Building in rural Tanzania

Proposal for a self-sufficient orphanage

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Department of Civil, Environmental and Natural Resources Engineering
Building in rural Tanzania
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Proposal for a self-sufficient child care center

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Department of Civil, Environmental and Natural Resources Engineering

Luleå University of Technology
Preface

This Master Thesis was conducted by Frank Edström and Jonas Nyman to complete the five year master's program in architectural engineering at Luleå University of Technology which is equivalent to 300 credits. The thesis was conducted from September 2015 to February 2016. The master thesis comprise of the work equivalent to 30 credits each.

To complete the master thesis a minor field study was conducted in Tanzania for eight week during September and November. The field study was sponsored by SIDA with a scholarship program called Minor Field Study. Other than financing the field study they had no involvement in the thesis.

The inspiration for the thesis was gained during a lecture several years ago, from a student writing her master thesis abroad through Architects without Borders. The idea of helping people living in underdeveloped countries through a master thesis felt both meaningful and interesting. Investigating in the possibility of doing this lead us, through an e-mail from Agatino Rizzo, to SIDA's minor field study scholarship. With a quick research about underdeveloped countries, Tanzania felt like a suitable choice. Tanzania has over 2 million children living as orphans (unicef 2013). Therefore the need for orphanages are high. We saw the potential of creating a proposal of a sustainable orphanage that can be built, driven and maintained by the local population.

We want to send many thanks to the people involved in the process of our master thesis, especially the people making the minor field study in Tanzania possible.

Among others:

- SIDA, the Swedish International Development Cooperation Agency.
- Jessica Klinte, owner of the orphanage CCY Tanzania.
- Abubakary Salama, PhD at Luleå University of Technology now working at UDSM.
- Benitho Lyakwipa, Architect and building engineer - Department of structural and construction engineering - University of Dar es Salaam.
- Golden Mdeke, Pastor in Illula.

We also want to thank:

- Lars Bemspång, our supervisor and senior lecture at Luleå University of Technology.
- Agatino Rizzo, our examiner and associate professor at Luleå University of Technology.
Abstract

The housing situation in the rural highlands of Tanzania is dire. People build inadequate, unhealthy houses with materials that need frequent repair and contribute to an unsustainable development through long transportations and increased deforestation. The roofing is most often made out of materials with abhorrent thermal and acoustic properties. The local building techniques are slowly disappearing due to urbanization and government buildings in modern materials are emulated which leaves few alternatives. There is also a lot of orphans in Tanzania. Some are living on the streets and others with relatives, few of which can afford to take care of them. The need for orphanages is great.

This thesis will examine how a sustainable and self-sufficient orphanage in the rural areas of Tanzania can be built with the purpose to create a design proposal. The research will focus mainly on building materials, systems and techniques as well as the culture and daily life in rural Tanzania.

To answer the research questions a qualitative methodology has been deployed and a field study has been conducted in Tanzania where interviews and observations were made.

The result of the study is presented in a design proposal for a sustainable orphanage situated in the rural highlands of Tanzania. The use of vaulted roofs for the buildings enabled the use of local materials like burnt bricks, fired with agricultural residue. The layout of the orphanage is designed with Tanzanian culture in mind and is supposed to convey a sense of family and community to provide the children with as normal a life as can be achieved. For the orphanage to become self-sufficient, it should be able to produce its own water and food. It should function as a closed system where the people inside the system is able to maintain it.
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1. Introduction

In the opening chapter the master thesis background is described. The purpose, delimitations and research questions for the thesis is showed here.

1.1 Problem background

Tanzania is one of the five most AIDS-afflicted countries in the world. Many children are born orphans and are forced to live on the street. There are approximately two millions children living on the street in Tanzania as a result of AIDS according to unicef (2013). These children have neither an address nor money and therefore are unable get healthcare and education. Today there are very few orphanages in Tanzania and the need to build more is great (Arkitekter utan gränser 2015).

Despite the vast amounts of fresh water available, many Tanzanians are still faced with water shortages due to insufficient capacity to access and store it both in rural and urban areas. Few households have access to clean drinking water from a piped source. Only a small fraction of rural households can access water to irrigate their farms. The lack of water and insufficient sanitation creates at large health problem as clean water is a basic need for a healthy environment (Morisset and Wane, 2012).

Walls of traditional houses in Tanzania are built out of mud. Unfortunately the often lack a long lasting quality, and as a result, houses need to be frequently repaired and rebuilt due heavy rain and minor earth tremors. People try to increase the lifetime of their houses by firing the mud to make more durable bricks. The main fuel for these fires is wood taken from trees in the surrounding area, which poses a major environmental threat by acceleration deforestation. (Tessema, Thaipale and Bethge 2009)

1.1.1 Climate

Tanzania lies just south of the equator and has a tropical climate with regional variations due to topography. Most of Tanzania is highland with the exception of a narrow coastal strip. The greater part of Tanzania is a central plateau of around 900-1800m, punctuated with mountain ranges. (McSweeney, New & Lizcano 2010)

The highland regions have temperatures around 20-23°C throughout the year, dropping by only a degree or so in the coldest months (June, July, August, September). (McSweeney, New & Lizcano 2010)

The north and east of Tanzania experiences two distinct wet periods. The short rains in October to December and the long rains in March to May. The southern, western and central parts of the country however, experience one wet season that continues October through to April.
or May. The amount of rainfall in these seasons vary greatly between regions, and can be as much as 300mm per month in the wettest regions and seasons but is usually 50-200mm per month. (McSweeney, New & Lizcano 2010)

1.2 Purpose

The need for more orphanages in Tanzania is obvious. Our goal is to find out what we can do to help a developing country, in this case the rural areas of Tanzania, to fulfill this need. To give a proposal on a solution that is looked upon from a new perspective. The question is how to build an orphanage in a sustainable way and make it become self-sufficient.

The purpose with this master thesis is to examine which preconditions and what possibilities exist to build a sustainable and self-sufficient orphanage in rural Tanzania. The master thesis will be conducted through literature studies and a field study. The field study will provide us with a foundation to understand how and why houses in rural Tanzania are constructed the way they are. It gives us an opportunity to understand the existing building techniques and how the use of material can be optimized under current conditions.

By comparing the results from the field study with conclusions from the literature study we hope to create a sustainable layout for an orphanage in rural Tanzania.

The aim is to produce blueprints for a sustainable and self-sufficient orphanage that will work as a showcase for other local communities in rural Tanzania with the focus on using locally available materials. This study could also be used as a good foundations for different NGOs who wishes to build in rural Africa.

1.3 Delimitation

In this section the delimitations for the master thesis is decided. The delimitations are set to not lose focus on the main subject and keep the master thesis inside reasonable frames.

1.3.1 Building

The main focus of the thesis lays in investigating local building material but as well looking into Tanzanian orphanages, culture, living standard and building techniques. This to make a blueprint proposal of a sustainable design that can be built and maintained by the local population. A proposal that can evolve and improve the living standards for orphans without creating a design that is too expensive and complex.

To keep the master thesis within reasonable limits, these delimitations were established:

1. The orphanage is to be used as a showcase for the local population in the highlands of Tanzania.
2. The building should have as low cost as possible to maximize the possibility for the local population to create similar buildings.
3. The building technique has to be adapted to the knowledge of local craftsmen or be easy to learn.
4. The orphanage layout has to be designed for the children who lives there.
5. It can be adapted to any reasonable location.
6. The building material should be sustainable meaning that it is:
   - Locally produced if possible, to focus on availability and eliminate the transport costs.
   - Long-lasting.
   - Low cost.
   - Easily handled and maintained.
   - Ecofriendly. It should have minimal ecological impact.

Since Tanzania is a large country with different climate zones, we decided to base most of our research in the highlands. The altitude in the highlands reduces day and night temperatures as well as increases rainfall. Because of the high rainfall, the vegetation is lush and green most of the year. The climate is pleasant, offering day and night comfort for most of the year but during clear nights temperatures may drop well below comfort zone.

1.3.2 Language and cultural barrier

Since the second language in Tanzania is English we have chosen to hold the interviews in English, hoping that the language understanding is enough to get correct information. When holding interviews with the local population of the rural village of Ilula, the English language is not commonly spoken. Instead of hiring a translator, we asked the local pastor, who spoke good English, to translate for us. All the literature that is used for the Master Thesis is written in English or Swedish.

1.4 Research questions

The main goal with the thesis is to define how an orphanage can be built and maintained in a sustainable and self-sufficient way. To answer this large and broad question we identified four sub questions:

- What defines sustainable and self-sufficient in rural Tanzania?
- What are the normal building materials and techniques in rural Tanzania and can they be improved without increasing the costs?
- What are the needs of orphans in rural Tanzania?
- What cultural, social and esthetical aspects have to be considered when building in rural Tanzania?
1.5 Field study

Sida, the Swedish International Development Cooperation Agency, is a government agency working on behalf of the Swedish parliament and government, with the mission to reduce poverty in the world. Through their work and in cooperation with others, they contribute to implementing Sweden’s Policy for Global Development (Sida 2014).

Through Sida we got the opportunity to conduct a field study during eight weeks in Tanzania as we were granted the MFS scholarship (Minor Field Study).

MFS is a scholarship program for field studies in developing countries. It is intended for students at universities and university colleges with an international interest, who wish to gather material for their Bachelor or Master dissertations for periods of 8-10 weeks. It aims to provide Swedish students with the opportunity to build up their knowledge of developing countries and development issues (Sida 2014).

Ahead of conducting the field study, Sida held a course on working in underdeveloped countries.

Our supervisor, Lars Bernspång, has lived in Tanzania for six years and he helped us get some contacts in Ilula and Mafinga. From there we set our route from Dar es Salaam to Mbeya and started to search for more contacts. We started dialogues with engineers and architects from UDSM, Ardhi and MIST as well as people running different orphanages along our selected route.

Illustration 1: Flight way to Tanzania
The route was randomly selected due to where we got our contacts. In the beginning different universities, orphanages and other relevant contacts was approached due to different possible routes. When a certain network was established, a route was decided. Then other contacts along that chosen route was approached to be able to get what we wanted and complete the field study. The route that was decided started in Dar es Salaam and ended in Mbeya. The climate zones being studied was decided by the way of traveling. Since many of the stops had different climate zones and prerequisites a place was not chosen in forehand.

Since our knowledge about the country and the culture was limited we had scheduled meetings with contacts, through people from LTU, who would give us an introduction to the country and other relevant people to interview. Starting with people working as engineers and architects at the universities. The questionnaires that we created before leaving were adapted to be more suitable for each specific meeting. For full interviews, see Appendix 1. Our broader knowledge gave us more relevant questions to be asked.

Illustration 2: Travel road in Tanzania
2. Methodology

In this chapter the methods used in the master thesis are presented.

The methods used in this study are characterized as qualitative. In a qualitative study the central assumption is that reality can be perceived in many different ways and that, consequently, there is no absolute objective truth. Instead of numbers, the collected data in qualitative studies is constituted of words and descriptions, qualities in other words. The method is more subjective than for example an experiment, since the researcher becomes an important instrument in collecting and interpreting data. (Hedin 1996)

According to Eklund (2014), a qualitative method is characterized by focusing the interest on open empirics. It is the perspective from the object of study that is proceeded. This means:

- Studying only one or few environments and these are studied as a whole with all their different hues.
- A close and direct relationship towards what is studied is there.
- Flexibility
- The participants own reality perception, motive and thinking are captured.
- That the studying process different phase flows into each other and becomes parallel.

Data in this research has been collected mainly through a literature study, interviews and observations. The secondary data came from literature found before, during and after this process which can complement as well as confirm the interviews.

2.1 Literature review

Before leaving on the field study a literature study was conducted where we researched Tanzanian culture and important aspects of building in developing countries to be able to prepare the interview questions for each group. The main literature that has been used in the master theory is:

- Climate and Design in Tanzania - Guidelines for rural housing, by Terje Bodoegaard (1999)
- Rural low-cost houses - Advice concerning design and choice of materials for rural housing in Tanzania, by Christer Svard (1980)
- Architecture for the poor - An experiment in rural Egypt, by Hassan Fathy (1973)
- Rainwater harvesting for domestic use, by J. Worm and T. van Hattum (2006)

The study started with a literature review in order to understand and learn from previous research and experience. The literature on how to build a sustainable and self-sufficient orphanage in the rural areas of underdeveloped countries are relatively low. There are
of course earlier examples of orphanages being built in a rural areas in underdeveloped countries but not with our definition of what is sustainable. It seems that in most of the cases found, the orphanage in question used too expensive materials and were dependent on outside help to function properly. The literature that is used in this thesis still gives a good foundation on what questions should be asked. It can confirm the answers and claims that have been recorded as well. There are literature on different materials, climate and how to build in rural areas of Tanzania.

The literature review gives a foundation for prerequisites and understanding of the issues. The literature was however not able to answer the research questions by themselves. By doing a field study the literature could be better understood by observations and interviews.

2.2 Field study

The research process of the field study has been conducted with an iterative approach, where the process always connects back to the initial research questions, searching for ways to improve the given preconditions. The data collection was based on qualitative studies.

The field study was conducted during eight weeks, from 1st of October to 26th of November.

During the field study interviews with different relevant groups were held and observations were documented with pictures, drawings and notes. The route traveled stretched from the east coast of Tanzania to the highlands, from Dar es Salaam to Mbeya. Through this route seven orphanages were visited. After all data were collected, it was analyzed and used to discuss different solutions and draw up some ideas.

Most of the stops were in the rural highlands of Tanzania and therefore a focus on the climate in the highlands were established.

The field study that were conducted for this thesis was of great importance due to the information that has been gathered to get a better understanding of the subject. To experience the country first hand is vital to be able to use the knowledge gathered and put it to good use. By being on site, insight was gained of what possibilities and problems there are. When conducting the field study, a good overall picture was gained by mixing interviews with observations.

By the interviews and observations we were able to analyze the information needed to decide how to continue with our master thesis. Information on what type of material to use, how to use it and what to think about when designing a child care center. For full interviews, see Appendix 1.
2.3 Observations

Observations in a qualitative study is often unstructured, meaning that situations and phenomena is noted down as it happens, in a so called open record. (Hedin 1996)

Unstructured observations was made during the field study. Part of the observations had a focus solely on architecture and building techniques. The other part was based on participation in daily life activities in the villages and orphanages visited. All the observations were documented with photographs, sketches and notes.

Most observations were made in small rural villages in the Southern highlands where basic infrastructure were insufficient. Small roads with low maintenance made transportation of supplies and materials difficult and expensive. Water was often fetched from communal wells, long distances from many households. Electricity where mostly a luxury which only a very few portion of the community could afford.

The general observations could be anything noted during the field study that we thought could be relevant to the research. These observations were noted down continuously as they were made.

The observations became an important part of the field study since it let us get a deeper understanding of what it means to live in rural Tanzania. However, it is important to note that the observations were made exclusively from our perspective and are therefore subjected to our interpretation and probably affected by our preconceived notions.

2.4 Interviews

With a qualitative method, semi-structured interviews is often used. This means starting from certain areas of discussion rather than exact, detailed questions. This lets the conversation take a more natural course and the person being interviewed is freer to control in which order different subjects is discussed. The purpose with these interviews is to understand the reality of the person being interviewed and therefore it is important to let the person talk as much as possible without being led by the interviewer. The questions asked should be open and give room for the person interviewed to elaborate on the answers, for example through asking follow up questions. (Hedin 1996)

Semi-structured interviews were conducted during the field study. This allowed the conversations to take unexpected turns and subjects of high import could be delved deeper into. The first questions were generally of a broader scope to get some basic knowledge about the architectural and constructional situation in Tanzania and later narrowed to questions related to the area of expertise for the person being interviewed. The interviews
usually covered 15 to 30 questions and lasted for approximately one to three hours. The longer interviews were conducted over two separate sessions of approximately one and a half hour each. The interviews were documented by taking notes.

A total of 17 qualitative, semi-structured interviews were conducted during the field study. 11 of these were with either engineers, architects or staff at the orphanage. These interviews generally went well, where the conversation often took unexpected turns and new areas where explored and discussed. Preconceptions was often changed in the beginning as a new understanding of the situation in rural areas was gained. The interview questions was often updated or added to after an interview as new ideas emerged. The difficulties experienced here was that the subject discussed often led into other subjects and it soon became difficult to keep track on what talking points had already been explored. This could sometimes mean that certain subjects where missed or just briefly visited during the interviews. After a couple of interviews, this led us to tighten up the sequence of the questions asked and instead focus on prompting the informant with follow up questions. This made the course of the interview easier to keep track on and qualitative information was still gained. The drawbacks where that the interviews did not flow as freely once this change where made and some information may have been lost because of it.

The six remaining interviews were conducted with the local population in the rural village of Ilula. These interviews presented a bigger challenge. None of the informant here except one understood English. This necessitated acquiring a translator which always makes the information gained more uncertain since we do not know how the questions are translated or if the translator let his own views on the subject affect the questions. The interviews became even more complicated because some questions where designed to get a better understanding on how the informant perceived reality, for example; “what does the word home mean to you?” These questions where generally not understood and examples had to be provided. Of course this often led to the example becoming the answer to the question and few relevant insights where gained from this.

When analyzing the interview data related to a specific topic, themes were created (e.g. “Building materials”) where we gathered all the data on this topic. This to make it easier to draw conclusions and notice contradictions between data gathered from different people.

2.5 The creative process

The creative process was an iterative process during the end of and after the field study. Ideas were sketched as they came to us. We discussed and filtered them down. The design changed constantly as a broader knowledge
was gained and our previous sketches laid the foundation for the new ones. Building materials and techniques were a governing factor in the design process. In the design proposal, the choice of materials for the orphanage will be based on the literature studied as well as the interviews and observations that were made.

2.6 Ethics

In qualitative methods, ethical aspects are especially important due to the small amount informants used and the personal information that they reveal. If the informant does not want certain information given to be used, this has to be respected. One should always be honest and open about the research being conducted. All participation is voluntary and the informants has to give their approval after being given detailed information. The information should be written and inform participants of who you are, what the purpose with the interview are, if it will be confidential, that she/he can stop at any time, who she/he can contact afterwards and how the result will be presented. The informant should also be able to take part of the result in some form and sometimes there is the need to complement the questions. (Hedin 1996)

Ahead of the interviews, the informants were informed about the aims of the research and how their information would be used through E-mail. At times it was forgotten to ask about the choice of being anonymous. These informant were given a fake name.

The informants are chosen after their relevance to the thesis; mostly for their profession but as well some for their gender or age to get as broad a perspective as possible. The engineers and architects where male because of the high educational gap between men and women while most of the personnel at orphanages was women. However, when conducting interviews with the local population of rural villages, a mix of genders and ages where ensured as to get an insight to different aspects of what daily life entails.

2.7 Secondary data

Since the thesis and especially the field study had limited time and budget we needed to rely on secondary data from the literature study instead of only relying on our own collected data. The data collected from interviews and observations are objective. Carefully collected secondary data could confirm primary data and thus strengthening it.

Using secondary data that have no direct contact with the case can be a problem according to Enroth. This can have four different consequences. The first one is that a lot of the information can be affected by the author because the data has his/hers understanding, structure and values. It is important that the researcher
can distinguish what is influenced by personal opinions and then can find a general understanding of the case that can be similar to the researcher's own. The next problem, due to the certain theoretical perspective the researcher has, is that not all data will be presented in the report. Missing data then becomes a larger problem when it comes to books and reports due to the author generalizing the data under a certain term. The final problem is the reliability of the secondary data and the author's method of collecting it but all these problems can be handled if the researcher is aware about it and carefully read through the literature to distinguish what is reliable. (Enroth 1987)

3. Theory

In this chapter the theory is processed. All information that can be significant to the result of the thesis is refined. This means analyzing different literature that can affect the purpose and the result of the thesis. The chapter summarizes four relevant and significant literatures.

3.1 Climate and environment

In the climate and environment section data of the climate, environment and buildings in uplands and high uplands are collected, due to the geographical delimitation.

3.1.1 Climate and Design in Tanzania – Guidelines for rural housing. By Terje Bodengaard (1999)

The book Climate and design in Tanzania - Guidelines for rural housing by Terje Bodoegaard is a textbook used at the University of Dar es Salaam (UDSM). The book addresses issues to take into consideration when designing buildings in the different climate zones of Tanzania. Since the focus of this thesis is the highland areas of Tanzania (Ilulua to Mbeya), the relevant data taken from this book is from the chapter uplands climate zone. See illustration 2 (page 2) for a map of the relevant areas.

