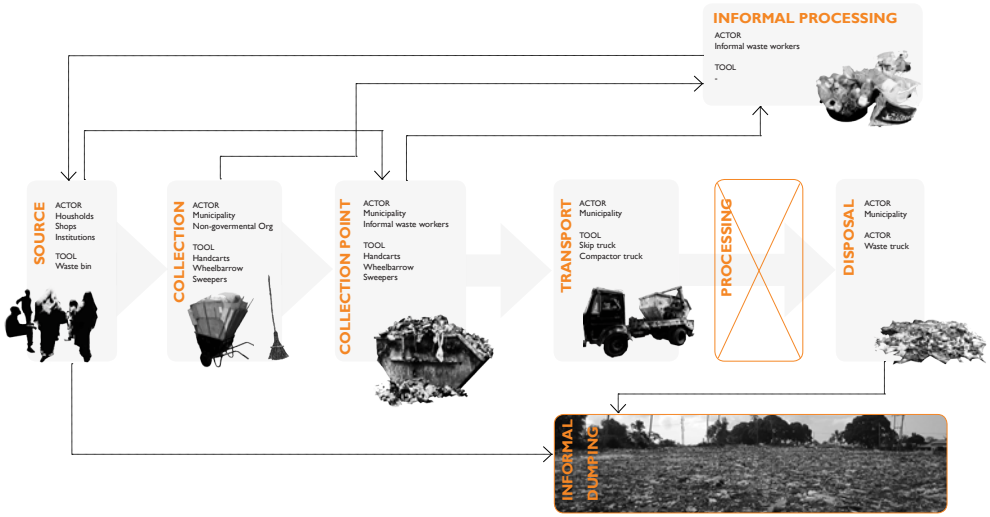


Figure 50. The figure shows the existing SWM process in Stone Town (see figure 10 for original size).

Figure 51. The figure demonstrates how the efficiency of the first three steps of the process combined with an additional stage of processing can reduce the amount of waste being transported to final disposal. The orange stars shows the new features in the figure and the dashed orange line shows reduction of waste. New waste bins are provided which allows separation of waste close to source. These waste bins are being collected by new NGO collectors and brought to the new large collection point. At the large collection point a new stage of processing is added where vermicompost, biogas and recycling trolleys are used to reduce the amount of waste transported to disposal.

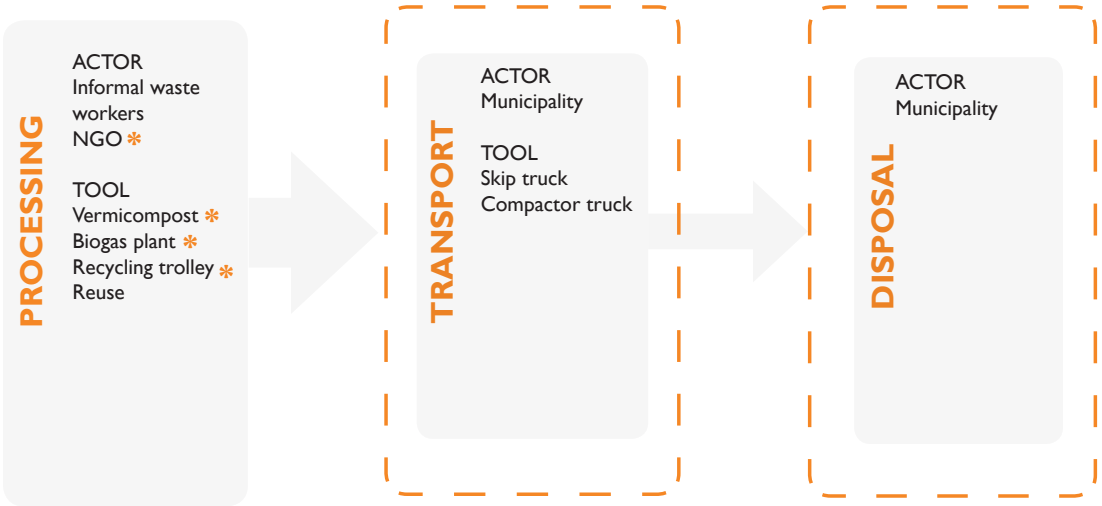


Figure 52. Figure of proposed developed solid waste management process.

7.4 SOLID WASTE MANAGEMENT STRATEGY

Based on this thesis theoretical background (see chapter 3) and the prerequisites of Zanzibar (see chapter 4), a solid waste management strategy has been developed. The strategy gives guidelines of how to design the process as well as specific sites. Each principle in the strategy is captured in a symbol, which will be used further on in the proposal to facilitate the connection between proposal and theory. Further, to enable a logic order of the principles of the strategy they are divided into three elements: physical, economical and social elements.

Physical elements

Physical elements refer to physical improvements, which will facilitate the process of solid waste management.

PRINCIPLE
Simplicity

It shall be easy to handle the solid waste in a proper manner, which is the opposite of today. The facility should be close to the source in a central position. Everyone shall be able to manage their waste, no matter age, gender or origin.

PRINCIPLE
Multi-funtional

By combining diverse activities in the same location, a variety of people can be attracted. These people will be able to perform various activities such as composting, gardening and trade at the collection points. This creates a platform for new meetings between people from different cultural groups.

PRINCIPLE
Minimazation

One important aspect for sustainable solid waste management is to reduce the amount of waste going for final disposal, as described in section 3.4.1. The reduction can be done in several ways, the important thing is to adapt for the local context. The quantity together with the waste composition needs to be investigated in order to choose the best method for reduction. Accordingly as much as possible shall be processed close to source (see section 3.6.2) which can be done by composting.

PRINCIPLE
Transparency

By making the process and actors of solid waste management visible, it is much easier for people to be attentive of its stages (see section 3.6.1). Creating awareness facilitates the choice of handling the waste correctly. Color-coding, uniforms and clear symbols for different purposes lend the process of waste management a transparency, ensuring that it is easy to understand and follow.

PRINCIPLE
Give place value

Places without any meaning or function, such as ruins, left over surfaces and similar is often more littered than areas with value (see section 6.3.7 and 6.2). By adding an aesthetic pleasing design to these places, interesting and appealing meeting places are created, which thereby add value to forgotten and littered areas.

PRINCIPLE
Safety

Collection points need to be safe and clean (see section 3.3.3) to encourage people going there with their waste. Spotlights should be put on collection points to raise the feeling of security and minimalize illegal dumping next to containers. Proper equipment, as whole containers and accurate gear, is crucial for the safety of waste management workers. A roof on each container will prevent leakage during rain seasons.

PRINCIPLE
Accessability

The location of the collection point shall be accessible and easy to find in contrast to the current placement (see section 3.6.2). The accessibility is needed for truck drivers, residents and tourists.

A clear sign program where the collection points are located will raise status of importance as well as the accessibility of the collection points.

PRINCIPLE
Decentralization

A resilient system should have many smaller collection points rather than a few large ones (see section 3.6.2). This way, people get closer to the collection point and the system gets less vulnerable in case a collection point is out of order. Further, this gives more options for the user since he or she can easily access a collection point.

Economical elements

Economical elements refer to activities that will generate profitable changes for the actors involved in solid waste management.

PRINCIPLE
Win-win

According to UN Habitat (see section 3.6.1) it should be profitable for all stakeholders to handle the solid waste properly. To achieve a lucrative system, the demand of cooperation between all stakeholders is necessary. The profit is different depending on who is concerned. Money, time or services can be facilities provided to various actors involved.

PRINCIPLE
Efficiency

As seen in section 6.3.8 and 6.3.9 a system characterized by intermittency creates confusion, which leads to an inefficient waste management system. Therefore, to make the system efficient, uniformity in materials and process is required. With a uniform process no unnecessary confusion occurs and the process runs smoother.

At what time and in which order different working duties shall be performed are factors that are also important for the efficiency.

PRINCIPLE
Integrate the informal

Instead of neglecting the informal waste workers, which today are reducing the waste without any charge (as seen in section 4.3.2) they should be formally included in the solid waste management process. By doing so the municipality honor and recognize their work which in return creates a trustworthy labor force (see section 3.5.2).

PRINCIPLE
Flexibility

Flexibility is about creating a system that allows changes over time. The process of waste management needs to be adjustable and have the possibility to adapt since the SWM in Zanzibar will be an ongoing topic. Solid waste will for example increase along with the rapidly growing population (see section 4.4.). Therefore, the system needs flexibility until the larger structures of solid waste management are set such as infrastructure and construction of a proper landfill site.

Social elements

Social elements refer to changes that will strengthen social coherence within the community and raise the level of responsibility for solid waste.

PRINCIPLE
Communication

Given that many actors are involved in the solid waste management process, communication is the crucial key for building a functional cooperative dialog. Good communication creates clarity, which leads to good working condition where every party knows his/her duties. In Stone Town, lack of communication complicates the solid waste management system. Therefore, this strategy plays an important role in the following proposal.

PRINCIPLE
Promote social initiatives

To create a sustainable solution it is essential to get people involved in the process. Instead of relying on expensive technical solutions social coherence can be created by including local residents (see section 3.6). There exist many social initiatives in Stone Town such as different NGOs (see section 4.3.4) but they are not properly supported. People participating in the process should be recognized for their work and get something in return. It should be profitable to contribute.

PRINCIPLE
Training & Education

Attitudes can be changed by information and education (see section 3.6.2). To get people aware, there needs to be an increase in practical experience. A variety of training programs are needed for different ages, positions and situations. Education can be provided by different instances of the society, such as schools or mosques. Training can be offered at specific nodes around the city where knowledgeable people teach others about sustainable solid waste management.

7.4.1 DISTRUBUTION OF THE PRINCIPLES ON THE DIFFERENT SCALES

The site scale, which allows the highest level of detail, includes the largest amount principles while the town scale only consists of four principles.

	PRINCIPLE *Give place value*	PRINCIPLE *Training & Education*	PRINCIPLE *Transparency*	PRINCIPLE *Efficiency*	PRINCIPLE *Accessability*	PRINCIPLE *Win-win*	PRINCIPLE *Promote soci*
SITE SCALE	●	●	●	●	●	●	●
STREET SCALE		●	●	●		●	
TOWN SCALE					●		●

PRINCIPLE Safety	PRINCIPLE Simplicity	PRINCIPLE Decentralization	PRINCIPLE Integrate the informal	PRINCIPLE Multi-funtional	PRINCIPLE Minimazation	PRINCIPLE Flexibility	PRINCIPLE Communication
●	●		●	●	●	●	
●	●		●		●		●
		●			●	●	

...l initiatives

7.5 TOWN SCALE

The town scale section demonstrates the design proposal and its underlying ideas for the town scale. The idea is a flexible system that can evolve with the city over time. Through decentralization of collection points an accessible and flexible system is created that can withstand future changes. Two new large collection points are proposed in the decentralized collection system. These will serve as information hubs in the network of collection points. The large collection points includes composting facilities which makes it possible minimize the amount of waste going for final disposal and thereby ease the transportation pressure. The composted organic waste from Stone town is then brought back as fertile soil to the city's green areas.

Section 7.5.1. demonstrates how the small and large collection points are put together to fit the prerequisites of Stone Town. The spread of collection points, their function and how they interrelate with their surroundings are displayed on a plan and further explained in text below. Further, the implementation of the solid waste management strategy is made clear by showing symbols connected to the text. Section 7.5.2 explains how the prototypes of the small and the large collection point function and interconnects with each other. The principles of the strategy that are used in this scale are shown below.

TOWN SCALE

Principles used:

PRINCIPLE
Promote social initiatives

PRINCIPLE
Minimization

PRINCIPLE
Flexibility

PRINCIPLE
Accessability

PRINCIPLE
Decentralization


Stone Town

7.5.1 A NETWORK OF COLLECTION POINTS

In this proposal, the collection points are given a new role in the solid waste management system. From being few and hard to locate, they are now increased in number and display a distinct design. Following the principle of decentralization, a greater number of collection points evenly spread over town reduces the vulnerability that a small number of containers imply, which also makes the system flexible.

One of the crucial ideas with the SWM system is to reduce the amount of solid waste transported to final disposal (principle of minimization). In order to achieve minimization of waste, the network of collection points includes two types; a small and a large one where the large one includes processing facilities.

The small collection point serves as a basic facility while the large collection point functions as a social hub in the network. The criteria for the site chosen for a collection point should be based on accessibility for residents, waste workers and trucks (principle of accessibility). In Stone Town, the road structure is the critical factor that determines if the collection point is accessible for trucks or not (see section 6.2.1). The city has only three major roads that are available for larger vehicles. The distance between existing collection points influence the accessibility for the residents. Today, it is a concentration of collection points at the north part of Stone Town (see section 6.2.2). Therefore, a new large collection point is proposed in the South part of town.

Small collection point

The small collection point provides a basic facility for storing the waste. It consists of a concrete slab, a roof, streetlight, a container and a recycling trolley. They are located at the same sites as before but with the above mentioned additional features, which will raise the quality of waste material and ease the workload for the informal waste workers.

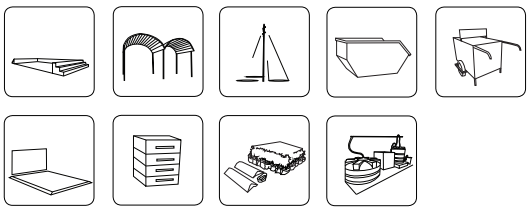
Large collection point

The large collection points become a social hub in the society where people can meet, share knowledge, cultivate and exchange goods with each other (principle of promote social activities). The aim is to raise the level of awareness of environmental issues and at the same time achieve a greater social cohesion within the community. The large collection point has the same base as the small collection point but is extended with a sorting area, vermi-compost, a community garden and a small biogas plant.

The criteria for the site of a large collection point are at least an area of 2000 square meters. The area is preferably close to a green space where the compost can be used. However, precautions must be taken with regard to the distance of commercial activities.