Uplands climate zone (Iringa)

Observation period: 1935-70 (Rainfall)

Altitude: 1640 m

Vegetation: Woodland in hilly areas, wooded grassland and grassland. Where sufficient rainfall, vegetation actively induced (agriculture, grazing, forestry etc.).

Temperature: A pleasant climate, never very hot, never very cold.

Annual means:
Max: 24.7 °C
Min: 13.5 °C

**Humidity:** Annual mean relative humidity at 1500 hrs: 52-60%

**Rainfall:** Annual mean: 743 mm, 175 mm per month in January and Mars.

**No. of rainy days:** 83

The Southern uplands has one rainy season: November-April. Hail may occur but is rare below 1500 mm. Some hail in Southern uplands, north of Mbeya.

**Winds:** Moderate breezes with no predominant direction. Strong gusts during thunderstorms.

**Wind speed in m/s:**

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Table 2: Wind speed average in Iringa. Data in m/s.

**Comfort aspects:** Solar radiation of houses may cause overheating, ventilation is required. Chilly during cool season. Cold nights cause discomfort and diseases among children. Few mosquitos.

**Siting:** Avoid exposed sites. Spacing of building not required. Orientation is not crucial, but still important. Surface water drainage control required when building on terraced plots (cut and fill) on sloping sites. Vegetation near houses to prevent glare, dust and erosion.

**Building plan:** Double banked houses desirable. Courtyard houses suitable. Yards to face east. Shaded verandas favoured. Roof overhangs not less than 0.6m, preferable not less than 0.75m. Heating required.

**Structure and materials:** Heavy roofs and walls with 8 hours’ time-lag most suitable. Walls not less than 20 cm thick. Lightweight North and South walls acceptable if insulated. Corrugated metal roofs should have (heavy) ceilings. Colored walls and roofs and roof to improve heat absorption.

**Openings:** Size: 10-25% of North and South walls. Louvre windows not suitable for bedrooms and living rooms, use glazed windows or tight fitting wooden shutters. Separate adjustable small ventilation openings required at high level. Window in East Facing walls advantage.

**Climate**
The altitude reduces day and night temperatures as well as increases rainfall. Because of the high rainfall, the vegetation is lush and green most of the year. The climate is pleasant, offering day and night comfort for most of the year but during clear nights temperatures may drop well below comfort zone. Houses in the Southern upland will receive most solar radiation on the North wall and due to the thinner layer of atmosphere of the uplands zone, the radiation will be greater than at lower altitudes. In most of the Tanzania it is cloudier during the morning hours, causing less radiation on Eastern walls than on West walls. In order to allow for heat storage in walls, complete sun exclusion of walls is not required. Generally the humidity during the day is fairly low, varying between 40 to 65% at Iringa airport at 1500 hours. Due to the low temperatures, the humidity is quite high at night. At Iringa airport it varies between 79 to 94% at 0600 hours. (Bodoegaard 1999)

**Siting and landscaping**

Spacing of houses should be kept to a minimum. The distance between houses should be decided according to the functional use of space, the need for outdoor shelters near the house, and the need for privacy and social contact. Since many household activities take place inside the house, there is less need for roofed outdoor spaces. Outdoor spaces near the house should be sheltered against prevailing winds by using other houses, outbuildings, walls or vegetation as shelter. The zone is generally well forested, and the vegetation must be used actively in creating an attractive environment. Grass and other vegetation with surface binding roots are required to stop soil erosion. Similarly thick foliage will prevent very heavy rains from washing away the topsoil. (Bodoegaard 1999)

The large quantities of rain falling throughout the year and the changing topography makes surface water control essential. Houses and settlements should not be located in most susceptible areas, such as on steep slopes and near fast flowing rivers, which are likely to cause large scale erosion. Throughout the zone sufficient drainage should be provided around houses and outdoor spaces. It is important to ensure that the yard is not likely to be flooded. Surface water must not be allowed to enter pit latrines. Similarly cattle pens should not be located at a higher level than dwellings. (Bodoegaard 1999)

**Building plan**

Circular and rectangular house plans are common, and a variety of courtyard types are used in Iringa region. Traditionally, double-banked houses have not been used, but they are becoming more and more popular as circular plans are being abandoned. The intense solar radiation and low night temperatures makes a compact building form the most appropriate in order to minimize solar heat gain and reduce heat loss during nights. A
compact double-banked building requires less external surface than a single-banked more elongated house. However, double-banked house consumes more materials for the roof support structure than a narrow single-banked house. Courtyard houses are suitable if ventilation can be controlled. It is an advantage to locate living room and bed rooms to the North or East side of the house. Controlled ventilation is a prerequisite, either through doors, windows or separate ventilation openings. The intensity of solar radiation and of seasonal rainfalls make it most desirable to have roofed outdoor spaces, adjacent to the main house. A number of household activities are carried out around the house, and it would be desirable to have several shaded or sheltered spaces, with varying degree of privacy, size and functional relationship to the house and any other outbuildings. A sheltered kitchen space with a simple wall against prevailing wind and driving rain is required if there is no kitchen inside the house. (Bodoegaard 1999)

Structure and materials

The zone consists to a large degree of well forested areas, which provide a variety of quality timbers, hardwoods as well as softwoods. There is an increasing utilization of softwoods for commercial purposes. Due to low temperature and continuous rainfall, laterite soils are mostly absent from this zone. However clay deposits provide an excellent raw material for brickmaking. There are also large areas with bamboo forests and despite its short lifespan, it is a very popular roof and wall material. Traditionally emphasis was put on high quality thatch roofs built as cone shaped circular huts. (Bodoegaard 1999)

A heavy structure is most appropriate for buildings, offering a long lifespan. Lightweight, well insulated structures would also be recommendable, but unfortunately there are now low cost insulation materials which are termite proof. Houses of burnt bricks should be promoted where there are suitable soils and an abundance of firewood. Bricks or various types of blocks are particularly suitable for low cost housing in this zone. A heavy structure will store solar heat during daytime and emit it at night. Similarly when indoor fires are lit, the radiant heat will heat up the fireplace, surrounding walls and any other objects, which will store the heat and emit it long after the fire went out. Thatched roofs should be as thick as possible, with a steep slope. This will ensure a quick runoff during rains. Corrugated metal sheets are becoming more popular, but their poor thermal performance in this zone make them almost unfit for roofing, when used without a ceiling or other additional roof covers. The advantages of corrugated metal roofs are obvious; they are lightweight, thus requiring hardly any support structure and waterproof even after the frequent rains. Once corrugated iron sheets have lost their reflective surface, they may on sunny days cause overheating of the interior. Lightweight sheets are also noisy during heavy rains. Sometimes the corrugated iron
sheets have been thatched, a practice which will give both sufficient heat and sound insulation. The roof slope should be no less than 18 degrees. A mono pitch roof with a single sheet spanning across can be almost flat. Heavy roofs are most appropriate, as they have excellent thermal properties. The only heavyweight roofing material which might become viable for low cost housing within the not too distant future, is burnt clay tiles. Roofing tiles might be produced as a small scale industry product, and become a realistic alternative for the neighboring villages. (Bodoegaard 1999)

Ceilings are a great asset in this climate. Particularly in houses with corrugated metal roofs, ceilings should by all means be provided in order to prevent heat loss at nights. Walls should be as heavy as possible, preferably not less than 0.3m thick. They should be constructed with bricks or blocks. As laterite soil deposits are rare, cement stabilized soil blocks cannot be generally promoted. However, sun dried mud blocks are commonly used. The susceptibility of water penetration in most building elements require certain precautions. All external walls should preferably be plastered, particularly Eastern walls. Water penetration due to driving rains can be reduced by correct siting and orientation. Heat storage in walls is required for the warming up of rooms during cold nights. External surfaces should therefore be left unpainted, or painted in non-reflective colors. Building materials and structures have a longer life span if they can be protected against water penetration. Termite attacks in this zone are not so common, and growth of fungus is not so widespread, due to low temperatures. Erosion of foundations and walls, and occasional flooding may cause more damage to buildings than any other factor reducing the lifespan of buildings. (Bodoegaard 1999)

**Lighting, ventilation and heating**

When deciding the size of openings, one has to bear in mind that the occupants often are ill dressed, bedded and with little resistance against diseases. Exposure to cold causes harm to an already stressed organism. The window area should roughly be 50% of the floor area of the house. If all openings are located on North and South walls, about 15-25% of these wall areas should be openable to give sufficient ventilation. Openings should allow for controlled ventilation. Windows should preferably be glazed, or in low cost houses, fitted with tight fitting wooden shutters. Ventilation openings for air exchange should be situated high to prevent draught. If indoor fireplaces are used, the house needs permanent ventilation openings. As air temperatures rarely exceed the upper limits of the comfort zone, ventilation is not necessary for comfort reasons. Ventilation is however necessary for convection cooling of the building fabric as a result of solar heat gain. Mosquitoes and other insects are not a major health hazard or factor of discomfort, but vegetation should be kept tidy and sufficient drainage should aim at preventing insect breeding pools. (Bodoegaard 1999)
Fireplaces are needed in most areas and should be located in living rooms. The same fireplace or chimney can be used for both kitchen and living room, thus making it possible to heat both rooms with one heat source. In traditional houses with thatched roofs the smoke from an open fire protects against mosquitoes, vermin and other insects. In houses with corrugated metal roofs, ceilings and lime-washed walls, the soot is not welcome and smoke is not required for termite protection. Open fires should be provided with chimney. They should be constructed of burnt bricks and have sufficiently large fire openings for cooking. The walls should be sufficiently thick for heat storage. The fireplace should be placed centrally in the house for maximum heating effect, and should have an opening to kitchen as well as living room. (Bodoegaard 1999)

3.2 Building materials and house design

In this section, information about the available building materials and some design advice are collected to make a foundation for the design and material choices presented in the Result chapter.

3.2.1 Rural low cost houses - Advice concerning design and choice of materials for rural housing in Tanzania.

By Christer Svard (1980)

The book Rural low-cost houses - Advice concerning design and choice of materials for rural housing in Tanzania by Christer Svard is a textbook used at the University of Dar es Salaam (UDSM). The book offers some guidelines when designing and choosing appropriate building materials in rural Tanzania.

Choice of materials

The main principle for choice of materials should be to utilize local, traditionally used building materials and methods as far as possible. The reasons for this are many and as follows:

- The materials are usually very cheap and easily available.
- The construction methods are known to the rural population (a prerequisite for self-help building).
- Traditional local materials are easy to maintain or replace.
- Constructions and materials are often well suited to the climatic conditions.
• It is in general an advantage to encourage local production, since this will contribute to the economic development of the rural areas.
• The country's scarce resources of foreign exchange are saved by using indigenous materials instead of imports.

However, there are drawbacks with local materials as well. Many of the traditional materials have the disadvantage of not being very durable, even if they are easy to maintain. It may in some cases be desirable to replace traditional materials by more durable “modern” materials, often not possible to produce in the villages. (Svard 1980)

Walls

Heavy walls are preferable in the upland areas since they store heat during the day and emit this heat during the night, thus keeping the house warmer at night and cooler during daytime. They are therefore suitable in areas with cold nights such as the highland areas (more than 1200 m above sea level). Heavy walls are made of for instance burnt bricks or soil-cement blocks, at least 300 mm thick. (Svard 1980)

Thatch

This type of traditional building material, like grass, are scarcely used today. It decays due to fungi and insect attacks, the risk of fire is great, it is difficult to keep clean and it harbors many insects and other vermin. Walls made from this type of material cannot be considered a satisfactory solution.

Soil

Soil walls can be a good and durable solution if the main disadvantages are mitigated; resistance against water and poor quality of internal surfaces. This can be achieved by providing the wall with a proper foundation and generous roof overhang and by giving it some kind of surface treatment. In mud and pole walls, rapid deterioration of the pole structure due to fungal and termite attacks is a great problem. Walls made from soil only (sundried blocks or monolithic walls) are not attacked by fungus and termites cause only little damage which makes them more appropriate than mud and pole walls.

For all types of soil walls proper maintenance is as important as proper construction. With yearly maintenance, a soil wall can last almost indefinitely. More than 50 years old soil block houses, still in good condition can be found in different parts of Tanzania. (Svard 1980)
**Bricks**

Burnt clay bricks make a very good wall material. They are strong, water resistant and can be produced locally if suitable clay and firewood are available. The somewhat rough internal surface of a brick wall can be improved with a cement or lime plaster or simply with a whitewash. This makes the wall brighter and easier to keep clean. However, too much cutting of timber for firewood causes problems of soil erosion. Further deforestation to get fuel for brick burning may have very serious consequences. This problem must therefore be looked into before recommending production of burnt bricks. (Svard 1980)

**Concrete**

Concrete blocks make a strong and water resistant wall. However, they have the disadvantage of requiring a lot of cement and they are usually too expensive. Block walls (soil-cement, sand-cement or concrete blocks), do not require a rendering coat on internal surfaces, if carefully made, but a whitewash is advantageous since it makes the wall easier to keep clean. (Svard 1980)

**Stone**

Very good and durable walls that can be made from natural stone, but construction of such walls (rubble work) requires a high standard of craftsmanship. (Svard 1980)

**Timber**

Timber walls are lightweight and therefore more suitable in areas with very warm nights where additional heat is undesirable. In most areas tough, timber is not a realistic option because of the price. (Svard 1980)

**Mortars**

In walls made of sun dried soil blocks a mud mortar is adequate for the joints. Some lime or cement added to the mud mortar can mitigate erosion of the joints and may improve adhesion between lime or cement plaster and the wall.

Burnt bricks and natural stone should preferably be laid in cement or lime mortar, but mud mortar can also be used without losing too much strength. Soil-cement, sand-cement and concrete block walls depend more on good joints and these blocks should therefore be laid in cement or lime mortar. (Svard 1980)

**External wall surfaces**

External wall surfaces should preferably be finished in a light color, like whitewash that reflects solar radiation. This
is valid for the whole of Tanzania except for very cold highland areas (above 1800 m) where it is desirable that walls absorb the heat of the sun. In these areas, light colored, reflective, surfaces are of no advantage. (Svard 1980)

Roof

Thatch

According to Svard, thatching has the advantages in that it has a minimal cost and that necessary skills to erect, maintain and/or replace a thatching are well known to the people. For many families it will therefore be the most realistic option. Thatching, whether of grass, reeds or palm leaves also has the important advantage of thermal insulation. Moreover, the supporting structure can be very simple, made of, for instance, wooden poles or bamboo. On the other hand, thatched roofs are not very durable but well laid and maintained roofs can last for 5 - 10 years. Other disadvantages are the risk of fire, the possible leakage during heavy rains and that the thatch can harbor insects and snakes. (Svard 1980)

Corrugated iron sheets

Of the modern roof covering materials, corrugated galvanized iron sheets are by far the most common. The main advantages of corrugated iron sheets:

- they are easy to transport (lightweight)
- they require only a simple supporting structure
- they require little skill for construction
- they are watertight

Although considered “permanent”, corrugated iron sheets have a limited durability due to rusting, especially in humid climates. Painting can retard this process considerably provided it is done often enough. A serious problem is the lack of thermal insulation which can result in intolerably high indoor temperature during daytime and very low temperature at night. Corrugated iron sheets are also very noisy in heavy rain. These two problems can, to some extent, be overcome if some kind of ceiling is erected. (Svard 1980)

Corrugated aluminum sheets

Corrugated aluminum sheets are more durable than corrugated iron sheets and practically maintenance free. They also reflect more of the solar radiation and this results in lower indoor temperature during daytime. Other properties are similar to those of corrugated iron sheets. The price of corrugated aluminum sheets is about the same as of iron sheets and they deserve to be much
more widely used because of their durability and comparatively good thermal performance. (Svard 1980)

**Burnt clay tiles**

Burnt clay tiles make a very good roofing covering. They are very durable, watertight and have acceptable thermal properties. Tiles have the disadvantage of being short and heavy, thus necessitating a strong supporting structure with closely spaced battens. The common types used must be laid on sawn timber, but if types that can be laid on a pole structure could be developed their applicability for rural housing would increase. Even if tiles are difficult to produce, it is desirable to increase the production, particularly small scale production, since clay tiles are an indigenous product, not requiring imports. (Svard 1980)

**Supporting structure**

Wooden poles, bamboo or sisal poles are the most used materials for the supporting roof structure. If carefully constructed, poles make a good, sufficiently strong, roof structure that can be used with many covering materials. Sawn timber is at a large extent also being used for the roof structure. If metal sheets or tiles are used as roof covering, it is easier to get a good result if the supporting structure is made of sawn timber rather than poles. Termite attack is a problem on wooden roof structures. Treatment with some kind of preservative is a good but unfortunately expensive solution. Where termite resistant timbers are found, they can be a cheaper alternative that should be used as far as possible. Many roof structures can be used, from the more complicated roof trusses to simpler structures with rafters on a ridge beam and load bearing walls. (Svard 1980)

The slope of the roof is determined by the covering material. The following minimum slopes should be used as a general guide:

- corrugated metal sheets - 1:3 (18 degrees)
- clay tiles - 1:2 (27 degrees), preferably 1:1,5 (33 degrees)
- palm thatching - 1:2 (27 degrees), preferably 1:1,5 (33 degrees)
- grass thatching - 1:1,5 (33 degrees), preferably 1:1 (45 degrees)
- 1:6 (9 degrees) can be an acceptable roof slope for corrugated metal sheets provided the overlap is increased from 100 mm to 200 mm. A mono pitch roof is very suitable for small spans that can be covered with a row of single metal sheets (no joints). Then the sheets can be laid almost flat. (Svard 1980)

**Ceilings**
Very few houses in villages have ceilings today but modern roof covering materials with poor thermal insulation, such as metal sheets, makes some kind of ceiling desirable. When a ceiling is constructed, the space between roof and ceiling should always be well ventilated. To prevent this space becoming a breeding ground for insects and small animals, the ventilation openings into the space between roof and ceiling should be screened. (Svard 1980)

Good ceilings can be made from traditional local materials such as reeds, bamboo or saplings. Such ceilings, usually covered with a mud plaster which improves the thermal and noise insulation, are used in some areas. A lime or cement plaster or simply whitewash improves the quality of the surface. (Svard 1980)

Among modern materials for ceilings, soft board and hardboard are the only realistic alternatives for a low cost house. They are reasonably cheap and easy to work with. Soft board has better insulation properties than hardboard but is not very durable, especially in humid climates. Good quality hardboard is more durable but is a poor insulator. To avoid sagging, the ceiling battens should be spaced no wider than 600 mm. Where timber is available, ceilings made of boards are, of course, a good alternative. (Svard 1980)

Future production of ceiling boards made of sisal reinforced gypsum (indigenous raw materials) is being discussed in Tanzania. Gypsum boards make a good ceiling but are heavy, difficult to work with and break easily. (Svard 1980)

Foundations

A very good, cheap and simple foundation can be made of stones. A foundation trench is dug deep enough to reach firm soil, free from roots. A depth of 300-400 mm is in most cases adequate. The trench is then filled with well compacted stones up to the ground level. If cement or lime is available the upper layers of stone should preferably be jointed with mortar (mud mortar should not be used since it only reduces the friction between the stones). To get a proper base for a masonry wall, the stone filling should be finished off with a 25 - 50 mm thick layer of cement or lime mortar if possible. On this type of foundation, a wall of any material can be constructed. When cement or lime mortar is available, the foundation should be carried up above ground level (about 150 mm) to protect the wall base. (Svard 1980)

Floors

The main disadvantage of the traditional soil floors is that the surface usually is on level, or even below, the ground
level outside the house. Moisture from the ground therefore often penetrates the floor surface and rainwater can sometimes flow into the house. A simple improvement is to build the floor up to a height of at least 150 mm above ground level. To get a better, more hygienic and durable floor, a floor slab of concrete is usually the best solution. The slab should be 50 - 75 mm thick with the surface trowelled smooth. The backfill material should be as coarse as possible and well compacted. A 100 mm thick layer of sand or very sandy soil will prevent the moisture from penetrating the floor. A hardcore of gravel, stones or broken blocks is a very good alternative. (Svard 1980)

Site preparation

If required, the site must be levelled before the construction starts, in order to drain off surface water and to avoid flooding of the house during the rainy season. If the ground slopes much, a terrace must be made. A trench to lead the rainwater away may be necessary as well. The ground must be shaped to slope away from the house for not less than 2.0 m from the external walls. In all filled areas the soil must be very well compacted. (Svard 1980)

Plot planning

The plot should be divided into areas for different purposes, for example areas for housing, for cultivation, for keeping cattle and so on. The size of the plot of course puts restrictions on the use. One acre (4050 m²) is a common plot size. The front part of the plot is usually the most natural to utilize for housing. Reasons for this are that connections to present or future infrastructural services (like piped water or electricity) can be made short and consequently cheap. Dirtier functions such as waste disposal and cattle keeping can be accommodated at the back of the plot, away from neighbors and public spaces. However, other factors such as topography, soil conditions and vegetation might imply other, more suitable locations for the house. (Svard 1980)

From a hygienic point of view it is important to keep houses and their surroundings dry. If the site has a depression, houses should normally not be built there. The area set aside for housing should preferably be easy to level in order to drain off the surface water, to avoid flooding of the house as well as still water becoming mosquito breeding pools. A site with a gentle slope, max. 1:30, will facilitate a proper surface drainage. Steep slopes are difficult to build on since it involves terracing of the slope, and should be avoided. The soil conditions may also influence the location of the houses. For
example, areas with clay or organic soil (peat) as subsoil are usually not suitable for building. (Svard 1980)

If the site has large trees it can be an advantage to build close to these in order to utilize their shading effect, either to protect the house from the heat of the sun or simply to provide a shadowed outdoor space. However, care should be taken not to build too close (min. 2-3m) to large trees because of the risk of the roots damaging the foundation. Trees, shrubs and grass, has an overall cooling effect, by providing shadow and absorbing the heat of the sun, and can be of great physiological and psychological value. Preservation of existing vegetation and planting of new trees should therefore be encouraged. Trees and shrubs can give useful protection from high winds and dust as well as reduce soil erosion. To prevent accidental fire from spreading houses, with noncombustible roofs like corrugated iron sheets the total distance between houses should not be less than 5 meters. (Svard 1980)

Today, domestic animals are often kept close to, or even inside houses where people live and near the places where food is prepared or where small children play. The reasons for this is usually security or, when animals are kept inside the house, to utilize the heat produced by the animals to keep the house warm during cold nights. This practice constitutes a great health hazard since it makes the immediate surroundings and the house difficult, if not impossible, to keep clean. The risk of spread of different diseases is consequently great. Therefore this practice must be strongly discouraged. In cold areas fireplaces should be used instead to keep the house warm. When animals are to be kept on the plot, a separate area for this purpose should be set aside in the layout of the plot. Sheds or pens for the animals, should be built, not too close to houses where people live, where food is prepared or where food and water is stored. Larger animals, such as cattle, should not be kept closer than 10 meters, preferably further away if possible. Where the risk of cattle theft is great, keeping the animals in a common cattle pen, for the whole village, with an organized guard could be considered. Another problem of hygiene is waste disposal. This must be considered in the layout of the plot. A place for a latrine and a special area for refuse disposal should be included in the plot layout. Human feces are one of the main sources for spread of disease in rural areas. A pit latrine must therefore not be built closer than 10 meters to houses where people live, where food is prepared or where food and water is stored. The site for the pit latrine should be well drained to avoid flooding. (Svard 1980)

There is no single, uniform tradition for grouping and orientation of houses and adjacent outdoor spaces in rural Tanzania. However, it can be noted that houses are
often grouped among a space for various outdoor activities. This space can vary in character from an open, semi private area in front of the main house, facing the visitor, to the very private, completely enclosed (by fences and/or outbuildings), courtyard behind the main house. Combinations, with a semi private area in front and a more private yard behind the main house, are also common. Local traditions are usually based on social and climatic considerations and must be allowed to have a great influence on orientation and arrangement of houses. The space around the house has a very important function since a lot of activities take place out of doors. The yard, open or enclosed, is an extension of the indoor spaces and as such the connection between indoor and outdoor spaces is important. The area set aside for housing must be large enough to allow future expansion. The expansion can take the form of additional houses or extension of existing houses. Possibilities for future expansion should be considered when the arrangement of houses is planned. (Svard 1980)

In most parts of Tanzania it is desirable to protect the walls of a house from the sun as much as possible in order to reduce the indoor temperature. This can be achieved most easily by orienting the house so that the short walls face the low morning and evening sun. In cold highland areas, where some sun penetration into the house can be desirable, a modification of the east-west orientation should be considered (a WNW-ESE orientation). The contours of the site affect the orientation of houses. Especially long houses should preferably be built along the contours (across the direction of the slope) to minimize terracing work. Several small houses in an open arrangement are easier to adapt to a sloping or undulating site than a large house. Large, shade giving trees should, if possible, be preserved and treated as an important and useful element in planning the arrangement of houses. (Svard 1980)

Design

Rural housing in Tanzania is today, in general terms, characterized by the following: very low cost, self-help and local materials. The economic context of the housing situation in the rural areas is that most families have very low incomes. The majority of the rural population can only afford to set aside very little money for building purposes. The majority of people in the villages today, have to rely on their own work for building new and better houses. Extensive use of local materials, like soil, wood and grass for building is mostly the only realistic low cost alternative in rural Tanzania. This, however, does not mean that bad houses have to be accepted. In fact, with some improvements to the
traditional constructions, very good houses can be built of mainly local and traditional building materials. (Svard 1980)

House Design

The traditional use of houses has, in the guide to the village museum in Dar es Salaam been described in the following way: “... the pattern of daily life in Africa allows for little time to be spent in the houses. A house is a place to sleep, to prepare and partake of food during rainy weather. It is a place to be born, to be ill, to make love and ultimately to die.” This indicates that many daily activities take place out of doors and that as much attention should be given to the layout of spaces around and between houses as to the specific house layout. Houses and adjoining spaces for outdoor activities should be regarded as a unit and good connection between indoor and outdoor spaces should be aimed at. This is important, for instance, when deciding where to place outer doors. In many cases two outer doors (one front and one facing the back yard) are necessary. A common quality in most traditional rural housing is the possibility for expansion. This creates the possibility, for families who can only afford to begin with one small house, to later improve their housing situation by adding extra rooms or by building additional houses. This expansion by steps must be expected to take considerable time but is nevertheless, for most rural families, the most realistic option. (Svard 1980)

One of the most obvious purposes of a house is to provide shelter for sleeping. A sound sleep is necessary to enable people to work efficiently. It can even be a health hazard in the long run, not to be able to rest properly during the night. To make a house as useful as possible, rooms for sleeping should be large enough to be used for many purposes as is the case in most traditional house types. The area of a sleeping room should therefore preferably not be less than 9 m². It should be able to accommodate three sleeping spaces with adequate circulation space between them. A sleeping space is here meant a space with the size of a bed (1.80 x 0.90 m or preferably 1.00 x 2.00 m, even if most beds are smaller). A room used for sleeping should have a minimum area of 3 m² per person (including children). Sufficient ventilation during nights is, for hygienic reasons essential in all rooms where people sleep. In highland areas it can sometimes be difficult to have enough ventilation and at the same time get protection against the cold nights. In these areas it is especially important not to have too many people sleeping in the same room. (Svard 1980)

Activities like meeting to talk and maybe drinking some beer, receiving and entertaining guests or simply sitting
down to rest, form an important and valuable part of daily life. To a large extent, this type of activity takes place outdoors. An outdoor space where people can sit down protected from the sun serves an important function. Planting trees is a recommended alternative when there are no suitable existing trees. A simple roof structure without walls is another alternative that gives a useful place protected from the sun and rain. There should also be an indoor space for this kind of activity that can be used when the weather is bad and during the evening. The space should be large enough to allow all household members and some guests to come together. It is difficult to state a specific area but 12 - 15 m² would probably be sufficient for most households. The room should contain an area for chairs and table, free from interfering doors, of at least 2,0 x 3,0 m. (Svard 1980)

The preparation and cooking of food can take place inside a house, in a separate outbuilding, or simply out of doors. A kitchen in a separate outbuilding is often preferred to cooking in a house where people sleep because of the problems of smoke from the open fire. On the other hand, in areas with cold nights it can be desirable to do the cooking inside the house where people sleep in order to utilize the heat of the fire to make the house warmer. It is very important to keep the space for preparing and cooking food clean. The simplest outbuilding, that gives protection from sun and rain and from which animals can be kept away, is therefore better than just a fireplace in the open air. The outbuilding does not always have to be provided with four walls. An open shelter with roof and two or three walls can be sufficient. This gives very good ventilation and little problem of smoke. The fireplace should if possible be provided with some kind of extract hood, connected to a chimney, to collect smoke and catch sparks. This is an advantage even if other cooking facilities than an open fire are used. A kitchen must be easy to keep clean and dry. Wall and floor surfaces should therefore be smooth and nonabsorbent if possible. A smooth and hard floor surface is particularly important. A kitchen must be well ventilated and have enough openings to provide proper daylight inside. Among other things, this makes the kitchen easier to clean. The space for cooking and preparation should at least be large enough to accommodate a fireplace or hearth (600 x 900 mm) and a workbench (600 x 1500 mm). The free floor space should be at least 1,2 m wide. A larger kitchen, accommodating in addition a cupboard of, for instance 600 x 800 mm may be desirable. Even if the kitchen is large enough, much of the work, like sifting, pealing, picking, lighting charcoal stoves, is done outside. A kitchen should therefore have close access to the yard, preferably a direct entrance. A verandah outside the kitchen is very useful for such outdoor activities. Close connection between the
kitchen and the place where meals are taken is also important. (Svard 1980)

Washing dishes can be done in the same space as where cooking and preparing food is done. Often it is simpler and more convenient to do the washing up out of doors. The space where washing up is done should have some kind of nonabsorbent and smooth floor slab to make it easy to keep clean. A simple roof structure for sun protection is an advantage. The space for washing up and drying the dishes should not be smaller than 1,2 x 1.8 m. The wastewater must be taken care of in a proper way. The simplest solution is to carry it out and throw it away, not too close to the house, in a place where the water drains off and does not form a mosquito breeding pool. Some kind of washbasin, connected to a drain leading the water away from the house, for instance into a soak away pit, is a convenient but also more complicated and expensive solution. Clothes are usually washed, not on the private plot, but at a lake, a stream, a well, or a communal water trap. If facilities for washing clothes are to be provided on the private plot, the simplest and most convenient solution is an outdoor space. A floor slab with a nonabsorbent and smooth surface should be provided. The floor should be slightly sloped to drain off water. A roof for sun protection is an advantage. Clothes lines or a simple rack, to hang the clothes on to dry, should be used. The wastewater can be thrown away as the wastewater from washing dishes. Washing dishes can very well be done in the same space as washing clothes. Combining these two activities in one space is a simpler and cheaper solution than providing two separate spaces. The simplest solution for personal washing, when facilities for this activity are to be provided on the private plot, is to build a separate shelter. A floor that is easy to keep clean is essential. The floor should be slightly sloping towards an outlet for the wastewater, and can be let out simply through a hole in the wall and into a small ditch that leads the water away. The walls of such a shelter can be simple provided they give enough privacy. Water resistant walls are an advantage. The space should not be smaller than 1,5 x 1,5 m. If the space is large enough it could also be used for washing clothes in. (Svard 1980)

Clothing and most smaller personal belongings can be stored in rooms for sleeping or for meeting etc. They can be stored in cupboards or in boxes. A very good solution is simply to hang clothes or smaller items on the wall or from the roof structure. The space between the roof and ceiling can be used for storage if there is an opening in the ceiling. For storing larger items such as a bicycle, farming equipment or fuel, a separate space is desirable. This space can either be a store in a house or be part of an outbuilding. A store in a house where people sleep is advantageous from a security point of
view, but a store in an outbuilding is usually simpler to build. If in a house, the store should be located close to an external door or have its own external access. A store should be at least 1.2 m wide and also be minimum 2 m long (which allows for a bicycle to be taken into the store). A window is not required in the store, but the ventilation openings must be sufficiently large to provide enough daylight to facilitate proper use and cleaning of the store. For short term storing of foodstuffs and of water for cooking and drinking, the kitchen is usually adequate. Water can be stored in clay pots or other containers which should preferably be kept away from the floor. Food containers should also be kept away from the floor for protection against pests. A good solution is to hang the food containers in rope nets from the roof structure. Another alternative is to place them on shelves. A well ventilated but mosquito proof cupboard is very useful for storing food. If the kitchen cannot be closed off against animals or burglars, a small separate store that can be locked, is desirable. This store should have direct access from the kitchen. The store must have permanent ventilation. The size of the ventilation openings must be sufficient to provide enough daylight to facilitate cleaning of the store. For long term storage of larger quantities of food crops a special outbuilding may have to be built. The traditional small granary, raised from the ground, is a very good solution if carefully built to make it water, insect and rodent proof. (Svard 1980)

The pit latrine is the most commonly used type of latrine in Tanzania. To prevent the spread of diseases, a well-built latrine is absolutely necessary. A pit latrine consists of a hand dug hole covered with a properly built slab and a simple shelter. It should be located at least 10 m away from houses. The pit should be as deep as possible to be sufficient for several years use and as narrow as possible to be easily covered with a slab. A 3 m deep pit with a diameter of 0.9 m should be sufficient for a family of five persons for 5 - 6 years. When dug in soil likely to cave in, the pit has to be provided with a lining. A lining made of sticks is often sufficient but sometimes a stronger lining, made of for instance burnt bricks or soil cement blocks with open joints, and must be built. The top part of the pit (400 - 600 mm) should preferably have a lining (collar) of a solid and waterproof material that can act as support for the slab and that prevents caving in. Concrete or burnt bricks can, for example, be used for the collar. The covering slab should have a nonabsorbent surface, sloping towards the hole, to be easy to keep clean and dry. The hole can be 150 - 200 mm wide and 300 - 400 mm long and should be above the center of the pit. The best material for the slab is reinforced concrete finished smooth with a cement rendering. The shelter can be very simple. It should have a roof that gives enough shade so that flies are not attracted. For the same reason there should be no windows, but the shelter should be well ventilated through shaded openings at the top of the
The inside measurements of the shelter should preferably be at least 1.2 x 1.5 m. A ventilation pipe from the pit, reaching above the shelter, can be advantageous in that it may reduce the odors. When, after several years use, the pit is almost full (0.5 m from the brim) a new pit must be dug and the old one covered with well-tempered soil. (Svard 1980)

These spaces described above can either be combined into one large all-purpose house or separated into several small buildings according to function. The large all-purpose house means better security and requires less building material than many small houses with the same total area. On the other hand many small houses can be simpler to construct and a separation of, for instance, spaces for sleeping into more than one house can mean more privacy. A separation of spaces into a main house for sleeping, meeting, taking meals etc. and one or more outbuildings for activities such as preparing and cooking food, washing dishes, washing and storing is quite a common design that has functional advantages. A combination of spaces for activities involving water (preparing/cooking food, washing dishes/clothes, personal washing) into one outbuilding facilitates the solution of the waste water problem and a possible future installation of piped water. Even if it is desired to have the kitchen in the main house it is advantageous to combine the spaces for the remaining activities involving water into one outbuilding. If these spaces are incorporated in an all-purpose house they should, for the same reasons, also be located together. (Svard 1980)

With regard to arrangement of and connection between rooms, houses can be divided into four main types (combinations do, of course, occur):

**External access type:** In this type all rooms have their entrance from outside only. This has disadvantage in terms of security and involves many expensive external doors. The lack of internal connection between spaces is often a disadvantage from a functional point of view but the resulting separation between rooms can be a good thing. For outbuildings external access applies well.

**Courtyard type:** Resembles the external access type but the rooms have their entrances from an enclosed yard (courtyard). In this case the security is better.

**Corridor type:** All rooms have an entrance from a corridor running through the house. This type provide good security (only one or two outer doors) and the rooms are well separated. A long corridor, however, often tends to be dull, dark and wasted space used only for circulation between rooms. The corridor type may be a good design in relatively small houses where the corridor is short or in combination with other types, especially the central room type.
Central room type: Instead of a corridor an ordinary room (usually the living room) acts as the area for circulation between rooms. Security is here very good and this type has more open character and the separation between rooms is not so pronounced. The central circulation room must be large enough to allow both space for circulation and space for furnishing. Too many doors leading into one room can make this room difficult to utilize.

The shape of the house is important in attaining a favorable indoor climate. A long and narrow, one room wide (single-banked), house allows for very good cross ventilation if correctly oriented. This type of plan is therefore especially suitable for areas with hot and humid climate. In the colder highlands area a more compact, two rooms wide (double-banked), type of plan is more suitable since it is easier to keep a house of this type warm during cold nights. Verandahs, or other kinds of shaded outdoor living spaces, are an essential part of the house in most parts of the country. In drier and cooler areas, a verandah should preferably be located on the north side of the house where it is exposed to more sun during the cold season. In large parts of the highlands, heat from a fireplace is an asset during cold nights in a house where people sleep. Certainly in areas more than 1800 m above sea level, a fireplace should be built, preferably in the living room. A room height of 2,4 m to the ceiling or the lowest part of the roof structure is, from a climatic point of view, quite sufficient. (Svard 1980)

The choice of roof shape is significant for the appearance of a house as well as for climatic and constructural considerations. A gable roof is easy to construct and allows for high level ventilation in the gables, which can have cooling effect. The hipped roof is more difficult to construct but, with good overhang, gives effective protection from the heat of the sun and from rain for all four walls. If a gable roof is used the gable walls are difficult to protect. The gambrel roof, popular in some areas, combines the advantage of the two previous types but is even more difficult to construct than the hipped roof. Flat roofs are expensive and difficult to make waterproof. To give a good indoor climate they are usually constructed of heavy material, requiring a very strong supporting structure. Irrespective of the roof shape it is important to protect as much of all the walls as possible by providing a generous roof overhang. The roof overhang for houses with normal wall height should be at least 600 mm. (Svard 1980)

Windows are essential in order to get good daylight in the house. Good daylight conditions are especially important in room where people stay for longer periods. To get minimum acceptable daylight, such rooms, of
small to medium size should have at least one window of 600 x 900 mm but preferably larger. In cold highland areas, the openings required for daylight are sufficient for ventilation. However, in these cold areas, there should also be some permanent ventilation openings in addition, located at high level to limit draughts. All windows should have some kind of shutter that can be closed against the cold during the night and/or against too much sun during the day. All large openings should be located in the walls facing north and south to avoid excessive solar radiation. In highland areas, doors or windows in walls facing east may be acceptable or even desirable in order to benefit from the heat of the morning sun. In very cold areas, openings also in the west wall can be welcome. (Svard 1980)

The security is a problem that must be taken into consideration in house design. Security requirements can sometimes contradict other recommendations, concerning for instance hygiene or climatic comfort. An example of this is the number and size of windows, where the need for security tends to restrict the number and size desirable for proper ventilation and daylight. Windows secured with burglar bars against intruders can also be a problem. They can be very dangerous in the case of fire, since they cannot be used as an emergency exit. If the door for some reason is blocked, people may easily be trapped inside such rooms and be killed by the smoke. Contradictions of this kind must be solved by some compromise solution, which will differ according to the magnitude of the security problem in different parts of the country. (Svard 1980)

3.2.2 Problems with wood as a building material

Although wood is a local material in most of the Iringa region there are some reasons not to use it as a building material. This section presents the material collected on problems with using wood as a building material.