Prototype SMALL

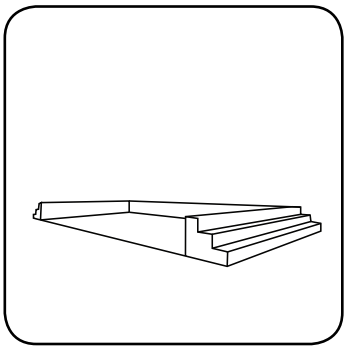
Prototype LARGE



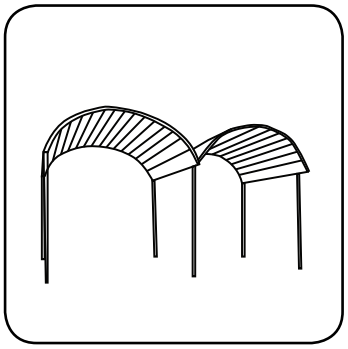

new collection point
improved existing collection point
border for collection of organic material
distrubution of composted material
Recycleble material is sold to agents at the harbor.
SMALL
Harbour facility
Developing area for park and recreation.
SMALL
Passing Show
All organic material in the North of town goes to to Mbuyani.
A large collection point in combination with a nursery.
LARGE
Mbuyuni
SMALL
Ngome Kongwe
All organic material in the South of town goes to to Vuga.
SMALL
Darajani
Fertile compost improve the towns green structure.
LARGE
Vuga

7.5.2 PROTOTYPES FOR COLLECTION POINTS

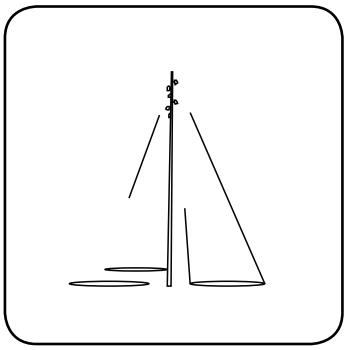
In this proposal of new collection points a flexible design is presented which takes into account the various needs of Stone Town. By combining different prototypes a custom-made collection point is possible. Following section describes each prototype and their purpose.



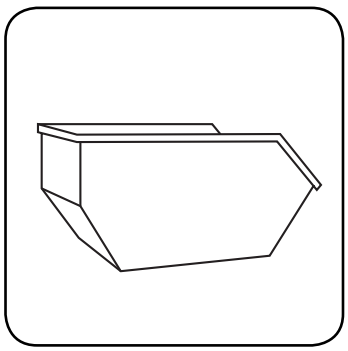
Concrete slab



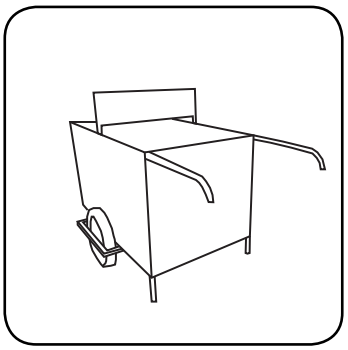
Roof



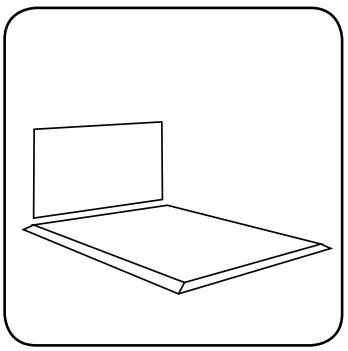
Spotlight



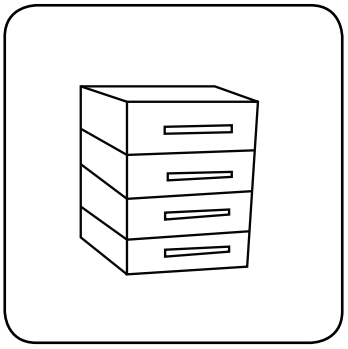
Container



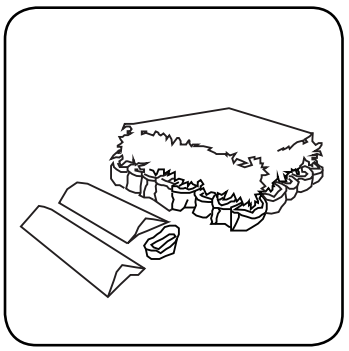
Recycling trolley



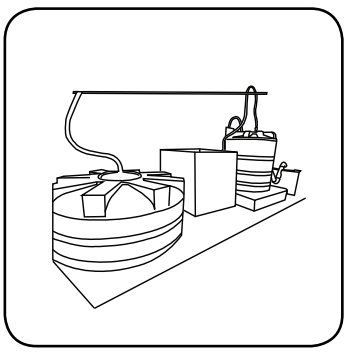
Separating area



Vermicomposting



Community garden



Biogas

Concrete slab
The concrete slab is a plate on the ground, which the container is placed on. It provides a stabile foundation and eases the job to keep the area around the container clean. The steps on three sides make it easier for people to reach up to the rim and throw their waste into the container.

Protecting roof
A roof of simple construction is working as a protection against weather conditions. It also prevents rain from coming into the container and causing the waste being wet and emitting pollutants. The rainwater is collected from the roof and lead to a barrel, which serves as a water reservoir to the community garden. Local material, such as iron beams and durable textile, form the construction of the roof.

Spotlight
The spotlight provides light for the collection point at the dark hours. It contributes to a safer environment and reduces illegal activities.

The armature of the spotlight is designed to attract attention to the collection point to make it easier to find. It is driven by renewable energy from the biogas plant.

Container
The container is the vessel where all mixed waste goes in. Existing containers are in poor condition due to rust and holes, but they have to be used until they can gradually be replaced with new ones of the same model. The container needs to be positioned so that a truck easy and safe access to collect it. Further, it needs to be close to the separating area so that the waste can be easily loaded in the container.

Recycling trolley
The recycling trolley is a wagon for recyclable material, such as plastic bottles, tins and glass. The trolley is equipped with a grid cage where the top part has custom holes for different types of recyclables. Since the recycling trolley has wheels it is flexible to move around. However, it needs to be positioned so the informal waste workers easily can collect it.

When full, the informal waste workers come and collect the trolley and sell the material. The aim of the recycling trolley is to ease the process of collecting valuable material for the informal workers and at the same time offers the opportunity for people who want to recycle.

Separating area
The separating area is a concrete surface, connected to the slab, which is easy to keep clean by brushing or flushing with water. The separating area needs to have a central part at the collection point since it is here the waste is being sorted and put in the correct recycling trolley, compost or container. It is desirable to have some type of demarcation to the surroundings since the unsorted waste may cause disturbance.

Vermicomposting
Vermicomposting is a type of compost, which include worms. The worms accelerate the decomposition process and create a very nutritious soil. The compost is built on top of a concrete surface in wooden boxes, which can easily be expanded as the separated organic material increases.

The compost is managed by the NGO and used as soil in the community garden. Interested residents have the opportunity to learn more about cultivation and may get free access to the produced compost.

Community garden
The community garden is a piece of land gardened by the NGOs running the collection point. The soil used for cultivation comes from the compost that provides an abundant yield. The return from the cultivation, in form of vegetables and plants, may be sold by the NGOs, to get an extra income or used for personal use. The residents who help to separate their household waste will also have access to nutritious compost and can participate in the cultivation.

7.6 STREET SCALE

The street scale section explains how the network of collection points operates in the updated solid waste management process on Sokomuhogo Street. The street includes the small Ngome Kongwe collection point and the large Vuga collection point. In between these collection points, the solid waste management process is described in terms of actors managing the waste, at what time it is done and where on Sokomuhogo Street it occurs. The principles of the strategy that are used in this scale are shown below.

STREET SCALE

Principles used:

PRINCIPLE
Win-win

PRINCIPLE
Integrate the informal

PRINCIPLE
Efficiency

PRINCIPLE
Simplicity

PRINCIPLE
Minimazation

PRINCIPLE
Communication

PRINCIPLE
Training & Education

PRINCIPLE
Transparency

PRINCIPLE
Safety


Sokomuhogo Street

7.6.1 COMPONENTS OF THE UPDATED SWM PROCESS

In order to explain how the updated solid waste management process leads to a reduction of solid waste going for final disposal, different components of the process needs to be revealed. These components include the actors managing the solid waste, at what time it is done and where on Sokomuhogo Street it occurs. The proposed SWM process builds upon a new collection system for separated waste which makes it possible to compost the organic material.

The involved actors and their obligations

People are participating in the process by separating their household waste. In return they get a reduced SWM tax and new waste bins. The separated waste is collected by NGOs and brought to the Vuga collection point. NGO:s are running the Vuga collection point where organic waste is composted, processed or sold. The dry waste is further separated and sold by the Informal waste workers.

The old waste bins containing mixed waste, from non-participating households, is collected by municipality door-to-door workers and brought to the closest collection point. The informal waste workers are continuing helping the municipality workers out at Ngome Kongwe and in return they get to sell the recyclable waste.

The proposed solid waste management system will need a flexible approach when it comes to the collection system. When introduced, a small number of residents will participate in separating their waste. But after a while, when people discover the benefits of participating, there will be greater pressure to collect separated waste. When this occur it is important to develop the collecting after the demand. This will require collaboration between the municipality collectors and the NGO collectors.

SEQUENSES

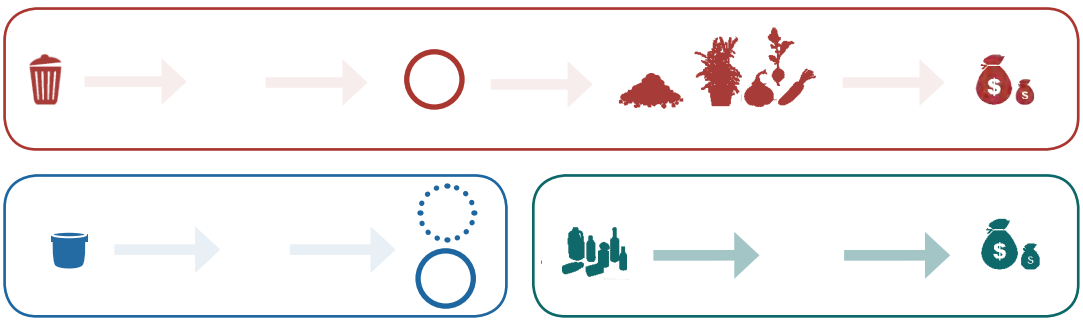


Figure 53. The figure illustrates the frequense of the actors' working duties in the solid waste management process. Red represents duties of NGO, blue represents duties of municipal workers and green represents informal waste workers.

Figure 54. The figure explains the symbols used in section 7.6.2.

Time schedule

In order to implement a sufficient SWM process, different activities are scheduled in figure 31. The activities are; waste bins are put on the street, door-to-door collection, street sweeping, separating and composting and information activities at Vuga collection point.

The figure shows that waste bins needs to be put on the street before the collection starts at 5.30 am. In order to keep a tidy environment, bins are only allowed on the street from nine o'clock pm until nine o'clock am when the door-to-door collection is done. The street sweeping is offset so that it occurs after the collection. Separating and processing is done at Vuga collection point before noon, but opens again in the afternoon for information and registration.

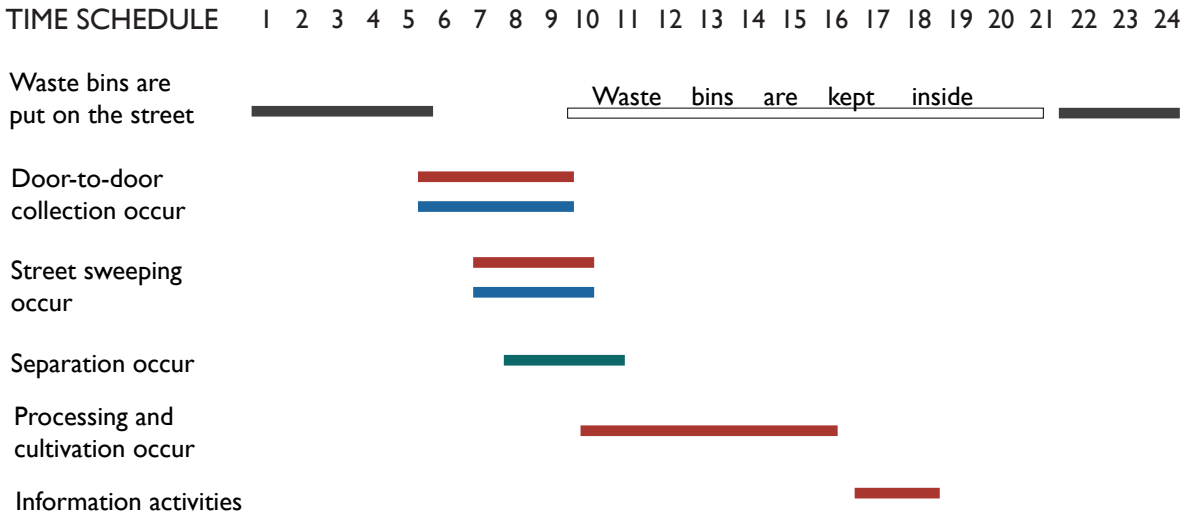
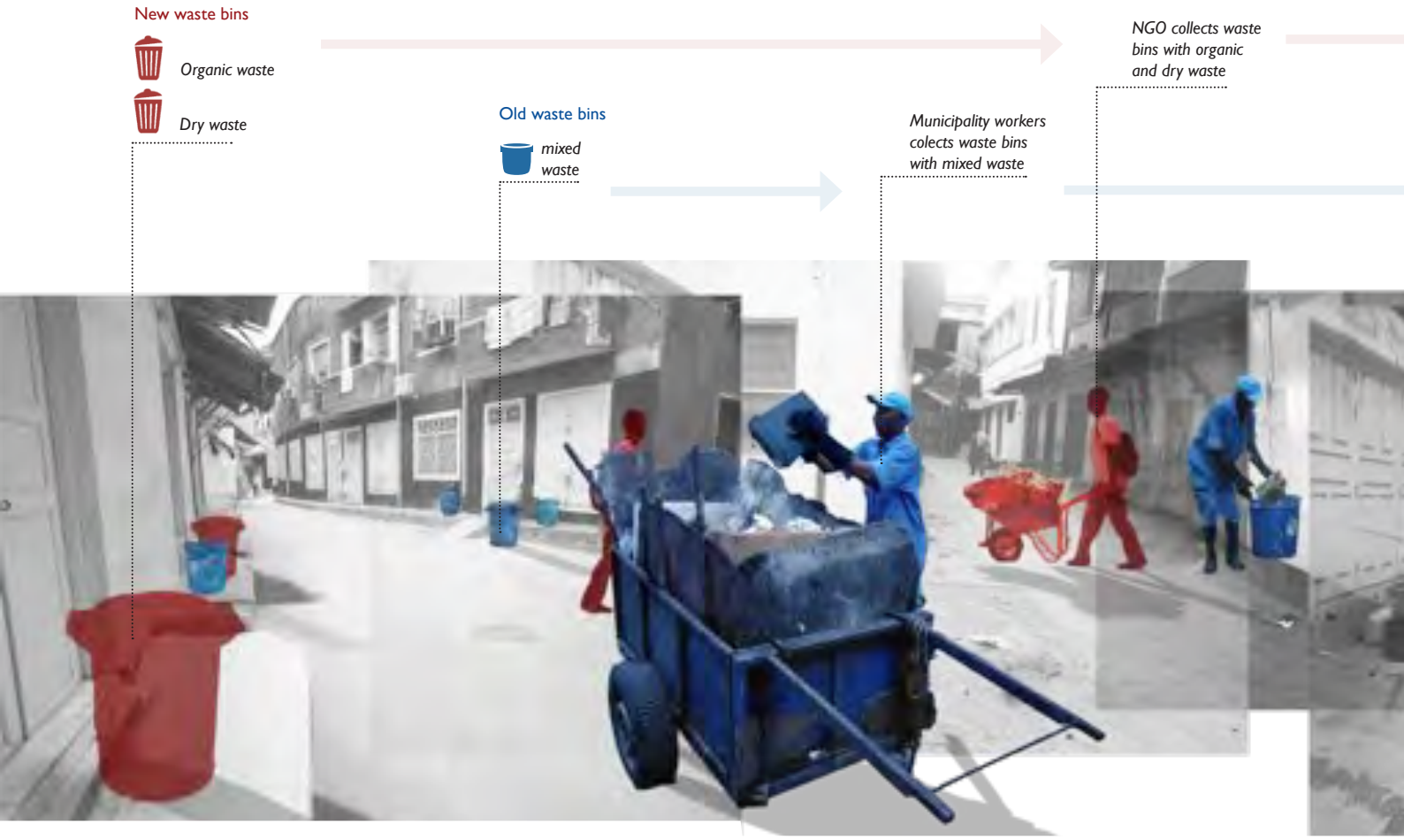


Figure 55. The figure illustrates at what time the actors' working duties in the solid waste management process occurs. Grey represents obligations of households, red represents duties of NGO, blue represents duties of municipal workers and green represents informal waste workers

In order to further explain the process, color-coded symbols illustrate the actors' obligations (see figure 30). The symbols also appears on the two following spreads where the principles of the strategy is linked to the proposal. The first spread, section 7.6.2, clarifies who does what tasks of the process on Sokomugogo Street. The second spread, section 7.6.3 reveals where on Sokomuhogo street the physical arrangements are and where the actors' duties occurs. The spread also shows important resources needed for the workers to carry out the duties.