Deforestation

According to the Forestry Department in Tanzania the harvesting of fuel wood and charcoal as well as changes in land use makes the forest in Tanzania under high pressure. The pressure will continue to grow along with the growing population. By changing the economic climate the government tries to stimulate private investments in plantation forestry to meet the future demand for wood fuel and also for the long term supply for wood-based industries. On the other hand the government tries to involve local communities in sustainable forest management. The overall goal is to establish a sustainable forestry that has a firm contribution to the national economy and decreases the poverty, which is often the basic cause of forest degradation. In Tanzania about 71% of the forest area is used for productive purposes. Besides fuel wood, forests
are source of logs for paper products, timber, wood based panels and poles. (Forestry Department 2000)

Further the Forestry department says it is estimated that more than 90% of the population in Tanzania, both in urban and rural areas, use biomass energy for cooking and heating. Hence bio-energy is the main source of fuel for the country’s population and accounts for approximately 90% of the total energy consumption in the country. Tanzania Traditional Energy and Environment Development Organization (TaTEDO) has revealed that about 65 million m³ of wood for fuel are consumed annually. The amount of wood fuel consumed will continue to increase with the increasing population. This is causing serious overexploitation and degradation of natural forests. In particular the production of charcoal by traditional earth kiln methods. The high tariffs for electricity and gas prevent the potential users to switch to non-wood based fuels. (Forestry department 2000)

It has been obvious that as the forest cover diminishes, the prices of wood fuel rises and the scarcity means that more money is allocated for acquiring wood fuel against other essentials. In some parts of Tanzania farmers meet their energy demands by using non-wood biomass such as farm residues and even cow dung, which would otherwise be incorporated in soils as organic manure for the future crops. (Forestry department 2000)

**Termites**

Termites is an insect that is very common in most of the tropical-subtropical areas. Termites can play a major role in the decomposition of dead wood, the soil formation and the material turnover in the ground. They are often difficult pests on timber in houses and on trees in plantation, mainly because they damage the roots. (Nationalencyklopedin 2016)

The degree of resistance depends on the tree species, the origin of the tree seed, the age and condition of the tree, the termite species and where the tree is growing (region/country). However as with crops, indigenous species are more resistant than exotics. (HDRA 2015)

In a study to investigate the level of termite damage on the dry, semi-deciduous Namakutwa forest in Tanzania, 982 trees were sampled and approximately 15 % of the sampled trees had been damaged beneath the bark level by termites. (Gould, Lowe and Clarke, 1993)

**3.2.3 Bricks fired with sustainable energy**

Unfortunately walls built out of mud often lack a long lasting quality, and as a result, houses need to be frequently repaired and rebuilt due to heavy rain. Houses made of fired bricks are durable, comfortable, clean, and healthier as well as attracts fewer insects. It also makes house owners freed from frequent rebuilding. The
problem with firing bricks is that the main fuel for this is wood taken from trees in the surrounding area, which poses a major environmental problem by accelerating deforestation. A more suitable option is to produce high quality bricks from local clay, fired with agricultural residues, such as rice husks, cotton or coffee waste, rather than wood. (Tessema, Taipale and Bethge 2009)

MRHP (Mwanza Rural Housing Programme) was established in 1990 in response to local requests for help to improve the quality of housing. Since 1995, MRHP has become a fully Tanzanian NGO working at the local level with training villagers in northern Tanzania to set up enterprises making high quality bricks from local clay, fired with agricultural residues. MRHP has developed a mold to make all bricks a standard size. After drying in the sun, about 4500 bricks are stacked to make a temporary kiln (the kiln is made of bricks that are being fired and is dismantled as soon as firing is complete). MRHP encourages brick makers to build a simple canopy over their temporary kilns to protect their bricks from rain which can damage them during brickmaking, drying and firing. MRHP has worked out a method of stacking the bricks to give the most effective flow of heat and water vapor between them to produce uniform firing. The agricultural residue is poured between the stacked bricks and the outside of the structure has a wall made of unfired bricks. Users find it much easier to pack a kiln with residue than with wood because it flows more easily into the gaps between the bricks. Paper or dried grass is used to start the fire which then ignites the residue. This burns slowly for three days during which time the bricks are fired. After four days the kiln is cool enough to be dismantled and the bricks are ready to use. Bricks made using the MRHP process have been approved to an international quality standard. By 2009, as a result of firing 450 million bricks using agricultural residues, the amount of wood saved was about 75.000 tons, with about 110.000 tons in avoided CO₂ emissions. (Ashden 2009)

3.3 Earth masonry and the Nubian vault

Earth masonry has constantly been in use for nearly 10.000 years and makes use of one of the oldest building materials on the planet. For several millennia arches, vaults and domes has been employed to enclose space. When properly designed, earthen construction is capable of considerable durability. Ample evidence of this is provided by the existing earthen masonry structures, still standing after more than 1.000 years. (Hall, Lindsay and Krayenhoff 2012)

The materials required for masonry of vaults and domes can be divided into two groups: solid components, which ensures compressive strength, and binder components, which ensures that compressive forces are transmitted and the cohesion of the whole. A minimum of binder component should be used to avoid the risk of shrinkage. (Joffroy and Guillaud 1994)
The earthen materials that can be used as solid elements are mud bricks, stabilized compressed earth blocks and fired bricks. The mud bricks, also called Adobe, is simply prepared by molding plastic soil and leaving it to dry. This material is the most widely used and is always inexpensive. Its shape and size can easily be adapted to various methods of construction but it requires fairly massive structures based on its rather low mechanical performance. Stabilized compressed earth blocks provides an alternative to the more costly fired bricks, being insensitive to water and having good mechanical strength. Fired bricks generally performs well and allows for either lighter buildings or larger dimensions but is a more expensive material. (Joffroy and Guillaud 1994)

The materials used as binder components are earth mortar, stabilized earth mortar and lime-sand mortar. The earth mortar is used to bond mud bricks or fired bricks. The good sticking properties of earth mortar enables the construction of vaults and domes without shuttering. Straw or sand is added to soils with an excessive clay content to avoid shrinkage. Stabilized earth mortar consists of regular earth mortar, improved with cement, lime, plaster or bitumen. These mortars are very suitable for binding compressed earth blocks or fired bricks. The main advantage of Lime-sand mortar is that it sets very slowly, staying malleable for quite a long time. By adding, for example crushed brick, it can be improved. Lime-based mortars are frequently used in conjunction with fired bricks. (Joffroy and Guillaud 1994)

Vaults and domes must be protected from water to avoid the risk of deterioration. The water must be channeled away from the building, using water spouts or downpipes. To protect the vault or dome, a renders or roof coverings can be used. The least expensive choice is an earth render. However, the use of an earth render requires periodical maintenance, the frequency of which depends on the nature and quantity of rainfall. Lime-sand and gypsum-sand renders have greater pliability and are better suited. A certain amount of maintenance might still be needed though. Thatch, flat stones or tiles can be used as roof coverings for certain forms of vaults. These solutions can be very efficient while remaining cheap, although they are rarely used. (Joffroy and Guillaud 1994)

Many people in rural Africa today are using corrugated iron sheets and sawn timber beams for roof construction. This method for roofing has several disadvantages. The use of sawn timber beams is accelerating deforestation and the iron sheets have inadequate thermal, acoustic and aesthetic properties. A program called “Earth roofs in the Sahel” has been established by The Association for Voute Nubienne (AVN). This program enables households in sub-Saharan Africa to build comfortable, sustainable and affordable homes. An ancient architectural technique for construction of timber less vaulted roofs called “la Voute Nubienne” or the Nubian vault, is promoted by the association. The villagers are enabled, by the program, to train to build houses with
vaulted roofs using, basic, local materials and simple, easy to learn procedures. In contrast to its traditional use, the Nubian vault technique has been simplified and adapted to provide protection during the short but heavy rainy seasons in Burkina Faso and Mali. (Tessema, Taipale and Bethge 2009, 36)

According to AVN, Nubian Vault roofs costs less to build than iron sheet and timber roofs, are cool in hot weather, warm in the coldest of nights, and can last for 50 years or more if properly maintained. AVN organizes the training and support of local Nubian Vault builders and entrepreneurs to promote the technique with a view to develop a self-sustaining market. At the same time, families can improve their quality of life, environment and economic condition through acquiring affordable and sustainable housing. Since the year 2000, AVN has trained 380 masons with 300 apprentices in training in the Nubian Vault technique. They have completed 1.800 vaulted buildings in 700 different locations and over 2.000.000 Euro of economic impact has been achieved on local economies. (The Nubian Vault Association 2015)

Originating in Upper Egypt, the Nubian vault technique is based on the ancient method of timber less vault construction, using only earth bricks and earth mortar. Vaults of mud bricks are still standing at the Ramesseum, the funerary temple of Ramses II in Luxor, after 3.250 years. The technique is virtually unknown in the rest of Africa. A simplified and standardized version of the Nubian Vault technique has been developed by AVN to make it easier to learn. No domes are used, the roofs are exclusively vaulted with a standard width of 3,25 meters, made from mud bricks of a standard size. The curvature of the vault is decided with the help of a guide cable. Wall thickness and openings for doors and windows are standardized as well. To reduce water penetration and erosion a plastic sheeting is incorporated. Labor, which is the major cost element in using the Nubian Vault method, is often provided by family members and neighbors on an exchange/barter/self-build basis, keeping cash in the local economy. The raw materials needed are earth, rock and water, all of which can be found locally and are ecologically sound. The method has been introduced successfully during the last ten years in Burkina Faso, Mali, Senegal and Zambia. (The Nubian Vault Association 2015)

With the Nubian Vault technique, construction can only occur during the dry season and must be completed before the seasonal rains start. Foundations can vary from 40 to 80 cm deep, depending on the properties of the ground and the site of the building. For loadbearing walls they need to be 70 cm wide and about 50 cm for the gable walls. The foundations are filled with rocks, bound with an ordinary earth mortar. The foundations should be raised 10-15 cm above ground level in sites where strong flows of surface water may occur during the rainy seasons. The load bearing walls which carry the vault are 60 cm thick and are laid using an earth mortar.
Gable walls are around 40 cm thick and are raised so as to lean slightly inwards by approximately 1.5 cm for each meter. For the vaults, good earth is used to make flat bricks (24 x 12 x 4 cm). The mason starts the vault by laying the first courses against one of the gable walls, using a mortar made from the same earth as the bricks. The central axis of the vault is defined by a cable made of six steel wires, coiled together and stretched between the two gable walls. To ensure that the masons maintain a constant radius for the vault, a cord fixed to a sliding ring on the cable acts as a guide. The roof is waterproofed using plastic sheeting over a smooth coat of mortar. A rendering of enriched mud mortar is then used to cover the sheeting, which provides additional protection against heavy rains and protects the plastic from the sun. For rendering, plain lime washes are inexpensive to apply and help reduce insect infestation. (The Nubian Vault Association 2015)

3.3.1 Architecture for the poor
By Hassan Fathy (1973)

In the book Architecture for the poor – An experiment in rural Egypt, Egyptian architect Hassan Fathy describes his plan for building the village of New Gouma, near Luxor, Egypt by using sun dried mud bricks and the Nubian traditional technique for vaulted roofing.

Fathy describes how his search for the traditional methods of constructing vaults without a wooden centering took him to Aswan, Nubia where he found the living survivor of traditional Egyptian architecture. When asking around for the masons responsible for these vault, he found that there was not much work for a professional builder of mud brick houses since every man in a village, whatever his job, was able to run up a vaulted house for himself. However there were still a few masons in Aswan who built vaulted roofs.

According to Fathy, when he hired the masons to construct vaulted roofs for one of his buildings it turned out to be very much cheaper than roofing the building with cement or timber would have been. The masons used a special kind of brick for the vaults. They were made with more straw than usual, for lightness, and measured 25x15x5 cm. They were also marked with two parallel diagonal grooves, drawn with the fingers from corner to corner of the largest face, which enabled the bricks to stick to a muddy surface by suction. The rooms which were to be roofed had two side walls, three meters apart, and a somewhat higher end wall against which the vault was to be built. Fathy describes the process of constructing the vault as follows: The masons lay a couple of planks across the side walls, close to the end wall and get up on them. By plastering the mud onto the end wall, they roughly outline an arch. With an adze, they trim the mud plaster to give it a sharper outline. The masons, one at each side, then begins to lay the bricks. The first brick is stood on its end on the side wall, the grooved face flat against the plaster, and
hammered well into it. With mud, the masons then makes a little wedge shaped packing against the foot of the brick, so that the next course will lean slightly towards the end wall instead of standing up straight. The second course is started with a half brick in order to break the line of the joints between the bricks. If the joints are in a straight line the strength of the vault is reduced and it may collapse. The masons put in more mud packing against the second course, so that the third course will incline even more acutely from the vertical. They gradually build out the inclined courses in this way, each one rising a little higher round the outline of the arch until the two curved lines of brick meet at the top. As the masons build each complete course they insert dry packing, such as stone or pottery, in the gaps between the bricks composing the course. Mud mortar must not be put between the ends of the bricks in each course since it can shrink by up to 37 percent in volume, and such shrinkage will critically distort the parabola, so that the vault may collapse. The ends of the bricks must thus touch one another dry, with no mortar. When the vault is six bricks thick at the bottom it should only be one brick thick at the top, so that it appears to be leaning at a considerable angle against the end wall. This way it presents an inclined face to lay the succeeding courses upon, so that the bricks will have plenty of support. This inclination stops the bricks from dropping off. Fathy means that in this way, a whole vault can be built straight out in the air, with no support, centering, instruments or drawn plan. All that is needed are two masons, standing on a plank and someone underneath to toss up the bricks for them to catch and then tap it in place with their adzes. As Fathy puts it: “It was so unbelievably simple!”

According to Fathy, there are two great points about mud brick housing with vaulted roofs. The first point is that it is very cheap; the material is taken for free, close to the building site. The only costs are the work needed. The second point is that it is beautiful. Fathy writes: “It cannot help being beautiful, for the structure dictates the shapes and the material imposes the scale, every line respects the distribution of stresses, and the building takes on a satisfying natural shape.”

Fathy explains that the greatest threat to mud bricks is damp. The mud may get wet from dew, rain or simply the humidity in the air. Seepage from below must be prevented, and the bricks may be protected by waterproof plaster made of bitumen-stabilized earth. Once mud bricks are protected from damp, they will, in Fathy's own words, last forever. Quite unprotected domed and vaulted buildings can be found in Bagawat and Kharga Oasis that have withstood the winds and sandstorms of the desert for 1600 years, simply because they do not get wet. Even though Gouma has a very dry climate, Fathy explains that he wanted the new village to be a true model village. For that reason he chose shorter spans for the domes and vaults (3 and 2.5 meters respectively), and increased the thickness of the walls.
This made the structure very rigid, so that if it is protected by an ordinary damp proof course and a simple plaster it will stand any weather anywhere.

Not unlike the uplands of Tanzania, Fathy means that Upper Egypt has a wide difference between day and night temperatures. Any surface exposed to direct sunshine receives a large amount of solar radiation by day and radiates a large amount of heat during the night. The comfort of people inside buildings in such climates depends largely upon the thermal properties of the walls and roof. The best materials used here are those that do not conduct heat. Fathy claims that sun dried earth bricks is one of the poorest conductors of heat since it has a very low natural conductivity and, because mud is weak, it necessitates thick walls. The mud brick houses of Upper Egypt remain remarkably cool for the major part of the day.

Fathy goes on to discuss the role of tradition. He means that tradition is not necessarily old-fashioned and is not synonymous with stagnation. Further he argues that a tradition do not need to date from long ago but may have begun quite recently. The first step in establishing a tradition has been taken as soon as a workman meets a new problem and decides to overcome it. When the same solution is adopted by another workman the tradition is moving, and when a third man has followed the first two and added his contribution, the tradition is fairly established. Further, Fathy means that the revival of the traditional crafts, slowly being replaced by more modern materials, is more a matter of giving them prestige than of teaching them again. The architect must find the hidden and dying crafts and bring them to light, give the craftsman back his lost confidence and encourage the craft to spread by giving new commissions.

On planning the village of new Gourna, Fathy means that the architect needs to start right from the beginning. One must let the new buildings grow from the daily lives of the people who will live in them, mindful of the trees and the crops that will grow there, respectful to the skyline and humble before the seasons. The architecture should be the visible and permanent expression of the character of the community, there must be neither faked tradition nor faked modernity. Fathy also writes about the importance to know the people that will live in the finished house. The facets of their daily life is what should determine how the building is designed. A quantitative study conducted by questionnaires with only “yes or no questions”, designed to produce statistics tell very little of value to the architect.

When planning the construction of new Gourna, Fathy explains that it is important to not become dependent on outside resources. He means that the whole village should be an entirely “do-it-yourself” operation. Every single article that could be made should be made on the spot. They would make their own mud bricks, build
kilns, quarry stones, burn lime, bake bricks etc. No one would be employed except the masons from Aswan and the villagers themselves. In this way, the project had the potential to become a vast technical school where the villagers would learn the various building trades. And local masons could learn the technique of constructing Nubian vaults.

On designing for children, Fathy writes that the average adult can scarcely imagine the precarious bases on which a child’s confidence rests. The school architect must see the world through a child’s eyes, to understand what will comfort and what will frighten a child, not merely understand the child’s needs in size and space. For example, the architect must engage all his skill to make the classroom a room that will engender confidence and a sense of security. Fathy recollects his secondary school from which he preserves the most vivid and delightful memories of unexpected corners, odd-shaped open spaces, halls and classrooms of all shapes and sizes as well as lovely gardens. He means that the casual surprises of the architecture must have caught the imagination and sensibility of many children. The building was however not originally a school at all; it was an old palace.

Fathy also delves into the problem of the hole left after digging out earth to make bricks. Pits like these are a prime source of malaria since mosquitoes breed in stagnant water. Fathy found that the simplest answer was not to fill them in but to widen them, deepen them, and connect them to the canals, so that the water could not stagnate. An important point about this artificial lake is that, to avoid that water will seep into the surrounding farmland and ruin it, it should not be much above the level of the drainage canal that serves the area. On the other hand, if the lake is at level of the drainage canal it acts as a fine drain for the farmland.

3.4 Water

“Water is essential to all life and vegetation. It is therefore important that adequate supplies of water be developed to sustain such life.” (Hatibu and Mahoo 1999)

Measuring and mapping citizens access to rural water supply in Tanzania

Water is a mutual common resource, fundamental to life and in sustaining the environment as well as enhancing the social and economic development of our wellbeing. It is vital for sustainable socio economic development, playing a central role in poverty alleviation through enhancing food security and domestic hygiene. (Mwamaso 2015)

Availability of adequate water supply of good quality, for drinking and other domestic use, reduces time spent
in fetching water, increases health standards by reducing the incidences of debilitating water and thus improve the socio-economic wellbeing of users (Mwamaso 2015)

3.4.1 Rainwater harvesting for domestic use. By Janette Wom & Tim van Hattum (2006)

Rainwater harvesting is defined as a method for inducing, collecting, storing and conserving local surface runoff for domestic water supply, agriculture and environmental management. Rainwater harvesting is a simple low cost technique that entails a minimum knowledge and offers numerous benefits. For drinking water purposes in rural areas, the most common technique is small-scale rooftop rainwater harvesting. Where rainwater is collected on the roof and transported with gutters to a storage tank. It offers water at the point of consumption. Collected rainwater can supplement other water sources when it becomes limited or are of low quality like brackish groundwater or polluted surface water in the rainy season. It also provides a good alternative and replacement in times of drought or when the water table drops and wells go dry. The technology is flexible and adaptable to a very wide variety of conditions. It is used in the richest and the poorest societies, as well as in the wettest and the driest regions on our planet (Hattum and Wom 2006)

Reasons for rainwater harvesting as described by Hattum and Wom (2006):

1. Increasing water needs/demands - a useful alternative and supplement to other water sources.
2. Variation in water availability - the availability from water sources can fluctuate strongly.
3. Advantage of collection and storage near the place of use - other sources can be located at some distance from the community. It can improve the accessibility, have a positive impact on health and strengthen a sense of ownership.
4. Quality of water supplies - other water supplies can become polluted through industrial, human waste or intrusion of minerals.

Advantages with rainwater as described by Hattum and Wom (2006):

1. Simple construction - the system is simple and local people can easily be taught.
2. Good maintenance - the maintenance is controlled by the tank owner itself.
3. Relatively good water quality - it is better than other available water sources.
4. Low environmental impact - a renewable resource.
5. Convenience at household level - it provides water at the point of consumption.
6. Not affected by local geology - provides wherever rain falls.
7. Flexibility and adaptability of systems - the cost of the system can suit local circumstances.

Disadvantages with rainwater as described by Hattum and Wom (2006):

1. High investment costs - systems is almost fully incurred during initial construction. Costs can be reduced by local materials and simple construction.
2. Usage and maintenance - the right maintenance is an important factor that often is forgotten.
3. Water quality is vulnerable - may be affected by air pollution, animal or bird droppings, dirt and organic matter.
4. Supply is sensitive to droughts - long dry spells can cause water supply problems.
5. Limited supply - the amount of rainfall and the size of the catchment area.