7.6.2 THE PROCESS - WHO IS MANAGING WHAT AT THE STREET SCALE

The process is based on the following five stages: 1. Waste bins are put on the street, 2. Door-to-door collection, 3. Street sweeping, 4. Separating, and 5. Processing & cultivation



WASTE BINS ARE PUT ON THE STREET

21-00 pm - 05.30 am

All waste bins are put on the street before the collecting starts. Residents are given the choice of further participation in the solid waste management process by separating their waste. The aim is to create awareness and make everyone feel responsible for his/her waste as well as the environment. The principles used at this stage of the process are:

Win-win - A reduced fee is used as an incentive to encourage people to participate. If attending, they will be registered at the collection point by the NGOs and provided with two new waste bins.

Simplicity - One bin is for organic waste and the other bin is for dry waste. Printed symbols will demonstrate what waste should be thrown in each bin. Household numbers are also printed on the side of the bins. The number will prevent bins being stolen and at the same time create a sense of responsibility for their own waste.

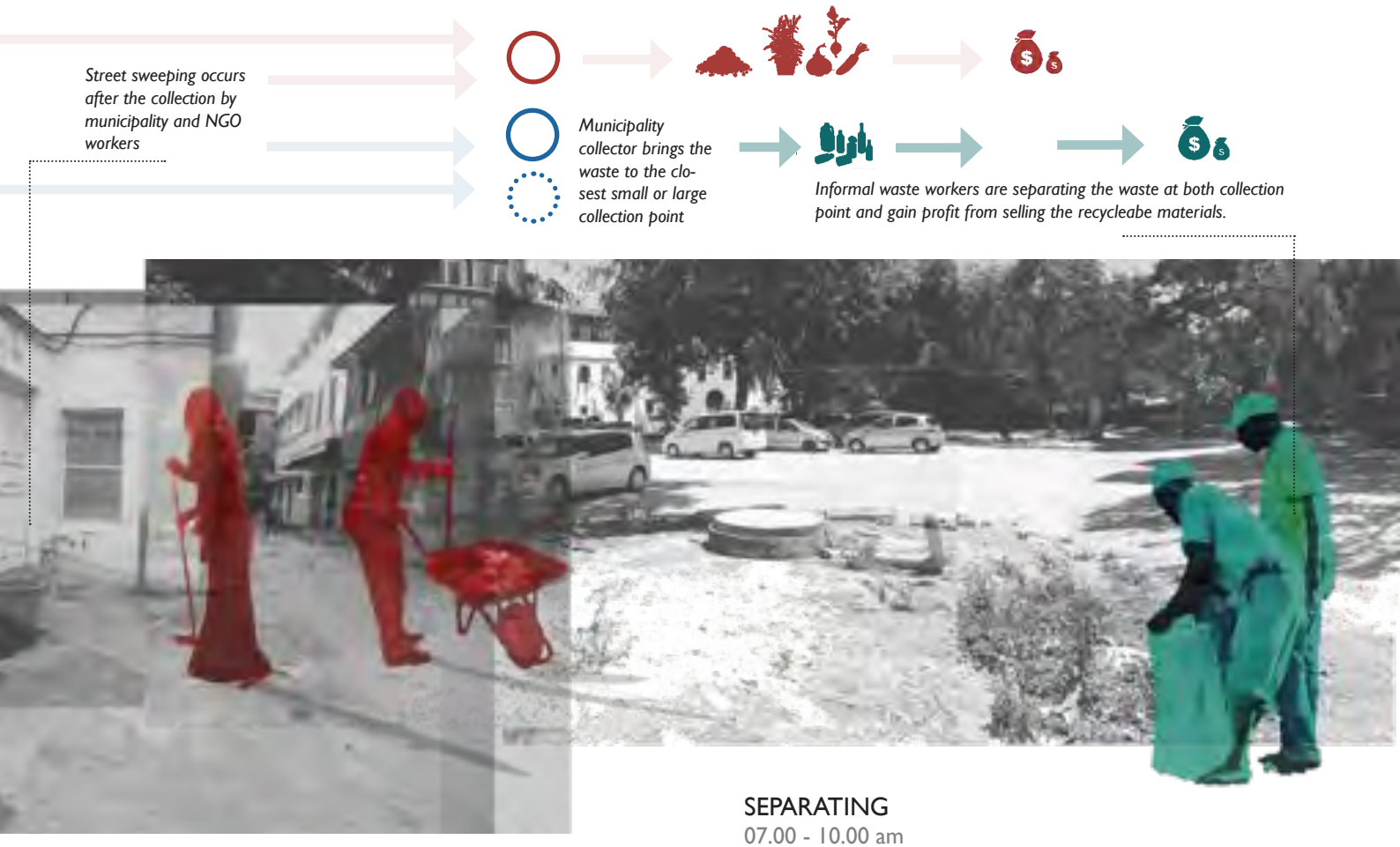
DOOR-TO-DOOR COLLECTION

05.30 - 09.00 am

The NGO workers are given a greater responsibility, which makes collecting of separated waste possible. NGOs and municipality workers are sharing the duties of door-to-door collection. The principles used at this stage of the process are:

Simplicity - NGOs are in charge of collecting the new bins that are used for separating waste while the door-to-door collector continues with collecting the waste bin with mixed waste. Since the new waste bins are uniformed and marked with house numbers the organization becomes clear for the different collectors.

Win-Win - The system creates more job opportunities which require recruiting additional NGO workers. NGOs are given a larger responsibility in the waste management process and thus a greater role in society. Their role is to inform, educate and train resident about solid waste management. In return, they are given the privilege of selling compost and plants from the cultivation which can add to their income.



STREET SWEEPING

06.30 - 10.00 am

The duty of street sweeping is divided between NGOs and municipality workers. The division is done by areas. The street sweeping occurs after the door-to-door collection instead of simultaneously. The principles used at this stage of the process are:

Efficiency - By offsetting the street sweeping one hour after the collecting starts, the risk of waste remains on the street reduces and the city environment becomes cleaner.

Communication - To implement the new order of sweeping the street communication between door-to-door collectors and street sweepers are important, not only duty wise but also between NGO:s and municipality workers. A new time table for different tasks and workers needs to be developed together with all the employees involved.

SEPARATING

07.00 - 10.00 am

The informal waste workers are in charge of separating the collected waste at both collection points. The principle used at this stage of the process is:

Integrate the informal - Instead of having an unhygienic situation for the informal waste workers this proposal aims to ease and secure their daily function. By letting the informal waste workers be in charge of the collecting trolleys, they can easier and faster transport the recyclables. In return, they are allowed to sell the recyclables and thus obtain a more reliable income.

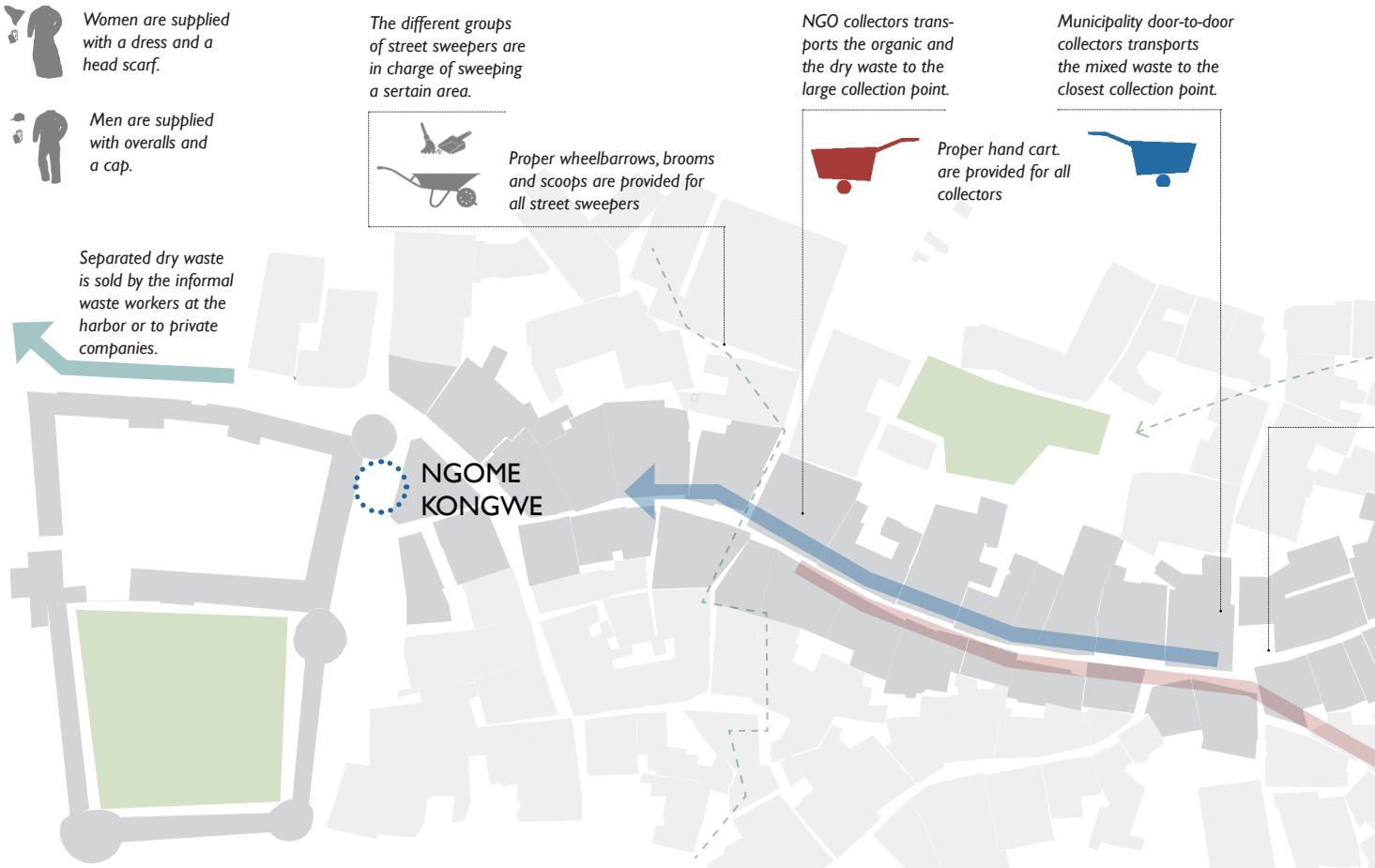
PROCESSING & CULTIVATION

09.00 am - 16.00 pm

Processing and cultivating is done at Vuga collection point by the NGO:s. The principle used at this stage of the process is:

Win-win - NGOs are reducing the amount of waste going to final disposal by composting and selling the organic waste. A reduction of waste is highly beneficial for the municipality in terms of transporting cost. Private companies are collecting accessible organic waste when the composting facility at the large collection point is full.

7.6.3 PHYSICAL ARRANGEMENT ON SOKOMUHOGO STREET



NGOME KONGWE COLLECTION POINT

The Ngome Kongwe collection point is run by the municipality waste workers. Informal waste workers are assisting with separating and selling the dry waste. All the mixed waste is brought here by the municipality door-to door collectors. Ngome Kongwe has the same functions as before but the proposed enhancement gives a safer working area and eases the working duties. The principles applied at Ngome Kongwe are:

Safety - In order to make the Ngome Kongwe collection point a safer area it is updated with spotlight, roof and a proper concrete slab under the container. The spotlight lighten up the area at night and prevents littering and destruction. The roof and concrete slab protects the ground from contamination.

Win-win - Informal waste workers are assisting the municipality waste workers with separating the waste. In return they are provided with recycling trolleys and the permission of selling the material.

WORKING CLOTHES AND EQUIPMENT

New equipment and working clothes are needed for the workers in order to properly perform their working duty. Appropriate hand carts are provided for all the collectors. Street sweepers are provided with viable wheelbarrows, brooms and scoops. The principles used for this part are:

Efficiency - The former inefficient work flow with one waste worker performing the duty at a time, because there is not enough of work tools available, will run smoother when everyone is provided proper gear and equipment.

Transparency and Safety - Working clothes, with organization logos printed on the back, are provided for all the waste workers. They are also given safety gear like gloves and boots. This is primarily for collectors' security but it also serves as information for residents about who is collecting the waste and contributes to a cleaner society. This will make the collection more transparent and clear which is not distinct today. Working clothes will also give the feeling of work pride and give a greater signaling significance to their everyday work.

PLACEMENT OF WASTE BINS ON THE STREET

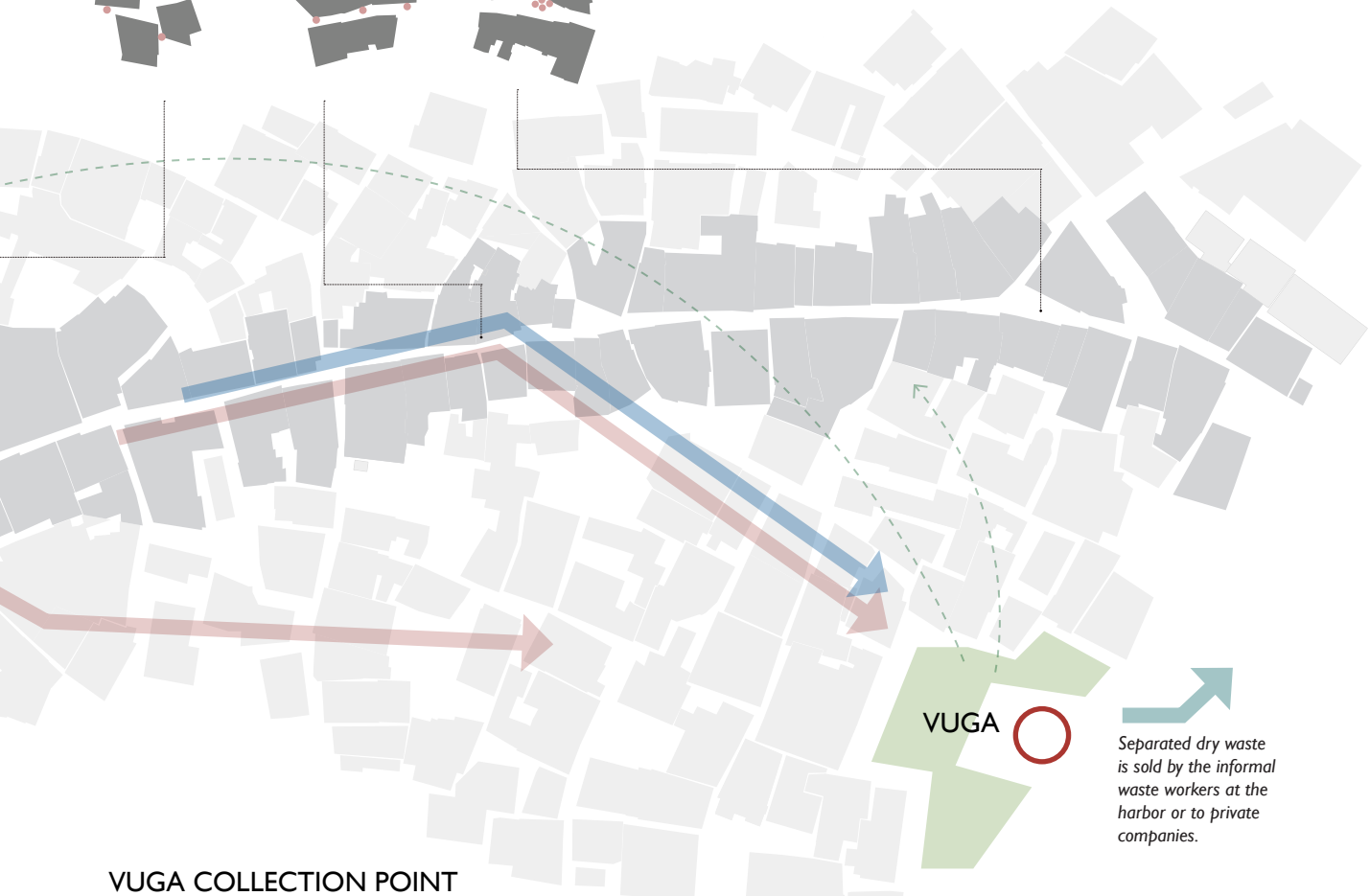
Squares - waste bins are put on crossing streets

Narrow streets - waste bins are put on one side of the street

Larger areas - waste bins are clustered at the widest part Junctions

COMPOST AND GREENERY

The organic waste, composted into fertile soil, is used to improve the green areas in Stone Town.



Separated dry waste is sold by the informal waste workers at the harbor or to private companies.

VUGA COLLECTION POINT

The Vuga collection point is run by one group of the NGO workers. Informal waste workers are assisting with separating and selling the dry waste. All the separated waste and some of the mixed waste are brought here. Vuga is a new large collection point in the area with the functions of separating, processing and cultivation. The place also serve as an information center.

Minimization - The Vuga collection point lessens the amount of waste going to Ngome Kongwe collection point, not only in quantities but also the composition. Since, the organic waste is composted at Vuga collection point, all the organic material can be removed from the produced waste. Excess organic material is collected by private composting companies.

abc

Training & education - Information about the updated solid waste management system and participant's obligations is given when they are signing in at the large collection point. The information concerns specific matters such as how the waste bins should be correctly placed on the street and how to properly separate the household waste. Display models, such as biogas and vermicompost, educate people of how to process solid waste. Those who wish will learn about composting or participate in social activities offered at the large collection points. The large collection point is also a place where different NGOs can meet and exchange knowledge and ideas.

7.7 SITE SCALE

The site scale is represented by three different sites; a collection point and two sites on Sokomuhogo street. Vuga collection point is a new proposed large collection point situated in the South of Stone Town, where the distance is far from other existing collection points. An extra focus has been put on this site since the large collection point plays a crucial role in the solid waste management.

A dark and narrow alley and an untidy residential area with a "non-place" charachter constitutes the two sites on Sokomuhogo street. Both are typhically sites of where people tend to dump their waste on the street.

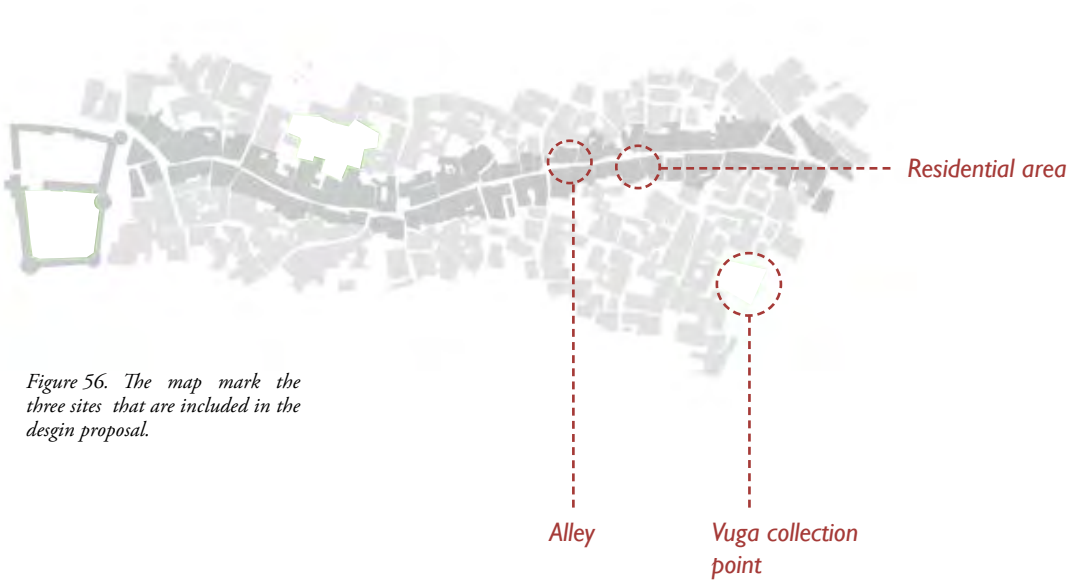


Figure 56. The map mark the three sites that are included in the desgin proposal.

SITE SCALE

Figure 57. Below principles are used in the site scale in order to implement the strategy. Each principle is explained in the site scale section.

Principles used:

PRINCIPLE
Win-win

PRINCIPLE
Safety

PRINCIPLE
Minimazation

PRINCIPLE
Simplicity

PRINCIPLE
Efficiency

PRINCIPLE
Transparancy

PRINCIPLE
Give place value

PRINCIPLE
Integrate the informal

PRINCIPLE
Multi-funtional

PRINCIPLE
Promote social initiatives

PRINCIPLE
Flexibility

PRINCIPLE
Accessability

PRINCIPLE
Training & Education

VUGA

7.7.1 EXISTING SITUATION

The open area by Vuga road is approximateley 2000 square meters and is today mostley used for parking. Otherwise, the area is used by the resident; children are palying in the North-East corner and women and men are socializing at the barazas.

The buildings are of variating character, but are of the approximateley same height. The old trees creates a roof for the spatiality and are of significant value, both for the site and to the whole town as they contribute to the towns poor green structure.

< 01 VEGETATION

Four large trees give a green roof to the site and also contribute with their gnarled old charachter. The field layer, such as herbs, grass or other low plants, are absent which means that the land is free of all vegetation.

< 02 RESTAURANT

A newly opened restaurant is sitauated in a corner of the site. The closeby surrounding is messy and people are parking their car just where the guest are sitting.

< 03 GROUND CONDITIONS

The elevation is relatively flat, except the area outside the music & culture center where the ground is slightly elevated. Otherwise, the ground is uneven with remnants of past activities.

< 04 CHILDRENS PLAY

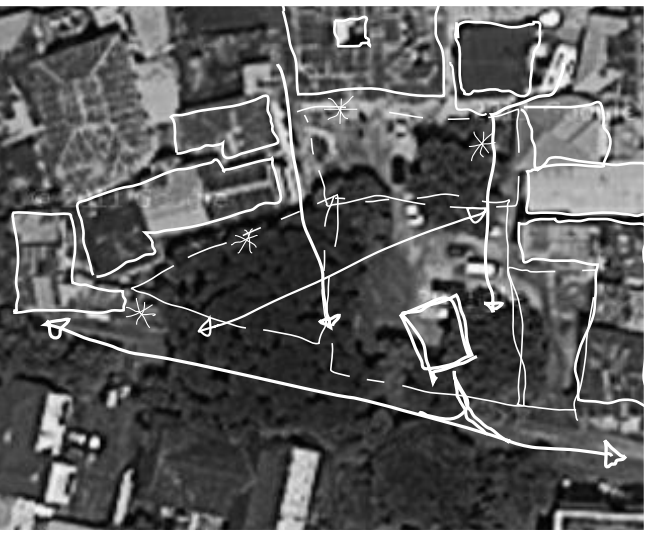
Children are playing in the East corner of the site, under the shaddows of the trees.

05 SOCIAL INTERESTS >

There is an interest for plants and cultivation among the residents in the area.

< 08 BUILDINGS

The flank of a building, that may be demolished, accomodates a hairdresser and a travel vendor.



7.7.2 PROGRAM - VUGA SITE

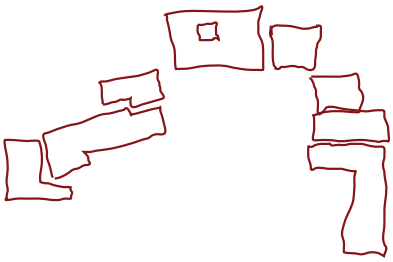
The program for Vuga collection point is based on the existing prerequisites of the site and the solid waste management strategy. The following points in the program come to show which position the design for the collection point is based on.

CREATE A FUNCTIONAL COLLECTION POINT

- Design a collection point based on the solid waste management strategy (see section 7.4).
- Make sure the container and separation area is concealed from the closeby residents.

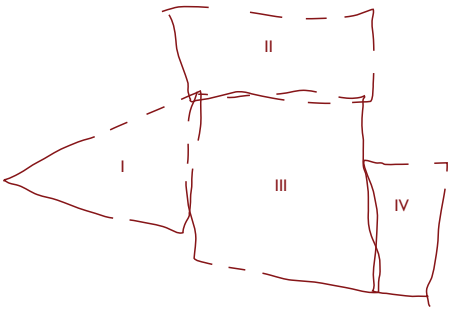
TAKE EXISTING ACTIVITIES IN BUILDING INTO ACCOUNT

- The music & culture center deserves an outdoor area that reflect the activity going on inside the house. The area must be practical for a car to drive up to so the musicians can bring their instrument to the building.
- The restaurant's outdoor dining area needs a more appealing setting.



REINFORCE SPATIALITY

- Existing rooms require concern in the design.



CREATE ATTRACTIVE SOCIAL AREAS

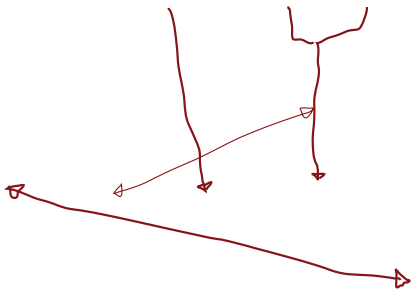
- The area where children are playing should be extended and further developed in order to give them a playful space in the public life, which is today missing in Stone Town.
- Encourrage the existing cultivation interest among the residents by giving an oppertunity to cultivate themselves.
- Provide free sitting opportunities in different locations.

ADD GREENARY

- Add more trees which give shaddow and cool down the temperature.
- Think of different layers of vegetation; field layer, bushes and trees, when designing the site.

CREATE A CLEAR PATH SYSTEM

- Create an efficient and clear path system that facilitates services to, from and withon the collection point.