Almost any roofing material can be used to collect water but thatched roofs, roofs with asphalt or lead should not be collected for drinking. If the system is properly fitted as much as 90% of the rainwater collected on the roof will be drained to the tank. (Hattum and Wom 2006)

There are two categories of storage reservoirs: surface tanks and subsurface tanks. Surface tanks are generally more expensive than underground tanks, but also more durable. A tap is required to extract the water from the surface tank. The material and design for the walls of subsurface tanks or cisterns must be able to resist the soil and soil water pressures from outside when the tank is empty. Tree roots can damage the structure below ground. Careful location of the tank is therefore important. Keeping it partly above the ground level and largely above the groundwater table will prevent problems with rising groundwater tables. A sub-surface tank or cistern requires a water-lifting device, such as a pump or bucket-rope system. To prevent contamination of the stored water, a safe water-lifting device and regular maintenance and cleaning are important. (Hattum and Wom 2006)

A checklist for assessing feasibility of RWH system rainwater as described by Hattum and Wom (2006):

Technical feasibility

- Rainfall and catchment area must be sufficient to meet demand.
- Design should be appropriate (easy to maintain).
- Materials should be available.
- Skills must be available locally.

Social and economic feasibility

...
• There should be a real felt need for better water provision.
• Designs should be affordable and cost-effective.
• Community should be enthusiastic and fully involved.

Environmental feasibility and health

• Rainwater harvesting should improve both the quantity and quality of the available water.
• It should have a positive impact on the user’s health.

Alternatives

• All reasonable alternative means of water provision should be investigated.
• Using other options in combination with rainwater supply should be considered.

These five steps should be followed when designing a rainwater harvesting system:

Figure 1: taken from Rainwater harvesting for domestic use (2006)
Step 1: Determine the total amount of required and available rainwater:

- Demand = Water use x Household members x 365 days
- Supply = Rainfall x Catchment area x Runoff coefficient

The run-off coefficient depends on the material. The table below shows some data on different materials.

<table>
<thead>
<tr>
<th>Type</th>
<th>Run-off coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Galvanized iron sheets</td>
<td>&gt;0.9</td>
</tr>
<tr>
<td>Tiles</td>
<td>0.6-0.9</td>
</tr>
<tr>
<td>Aluminum sheets</td>
<td>0.8-0.9</td>
</tr>
<tr>
<td>Flat cement roof</td>
<td>0.6-0.7</td>
</tr>
<tr>
<td>Organic</td>
<td>0.2</td>
</tr>
</tbody>
</table>

Table 4: Run-off coefficients as provided by Hattum and Worm (2006)

Step 2: Design your catchment area:

- Here it is important to think about the roofing materials run-off coefficient.
- The catchment area is the horizontal plan area of the roof.

Step 3: Design your delivery system.

Step 4: Determine the necessary size of your storage reservoir:

- Required storage capacity = Demand per month x Dry period

This calculation is however a rough estimate.

Step 5: Select suitable design of storage reservoir.

Hattum and Worm (2006) writes about the advantages and disadvantages when using a tank (surface) or a cistern (sub-surface).

Advantages with a tank:

- Above-ground structure allows for easy inspection for cracks or leakage
- Many existing design to choose from
- Can be easily purchased “off-the-shelf” in most market centers
- Can be manufactured from a wide variety of materials
- Easy to construct with traditional materials
- Water extraction can make use of gravity in many cases
- Can be raised above ground level to increase water pressure

Disadvantages with a tank:
• Requires space
• Generally more expensive
• More easily damaged
• Prone to erosion from weather
• Failure can be dangerous

Advantages with a cistern:
• Generally cheaper
• Surrounding ground gives support allowing lower wall thickness
• Requires little or no space above ground
• Is not in the way (below ground)/not as noticeable

Disadvantages with a cistern:
• Water extraction (to draw water or for cleaning) is more problematic – often requiring a pump
• Leaks or failures are more difficult to detect
• Contamination of the tank from groundwater is more common
• Tree roots can damage the structure
• There is danger to children and small animals if tank cover is left off
• Flotation of the cistern may occur if groundwater level is high and cistern is empty
• Heavy vehicles driving near a cistern can cause damage
4. Analysis

In this chapter the result of our master thesis is presented. The result of the interviews and observations from the field study as well as the conclusions from the theory and collected data. In the view of these conclusions a proposal was created.

4.1 interviews

Interviewing different types of people gave a broader perspective on what is needed to create a sustainable and self-sufficient child care center. In summary, through our interviews, the main conclusion that could be drawn are presented below.

4.1.1 Building materials

During the interviews it became apparent that burnt bricks and clay bricks was the most commonly used building materials in rural Tanzania. The clay needed for making bricks seemed to be locally available at every place visited. Indeed, according to Danstan Kishaka, secretary engineer at the regional commissioner’s office in Mbeya, workable clay can be found in 90-95% of the villages in the Mbeya region. Plastering the walls is also common but only when it can be afforded. According to Elvis Francis, landscape architect at Mbeya University of Science and Technology (MUST), the law of the municipality do not allow clay bricks, they have to be burnt. This law is however ignored in many parts of the rural areas.

The roofing is mostly in corrugated iron sheets with a wooden support structure. According to Lucas Madaha, water engineer for Iringa district council, Aluminum sheets is currently a popular roofing material in Iringa since the populace consider it looking good and working effectively. The material does not corrode as easily as iron sheets without aluminum which starts to rust and leak after a couple of years. The Iron sheets has to be transported from Dares Salaam as well. Madaha also says that burnt clay tiles used to be common in the Iringa district but it is more expensive than iron sheets if there is not a factory nearby. Despite many of the local populace making burnt bricks themselves, knowledge of the technique on making and building with burnt clay tiles seems to be nonexistent. Indeed, very few uses burnt clay tiles for roofing in Tanzania today. According to Benitho Lyakwipa, architect and building engineer at the University of Dares Salaam, burnt clay tiles should be a good option for roofing but it is heavier than iron sheets so that the construction needs to be more durable which could prove to be too expensive. Further, Lyakwipa says that domes made of clay is a good alternative for roofing.

The foundations are built in stone which is a local inexpensive material and is available everywhere.
Cement is often used as the binding material. In Mafinga, stone seems to sometimes be used for decoration in parts of the wall. According to Madaha, using stone for walls is however too expensive due to longer construction time, transportations and the cutting process. Stone paving is sometimes used for flooring though, and is not too expensive.

Many sources mentioned deforestation as a big problem in Tanzania. This indicates that the use of wood as a building material is not a sustainable option. Another problem with using wood is that it is susceptible to termite attacks and the treatment available is too expensive to make it a realistic option. The deforestation problem also presents a drawback to building with burnt bricks since mostly firewood is used when the bricks are being fired. However, many of the informants agreed that this is no reason not to use burnt bricks since agricultural waste, like corn husks, can be used instead of firewood.

The interviewed architects and engineers all mention that concrete is an expensive building material. Cement is only manufactured at the coastal towns which means a long and insecure transportation of the material. According to Lyakwipa, people in the rural areas often lack the knowledge of mixing concrete, they cannot pinpoint how many parts of what material to use and is therefore mixing in rough estimates.

Transporting building materials is expensive. According to Jessica Klinte, founder of the orphanage CCY Tanzania, to hire a truck costs about 800 SEK/day (about 90 USD) excluding diesel. The standard salary in Tanzania is about 200 to 300 SEK (about 23 to 35 USD) per month. The cost of bricks can be reduced if the brick oven is built on site, taking away the transportation costs.

In the village of Ilula, most of the informants seemed very impressed by modern building materials like concrete and corrugated iron sheets. These materials were by far the most wished for by the local populace.

4.1.2 Design and climate

Benitho Lyakwipa means that there are few who adopts a holistic view on building in Tanzania, the focus often lies in the details. The buildings becomes more expensive and the architects benefits on it so there is no drive to create less expensive buildings and when the price for a building increases the development in rural areas stand still. The cheaper proposal seldom gets built, so the architects only draws for the rich. Lyakwipa adds that new material that is used in the cities is looked upon as modern materials and the local materials is therefore becoming unpopular. To many, the choice of material is a sign of status. According to Ludigija Bulamile, coordinator of the Architecture Programme at the University of Dar es Salaam (UDSM), in Tanzania today the government buildings works as a showcase for the
population on what should be considered modern and beautiful. The main part of the population therefore chooses to build concrete houses with iron sheets for roofing if they can afford it.

According to Lucas Madaha, there are five questions that should be answered when building in the rural areas:

- Where are you building?
- What materials should be used?
- What materials are available and where?
- How should the roof be built?
- What craftsmen are available?

Lyakwipa means that the most important thing to think about when designing spaces is how the people living there are going to use them. The architect should not define every space. Spaces mean different things to different people, let them decide how they should be used. One room can create several different spaces. In outside spaces stone gardens can be created to form natural places to sit. It is important to not overdesign but think about what the people living there actually needs. Elvis Francis is on the same track as Lyakwipa. He means that the most important thing is the users, in this case the children. An orphanage has to be designed for them, for example think about their age and so on. The material should be used to capture the children's imagination. It is important to have sustainable materials and think about the landscape and how it affects the children. Lyakwipa also says that it is important to think about maintenance. For an orphanage to become self-sufficient the people living there must be able to maintain it. Therefore the building needs to be sustainable and easy to maintain with minimal service.

The surrounding environment is important to think about according to Hellena Msese, manager of Mafinga child care center. She means that, when about to build an orphanage, one should consider climate, location, water and safety. Access to water is vital but the orphanage should not be built where floods may occur during the rainy season. It should preferably be situated on a peak where earthquakes are not common. The orphanage should also be placed at a safe distance from a village and wild animals. Rocky grounds should be avoided. All of the informants situated in the highlands said that the climate was comfortable during most of the year. Certain periods, mainly June to August, it can become a bit cold and an extra blanket can be needed during the night. These places were built with burnt bricks and corrugated iron sheets for roofing, and had no fireplace inside the house.

Bulamile says that most of the activities in daily life is performed outside, making the yard one of the most important spaces in a Tanzanian home. If a home is situated in a highland region like Iringa, where the climate is colder, it is preferable if the yard is more
private and protected against wind. This could be accomplished by placing several houses to create an inner courtyard. Many of the informants also mentioned that it is important to have, for example, a lot of trees to create natural shades and decrease direct sunlight. According to Elvis Francis, it is important to think about orientation, movement and activities. How to move between places. To think about where the different functions are placed. Paved surfaces and many green areas also create a nice environment. Levels and drainage surfaces are important during the rainy season when the water needs to be drained quickly.

When talking about important spaces, many of the informants seemed to think that the sitting room were of the highest importance and it should be large enough to accommodate all occupants at the same time. The kitchen and toilets was also mentioned often. These spaces are traditionally placed outside of the house, in separate buildings, and this practice is still widely used in the rural areas. Few of the kitchens in rural areas have a chimney. According to Jessica Klinte, this is a problem since the room becomes smoke filled and very unpleasant. Francis also mentions that storage is very important in rural areas, for example to store crops. Glass windows should be used in the highland areas. They should also be possible to open for ventilation purposes.

A general conclusion that could be drawn from the interviews conducted in Ilula was that the bedroom was generally deemed the most important room, often associated with health and privacy. When asked what the word home meant to the informant the common answers were twofold; “family” was often associated to the word, otherwise the more practical answer “a place where people live” was given. On the subject of beauty, plastering and paint was mentioned often as an easy way to get a better looking home. Some of the informants also mentioned that a fence would increase the quality of their home.

4.1.3 Orphanages

According to Danstan Kishaka, the government has a department who tries to contribute with money and checkups to see if different orphanages is doing well but most of the orphanages get money and help from the private sector. The documentation needed to start an orphanage is an action plan, a certificate of land ownership and a building permit which should follow the government standard. This needs to be approved by the village council. It seems that it is easy to buy land since many are selling. Some of the orphanages had got their land for free, donated by the local population. In the village of Ilula the locals even helped to build the road to the IOP orphanage for free. According to Lucas Madaha, one option to start an orphanage could be to make an agreement with the village that if they provide the land, one could start the orphanage and get it
running self-sufficiently to later turn it over to the village so that it gets a local owner.

As a foreigner, starting an orphanage in Tanzania, Jessica Klinte advises that one should start with acquiring contacts and planning the economy. The plans and blueprints should be finished before starting the work in Tanzania. A good relationship should be established with the local population. Kishaka elaborates on this and also explains that it is preferable if the local population feels like they are a part of the project. They ought to be invited to meetings where the advantages of the project is explained. They should also be allowed to participate in the project so that they get a sense of ownership and becomes more invested. Msese adds that the personnel who takes care of the children should be educated or possess some prior knowledge through experience. There are schools who educate personnel during two years.

Orphaned children should still have a chance to grow up with a sense of family and an orphanage should try to emulate this according to Klinte. Ludigija Bulamile agrees with this and mentions the Save Our Souls (SOS) orphanage in Dar es Salaam as a good example of this. They have made their orphanage into a village where ten kids and one of the staff lives in each house. This makes the children in each house like siblings, the staff living with them becomes like a parent and the orphanage becomes like a community in itself. Klinte also explains that it is important to maintain the African culture. The children will later live in the Tanzanian community and should be accustomed to local standards. Benitho Lyakwipa explains that, when designing an orphanage, it is important to try to understand the orphan. The architect should ponder what it means to be an orphan. The children living in most orphanages originally comes from all over Tanzania and are from different cultures and situations which could pose some problems. Therefore it is important to create a positive community within the orphanage. It should function as a closed system, be self-sufficient, and the people inside the system should be able to support it themselves. Msese adds that an orphanage should not be dependent on donations. This makes income generating activities and functions desirable.

Another important thing, according to Lyakwipa, is to create a learning environment where the children can learn useful skills through helping the orphanage, for example cleaning, doing dishes, cooking, craftsmanship and helping out in the plantation. The children should be taught to create things that can also help with maintaining the orphanage, like clay tiles if such roofing material is used for example. Think about letting the children paint the inside walls. They could be split up between the children and they can paint whatever they like on their allotted area. This will make the children care about the house and help keeping the walls clean. Let the children be a part of creating their home. It will give them a sense of ownership and make them care more
about it. CCY Tanzania has already started a school for the orphans as well as other children from surrounding villages. Mafinga childcare center and Bez Mamy hopes to do the same and integrate it with their respective villages.

According to Msese, the most common situation for an orphanage is to take in very young children but there are also orphanages that takes in children from the age of four to five years. For example, David says that Bez Mamy only accepts children above the age of four since the orphanage is not equipped to take care of children younger than that. Meanwhile, Klinte tells of how, when CCY Tanzania first opened, the smaller children was able to adapt faster than the older ones, but it was still very chaotic during the first four months. She also mentions that nowadays, the children likes to play grownups. They want to help cleaning, washing and so on. On all the orphanages visited, the children liked to play football. Other popular activities is to play in the playgrounds available, playing with pearls and drawing. David says that it is important to make sure to support the children's talents. If, for example, someone is good at football, it is the orphanages job to make sure that he or she has a football available. In other words; give the children a chance to thrive. According to Klinte, there are still around 180 children that needs help in the surrounding area of CCY Tanzania.

### 4.1.4 Culture and tradition

Fred Nderimo, Architect at Ardihi University in Dar es Salaam, says that traditionally in Tanzania, building a house in a rural village was like a big event where everybody in the village helped. Today, every family builds their home by themselves with hired help which increases the costs. Nderimo also explains that the knowledge of local building techniques in rural areas are disappearing since it is not inherited to the same extent any more. This is because many of the young people move to the cities. Few people know the local building techniques today and when people in rural areas needs to hire local craftsmen there are mostly around two to three people available with the necessary knowledge. According to Lucas Madaha, most houses looks the same in Tanzania today since it is very common that people are copying each other. Traditional houses however, are differently built depending which tribe you are from. The Hehe tribe in Iringa often had round houses with thatch roofing.

Both Benitho Lyakwipa and Elvis Francis tells of the oral tradition in Tanzania which means that people gather around the fire in the evening sharing knowledge and telling stories in through the night, sometimes falling asleep outside. Sitting by the fire is especially popular in the highlands, where the climate is colder. Lyakwipa means that in western countries people plan so far ahead. In Tanzania, people has a shorter memory. The
important thing is what is happening right now. People in the rural areas can normally only afford to plan for one day at a time.

Jessica Klinte describes the culture in the villages of Bumilajinga and Matanana as a Christian community with a touch of tribe religion. Respect to the elder is an important part of the society but this can also become a problem when position and gender plays in. Other problematic aspects is that physical punishment for children is deeply rooted and that the local population has deep faith in natural medicine. According to the village leaders, the boys and girls has to have separate toilets. When it comes to clothing, the shoulders and knees should be covered. This especially applies to girls. It is however important that the children adapt to the African culture so the transition to the local society becomes easier. They should not be raised as westerners.

4.1.5 Water and electricity

According to Lucas Madaha, the most common way to acquire water is:

- Groundwater via well. This water is safe to drink but it should be boiled before drinking if the water has been taken out of the well more than three days ago.
- Gravity water scheme (from a river). This water should be boiled.

The best way to acquire water depends on the place but a gravity water scheme is used if possible since it is the cheapest option. The pipes is the most costly factor here. If there are no river nearby, groundwater is used. Groundwater, through a well, has better quality to the water and is safe to drink without cooking but it is a more expensive option. Ludigija Bulamile says that a well is a good alternative but they cannot be too deep due to the cost of drilling. The wells should also be placed a distance from the latrines. The general calculation values for water needs are as follows:

When using a latrine: 25 liters/day & person
When using a modern toilet: 50 liters/day & person
For agriculture: Water is pumped from a stream if possible

According to Bulamile, it is important to utilize rainwater harvesting. There are vast amounts of rainwater but few people are taking advantage of it. Madaha means that rainwater harvesting is used as a supplement and can cover up to 20% of a household’s water needs. Harvested rainwater needs to be cooked before drinking. If cooking the water is not a possibility it can be purified up to 50% with solar radiation. Disinfectant is not that expensive but it needs to be handled by an expert. Rainwater harvesting is becoming more common since
the government has started to promote it. About 30% of the households in the Iringa district is using rainwater harvesting and almost everyone who builds a new house is adding a tank for it. All of the orphanages visited in rural Tanzania either had or planned to implement rainwater harvesting. Jessica Klinte means that when the system is implemented, the rainwater will be used for washing.

When it comes to energy supply, most sources means that solar power is the best alternative. It is a onetime investment which becomes cheaper in the long run. Danstan Kishaka informs that the cost of the government’s energy is 360 Tsh/kWh. Mafinga childcare center uses this as their main energy supply and Hellena Msese means that it is very expensive. CCY Tanzania uses a solar panel that charges a battery during the day which is used for lights and radio during the evening. According to Madaha, an important point when considering what energy and water system to use is that the people using the system needs to be able to maintain and run it. It should be kept cheap and simple. Rainwater should be used as a complement.

4.1.6 Agriculture

According to Elvis Francis, the land is very fertile in the highlands. To become self-sufficient through agriculture, one just needs to plant more than is needed and sell for a profit. It is, for example, easy to make a profit from selling watermelons. About ten to twenty hectares should be needed for an orphanage of about 40 children. Most plantations are dependent on the rainy periods which requires much more land to get the same harvest. With an irrigation system, one can harvest four times a year compared to two. Workers and a tractor is needed to prepare the field but the children can also help when possible. There are a lot of local knowledge available. A greenhouse should be considered as well since it can increase production. A plantation is not a big investment as long as the land can be acquired. Seeds are relatively cheap. Hellena Msese means that to become self-sufficient, it is important to optimize. With better knowledge of agriculture, less land can be used for a bigger harvest. Jessica Klinte adds that to be able to compensate the costs with selling food, one must find something unique to cultivate that meets demand.

According to Francis, rice requires a lot of water and an irrigation plan or a nearby pond will be needed. Maize can be planted on regular fields. Beans are planted together with the maize two months later and can then be harvested at the same time. Klinte means that tomatoes and onions is harder to cultivate since much more water is needed. For most of the orphanages, mainly maize, which is dried and stored, is cultivated. This is mostly used to make ugali. Ugali with beans is by far the most common food in rural Tanzania. None of the
orphanages visited covered their food demand through agriculture. Most orphanages also had cows to produce the milk needed.