7.7.3 DESIGN VUGA COLLECTION POINT

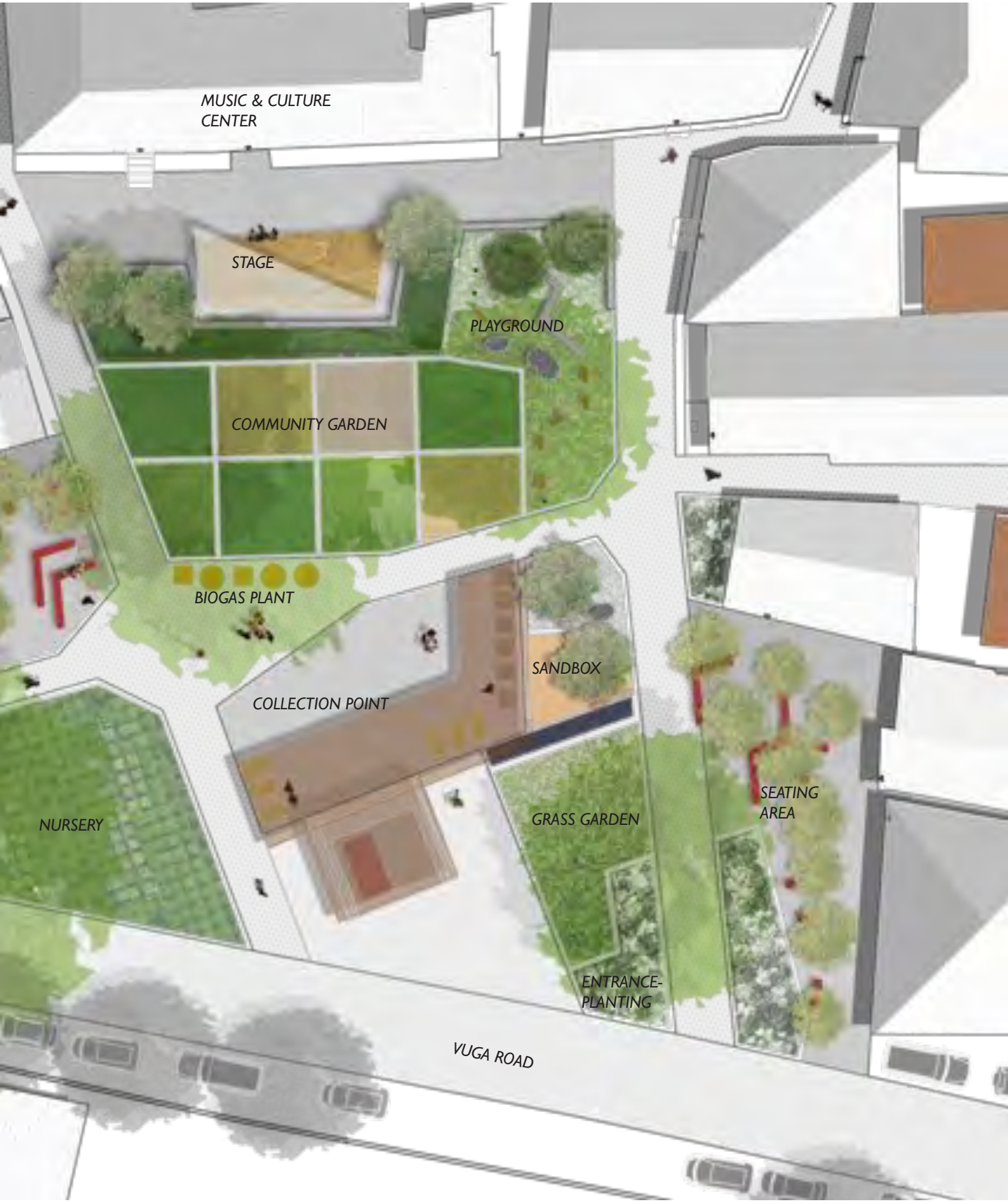
The new large collection point by Vuga street is design as a public space full of activities that attract people with different interests and needs. Simple solutions, local material and well balanced disposition and organization of spaces has been starting points for the design. Although handling the solid waste is the site's primary function, seating, play, education, recreation, commerce, culture and cultivation has also been prioritized.

functional areas

social areas

blue and green areas

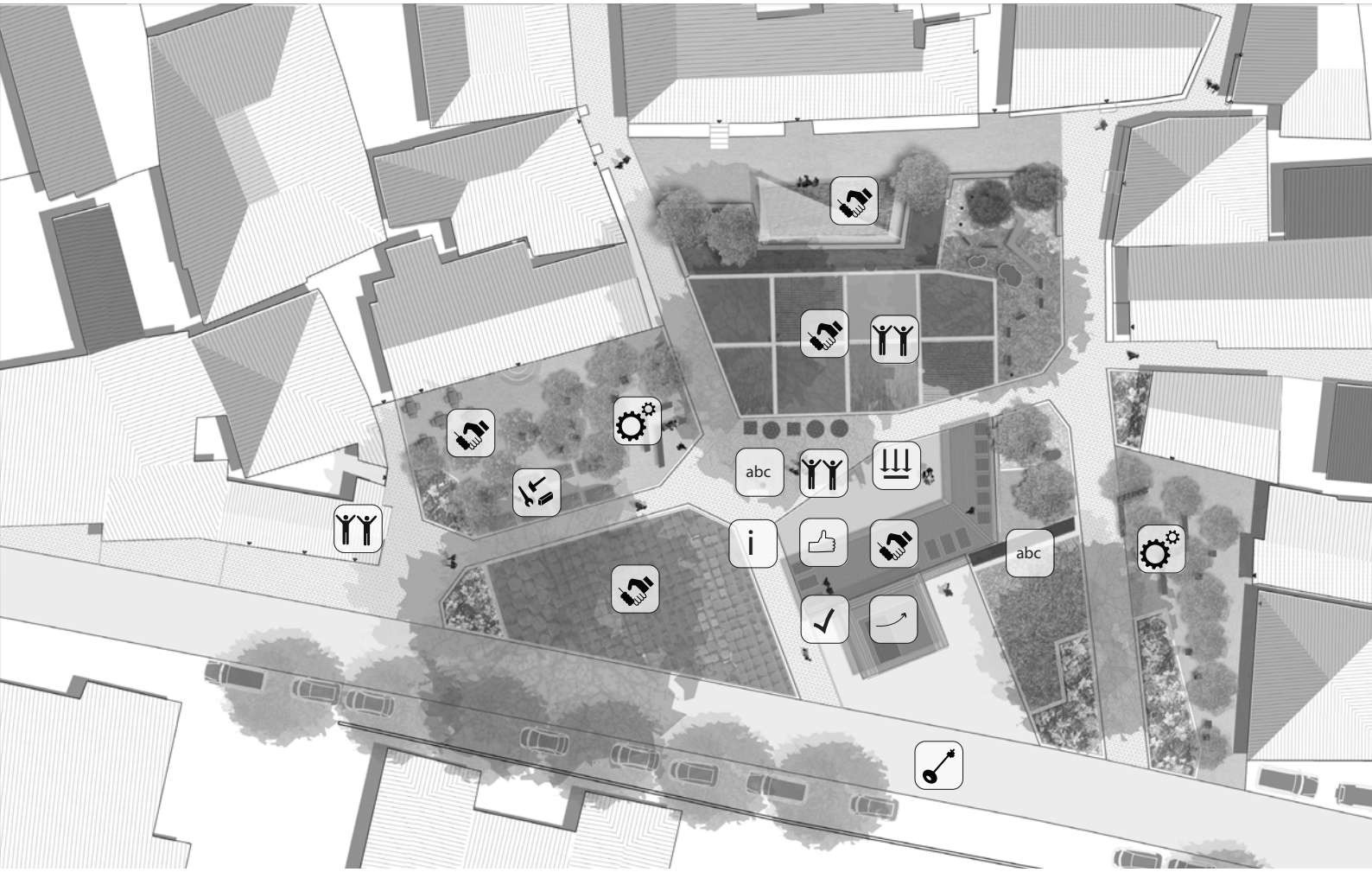
circulation


MUSIC & CULTURE CENTER
STAGE
PLAYGROUND
COMMUNITY GARDEN
BIOGAS PLANT
SANDBOX
COLLECTION POINT
NURSERY
GRASS GARDEN
SEATING AREA
ENTRANCE-PLANTING
VUGA ROAD

scale 1:250

PRINCIPLES USED ON VUGA

This spread shows which principles that has been used when developing the design proposal.



PRINCIPLE
Safety

The collection point is equipped with spotlights for making the area safer at the dark hours. The environment is also protected by covering the container with a roof which minimizes leakage from the waste in rainy seasons. A concrete slab is protecting from contamination of the ground.

PRINCIPLE
Transparency

The facilities of the collection point is color coded to make the process clear. For example, red is used on the spotlight and the roof construction as signal color to attract peoples attention. Signs are demonstrating both placement of the facilities as well as the SWM process. Furthermore, symbols are put on recycling trollies and composting boxes which makes it clear where to put the waste.

PRINCIPLE
Accessability

The collection point is placed next to Vuga road, one of the main roads in Stone Town. The placement makes the site easy to find and accessible for trucks. The area is also accessible for waste workers since the two North connecting paths are wide enough for handcarts and wheelbarrows.

PRINCIPLE
Win-win

The NGO:s managing the collection point will profit from both compost, plants from the nursery and vegetables from the community garden. Also the surrounding activities will benefit from the collection point. The restaurant will get a more appealing surrounding which probably will give them more costumers, the music and culture center will have a outdoor stage to perform own and residents get more surfaces to socialize on.

PRINCIPLE
Integrate the informal

The informal waste workers are separating solid waste brought to the separating area by the collectors. The discarded material is put in the container while the recyclable material goes in the recycling trollies. When full, the trollies are brought to the harbor by the informal waste worker and sold to agents, which shippes the material to the mainland for recycling. By integrating the informal waste workers their important role in the process will be recognized.

PRINCIPLE
Multi-funtional

Vuga combines a variety of social activities such as a scene, a playground, a trading area, an outdoor classroom, with the functional activity of the collection point. The social activities raises the quality of social life for the residents in the neigbourhood. By providing many options, the area will attract people from different cultures sharing the same interests.

PRINCIPLE
Promote social initiatives

The NGO:s with large commitment for the environment will get a platform for their interests by having responsibility for the collection point. One flank of a building will serve as a NGO center where the resident sign up for separating of their waste or just visit for information. The community garden is also managed by NGO:s but residents that are interested of gardening are welcome to participate.

PRINCIPLE
Minimization

Minimization is crucial for the activities on site. By facilitate different recycling activities it will be possible to lessen the amount of waste going for final disposal. The collection points will be equipped with recycling trolleys which facilitates separation of plastic, metal and glass. Further, the majority of processing will be by composting the organic material.

PRINCIPLE
Flexibility

A flexible design is applied in several sites on the collection point. The vermicomposting boxes are expendable as the amount of organic material is risen along with the number of participants. All over, most of the furnitures are removable so the sites can be used in different purposes. For example, the trading area has loose tables that can be used for trading or selling clothes and tools. Without the tables the site may be used for games or other activities. A movable roof on wheels is covering the container which can be rolled back when the skip truck comes to collect the container.

PRINCIPLE
Training & Education

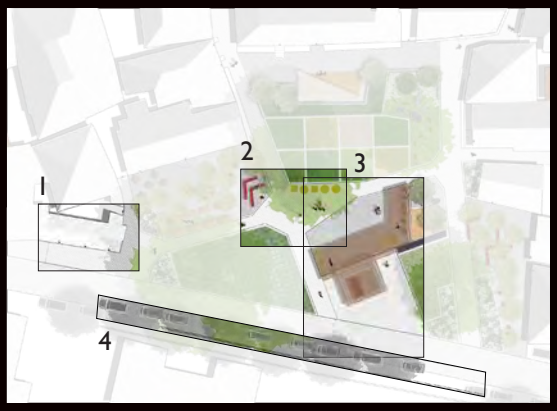
The whole collection point is constructed in a pedagogical manner and is open for visitors. The outdoor classroom provide space for groups to meet and learn about recycling, composting, biogas and cultivation. Practical training can also be done since display items are showcased. A small stormwater management area demonstrates how rainwater from the roof can be collected and purified in a grass garden.

PRINCIPLE
Simplicity

The design of the concrete slab, with steps from three angles, makes it easy to throw waste into the container. The site chosen for the collection point is located at the south part of Stone Town where currently such a facility is missing. This will make it easier for people in the neighborhood to manage there waste in a proper man-

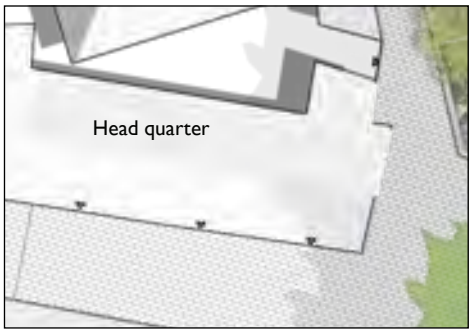
FUNCTIONAL AREAS OF VUGA

The solid waste management facilities at the Vuga Site are explained in closer detail on this spread. The idea of the proposal is to create a functional area which combines a collection point with a socializing space for local people. In order to enable such an area, the SWM facilities are placed at the south part of the Vuga site, which makes them less intrusive upon occupied areas. Public green areas frame the SWM facilities and provide a natural distance from the houses.



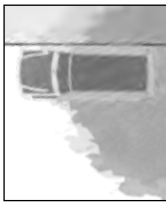
Area 2 is located at the middle of the collection point and serve as the centre for the collection point. A red-colored lamp pole with a spotlight marks the center and lights up the area after dark. As informational meetings should be provided to introduce the new SWM system, there is space for an outdoor classroom. The outdoor classroom features removable furniture which facilitates flexible usage of the area. The biogas plant processes part of the organic material, and the energy gained from the biogas will be used by the spotlight to illuminate the space.

FUNCTIONAL AREA 1



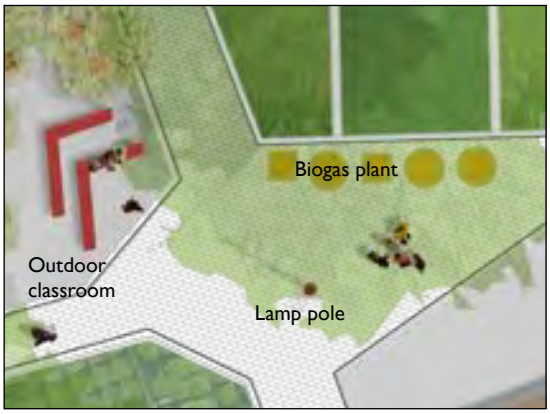
Area 1 shows the new information head quarter for the collection point. Here, residents sign in to participate in separating their waste. It is run by the NGO in charge of the site. Equipment can be stored in the backyard while new waste bins are kept inside the head quarter.

Area 4 consist of a parallel parking along Vuga road. This parking facility together with avaliable free spots closeby should provide ample space for all the cars that were parked at Vuga site previously.

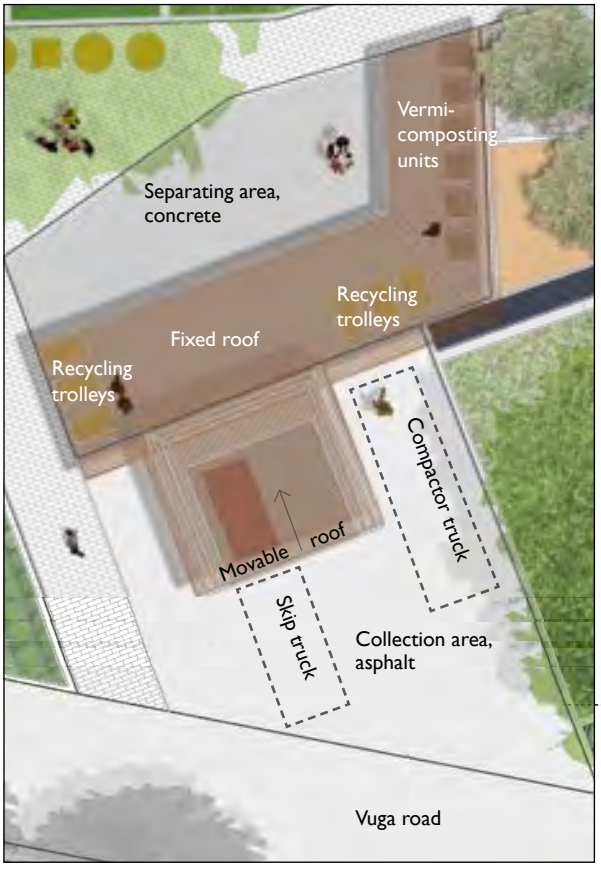


The collection area is placed at an oblique angle close to Vuga road for the convenience of the truck drivers. The trucks drivies from the Western direction of Vuga road, then they pass the collection point slighetly to enable a reverse onto the collection area. The skip truck can easily drop an empty container beside the filled one and thereafter pick up the filled container. If the separating, selling and processing of waste works correctly, the compactor truck would not be needed. But in high season, when a larger amount of waste is produced, there is place for the compactor truck beside the skip truck area.

FUNCTIONAL AREA 2



FUNCTIONAL AREA 3



Area 3 shows the core of the collection point. All the waste from the door-to-door collection is gathered at the separating area. The organic waste is put in the vermi-composting units while the dry waste is sorted in the recycling trolleys and the remainder ends up in the waste container. The vermi-compost produces not only fertilizer but also plenty of worms. The worms are protein-rich and can therefore be sold as stockfeed for chickens by the NGOs. A fixed roof covers parts of the separating area for sanitary reasons during rainy seasons. It also provides shade for the vermi-compost and protects the recycling trolleys. The movable roof prevents the container from being flooded during rain and causing contamination from the waste. The roof can be rolled under the fixed roof when the skip truck comes to collect the container. In the future it would be desirable to replace the worn-out old containers with new covered ones, and the container roof could be utilized for shading something else.

FUNCTIONAL AREA 4

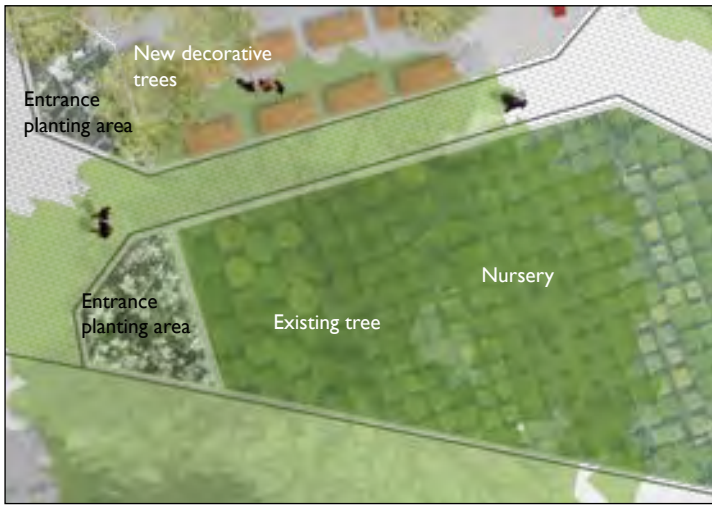
GREEN & BLUE AREAS AT VUGA

The green and blue areas are created to show how water and greenery can improve the character of the site. While they provide a pleasing aesthetic, it also serves an educational purpose by showing the collective qualities of water, especially in how grassy gardens absorb excess run-off water. Resdients can also learn gardening skills or enjoy the relaxing shade of the tree canopy.

Area 1 is comprised of a community garden divided in smaller units. The community garden is run by the NGO but residents are welcome to learn and participate in the cultivation. A free-standing hedge defines the cultivation bounderies and creates a visual wall protection towards the collection point.

The existing trees together with the additional decorative trees creates a nice spatiality and protects the area from drying out. Domestic hardy species, such as Pemba grass, are used to make the site sustainable. Further, the large proportion of green space allow a larger amount of rain water to percolate into the ground.

BLUE & GREEN AREA 2



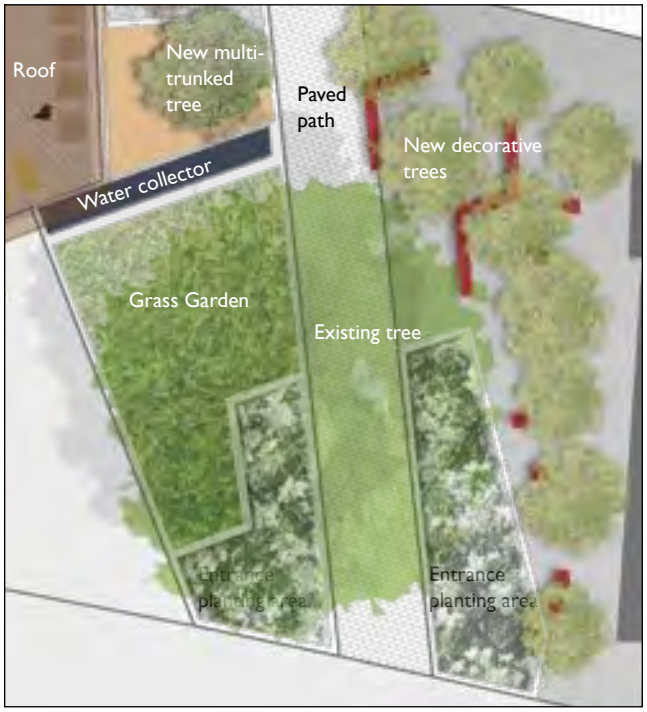
BLUE & GREEN AREA 1

Area 3 is the entrance from the Southeast direction of Stone Town. The decorative planting areas mark the entrance with fragrant plants. The rain water from the roof is led down to the rectangular water collector. The pure water can be saved and later used for watering the cultivations. A low lying grass garden demonstrates how the run-off can be purified by water-tolerant plants. By having paved paths and gravelled areas, the run-off water can easily percolates the ground.

The new decorative trees forms a light shading roof over the seating area and the multi-trunked tree provide ample climbing fun for children.

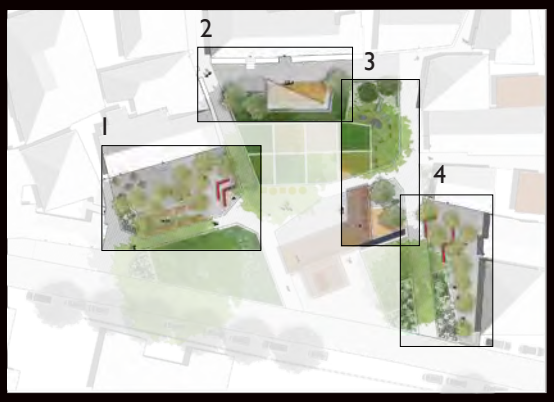
Area 2 is the main entrance to the Vuga Site. The two planting areas frames the entrance and lead the visitor to the center of the area. On the right side, when passing the entrance, a nursery creates a room divider and protects the area from the road. The nursery is run by the NGO, and residents participating in the new solid waste management system have the privilege of having a discount on plants.

BLUE & GREEN AREA 3

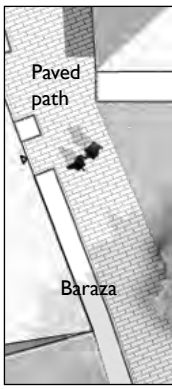


SOCIAL AREAS AT VUGA

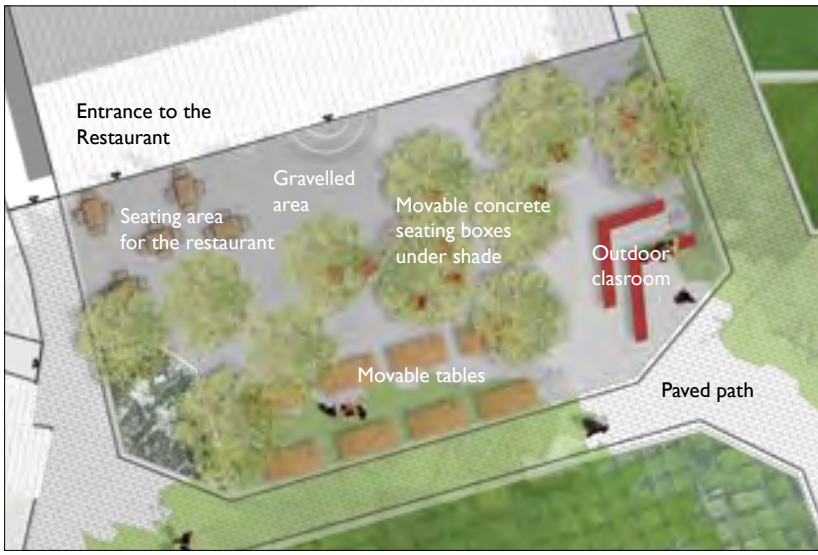
The social areas are developed to meet the need of places to socialize for residents living nearby. These areas, together with the entrances and barazas, create a form of social border around the Vuga area.



Area 2 creates an eyecatching entrance to the cultural centre by providing a stage where concerts and other outdoor performances can be held. It is also a place for relaxing or socializing under the shade provided from the canvas. The stage is framed by a retaining wall. This wall brings up the height difference of the place and creates a nice spatial experience. The wall, barazas and scene creates sustainable seating facilities around the area. The generous open graveled area in between makes the culture centre accessible by car when the musicians need to unload their instruments.

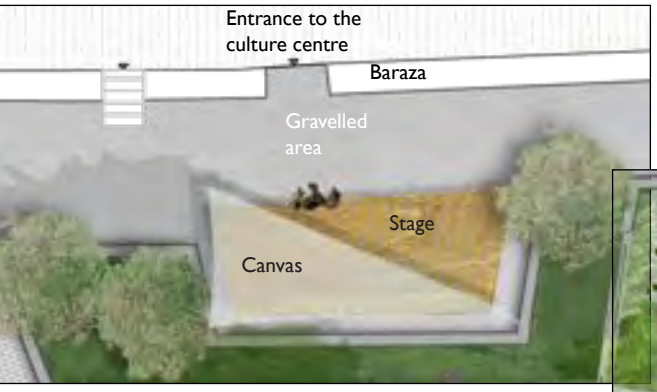


SOCIAL AREA 1

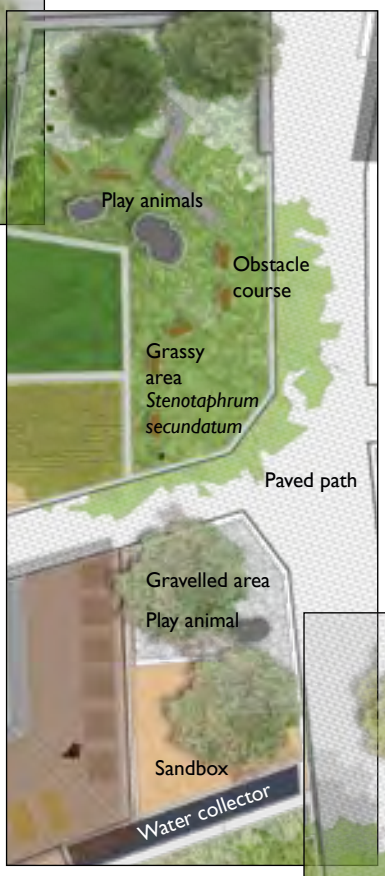


Area 1 is an open gravelled area punctuated by trees. It serves as a flexible area with removable funiture where people can meet and relax. Concrete boxes with woodenseats are placed under the trees for seating facilities. The outdoor classroom can also be used as a socializing area when not in use by the NGOs. The South part is an open area where occasional sale or trade is allowed. Since the tables are movable the area can also be used for other activities. The Northwestern part is dedicated to the restaurant's guests but is tastefully integrated with the aesthethics of the site.

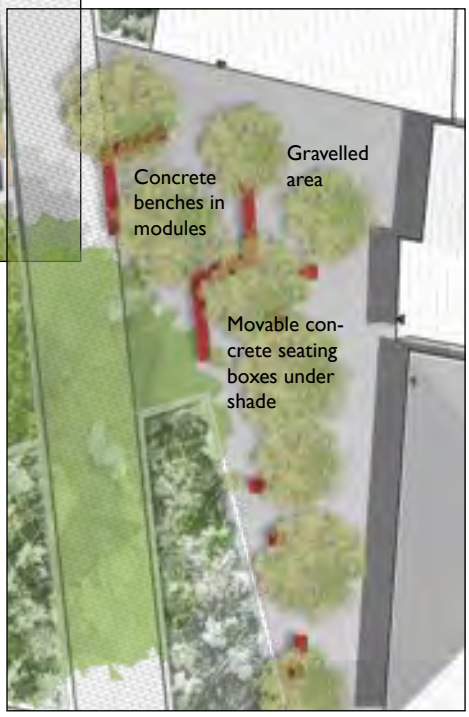
SOCIAL AREA 2



SOCIAL AREA 3

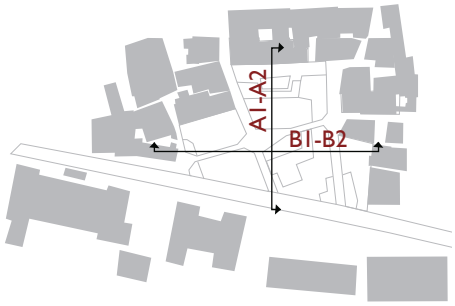


SOCIAL AREA 4



Area 3 is a playground for children, of any age from the neighbourhood. Local materials like logs, concrete and reused car tires are used to build the components. For the older children, there is an obstacle course that meanders around the grassy area, useful for practesing motor skills and balance. A swing is put up in the existing large tree and play-animals are placed around the playground. The graveled area is spotted with multi-trunked trees which provides both shade and exciting play-area for smaller children. The sand box is placed next to the water collector which makes water games possible.

Area 4 is a social and flexible area shaded under a canopy of ornamental trees. Removable funiture are placed over the surface and create seeting groups as well as individual seetings. The furniture are constituted of concrete benches and chairs with wooden surfaces.