4.2 Observations

During the field study, certain places of importance to the subject were visited. While being in these places, and also while experiencing daily life in Tanzania, observations were made as to delve deeper into the culture and society of the country. The most important findings from our observations are presented here. Note that, unless otherwise mentioned, the observations are purely from our point of view, thus influenced by our personal disposition.

4.2.1 Village museum, Dar es Salaam

At the start of the field study, the Village museum in Dar es Salaam was visited to get a better understanding of the different types of houses traditionally built in Tanzania. The museum has built exact copies of traditional rural houses, many of which is still being constructed today. The houses mostly used mud and poles for the walls and thatching for the roofs but some were built completely by sticks and thatch. The houses were either circular or rectangular, often depending on place and specific tribal traditions in that area. There were most commonly at least two external doors in the houses, one in front and a smaller one in the back. The use of windows are rare and when existing, they are very small, more like ventilation openings. A common method for ventilation was to keep the top of the wall, right under the roof, without the mud wall. The layout of the houses was most commonly a kitchen with an open fire in the middle of the house and two bedrooms connected to it, one for the parent and one for the children. Some tribes traditionally practices polygamy in which case, two houses are often needed, the main house for the senior wife and a smaller one, at the back, for the junior wife.

The most relevant tribe for the project is the Hehe. Hehe are Bantu speakers and have lived in the Iringa region for approximately 1300 years. This group is believed to have originated from Dongwa, Bena, Sagara and Kimbu. The Hehe practice agriculture and animal husbandry communally. Marriage is a symbol of respect among the Hehe and among other things the bride and groom are required to behave according to the custom and tradition of the society. Laziness and selfishness are highly discouraged to the couples. Death is normal and a natural thing for the Hehe which the saying “Death is good” clearly illustrates. The dead are buried while seated heading west, where the Hehe is believed to originate from. The Hehe has a long history in leadership.
and fighting experience. They are praised for their resistance against the imposition of the imperial rule and especially for their victory against the German colonial invasion. (Village Museum, Dar es Salaam, 2015)

The Hehe house was one of the most complex houses displayed at the village museum. It has a raised foundation and is rectangular with a small inner courtyard. It is built with burnt clay bricks and mud plaster with thatch for roofing.

Photo 1: Traditional Hehe-house. Photo by author
Photo 2: Traditional tribe house. Photo by author
4.2.2 Mwenge child care center, Dar es Salaam

This orphanage, situated in the Mwenge district in Dar es Salaam, wished to remain anonymous and is therefore only named as “Mwenge child care center” in this paper.

The orphanage was relatively low budget comparing to the others which became apparent once the grounds were examined. It was run by the local population and financed by the state. The outdoor space was a small courtyard, surrounded by small one story buildings. There were approximately 60 orphans living there, 40 boys and 20 girls. They were separated into two rooms where bunk beds were lined up. There was not much space in the room for anything other than beds. The other rooms served functions such as kitchen, washroom and staff room. The general feeling of the place was one of resignation. The staff just sat around, doing nothing. The children did the same, no playing, no screaming, just sitting, and staring off into space. When new people were introduced, the lack of intimacy became apparent as the younger children almost fought each other to be picked up. The older ones stood hovering at the edges of the gathering, wanting to be a part of it but not daring to come forward. The small enclosed spaces felt more like a prison than a home.

Photo 3: Children playing. Photo by author
4.2.3 SOS – Save Our Souls orphanage, Dar es Salaam

There were a significant contrast between Mwenge child care center and SOS. The area is huge, with paved walkways and big outdoor spaces with green grass and trees. The orphanage itself was divided into several buildings, housing about ten children each along with a “mother”. The “mother” was a person from the staff living with the children in one house, taking on the duties as their parent like cooking dinner, cleaning and generally taking care of them. The concept of this orphanage was to make the children feeling like they were a part of a family which, in turn, was part of a society. The orphanage was formed like a village, and in each house lived a “family” where the children are brothers and sisters and the woman living with them are their parent. The orphanage housed just over 100 orphans. On the grounds, there is a preschool as well, providing an early start in education for children from ages four to seven, when they start primary school.
The houses are made of concrete, with iron sheets for roofing. The sheets are formed as burnt clay tiles which raises the question why that material was not used in the first place. The ceiling was made of concrete as well. Inside the house, at the entrance were a small living room with a table for eating. To the left of the entrance were four rooms for the children as well as a room for toilets and showers. To the right of the entrance is the kitchen and the “mother's” room. The “mother's” room had a TV which the children used to watch when the time allowed. The kitchen had an external entrance to a small outdoor verandah where food were prepared and dishes were washed.

It was strange, stepping into these grounds, it felt almost like being in another country. Totally walled off from the busy city life of Dar es Salaam, the orphanage felt like a small western village street with its green grass and the style of style buildings, only betrayed by the pressing humidity of the tropical climate. Although a very nice orphanage, it became apparent that modern material and planning had taken precedence over cultural considerations.

Photo 4 & 5: Orphanages houses.
Photos by author
4.2.4 IOP orphanage, Ilula

In contrast to the orphanages mentioned above, IOP was the first one visited that were situated in a rural upland village. The climate here is much drier and colder than in coastal towns like Dar es Salaam. It was during the warmer season that the observations took place but a big difference in temperature and humidity was noted, especially during the night. The landscape during this time (just before the short rains) is very dry and the red clay surrounds all houses and roads. The resources available in rural villages like Ilula is what the land offers, in this case mud, sand and stone.

Materials like metal sheets and cement has to be transported from towns like Dar es Salaam. Most houses in Ilula were constructed from mud or mud blocks. Some buildings, like the IOP orphanage, were in burnt bricks. Those who could afford it, which were very few, had cement plaster on the inside walls.
The orphanage was built in burnt bricks with corrugated iron sheets for roofing. The foundation is concrete and the inside walls had cement plaster. The ceiling was built in gypsum boards. The building is U-shaped. The staff was situated in the middle of the building with the children in the left wing and the volunteers in the right wing. There are four children in each room, two older and two younger, which are supposed to take care of each other. There is also a kitchen, dining room, kids' corner and classroom for home studies in the children's wing. The volunteers have their own dining room and showers.

On the left of the building and on the backside there is a plantation where the orphanage cultivates vegetables, onions, tomato, spinach, banana, orange, lemon, and mango and so on. To the right of the plantation there is also some cattle pens for cows, goats, pigs, chicken, rabbits and dogs. The caretaker takes care of the plantation and the livestock with the help of volunteers. The children help out when the time allows. Spare produce from the plantation is sold to the village population for extra income.

Photo 6: Orphans drawing. Photo by author
The orphanage has its own well and some electricity through solar panels. The children were very polite and not in as much need of intimacy as the children in some other orphanages. It was noted that they liked drawing and painting a lot. Most of the kids there were drawing during the short time spent there and there were drawings all over the walls of the dining room, kids’ corner and classroom. The children often stay at the orphanage until they finish university.

Photo 7: The courtyard of the orphanage. Photo by author
Photo 8: Cattle pen. Photo by author
Photo 9: Plantation. Photo by author
4.2.5 Mafinga child care center, Mafinga

Mafinga child care center is situated in a small society just outside Mafinga town. Mafinga is a small upland town and compared to Ilula the relatively heavy rainfall makes the area lush and green throughout most of the year. The climate is a little colder than Ilula. It is comfortable most of the time but can become a bit cold during the night. Local materials in Mafinga include timber, mud and stone.

The orphanage is, together with SOS, one of the biggest complexes that were visited. The difference from SOS is that Mafinga childcare center is locally run and therefore has a much less secure economic situation. This is an important aspect to take into consideration in this study since the plan is that the orphanage presented here should be turned over to the local population as soon as it becomes self-sufficient.
Most of the houses in this orphanage is built with burnt bricks with the exception of two newly built guesthouses in concrete with four rooms per house. All houses has iron sheets for roofing. The main buildings in the orphanage consists of four long buildings, creating an enclosed courtyard with a playground. The houses is designed to take care of children in different ages. The first is for children from ages 0 to 2 years and has a nursery. The second building houses the kitchen and dining room as well as children from 2 to 3 years of age. When the children living here grows older they move into the third house and so on. When the children gets even older they move a bit away from the younger children to a newly built house for the older children. The boys’ house is finished but the girls house is still under construction. These new houses were built because the orphanage only took care of smaller children in the beginning but now the older ones can stay until they finish school. This means they have to expand and build separate buildings for the older boys and girls.

Surrounding the main buildings is storage buildings, cattle pens and houses for the staff. Most of the staff lives at the orphanage in their own houses with their own cattle there. This is supposed to make things easier in case of emergencies and so on. The cattle kept are mostly cows, pigs and chickens.

Above the main buildings there are another playground and two hand pumped wells. When the wells were dug they produced enough water but they often run dry during the dry season now. The orphanage make use of rainwater harvesting but it is not enough. Above the wells is the staff and guest dining hall and kitchen with the guesthouses directly behind it. Connected to the kitchen through a roofed walkway is a preschool for the village children which is supposed to open soon. A thing of note is that roofed walkways can be found on other places in the orphanage as well.

The children were polite and mostly shy. It took some time for most to become less guarded and wanting to play. It seemed the children liked to play around with the cattle, especially herding cows into the pen since they walk freely over the grounds mostly. Otherwise the playground and games with balls like football or just throwing a ball against a wall are popular. The children seemed to be generally happy but the younger ones seemed sad and scared at times.

The orphanage also had a large plantation where maize is harvested. Vegetables are planted during the rainy season as well. It was noticeable that this orphanage had a lot less resources than others visited. The roofs were rusted and at sometimes held in place with stones or bricks. There were a lot of other maintenance work in
need to be done as well but clearly the economic situation only allows for what is most needed.

Mafinga childcare center is owned by the local church and is a Christian orphanage. Muslim children are welcome nevertheless and treated in the same way. The orphanage has even stopped eating pork out of respect for the Muslim children. The children comes first or like Hellena said when asked about it; “People is what’s important.”

Photo 10: Playground. Photo by author
Photo 11: Orphan getting water. Photo by author
4.2.6 CCY Tanzania, Bumilayinga

CCY Tanzania is a small orphanage situated in the outskirts of the small rural village of Bumilayinga. The nearest city is Mafinga about 40 minutes away by car. The orphanage was started in October 2013. Bumilayinga and the nearby village of Matanana is in the high uplands area and the climate here is noticeably colder than for example Ilula. It was comfortable as long as the sun was up but during the evening and especially during the night it became quite chilly. The vegetation was a lot like Mafinga with much green and many trees. The view was stunning as well. Compared to the other orphanages mentioned here the most time was spent in this place because this is the most relevant case for this study since it is a newly started orphanage in a rural village, built on limited resources.

There are 20 children living at CCY and the main house is built in burnt bricks with a stone foundation and iron sheets for roofing. The ceiling is in wood panel. Central in the building is a large living room and around it is the children’s rooms, toilets/washroom and a storage room. The kitchen is just besides the orphanage and is built much the same way but there is no ceiling, doors or windows. Here food is prepared and eaten during lunchtime. When it is colder during the morning and evening, breakfast and dinner are taken inside the main building. The problem with the kitchen is that food is prepared over open fires in large kettles but there is no chimney. The window openings are not enough and the room becomes smoke filled.

Photo 12: Sunset at CCY.
In the background you see the kitchen. Photo by author
In the main building, the walls are built inside the frame of the foundation. This could be a problem during the rainy season since water stays at the base of the wall instead of running off. A new outside toilet/washroom with separate rooms for boys and girls is being constructed since the village council has deemed it inappropriate for boys and girls to go in the same room. This is also built in burnt bricks.

The Volunteer house is about 50 meters away to the side of the main building which grants some privacy for the volunteers. This is built in burnt bricks with iron sheets for roofing. Some outside walls and all inside walls are plastered with cement as well. There is no ceiling tough and the plaster does not go all the way up. The lack of ceiling makes the sound of heavy rains deafening. The windows are placed in line with the outside wall which creates a problem during the rains since water is leaking in. This could easily have been fixed if the windows had been placed a bit further in. The orphanage has a plantation where maize and beans are grown as well.

Photo 13: Orphanage house. Photo by author
Photo 14: Volunteer house. Photo by author
CCY does not have a private well and water has to be carried from the village well, about 600 meters away. There are no electricity or running water but solar cells are used to have light in the main building during the evenings. There are two “mothers” living at the orphanage, taking care of the children, cooking food and so on. The children seemed happy and liked to play with both volunteers and each other. This was actually the first place that were visited for more than a day that had no feeling of institution but rather that of a large family.

A problem at CCY was that there was no place to hang cloths for drying except for outside on the ground. This makes the clothes hard to dry, especially during the rainy season.
4.2.7 Italian orphanage, Matanana

This Italian orphanage situated in Matanana was briefly visited with Jessica Klinte from CCY Tanzania. The building itself was nice with a curved, organic form and burnt clay tiles for roofing. The foundation was in concrete with burnt bricks for walls and a colonnade went around the building to create a roofed walkway. The form of the building created a small enclosed courtyard which was quite nice at first but soon felt too small and enclosed. It felt like being locked in since there were no other pronounced outside area to which one could go. One thing that were noted during the visit was the building for drying clothes. This was a round roofed shelter in burnt bricks laid with a spacing that created ventilation holes round the whole building. This will keep the clothes dry during rains but still provide sufficient ventilation for them to dry quickly. The orphanage used solar panels for electricity and had water tanks.

The oldest children shared smaller rooms but most of the children (the young ones) all slept in rows in the same room. This gave the feeling of an institution and would not be recommended for the wellbeing of the children. Since most of the children here were very young a room had been put aside for health control with medicines, scales and so on.
4.2.8 Bez Mamy, Mbeya

Bez Mamy or without mother, in English, are a Czech orphanage situated in a small rural village near Mambi in the Mbeya region. Mambi is in the highlands but the climate here is much warmer and more humid than the other highland areas described above. This, however, cannot be compared to the pressing heat of Dar es Salaam. Compared to the green and lush vegetation of Mafinga and nearby Bumilayinga, the landscape here is generally very dry and bare though it would still be considered green in comparison with Ilula. Local materials include clay, stone and sand. The open landscape here provides very strong winds. The ground is rocky and hard to dig in without expensive equipment. Nevertheless, the landscape was beautiful with some mountains towering in the distance and big open spaces where you could see thunder far away on the horizon.

Out of the 23 children living at the orphanage now, only 4 of them are girls. The orphanage consists of two identical buildings for the children, one for the boys and one for the girls. These have a rectangular shape with access to the rooms from a large inner courtyard with toilets and showers in the back. Burnt bricks are used for the walls and stone for the foundation. The roofing is in corrugated iron sheets and the ceiling was gypsum boards. The inside walls were plastered. The girls building however, is still under construction and is used for keeping chickens and rabbits for the moment. Between these two buildings is the cantina where the children eat, study and have evening prayer. This building consisted of three rooms; a storage room, the kitchen and the dining room. The cantina was built in the same way as the other buildings with two exceptions. The ceiling, which only covered half of the building, was in woven wooden panels. There were no glass in the windows which was instead covered with fabrics in case of strong winds. This however made the room very dark.

Photo 14: Orphanage house for boys. Photo by authors
Bez Mamy is a Catholic orphanage and is run by nuns. The sisters have their own complex across the road from the orphanage. This complex was used for the orphanage before the boys' building was finished and the girls still live here until their building is finished.

Religion was much more noticeable and strict here than in Mafinga child care center. For example, even if praying before dinner is common, the evening prayer was extensive and took a lot of time here. The children seemed very disciplined as well. Of course, some of the difference noted may be due to the fact that this orphanage was Catholic as compared to the other Christian orphanages which were Lutheran.
Another thing of note was that this catholic orphanage is built in a wholly Muslim village which creates some tension. It seems the orphanage and the village have an uneasy coexistence where on one hand, the orphanages help children and families in need but on the other hand take in Muslim children and, in doing so, convert them into Christians. Even though the first is appreciated, the second is not.

The children's living arrangement felt much like summer camp; the rooms were big with three bunk beds and open storage areas with toys and clothes. The children seemed to have lot of fun and to be happy though sometimes very mature for their age. The sisters’ complex make use of rainwater harvesting. The rest of the water needed is brought from a nearby spring. The orphanage wants to dig a well but the ground is too hard to make this a realistic option in the near future. Some electricity is gathered through solar cells but this is just enough for lighting.

Photo 16: The courtyard in the boys’ house. Photo by author
Photo 17: Inside the boys’ bedroom. Photo by author
4.2.9 General observations

Presented in this section is a summary of general observations that were gathered.

Electricity

Photovoltaic (PV) is used almost everywhere but only for more simple things like lighting. This can be a good alternative instead of buying more expensive electricity from the state network. To be able to generate electricity for larger things, for example a refrigerator, larger solar panels and batteries are needed which could prove too expensive.

Building process

The buildings in the rural areas are often built in steps, due to the population’s lack of economic resources. With the lack of possibilities to save money in the bank their money is instead invested in material and labor for the house. This leaves a lot of half-finished buildings standing in the villages for several years. There seems to be a lack of professional builders in rural towns, excluding many building techniques as an option.

Buildings and material

It is not hard to see what type of building materials is most used in the rural areas. A standard house is built with burnt bricks and shaped in a rectangular form. The roof is often a saddle roof built with wooden beams and corrugated iron sheets. The house is often relatively small for a family, consisting of two bedrooms and a living room. The connecting yard can be as big as the house and surrounded with some kind of fence. A place for cooking and washing is usually placed outside in the yard. The poorer people build in a similar way but mostly with mud or mud bricks and the iron sheets are often rusted and patched up with whatever material is on hand, held down with rocks.

Cooking

When cooking food a lot of smoke gathers in the room since there is no direct ventilation or transportation for the smoke. A solution for this is a common need in houses. The room’s gets smoke filled which is a problem both for the health and comfort of the occupants. A chimney of some kind is therefore needed to make the everyday living easier and healthier.

Waste

For the trash and waste a hole is dug that then are filled with waste. When the hole is almost half full the trash/waste is burned.
Windows

Bars for the windows was seen on all the orphanages. This is to protect the buildings from being robbed and from wild animals. The general picture of orphanages in Tanzania are that the possibility of finding things are higher since there are often volunteers living there. According to the staff on the different orphanages it is very unusual that it happens but they are there for safety purpose. Windows that can be open outwards often got broken due to the strong wind that can be in the highlands which can catch and break the window. A simple solution can be to making the windows opening inwards.

Roofs

The corrugated iron sheets get rusted over time, but if the iron sheet is in aluminum it lasts longer. This is a problem since many of the rural population cannot afford to replace the iron sheets which will start to leak. When it rained the iron sheets did not provide any sound isolation at all. The sound where, according to us, unbearable.

There were a few buildings, mostly in cities though, which used burnt clay tiles for roofing. This is probably because the technique for making clay tiles is unknown in the villages. This however, could be taught and since many of the rural population burn their own bricks, why should they not have the means to burn their own clay tiles. Another problem with clay tiles is that the heavy weight of the material requires very strong load bearing walls and carrying structure. On the other hand, clay tiles hold the heat better than corrugated iron sheets which could prove valuable during cold nights. No vaulted roofs were seen in the rural areas.

Constructions

In the highlands, the construction made of wood did not seem to have any problems with termites, but at the same time, it did not carry any heavy weight so the stresses were minimal.

Roads

The main road between Dares Salaam and Mbeya was asphalted but it was not optimized for transports, due to the crooked, bumped and up/downhill roads due to the hilly landscape. It was a lot better than the side roads to nearby villages though, where the roads was created naturally or by sand, gravel or clay with a lot of holes. This is one problem when ordering material by transport.

Water
Getting water is not always an easy task, sometimes people have to walk miles to get drinkable water. Water for washing is often easier to get. This varies of course a lot but in general this becomes a daily task where buckets of water is carried for long distances on your head.

**Location**

Most of the orphanages are located near, but not too close, to a village. This can be to keep a connection to the local population but at the same time be able to keep the children “safe”. A larger plot of land and a space between the communities makes it possible for the orphanage to grow in time, with adding buildings, farming and other areas.

**Orphans**

In general the children seemed to be very happy, kind and curious, especially children between 3 and 6 years old. For the boys, the most popular thing to do was playing football. Drawing, singing, dancing and playing drums seemed to be popular things to do for all the children.