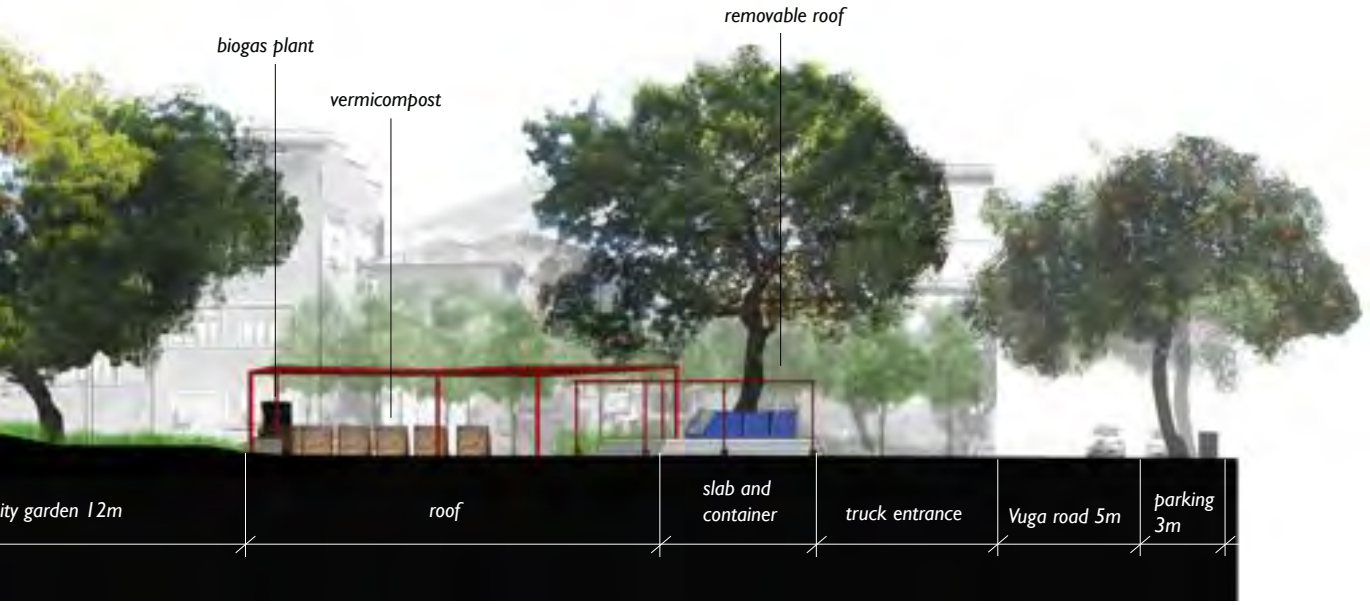
SECTIONS

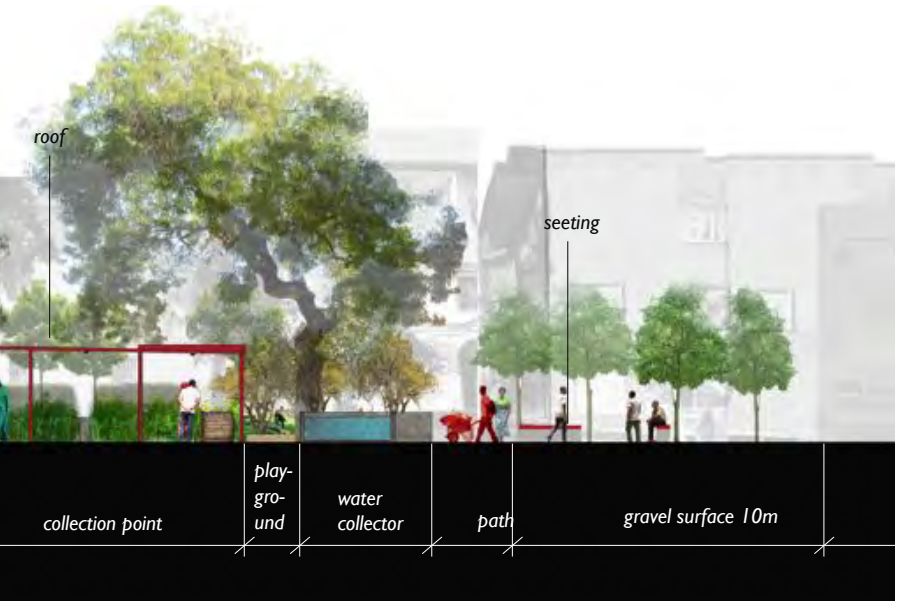
This spread show two sections that will give a more detailed view of the design proposal for Vuga collection point. The sections demonstates spatial experiences, measurments and heights.

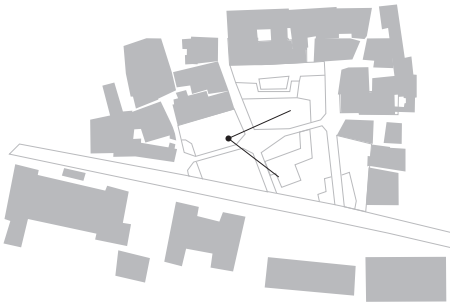
SECTION A1-A2

SECTION B1-B2

scale 1:250


removable roof
biogas plant
vermicompost
ity garden 12m
roof
slab and container
truck entrance
Vuga road 5m
parking 3m


roof
seeting
collection point
play-gro-und
water collector
path
gravel surface 10m



PERSPECTIVE

The perspective illustatrates the centre of the collection point marked with the red-colored lamp pole. The solid waste management facilities are placed on a concrete floor under the shading roof. Residents are also using the site for socializing and cultivation.

ALLEY

7.8.1 EXISTING SITUATION

The alley is a typical site where residents tend to dump their waste in Stone Town. The alley is windingly headed towards a parallel street north of Sokomuhogo street.

< 01 DECAYING AREA

The alley is decaying with discolored facades, dirt and broken pipes which impairs the appearance of the street.

< 02 WASTE ACCUMULATION

The decaying state of the alley makes it a place where a lot of informal dumping occurs. Since the door-to-door collectors are not obligated to pick up waste that is not put in a waste bin, the alley does not get cleaned on a regular basis.

< 03 UNSAFE SHORTCUT

Due to the unpleasant environmet few people are still using the alley as a shortcut. The alley gives a feeling of unsafety which increases by the impossibility to see the end of the alley.

< 04 VERTICAL SPATIAL VOLUME

The vertical spatial volume the alley possesses gives an interesting solemn character. But, the dense physical structure of Stone Town lets in a small amount of light which darkens the alley and makes it unpleasant.

7.8.2 PROGRAM - ALLEY

The program for the Alley is based on the existing prerequisites of the site and the solid waste management strategy. The following points in the program show which position the design for the Alley is based on.

GIVE PLACE VALUE

- In order to prevent littering the alley has to be of value for the residents, something they are proud of. Therefore, local artists are hired to create art attractions which will raise the status of the alley.

CREATE A SAFER AREA

- The alley needs light at the dark hours which will prevent littering at night and raise the feeling of security. Facades are repainted in white to further bring in light to the alley.

- In order to create a hygienic area, all waste and dirt is removed and broken pipes are repaired.

7.8.3 PROPOSAL - ALLEY

The narrow alleys in Stone Town could create interesting art assets around town. Instead of being dark informal dumping places, the alleys could be useful shortcuts in an exciting environment. Simple solutions like painting and put up light can create a totally new atmosphere. Scattered around town, these alleys has the opportunity to become a great tourist attraction.

PRINCIPLE
Give place value

Asphalt painting is decorating the floor and gives a feeling that someone cares about the alley. The walls are restoarated and painted white which lighten up the alley and gives the impression of a larger spatial volume.

PRINCIPLE
Accessability

By upgrading the alley and creating an interesting environment, the alley will become much more accessible for the residents. The alley can be used as a shortcut again.

PRINCIPLE
Promote social initiatives

By involving local artists or schools to paint the decorative floor social coherence can be created. This helps keeping the alley in order and prevents littering.

PRINCIPLE
Safety

Street lights are put up for the safety during the dark hours. It also makes an interesting feature at night and demonstrates how light can be used to enhance different areas at night.

^

There are many beautiful details around Stone Town. For example, this grid, which is protecting a fan, has a great graphic design. The design has been an inspiration for the proposal. By using already existing features and designs the proposal will fit in nicely in the environment.

< *The night view at the alley. Spotlights are creating interesting shadows through the path. It brightens up the colorful artfloor and gives a warm light which creates a feeling of a safer environment.*

RESIDENTIAL AREA

7.9.1 EXISTING SITUATION

In the South part of Sokomuhogo Street, is a place where much waste is accumulated. Here are different types of surfaces that all have one thing in common: they have no clear function or meaning.

The gap between the two buildings is a steep, where people throw their household waste and where water flows during rainy periods. The water causes the soil to erode and eventually raging down the street.

Between the stairs are areas that look to have previously functioned as planters. Today, however, it grows mostly weeds in the naked soil. They make a dull appearance for the residence and shops in the building.

On the left corner of the surface soil becomes very dry and exposed.

Λ 01 EROSIVE SOIL

Λ 02 UNAESTHETIC ENTRANCES

Λ 03 DUMPING AREA FOR WASTE

7.9.2 PROGRAM

The following points are based on site conditions and problems:

CREATE A VISUALLY APPEALING ENTRANCE

- The surfaces next to the entrances need to combine visually appealing design with functional solid waste management.

BIND SOIL

- The soil in the steep between the buildings needs to be binded to prevent soil falling down on the street.

PREVENT PEOPLE FROM DUMPING

- Design the dry exposed area so it prevent people from dumping waste at it.

Figure 58. The collage shows the existing situation on Sokomuhogo Street with scattered litter are thrown between the stairs and buildings.

7.9.3 PROPOSAL

The proposal is based on the conditions of the site and the functions that are needed to respond to the program. A grass planting bind the soil while it raises the decorative value of the site. Some grasses also helps to take up pollutants in soil and water. Vessels, which captures water and delays it, creates shimmering water surfaces which attracs birds and insects.

Between two entrances has the facilities for solid waste management been gathered. The clustering of bins makes it convenient for the door-to-door collector to collect and the numbers on the bins contribute to make the owners more responsible for their waste. The bins used are the ones stored by the municipality in the workshop close to Stone Town (see section 4.3.8).

A herb garden enhances the street life by adding color, texture and smell. Signs informs about which sorts of herbs that has been planted and how they can be used. It is free for the residents to use the herbs and the planting has the potential to become a meeting site for site.

Waste bins are clustered for the convenience of the door-to-door collectors (see section 5.1.3). Further, the waste bins are marked with house numbers and perforated in order to prevent theft.

Combost boxes

Herbal garden

PRINCIPLE
Give place value

This principle permeates the entire proposal. By adding functional features that are also aesthetically pleasing, as the grass planting which binds the soil, the place is added with value. Hopefully this makes people appreciate the site more and stop littering.

PRINCIPLE
Decentralization

By placing two smaller composts operated by the residents, they get close to their recycling. In addition, they can have their own nutrient-rich soil that can be added on the plantations.

PRINCIPLE
Training & Education

By having signs in the herb garden, which can both contain the names of plants and information about how plants can be used, is the opportunity given for the curious to take note the plantation on a deeper level.

08

DISCUSSION

REFLECTIONS ON THE PROJECT

This chapter discuss different aspects of the proposal as well as the knowledge gained from the project. The relationship between landscape architecture and SWM initiates the chapter continued by a discussion of the proposal. The discussion includes the new SWM process and the changed roles of its actors, the possibility of transferring the result to similar contexts and credibility of the results. Consistency with the theory of the ISWM model and the waste hierarchy model is debated. Finally, the discussion finishes with addressing further interesting research topics.

8.1 DISCUSSION

The following discussion is an attempt to address the most important aspects that we have encountered during our work in Zanzibar. We are arguing for the landscape architect's role in the planning of SWM, discussing the transferability of our proposal and addressing the difficulties that Zanzibar is finding itself in.

8.1.1 LANDSCAPE ARCHITECTURE AND SWM

Solid waste management could be seen as an unexpected subject for a landscape architect. Our argument is that solid waste management should be viewed as a process, which not only affects and interferes with, but is also built upon the landscape. As landscape architects we have a great interest in processes that create a townscape, and view the basic facility of solid waste management as being one of the most important ones. All physical aspects of solid waste management, such as bins, containers and particularly the waste itself, influence the town both aesthetically and spatially.

As mention in the introduction, solid waste management is a topic often reserved for engineers. It is quite probable that the outcome of our proposal is very different from what an engineer would propose. This is because landscape architecture link infrastructure to social, environmental and aesthetical aspects. Through this thesis, we hope to show how landscape architecture can assist in improvements the SWM. Moreover, we hope that this thesis can result in further involvement for landscape architects in the planning of solid waste management.

We have taken into consideration that landscape architecture in general tends to put great emphasis on the beatification of spaces, especially in developing countries. Popular attractions, such as Stone Town, are often visually improved to keep the tourist industry flowing. A lot of effort is put on the design at the expense of functional and social qualities. Instead, we propose that a more functional approach could be incorporated. This does not mean that the function should determine the design, but the interaction between aesthetics and function should become a productive inspiration for the design. If landscape architecture also contributes to the more functional aspects of a city, these areas will also gain value and appreciation. The aim of landscape architecture should be to include all parts of the city in the design. For example, in our design of the Vuga collection point, there exist plenty of green "beautified" spaces that may not seem connected with SWM. But these incorporated green areas are important as a visible reminder of how the processed organic material can be used. A combination of different activities can serve to create curiosity, and hence, it attracts people. The attraction of people is necessary to help educate the larger community about the process of solid waste management. Moreover, a well-designed collection point signals that SWM is an important part of the society. As a positive consequence, the waste workers status is raised together with the awareness of the residents.

Our main contribution is combining solid waste management with landscape architecture. The work process has been permeated by a landscape architecture point of view. This view is transparent in the choice of factors analysed, especially in how the proposal links solid waste management to green and blue infrastructure and social aspects. Another contribution to the topic is our working approach. By our multi-method analysis, every stage of the process has been exposed and evaluated. We believe it is important to know the process in such detail to find what minor adjustments help streamline the process.

8.1.2 THE AIM AND RESEARCH QUESTIONS

As mentioned in chapter 1, this thesis aims to find site-specific solutions on solid waste management on a local scale. To achieve this goal, we needed answers to the following research questions:

1. What are the challenges and opportunities in Stone Town – Zanzibar in terms of solid waste management?
2. What would be a strategy and design of solid waste management that can respond to the problems and contextual conditions in Stone Town - Zanzibar?

The research questions created a problematic situation. Evidently, the answer to the first question would prejudice the result of the strategy and design. Arguably, if there are gaps in the problem statement, the design could subsequently be affected. Since only two months were spent doing research in Stone Town, there was a strong possibility that a full account of challenges and opportunities was severely restricted to us, especially compared with a resident living in the area. Still, there are benefits with an outsider's eyes, such as a new perspective of the realities of the situation and an opportunity to bring new experiences and knowledge from another part of the world. However, it is important to emphasize that the design proposals are only examples of possible designs based on the strategy. There may well be a different outcome with another landscape architect/architect/urban planner designing the proposal. However, it has been this thesis's focus to create a new way of thinking of waste management, instead of producing an exact design.

This thesis has based the solid waste management strategy and designs on a local approach. We have found many advantages with using a local approach, such as discovering how small details affect each step in the solid waste management process. By adjusting these details the whole process can be more effective, without large expenses.

In the proposal, we have focused on the four first stages of the SWM system, namely source, collection, collection point and processing. This is due to changes of the two last stages; transport and disposal demands large infrastructural changes and is thereby not included on the local scale. One can argue the logic of excluding the two last stages when designing a process. Thus, our analysis covers all six stages to create a holistic proposal that relates to the whole process.

8.1.3 REFLECTIONS OF PROPOSAL

This section discusses the proposal from different aspects; the process, the actors, frames, transferability, important aspects not mentioned beforehand and the credibility of the result.

Process

The proposal is based on process-based thinking. This means that it considers the entire process, from source to disposal. Our proposal is not only designing sites, but also to design a sequence of events where all different stages and actors interrelate. Many of the suggested changes in the proposal are free of charge, such as changing the time and order tasks shall be done. For example, having the street sweeping done after the door-to-door collection or adjusting the timeframe for when waste bins are allowed on the street, will make the SWM process runs smoother and consequently the city becomes cleaner. Although these changes do not demand economic resources, they will require communication between workers.