**Orphanages**

A lot of the orphanages are built with some kind of involvement by churches from the nearby village. It makes religion a focal point in daily life.

It felt that the staff on the different orphanages had different relationships towards the orphans depending on how long the staff worked there or the children stayed there, what age they came and left. Of course it is understandable that if a child arrives at a very young age and are planned to stay there a longer time the staff builds up a more parental relationship than when a child is scheduled to be there for a few years and arrives in older age.

**Culture and religion**

A lot of people in Tanzania wear their religion very openly and often talks about it, whether they are Muslims, Christians or have a native religion. This is very palpable when speaking to them or seeing religious elements in ones surrounding, it is a part of their daily life. The phrase “if God wills it” is very commonly uttered.

It is custom to eat with your hands, and especially your right hand. This is most important for Muslims but it is also a health issue since you wash your behind with the left hand. The toilets in the rural area are very simple toilets with just a hole in the ground, called pit latrines. To flush and clean your behind a bucket of water is poured on
yourself and into the hole. Toilet paper is rarely used if the building is not strongly influenced by western customs.

**Daily life**

Household chores take a lot more time than in western society, especially in rural areas. Water has to be fetched, mostly hand pumped and carried long distances, clothes and dishes have to be washed by hand and there are no machines for cultivating the earth.

In general, both the orphans and the staff had a schedule to follow but at the same time the routines did not seem to be as time punctual as in the western world.

**Tanzania and donations**

Many orphanages in Tanzania seems to be dependent on donations from NGOs and the private sector. This cannot be considered sustainable since it does not help the orphanage in the long run. What happens if the donations stops coming? To ensure that the children are taken care of, the orphanage should be able to ensure that it can survive tough economic situations without outside help.
5. Design Proposal

In this section, building materials, layout, functions and so on, are chosen and presented and explained in a proposal on how to build a self-sufficient orphanage in the rural highlands of Tanzania.

5.1 Materials and building technique

When building a sustainable orphanage in the rural areas of Tanzania one of the most important things is to choose the right building material.

A list has been made as to the requirements that must be met for a material to be considered sustainable in this thesis:

- High availability - The material be easy to obtain in the rural areas.
- Low cost - The material should be realistic and affordable for local population.
- Durable - The material should be able to resist different weather and general wear in a proficient way.
- Easy to handle and maintain - The material should need no expert knowledge to be built with and require minimal maintenance. If new techniques are introduced they should be easy to learn.
- Few ecological drawbacks - The material should not have negative environmental effects by being used as a building material.

These points are a core focus on choosing material. If it fulfills these points it means the material can be counted as a sustainable material.

Foundation

A very good, cheap and simple foundation can be made of stone. Stone is highly available everywhere in the highlands of Tanzania. It can be gathered for free and only needs to be transported a short distance to the building site. It is also easy to handle when building a foundation. The local knowledge is there since stone foundations are very common in Tanzania. Therefore stone has been determined to be the most suitable material to use for the foundation.

A foundation trench should be dug to a depth of approximately 300 to 400 mm. The trench is then filled with compacted stones up to ground level. To protect the wall base, the foundation should be carried up about 150 mm above ground level. The upper layers of the stones should preferably be jointed with a mortar. The stone filling should be finished off with a 25 to 50 mm thick layer of lime mortar to get a good base for a masonry wall. The wall should be placed a little outside...
the foundation to prevent water from gathering against the base of the wall.

Walls

A heavy structure is preferable in upland areas since it stores solar heat during daytime and emits this heat during the night, thus keeping the house warmer at night and cooler during daytime. The walls should be at least 300 mm thick. Another thing to take into consideration when choosing a building material is the deforestation which poses a major environmental problem in Tanzania and makes wood an unsustainable building material.

Walls made of mud bricks can be, if properly maintained and protected against damp, very durable and a good alternative for rural housing. The material is very low cost, does not require any wood for construction and is available almost everywhere in Tanzania. Unfortunately, mud bricks are very sensitive to heavy rains, which is very common in the highlands. To minimize maintenance work it would be preferable with a material that is more resistant to water.

Concrete blocks make a strong and water resistant material but they require a lot of cement and are usually too expensive. Cement is only manufactured in the coastal towns which means the material is not local and it requires a long and insecure transportation. Very good and durable walls can be made of stone but construction of such walls requires a high standard of craftsmanship which increases building time and costs.

Burnt bricks make a very good wall material and is determined to be the most appropriate material for building in the Tanzanian highlands. It is durable, water resistant and can be produced locally. It is also one of the most common building materials in Tanzania, meaning most of the local population know how to find appropriate clay and how to fire it into burnt bricks themselves, making it a low cost material. The problem presented with this material is that mostly firewood is used when burning the bricks. This problem can however be remedied through the use of agricultural residue instead of firewood for the firing of bricks. MRHP (Mwansa Rural Housing Programme) is currently producing high quality bricks, fired with agricultural residue, in Tanzania. A recommendation is to contact MRHP for a consultation or to ask for the possibility to collaborate with them and spread their knowledge.

The burnt bricks should preferably be set in a stabilized earth mortar consisting of regular earth mortar, improved with for example lime, plaster or bitumen. These mortars are very suitable for binding fired bricks. The somewhat rough internal surface of a brick wall can be improved
with for example lime plaster or simply with a whitewash. This makes the wall brighter and easier to keep clean.

Roofing

The predominance of corrugated iron sheets for roofing was obvious when traveling through Tanzania. It was, in fact, a rare occasion when another roofing material was seen at all. There are some positive aspects to this kind of roof. Although not being a local material in rural villages, it is lightweight which means it is easy to transport and require only a simple supporting structure. They are also watertight and little skill is needed for construction. However, the disadvantages with this method for roofing by far outweighs the advantages. The use of sawn timber beams is accelerating deforestation. Another serious problem is the lack of thermal insulation which can result in intolerably high indoor temperature during daytime and a very low temperature at night. The acoustic properties of this material is also inadequate and during heavy rains it can become very noisy.

Burnt clay tiles is a very good alternative for roofing. They are very durable, watertight have good acoustic and acceptable thermal properties. Like burnt bricks, burnt clay tiles could be fired with agricultural residue by the local population which would make it a relatively cheap and local alternative. The technique for roofing with the material would however need to be taught since few of the rural populace use this material. The main disadvantage with burnt clay tiles is that they are short and heavy, thus necessitating a strong supporting structure with closely spaced battens.

Egyptian architect Hassan Fathy rediscovered the ancient technique of Nubian vault construction described in his book Architecture for the poor (1973). The Nubian vault technique is originally used to build vaulted roofs in mud bricks without the use of a supporting structure. The Association for Voute Nubienne (AVN) has established a programme in sub-Saharan Africa which teaches the rural population how to build a simplified and standardized version of the Nubian vault. This version of the technique has been developed by AVN to make it easier to learn. This technique is very simple to use but masons have to be trained first. It uses local, low cost materials and the vaults built by AVN masons costs less than corrugated iron sheets and it lasts much longer if properly maintained. The roof also has excellent thermal and acoustic properties.

The Nubian vault technique is deemed appropriate for building in the highlands of Tanzania if properly adapted to the climate. Due to the heavy rains in this area, it is recommended to build the vaults with burnt bricks, fired with agricultural waste, instead of mud bricks. This also
reduces the maintenance needed to protect the roof since burnt bricks are not as sensitive to damp. It is still recommended to waterproof the roof using a plastic sheeting and to apply a lime-sand render to cover it. As for the binding component a stabilized earth render is recommended.

The Nubian vault technique is not practiced in rural Tanzania. This means that local knowledge cannot be used for building the roofs. Outside help should be sought, perhaps from AVN. The masons used should also train local masons in the technique before and during construction. If local masons can learn the Nubian vault technique and promote it, money will be kept in the local economy. This has the potential to make the building into a showcase, promoting a sustainable and low cost solution that can compete with corrugated iron sheets and create a better housing situation for the rural population in Tanzania.

As for doors and windows, regular wooden doors and glazed windows with a wooden supporting structure should be chosen. The windows should be possible to open for ventilation and one window should span no more than 900 mm. The windows should also be placed in the middle of the wall as to be protected from driving rain and possible leakage.

5.2 Water

Getting water is not always an easy task, sometimes people have to walk miles to get drinkable water. This cannot be considered a sustainable solution for an orphanage housing about 40 children and a nearby source of water is needed. The best way to acquire water depends on the place but, if possible, a gravity water scheme should be used since it is the cheapest option. This is an especially appropriate alternative to acquire water for agriculture.

If there are no river nearby, and the local village well is too far away from the orphanage, groundwater should be used. Groundwater, through a well, is of better quality than from a river and it is safe to drink without boiling. This is however a more expensive option. Since no specific place is chosen for the proposal, it has to be assumed that a well is necessary. To reduce costs, the well should not be dug too deep.

There are also vast amounts of rainwater but few people are taking advantage of it. Rainwater harvesting is a good supplement to the other methods when they become limited or are of low quality like brackish groundwater or polluted surface water in the rainy season. The method is important to utilize to ensure that the orphanage is self-sufficient. Rainwater harvesting is a
simple, low cost technique that entails a minimum knowledge and numerous benefits. For drinking water purposes in rural areas, the most common technique is small scale rooftop rainwater harvesting where rainwater is collected on the roof and transported with gutters into a storage tank. It offers water at the point of consumption.

The type of tank chosen for rooftop rainwater harvesting is a subsurface cistern. It is generally cheaper than a surface tank and requires little or no space above ground. Placement is important since tree roots can damage the structure below ground. A pump or some other water lifting device is required.

The total amount of water needed for the orphanage can be calculated as follows;

\[
\text{Demand} = \text{Water use} \times \text{Household members} \times 365 \text{ days.}
\]

The calculation value for water usage when using a latrine is 25 liters/day & person. The orphanage is designed to house approximately 32 children and 4 adults. Thus the water demand of the orphanage becomes;

\[
25 \times 36 \times 365 = 328,500 \text{ liters/year}.
\]

The water available from rainwater harvesting can be calculated through;

\[
\text{Supply} = \text{Rainfall} \times \text{Catchment area} \times \text{Runoff coefficient}
\]

The recorded yearly means of rainfall in the Iringa region varies from 743 mm to 935 mm. The rainfall is set to 740 mm/year. The catchment area for the houses is measured to be 95 m² x 4 houses = 380 m². The runoff coefficient is set as 0.7. This is the coefficient for clay tiles but since it is the material closest in texture to a lime-sand render that is the value used here. This makes the Supply through rainwater harvesting become;

\[
0.74 \times 380 \times 0.7 = 197 \text{ m}^3/\text{year} = 197,000 \text{ liters/year}
\]

The necessary size of the storage reservoir can be calculated as follows;

\[
\text{Required storage capacity} = \text{Demand/month} \times \text{Dry period}
\]

The demand per month is 328,500 liters/year / 12 months = 27,375 liters/month. The dry period lasts for 4 months in Tanzania thus the required storage capacity is;

\[
27,375 \times 4 = 109,500 \text{ liters} = 110 \text{ m}^3
\]
Since there are four houses and thus four tanks, the required storage capacity should be approximately 27 m³ per tank. This is however just a rough estimate. This is the capacity needed to utilize rooftop rainwater harvesting for these houses to a maximum. However, this makes for a very large cistern and should probably be kept smaller. Another drawback with rainwater harvesting is that it needs to be cooked before drinking. If cooking the water is not a possibility it can be purified up to 50% with solar radiation. Another option is to use disinfectant. It is not that expensive but it needs to be handled by an expert. Therefore, rainwater harvesting will only be used as a supplement in this proposal and mainly for agricultural purposes.

5.3 Agriculture

Agriculture is vital for the orphanage to become self-sufficient. It is also an opportunity for the children to learn the most commonly practiced local craft. The most common crops in the region is maize and beans which is also easy to cultivate. Therefore it should constitute the main part of the plantation. The land in the highlands of Tanzania is mostly very fertile and the orphanage should produce more than what is needed and sell for a profit. The profit can then be used to buy the food needed that is not appropriate to cultivate in the area. Since no specific place is chosen for the orphanage, further studies needs to be made on what is best cultivated in the chosen area and what products are in high demand at the local market. Most plantations are dependent on the rainy periods but with an irrigation plan the production can be doubled with the same land use. A vegetable and fruit garden should also be kept at the orphanage. A caretaker should be hired for taking care of the farm and should mainly be complemented with volunteer work. The children should also help with the farm when time allows. If needed, temporary workers should be hired.

As for livestock, at least cows and chicken should be kept to fill milk and egg needs. A cattle pen needs to be built and it should be kept at a distance from the main part of the orphanage for hygienic reasons.

5.4 Cultural considerations

Traditionally, building a house in rural Tanzania was like a big event where everybody in the village helped. Today, every family builds their home by themselves which increases the costs. Through involving the local population in the creation of an orphanage there is perhaps a possibility to bring back this tradition to them. The local population should preferably feel like they are a part of the project. They ought to be invited to meetings and participate in the project so that they get a sense of ownership and becomes more invested. This
also preferable if the orphanage is to become a showcase on alternative building techniques.

There is an oral tradition in Tanzania, meaning that people gather around the fire in the evening, sharing knowledge and telling stories. Sitting by the fire is especially popular in the highlands. This suggests that an outdoor fireplace may be a good addition to the orphanage.

Religion plays a big role in daily life. Most of the highland villages are Christian and it is not uncommon that tribe religions are practiced to some extent. It should be considered to keep the orphanage relatively close to a church or mosque so the children have the possibility to practice their religion. The orphanage itself should of course take a neutral stance to religion and allow every person to practice whatever religion he or she chooses.

It is important that the children adapt to the African culture so the transition to local society later becomes easier. They should not be raised as westerners. However, some traditions that can hurt the children, like physical punishment and natural medicine, should not be tolerated at the grounds of the orphanage.

5.5 Site plan & layout

The site chosen for the orphanage should be located near the village. This provides several advantages, like building a good relationship with the local population. The orphanage is there to help the village and with a good relationship, the villagers will be more open to help the orphanage in return when it is needed. A closeness to the village also means a closeness to the communal well, the market and religious services that is considered important in Tanzania. There should preferably be some medical clinic close by as well. However, the orphanage should still not be situated in the village due to safety reasons. An agreement should be made with the village that if they provide the land needed for the orphanage, it will be turned over to the village once it runs self-sufficiently.

Since the orphanage is planned for the colder highlands, exposed sites should be avoided, particularly along deforested ridges, where strong winds and driving rain may be experienced. Houses should not be sited on steep slopes and hard or rocky ground should be avoided. The area for housing should preferably be easy to level in order to drain off surface water. It is important to ensure that the yard is not likely to be flooded. For hygienic reasons, surface water must not be allowed to enter pit latrines and cattle pens should not be located at a higher level than dwellings.

It is important to give the orphaned children a chance to grow up with a sense of family. The orphanage should therefore be planned as a small society instead of an institution. The idea is to create several smaller houses
where the children can live with one adult as a family. The houses should be placed around a yard, creating a neighborhood. The houses and outbuildings should be grouped to give protection against cold winds. The distance between the houses should be decided according to the use of functional space, the need for outdoor shelters near the house and the need for privacy and social contact. The highlands are generally well forested and the vegetation should be actively used to create shelter and an attractive environment. Grass and other vegetation with surface binding roots is also required to prevent soil erosion. The space around the house has a very important function since a lot of activities take place out of doors. The orphanage should function as a closed system and the people inside the system should be able to maintain it.

The plan is to house approximately 40 orphans in four separate houses. This means that each house has a capacity for 10 children and one employee, living there with them. The houses will be placed to create an inner yard, containing a playground, a well, and a fireplace. The toilets will be in a separate outdoor building, two houses sharing one building with four toilets.

It is important to create a learning environment for the children. Therefore a workshop will be built where the children can study or be taught practical things like craftsmanship and agriculture. The workshop can also be used to create things that help to maintain the orphanage. The children should also be taught other useful skills like cleaning, doing dishes and cooking. In fact most children seemed to like doing these grownup activities. The workshop should face the yard and be situated near the farm for easy access to both.

Since the orphanage is planned to be self-sufficient, income generating functions and activities is desirable. The farm is supposed to be the main source of income for the orphanage but a volunteer house is also appropriate for extra income and help at the orphanage. The volunteer house will be placed aside from the yard, near the farm to offer some privacy to the guests. Storage areas are very important, especially for food from the farm. Two storehouses will be built and placed close to the workshop and farm, closing the yard and protecting it further from strong winds.

The farm will be situated at a lower level than the orphanage and behind the workshop. The plantation area should be made as big as needed for the orphanage to become self-sufficient. A cattle pen will be built next to the plantation.

Space should be made available for further expansion of the orphanage. If not already available, a pre-school could for example be built for the orphanage and integrate the village children.

Illustration 9: Site plan over the proposal. Illustration by author
Illustration 10: Layout over the toilets. Illustration by author

Illustration 11: Layout over the orphanage house. Illustration by author

Illustration 12: Layout over the store house. Illustration by author

Illustration 13: Layout over the volunteer house. Illustration by author
Illustration 14: Layout over the cattle pen. Illustration by author

Illustration 15: Layout over the workshop. Illustration by author
5.6 Design
When designing spaces, the most important thing to think about is the people going to live there. Therefore every space should not be defined but room should be left for the future occupants to decide how to use them. What is described below are suggestions of how these spaces could be used, not how they should be used.

The vaults covering the buildings impose the measurements used on the building. The vaults either span 3 or 4,5 meters and has to be carried by a supporting wall. The vault spans have been chosen to simplify the building technique and make it easier to learn.
The houses

The four houses presented here house eight children and one adult. They are made relatively simple to keep costs down and make it a realistic option for the local population as well. The inside of the house consists of four bedrooms, (three for the children and one for the member of the staff living with them) and a sitting room. The sitting room which is also the entrance of the house, measures 4.5 x 8 meters. This is the place for taking meals when it is cold outside and the social space of the house. The staff room as well as one of the children’s room measures 3 x 3 meters and the other two children’s rooms measure 4.5 x 3 meters. The bigger bedrooms are designed to house three children each and the smaller one is for two. The long load bearing walls that carries the vaults are plastered on the inside for a brighter and cleaner indoor environment. Maybe these walls could be split up between the children living there and they could paint whatever they want on their part of the wall. If the children are a part of creating their home it will give them a sense of ownership and perhaps one of belonging.

The kitchen is placed outside the house connected to it by a vaulted walkway and the entrance. Two of the walls of the kitchen is open for easy access and to keep it well ventilated. There are three fireplaces available in the kitchen for preparation of food. These are connected to a chimney as to reduce smoke from filling the room. Enclosed by the outer walls of the house and kitchen as well as a screen wall, is the private courtyard where daily activities like preparing food and doing dishes can be performed. The screen wall is in burnt bricks and built for wind protection and privacy. In parts of the wall, the bricks have a small spacing as to not make it feel to enclosed and for light breezes to be able to blow through. The private courtyard is close to the houses rainwater cistern for easy access.

Two washrooms are built between the houses where the thought is that two of the hoses share one washroom. The washrooms consists of a round building with four rooms. Each room is accessed from the outside and is equipped with a toilet and enough space for washing. The toilets are connected to a pit latrine. The washroom is the only building covered with a dome. The technique used is much the same as with the vaults and since the orphanage is planned to be a showcase, this option for roofing should be introduced as well.

Illustration 16: Entrance.
Illustration 17: View on the orphanage houses.
Illustration 18: Inside the house

Illustrations by author
The workshop

The workshop is created as a place for learning. Here, the children can sit in a calm environment and do homework or learn practical knowledge like for example farming. The workshop comprises of two buildings, facing each other, with three study rooms in each. The rooms all measure 4 x 4 meters. The space between the buildings is meant to function both as an entrance to the workshop and an outdoor environment offering a place to sit and study. It is covered with spaced wooden planks to protect against strong sunlight while still offering enough light to read. Against the walls facing the yard, a layer of benches are created to make a place for sitting. This space could be used for outdoor lectures or demonstrations as well if needed.

The storage buildings

The two storage buildings consists of two rooms each measuring 3 x 4 meters. And has separate entrances with on the gable wall. The buildings face each other over the yard. The walls facing the yard has, like the workshop, benches where people can sit.