To design a process is a complex task since it includes many components and actors. We are fully aware that the new proposal needs to be gradually adjusted if fault occurs. By suggesting a focus on small-scale interventions and to build upon existing prerequisites and patterns of Stone Town, a feasible proposal has been developed.

Actors

To have a sustainable SWM process we believe all actors must gain from the system. To succeed, an adjustment to the allocation of responsibilities is needed. The proposal presupposes a new role of the NGOs. It is debatable whether they are able to handle the responsibility the proposal implies, given their low level of education and scarce resources. But they exhibit sincere commitment, and with the right support from the municipality, and preferably also the private sector, they have large potential to succeed. The municipality has a lot to gain from the private initiatives taking on more responsibility for the solid waste management. NGOs will form a committed and thereby liable labor force, which has the potential to spread their commitment to the rest of the society. Even if the NGOs are dependent on the municipality, it has been important in our proposal to give them incentives to fend for themselves: sadly, the municipality does not always have the resources to pay them or give them the proper equipments. By giving them the opportunity to sell compost, vegetables and plants they become less reliant on the municipality.

The residents need to take more responsibility in the SWM process. We have created economical, educational and social benefits to incite participation. The reduced fee suggestion, an economical benefit, is a good encouragement to get peoples attention in the beginning of the project. But without education and providing social activities, people will lose interest in the long term. In the future, the stimuli need to be adapted for the developing needs.

In interviews with residents of Stone Town, the information emerged that some people wanted an extra collection and street sweeping per day. We found that it was problematic to

incorporate this idea as it gives mixed messages to the residents about the responsibility issue. Sweeping one more time a day can signal that it is permissible to throw waste on the street. Yet, it is understandable that people want facilities to manage the waste during daytime. We strongly recommend a priority from the municipality to introduce street bins instead, which do not take away the responsibility from the residents to throw away their own waste. The street bins should be evenly spread over town but in a higher density in crowded areas like Darajani market. Obviously, this requires further analysis to achieve a proper solution.

The informal waste workers are contributing to the SWM process by collaborating with the municipal door-to-door collectors. The proposal aims to ease the workload for the informal waste workers by giving them a formal role in the process. However, this presumes that the informal waste workers a reliable labor force, which may be uncertain today. Since they are unorganized individuals they, in particular, need to find the solutions profitable. Their working conditions are substantially improved by providing both a larger quantity and improved quality of recyclable waste at the large collection point.

Frames for the proposal

The fact that Stone Town is a World Heritage site has affected our design proposals in surprisingly few aspects. The designs of landscape architects always strive to respect local culture and practises, to create identity and provide strong character to the sites being analysed. However, certain solutions, for example those that created encroachment on the facades, were discarded.

A much more limiting constraint on our proposal was the status of Tanzania as a developing country. With the country's poor economic resources, our proposal needed to be more or less self-supporting. By recycling, reusing and processing the system should be able to pay for its maintenance. However, since we have not conducted any detailed economic analysis, further investigations need to be done.

The largest threat against the proposal, as we see it, is the issue of corruption in Tanzania. Since our proposal builds upon collaboration between the actors it is important to have open communication, without dishonesty or fraud. Here, the municipality has an important role for setting the bar. They have to take responsibility for their employers. In order to keep a reliable work force, all waste workers have to be properly paid and acknowledged. We are aware that the corruption problem is spread all over the country with the Government ultimately responsible.

Transferability

Since the municipality desire to extend the solid waste management system to other parts of Zanzibar Town, it was important to evaluate the existing system of Stone Town. Our analysis shows that the existing system of door-to-door collection demands functionality in material and equipment, paved streets and proximity to collection points. None of these factors exist outside Stone Town, which makes the door-to-door collection inappropriate to extend. Instead, we would propose a community-based solution where people themselves go to the collection

point. In order for it to function, the collection point must include other social activities which attracts the residents. This requires further analysis of the site-specific prerequisites outside of Stone Town.

A major aspect of this thesis has been to make the result transferable to different areas of Stone Town. By choosing a typical street and representative sites where waste is being accumulated, the result can be transferable to other similar contexts. This does not imply that the result/design does not need adjustments to other environments, but the proposals give an idea of how the strategy may be implemented on site. Although the SWM strategy is based on the conditions of Stone Town, other similar places in developing countries can adopt the strategy. But, since the prerequisites of Stone Towns are unique, it may cause problems when using the strategy in an all too different environment. Then, a new strategy must be developed where our method can be applied. Since we have developed a method adapted and tailored after SWM in developing countries, the method can serve as a template to evaluate SWM processes in other areas.

Important aspects not mentioned in the proposal

The proposal includes primarily physical objects, such as different kinds of programmed surfaces, items such as containers and bins and the planning of spaces. Obviously, these items do not float freely outside of a political and/or economic context. These aspects are essential for the solid waste management process but have not been included in the proposal due to our limitation on the local scale. However, we would like to mention some important aspects outside the local scale that could make a major improvement. For example, laws and regulations of solid waste are unclear, too general or simply missing. With stricter laws, and penalties for violating these, attitudes can change. However, this requires that there are actual alternatives to illegally dumping waste, and these do not exist today.

Currently, the municipality is alone in its role of managing the solid waste which they have difficulties to cope with. There exist private enterprises on Zanzibar with the potential of contributing with knowledge and facilities for processing of solid waste. Hence, the ZMC seems to be unwilling to cooperate with them. It is unclear if this is because of financial or political reasons. It could be worthwhile to involve reliable private companies for obtaining a proper SWM on the Island.

Economy also highly affects the process of solid waste management. Since the Ministry of Finance collect the SWM fees and distribute them to several divisions of the municipality, the DSDSW have very little influence over their budget. Instead, it would be beneficial if all the SWM revenues could be combined under the umbrella of the municipality, or more particularly DSDSW. This would lead to less bureaucracy and ease the planning for future SWM expenses of DSDSW.

Further, due to the problems of financing the SWM, Zanzibar is dependent on external actors which are providing knowledge and aid (see section 4.3.8). One of the external actors, the Finnish government, is developing the first waste management strategy in Zanzibar. The

strategy will be crucial for the SWM development since it will hopefully force consideration of SWM into the physical planning. The Word Bank is another external actor contributing with new equipment for the SWM. Unfortunately, the equipment can not be used until the requirement of a proper sanitary landfill is built. Similar situations can be avoided if accurate analysis of the entire SWM process is made before sending donations. According to our analysis, the ZMC is currently in urgent need for a sanitary landfill. Further, they require proper safety gear, clothes, handcarts and brooms for the waste workers before more technical equipment such as trucks are being sent. This is crucial to ensure that the municipal workers are not exposed to occupational injuries. Another addition that would improve the sanitary problems at the collection points for the workers is to reintroduce public toilets in the city. This would prevent people from defecating behind the container and create a more sanitary working condition for the waste workers.

Finally, working agreements need to be improved for the employees. Permanent employment with decent salary and gender equality are aspects that would significantly raise the standard of everyday life. Since The Environmental Policy of Zanzibar (The Revolutionary Government of Zanzibar 2013) includes a gender goal, this is an excellent opportunity to give women a chance to possess half of the leading positions at the collection points.

8.1.4 CONSISTANCY WITH THEORY

Two waste management models are presented in the theoretical background. ISWM is brought up as a relevant theory to use as a starting point for waste management in a developing country. We have however critiqued the model when it comes to changing the entire SWM organization. After developing the proposal we are even more convinced that the organization must be changed step by step from its current conditions. Otherwise, it becomes almost impossible to improve the solid waste management system due to existing economic constrains.

Our main idea and hope with the proposal is to reduce waste going for final disposal according to the principles of the waste hierarchy model. Thus, we have combined our knowledge from the two models in order to create our strategy.

8.2 FURTHER RESEARCH

The most pressing need when it comes to further research is to retrive the current data on quantities and composition of SW in both Zanzibar Town and other parts of the Island. Not until that data is collected it will be possible to develop a proposal that is fully adapted to the prevailing circumstances.

In order to have the permission of using the equipment sent from the World Bank and be able to control the disastrous contamination problem on the Island, a proper site for a sanitary landfill is an urgent topic to investigate.

Another interesting matter to explore is how our solid waste management strategy can be implemented in rural areas and new exploitation areas. The need for simple and non-expensive strategies will only grow as the worlds' population continues to expand.

It is also of interest what other professions could contribute to the design of a solid waste management process. Are there professions hitherto unconsidered that would have other ways of looking at the process? That could be combined with the view of a landscape architect and engineers?

POSTFACE

This thesis has been a part of a Minor Field Study sponsored by SIDA. By bringing in the subject of SWM into landscape architecture, we hope that this thesis will contribute to a development of the field. The importance of the topic of SWM will continue to increase along with the rapid urbanization.

This thesis has brought us to critically examine our own SWM system and how willing we are to accept the responsibilities that a sustainable solid waste management system requires. Habits are difficult to change therefore we believe that people need encouragement for doing so. This is where landscape architectures have a great opportunity to be a part of transforming the view of solid waste management.

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SEMI-STRUCTURED INTERVIEWS AND PERSONAL COMMUNICATION

Abdulraman, Khamis Ali; head of municipal waste workers, Zanzibar Town (2013). Semi-structured interview 1th of October.

Abubakar, Salim; biogas entrepreneur, Zanzibar Town (2013). Semi-structured interview 10th of October.

Hamilton, Nell; founder of Sustainable East Africa, Zanzibar Town (2013). Semi-structured interview 23th of October.

Juma, Jamal Khamis; general secretary of Zacedy, Zanzibar Town (2013). Semi-structured interview 3th of October.

Juma, Mzee, Khamis; director of Zanzibar Municipal Council, Zanzibar Town (2013). Semi-structured interview 20th of September.

Juma, Muhammad; director of Urban and Rural Planning, Zanzibar Town (2013). Personal communication 7th of October [e-mail]

Jumbe, Aboud; Department of Environment, Zanzibar. 2013. Semi-structured interview 9th of October.

Makame, Hija, Abdalla; accountant at DSDSW, Zanzibar Town (2013). Semi-structured interview 30th of October.

Møller, Lars; adviser for the SMOLE project, Zanzibar Town (2013). Semi-structured interview 19th of September.

Rajab, Salum; Environmental Health Office, Zanzibar Municipal Council (2013a). Semi-structural interview 23th of September.

Rajab, Salum; Environmental Health Office, Zanzibar Municipal Council (2013b). Semi-structural interview 1th of October.

Rajab, Salum; Environmental Health Office, Zanzibar Municipal Council (2013c). Semi-structural interview 30th of October.

Ramadhan, Said Muhammed; leader of The Volunteer Glittering Group (2013). Semi-structured interview 2th of October.

Rehani, Salum; project coordinator of Organic and local produced in Zanzibar (2013). Semi-structured interview 30th of October.

Sheha, Mjaja, Juma; director of the Department of Environment, Zanzibar. (2013). Semi-structured interview 19th of September.

Vinnerås, Björn; PhD, Associate Professor (Docent) of Environmental Engineering at the Swedish University of Agricultural Sciences (2013). Semi-structured interview 14th of August.

Woolven, Tim; sales manager at Zanrec, Zanzibar Town (2013). Semi-structured interview 4th of October.

APPENDIX 1

SAMPLE INTERVIEW QUESTIONS FOR RESIDENTS AND SHOP OWNERS

Name:
Address:
Household / Commercial

How many people are you in your household?
What do you do with your waste?
At what time?
Who is doing it?
How much waste do you normally produce per day (number of bins)?
Do you know who is responsible for emptying the dustbins and sweeping on this street?
How is your satisfactory with the waste management?
What kind of improvement would you like to see?
Would you consider separating organic waste in your home and from the rest of your waste in different bins? Yes / No
If no, why not?
Would you consider being responsible of taking your own waste to the collection point, if it would keep your neighbourhood cleaner? Yes / No
If no, why not?
Are you paying any fee for the municipal collection? Yes / No
If no, why not?
If yes, how much?
Is it something else you would like to share / add?

APPENDIX 2

INTERVIEW TOPICS FOR ABDULRAMAN, KHAMIS ALI

1th of October

Door-to-door collection in Stone Town
Street sweeping in Stone Town
Employees
Challenges and opportunities of SWM in Stone Town

INTERVIEW TOPICS FOR ABUBAKAR, SALIM

10th of October

The suitability of small scale biogas plants in Zanzibar
Functionality of existing biogas plants
Challenges and opportunities with biogas plants in Stone Town

INTERVIEW TOPICS FOR HAMILTON, NELL

23rd of October

The aim of Sustainable East Africa
Different projects the NGO is involved in
Composing in Stone Town

INTERVIEW TOPICS FOR INFORMAL WASTE WORKERS

Recyclable material
Profit from recyclable material
Customers

INTERVIEW TOPICS FOR JUMA, JAMAL KHAMIS

3rd of October

Sweeping areas for Zacedy
The contract with ZMC
Wages and working conditions

INTERVIEW TOPICS FOR JUMA, MZEE, KHAMIS

20th of October

The system of SWM in Zanzibar Town and Stone Town
Distribution of SWM resources
Challenges and opportunities in Stone Town concerning SWM
Fee collection

INTERVIEW TOPIC FOR JUMBE, ABOUD

9th of October

The new SWM strategy

INTERVIEW TOPIC FOR MAKAME, HIJA, ABDALLA

30th of October

Budget and revenues for DSDSW concerning SWM

INTERVIEW TOPIC FOR MAKAME, MØLLER, LARS

19th of September

The new SWM strategy

INTERVIEW TOPICS FOR RAJAB, SALUM

23th of September

SWM in Zanzibar Town and Stone Town
Future plans concerning the SWM system in Stone Town and Stone Town
Disposal of MSW
The NGOs role in the SWM system

1th of October

Revenues for the SWM
The ZUSP project and its contribution for the SWM in Zanzibar Town

30th of October

Private sector and SWM

INTERVIEW TOPICS FOR RAMADHAN, SAID MUHAMMED

2nd of October

The aim of Glitters Volunteer Group
Challenges and opportunities with the duty of street sweeping
Finance of the organization

INTERVIEW TOPICS FOR REHANI, SALUM

30th of October

The aim of UWAMWIMA
Organic farmers on Zanzibar
Organic fertilizer

INTERVIEW TOPICS FOR SHEHA, MJAJA, JUMA

19th of September

SWM in Zanzibar

Laws concerning SWM in Zanzibar

INTERVIEW TOPICS FOR VINNERÅS, BJÖRN WOOLVEN, TIM

14th of August

SWM in Zanzibar

Laws concerning SWM in Zanzibar

INTERVIEW TOPICS FOR WOOLVEN, TIM

4th of October

The aim of Zanrec

Future ambitions with Zanrec

Processing organic waste