The yard

The yard is a big shared space for all the occupants of the orphanage, enclosed by the four houses, the two storehouses, and the workshop. The space is enclosed to prevent strong winds. Central in the yard is the well, for easy access, and the fireplace as a gathering place. The placement of these functions can be considered symbolic as well: Water is life. The fireplace is traditionally a place for gathering and learning. Life, the people and learning should perhaps be considered central in the design of an orphanage. These functions are surrounded by the playground, offering a place for fun and games. In front of the workshop, between the two storage buildings is an open space that can be used for sports, learning or theater. Trees are placed on the yard as further windbreaks and protection against the sun. Stones are also placed around the yard to create natural places to sit.
The volunteer house

The volunteer house is needed for extra help on the orphanage as well as a source of income. The building consists of three bedrooms measuring 2,5 x 3 meters and should house two volunteers each. The big room measures 5 x 3 meters and could be used as a shared sitting room or another bedroom in case of need. The smallest room measures 2 x 1,5 meters and is the shared washroom, equipped with a toilet. All rooms open on to a verandah facing the farm for some privacy from the orphanage.

The farm

The farm, situated behind the workshop consists of a plantation, a fruit and vegetable garden as well as a cattle pen. The cattle pen is roofed with corrugated aluminum sheets because of how broad the building is and since the thermal and acoustic properties of the roofing material is not as vital in this building. The cattle pen offers a central walkway with four stalls on each side where cattle like cows, chicken, pigs or goats can be kept. The stalls each have an opening to a fenced outside space. These spaces are also connected to a fenced gracing area around the cattle pen.
6. Discussion & conclusion

In this chapter a discussion about the work on the master thesis and the results is made. An argumentation on the proposals viability is made and the research questions are answered.

6.1 The research questions

The research questions as described in the beginning of the report is here answered:

- What defines a sustainable and self-sufficient orphanage in rural Tanzania?

A sustainable orphanage in rural Tanzania means that it is built with local, low cost, building materials and techniques to minimize transportation and boost the local economy. The materials should also be highly available as not to hollow out local resources. The use of wood will for example contribute to the deforestation problem. A sustainable orphanage also means that it should have as low ecological impact as possible. It means that the buildings should be as durable as possible, minimizing maintenance and thereby long term costs and further use of materials. It means that the children living there are taken care of and is educated so they in tum can later contribute to the Tanzanian society. For an orphanage to be considered sustainable it should also be self-sufficient.

A self-sufficient orphanage in rural Tanzania means that it is not dependent on outside help to be maintained and provide the children with food, water and education. Food and water should be produced at the orphanage and it should have enough income generating activities, like volunteer work and selling of food, that it can cover any expenses that may occur.

- What are the normal building materials and techniques in rural Tanzania and can they be improved without increasing the costs?

The normal building materials in Tanzania is stone for the foundation, burnt bricks or fired bricks for the wall and corrugated iron sheets with a wooden supporting structure for roofing. The stone foundation is often finished with a cement or lime mortar and the walls with a cement or mud mortar depending on what is afforded. In the highlands, the foundation is often carried up about 150 mm above ground. The trusses are most often constructed from sawn timber beams. Ceilings are very rarely used.

The materials and techniques used for foundation and walls are already quite good, especially for the Tanzanian highlands. Stone, mud bricks and burnt bricks are generally very cheap, and easy to make. Mud bricks are not water resistant and may need a whitewash to be protected but burnt bricks is a very good choice for the highlands. The problem with burnt bricks are the use of
wood for firing them. This can however be rectified by using agricultural residues to fire the bricks instead. The roofing situation is however very poor. Corrugated iron sheets have deplorable thermal and acoustic properties which makes it an especially bad choice in the highlands where temperature is lower and rainfall is more common. The iron sheets also have a short lifespan, starting to corrode and leak after a couple of years. Most of the rural population cannot afford to replace them as often as needed and they are instead patched up with whatever material can be found, often held in place with stones. A better alternative is burnt clay tiles which can be produced locally at a generally low cost, lasts much longer and has much better thermal and acoustic properties. However, this material requires a stronger supporting structure which may, in the end, prove too expensive. Vaulted roofs, at least when using the Nubian vault technique, is perhaps the best alternative. Mud bricks or burnt bricks can be used for the vaults. Mud bricks requires thicker supporting walls and more maintenance to protect it from damp while burnt bricks is the costlier alternative. These materials have excellent thermal and acoustic properties as well. The vault itself offers a higher standard of living, creating beautiful, spacious rooms. The main disadvantage with vaulted roof is that the technique is virtually unknown in rural Tanzania. This however, should perhaps be seen as an opportunity for the technique to be spread. It has successfully been implemented in other parts of Africa and if local masons are taught how to build the Nubian vaults people in rural Tanzania can increase their standard of living while supporting the local economy instead of buying imported metal sheets, transported long distances from the large cities.

• What are the needs of orphans in rural Tanzania?

The most pressing need of some orphans in rural Tanzania is a safe place to live. Most orphaned children lives with relatives who cannot afford to take care of them. An orphanage can meet this need but it also needs to provide water, food, clothes and education. With these basic needs covered, the orphan also needs to feel a sense family and belonging. In other words, the orphan needs a home. A safe place to play, leam, develop and grow up. The orphan also needs to be in touch with the African culture and society since he or she will later become a part of it.

• What cultural, social and esthetical aspects have to be considered when building in rural Tanzania?

Be it Christianity, Islam or local tribe religions, faith is very important in the Tanzanian society. When planning an orphanage, this should be taken into consideration. Perhaps the orphanage should be situated close to a church or mosque so that the children can practice their religion if they wish. Other cultural aspects that may affect the day to day life while running an orphanage is for example the deep faith in natural medicine and the practice of physical punishment of children which is
deeply rooted in Tanzania. Such practices, that may be harmful for the children, should not be allowed on the orphanages grounds.

There is an oral tradition in Tanzania. This means that people gather around the fire in the evening, telling stories and sharing knowledge into the night, sometimes falling asleep outside by the fire. This is especially common in the colder highland areas. In the design proposal, this is incorporated in the orphanage to create a gathering place.

As a westerner building an orphanage in Tanzania, many people expect you to have unlimited resources. This can perhaps be a problem since some people may try to take advantage of it. Corruption is a big problem in Tanzania and should be considered in certain situations. The construction workers should not be paid by the hour since this often leads to a longer construction time and higher costs. A salary based on work done should be used instead.

The government buildings are seen as modern and beautiful to the rural population. They are very impressed with modern materials like concrete and corrugated iron sheets even if concrete is most often too expensive and the iron sheets are not appropriate. This may cause a problem for the orphanage as a showcase since it only uses local materials that are more unpopular. It is however important to try and make these materials more important since they are most often the only realistic option in rural villages.

6.2 The design proposal

It was apparent that a heavy structure were preferable in the highlands and stone was a natural material to use for the foundation. For the walls it was harder to decide between mud bricks or burnt bricks. In the end, this too was an easy decision since burnt bricks offered more advantages relative to the higher price. This especially applies in the highlands since the seasonal rains are heavier here. The fact that the bricks can be fired with agricultural residue instead of firewood further convinced us to use the material. The biggest problem we faced when choosing materials was what to use for roofing. The most common roofing material was, as mentioned several times, corrugated iron sheets with a wooden support structure. Besides the deplorable properties of iron sheets, again; especially for buildings in the highlands, the use of a wooden support structure only further contributes to the massive deforestation problem in Tanzania. The thermal and acoustic properties of the roof can of course be improved with a ceiling. However, this is generally too expensive for most of the rural population and since the building preferably should be used as a showcase, the costs have to be kept within certain limits. Unlike stone and bricks, iron
sheets is not a local material, thus eliminating it as a sustainable building material, at least according to our definition. So corrugated iron sheets would not be used for roofing. Are there any better alternatives though? Burnt clay tiles was the main candidate for a long time. This material could be locally produced, it has good thermal and acoustic properties and is more durable than iron sheets. There are however three main drawbacks with using this material that in the end led us to abandon the idea. The first is that the technique for building with burnt clay tiles are generally not known in the rural villages. This is however not a big problem since it can easily be taught, offering a new and better local alternative for roofing. The second problem is that burnt clay tiles is quite a heavy material, thus necessitating a stronger supporting structure which might in the end prove too expensive to be a sustainable option. The third problem is that said supporting structure would be built in wood, contributing even more to deforestation than the other roofing option. These problems led us to consider what roofs could be made without the use of wood which in turn led us to the Egyptian architect Hassan Fathy and the technique for building Nubian vaults. This is an ancient technique for building vaulted or domed roofs without the use of any supporting structure, originally constructed with sun dried mud bricks. Again, the choice between mud bricks and burnt bricks were discussed and for the same reasons as mentioned above, burnt bricks was chosen in the end. This kind of roof has all the qualities to define it as a sustainable option. It is durable, has good thermal and acoustic properties while remaining low cost and the materials can be locally found and produced. It also has minimal ecological impact. The only problem with the material is that the technique for constructing Nubian vaults is virtually unknown in rural Tanzania. However, after seeing and experiencing the housing situation for ourselves, we believe that another low cost roofing alternative is sorely needed in Tanzania and that it would be worth the trouble of trying to introduce one. As described in the Theory section, this has actually already been successfully done in sub-Saharan Africa by the Association for Voute Nubienne (AVN) where the technique has been simplified and standardized to make it easier to learn. To make the vaulted roofs for the buildings masons who know the technique has to be hired from the outside. The possibility of a collaboration with AVN should perhaps be investigated. The masons should however not be hired just for the construction of the vaults but also to teach the technique to local masons so that it can be used in future construction of rural houses. This would create new job opportunities for the rural population while keeping money in the local economy. Of course, to accomplish this is not as easy as that but it is certainly a good opportunity and, if
executed correctly, may contribute to a better housing situation in rural Tanzania.

Parallel with choosing building materials, the layout was drawn and redrawn several times. It was only during the last week of the field study that the proposal began to take shape and by then we had realized that the delimitations chosen for the thesis was still too broad. To design a whole orphanage is a huge task. The focus of the thesis became the building materials and techniques as well as how to make it sustainable and self-sufficient. Originally, the plan was to calculate the costs and choose a specific site as well but in the end there we had simply not enough time to do this. The project had become too big.

The layout presented in the design proposal is mainly based on the information gathered in the literature study and the interviews with some ideas taken from the observations. The plans of the buildings were limited since the use of mainly vaulted roofs put some restrictions on the form. This made for fairly simple buildings but that is perhaps for the best since the roof construction cannot be made too complicated if the technique is to be easily learnt. The most important buildings are placed to create a semi private yard. This is mostly done for wind protection and to create a sense of community. The whole layout is in fact designed to create a village feeling. Orphans should have as close to normal childhood as ordinary children. The implementation of the village idea came from the Save Our Souls (SOS) orphanage. We believe that this is the best way to create a sense of family for the orphans and to prepare them to eventually enter the Tanzanian society.

Rainwater harvest should only be a supplement to the regular methods of acquiring water in case of drought or contamination of the storage tank. The farm should be able to provide the orphanage with most of the food needed and an income for covering all other expenses. The area needed and the crops to be cultivated depends on the location and this should be further studied.

It should be mentioned that the use of corrugated iron sheets for the cattle pen is, although not in accordance to our argumentation, mainly chosen because the building was considered too big to span a vault. This could however be used to a learning purpose to compare the quality of the roofing materials and serve as an argument in itself why not to use the material more widely. Another instance when we contradict our own arguments is the use of wooden planks for sun protection in the workshop yard. This can of course be replaced by some other material. But in case the orphanage is situated near the Sao Hill sawmill (near Mafinga) an argument can be made for the use of some small...
amount of wooden materials. The cost of wood would not be as high and it would constitute a local material. Perhaps some faulty timbers could be obtained at a lower price to use for such decoration. The decision to incorporate domes in the design of the washroom is used as an example to showcase the different options available through the use of the Nubian technique. All these details can of course be changed or replaced. This is merely a general proposal. For a more complete plan, a site has to be chosen so that the layout may be adapted to it.

6.3 Further research

As mentioned earlier, the design of a self-sufficient orphanage is a huge undertaking and the size of this thesis did simply not allow for all the necessary research to be done. Here some areas of further research in the subject are presented.

A cost analysis should be made as to decide more exactly how much money differentiate different building materials and techniques as well as choices for rainwater harvesting and income generated from different crops.

To make this proposal more realistic, a site has to be chosen and further research has to be made as to the existing preconditions of this site. After this, the layout can be adapted to the chosen site.

Further research on agriculture should also be conducted. What crops can be cultivated and which are in most demand in the local market are examples of questions that need answers before continuing to plan the orphanage. Once the site of the orphanage has been chosen a more place specific study can be conducted. How much land is needed for the plantation in order for the orphanage to become self-sufficient should be explored as well.
7. References

7.1 Bibliography


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7.2 Interviews

Bulamile, Ludigija; Head of architectural department at the University of Dar es Salaam. 2015. Interview October 5.


Francis, Elvis. Landscape architect at Mbeya University of Science and Technology. 2015. Interview November 11.

Kishaka, Danstan. Secretariat engineer at Regional Commissioners Office, Mbeya. 2015. Interview November 9.


Lyakwipa, Benitho. Architect and building engineer at the University of Dar es Salaam. 2015. Interviews October 7 and 9, November 16.


8. Appendix

The appendix contains collected data from interviews, drawn ideas sketches and relevant pictures from the field study.

8.1 Interviews

The interviews was prepared with questions adapted to respective informant. Starting with introducing ourselves and the goal of this study, simultaneously trying to get the informant to feel comfortable. The prepared questions were normally asked in a numerical sequence but if the conservation took an unexpected turn the sequence of questions were adapted to this. The interviews were structured like talking points mixed with suitable questions around that talking point.

When holding the more open and informal interviews and prompting the informant with follow up questions, he/she often became more interested and dedicated to the cause of the project. Perhaps this was due to their personality, knowledge and understanding of the subject. This way of interviewing gave us more answers to questions we did not think of asking due to our limited knowledge. The negative effect was that some questions were forgotten due to the natural changes in topic.

The more controlled interviews, where the informant were hard to delve deeper into the current subject, questions continued being asked in a numerical sequence. The answers was easier recorded but those interviews were often less valuable since a lesser amount of information was gained.

Interview with Dr. Ludigija Bulamile - Building engineer

Head of the architectural department at the University of Dar es Salaam. This interview is more like an informal meeting where the subject at hand were discussed.

On building materials

Timber is mostly used for trusses, furniture and porches. Timber and thatch that is used for roofing is rapidly decreasing due to an increasing population. The population is still using a comprehensive amount of timber for heating. The result of timber decreasing is that the cost of the material is rising which makes it an unsustainable material from an ecological and economical perspective. Deforestation is a large problem in Tanzania.
Stone is a local inexpensive material and is available everywhere. There are however few who has the knowledge on how to use it as a building material.

Burnt bricks is often used but are maybe not sustainable due to the amount of wood being used for burning. Burned clay tiles are at the current situation not used for roofing because it is not considered to be modern. The most common materials used for roofing is iron sheets or thatch.

Concrete is an expensive building material. Cement is only manufactured at the coastal towns which means long and insecure transportation. For a lower price on concrete the amount of lime can be increased. This however, lowers the quality of the concrete.

**On design**

The government buildings works as a showcase for the population on what should be considered modern and beautiful. The main part of the population therefore chooses to build concrete houses with iron sheets for roofing if they can afford it. Since most of the activities in daily life is performed outside, the yard is one of the most important spaces in a Tanzanian home. For example; if the home is situated in a highland region like Iringa the climate is a lot colder. In such cases it is preferable if the yard is more private and protected against wind. This could be accomplice by placing several smaller houses to create an inner courtyard. The fireplace is also important in these regions.

**On functions**

For water supply wells is an alternative but they cannot be too deep due to the cost of drilling. The wells should also be placed a distance from the latrines. It is important to utilize rainwater harvesting. There are vast amounts of rainwater but few people are taking advantage of it. It can be harvested through the roof by gutters and a water tank where you can add some chemicals to keep the water clean. This technique should be showcased.

Because of the deforestation, the waste from harvesting rice and maize should be used instead of wood fire.

**On problems in rural areas**

A big problem in the rural areas is that a large part of the young population is moving to the larger cities. This means there are too few local craftsmen available in the rural villages and the few who are available is often old and cannot handle the required workload. The lack of young craftsmen also means that the local knowledge of building techniques is slowly being forgotten since there are too few to pass on the knowledge to. Another
problem for construction in rural areas is the government's priorities. For example; the ministry of social welfare, who amongst other things are supposed to handle the orphans, has a very small budget.

On orphanages

Orphaned children should still have the chance to grow up with a sense of family. A good example is the SOS orphanage. They have made their orphanage into a village where ten kids and one of the staff lives in every house. This makes the children in each house like siblings, the staff living with them becomes like a parent and the orphanage becomes like a community in itself.

Important rooms/spaces for an orphanage is sleeping places, public spaces, classrooms, canteens and a workshop.

Interview with Fred Nderimo – Architect

Architect working at Ardhi University in Dar es Salaam. Like the interview with Dr. Boniface, this interview was also like an informal discussion.

On building materials

Cement is only manufactured at the coast of Tanzania and is therefore creating a high transport cost and uncertainty for spillage of the material. Concrete Roofs, especially at the coast, is not working because it starts to corrode and leak due to the salt water from the coast. Steel has a low availability.

Burnt bricks and clay bricks is the most commonly used building material in the rural areas. Stone is a very common material in the Iringa region but gets expensive due to the cost of transportation and the fact that it is hard to work with. There are trees that is resistance against termite attacks and can therefore be well used as a building material.

On culture and design

In the past, building a house in a rural village was like a big event where everybody in the village helped build the house. Today, every family builds their home by themselves which increases the cost. The knowledge of local building techniques in rural areas is disappearing since it is not inherited to the same extent any more. This is because many of the young people move to the larger cities. Few people know the local building techniques today and when people in rural villages needs to hire local carpenters there are mostly around two to three people available with the necessary knowledge. In the cities, the construction workers have the required education and work for construction
In the rural areas there are few rules and building permits are rarely needed.

It is important to take the relationship between men and women as well as the different activities in daily life into consideration when designing a house. The kitchen is an important part of a Tanzanian house. Safety plays a large role in design in Tanzania.

**On problems in rural areas**

Geotechnical data is not available. Geological tests are too expensive and in the end most constructions are based on guesswork.

Building costs in Tanzania are rapidly increasing and keeping the budget down is crucial. Land prices are increasing as well but the land is not really bought but loaned from the government.

Termites are a big problem in Tanzania. It is possible to treat building materials against termite attacks but it is too expensive to be a sustainable options over large areas.

Rainwater harvesting is mostly not implemented today. What type of water harvesting method to use is dependent on material and construction. A tip is to always separate drinking water from washing water.

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**Interview with Benitho Lyakwipa - Architect and building engineer**

Architect and building engineer working in the Department of structural and construction engineering at the University of Dar es Salaam. The interviews with Benitho were separated into three sessions. The first session was more of an informal meeting while we finished our discussion with Fred Nderimo and Benitho joined us. The second session was a semi structured interview. The third session was just an informal conversation after our studies in the rural areas to discuss our experiences.

**Session one and two**

The core points to take into consideration when building an orphanage is the material, design, technique and the user.

**On building materials**

Concrete has a long transport distance since its core ingredients are cement which is only are available at the coast of Tanzania. The long distance of transportation creates an uncertainty for the material. People in the rural areas often lack the knowledge of mixing the concrete, they cannot pinpoint how many parts of what
material to use in the mixing and is therefore only mixing it in a rough estimate. The positive thing about steel is that it becomes cheaper to transport due to its volume weight.

Burnt bricks and clay are the most common building materials in Rural Tanzania. Due to the deforestation problem corn husks and other waste products from farming should be used for burning bricks. Burnt clay tiles should be a good option for roofing but it is heavier than iron sheets so the construction needs to be more durable which could prove to be more expensive. A dome made of clay is a good alternative for roofing.

In Iringa there are a lot of trees and stone to be used as building materials. In Morogoro burnt bricks, clay, cement and iron sheets if often used.

Problems in general construction

A problem when building is that it can be hard to coordinate all professions, example architects, engineers, the client and so on. What the client wants is often forgets.

There are few who adopts a holistic view on building in Tanzania, the focus often lies in the details. The buildings becomes more expensive and the architects benefits on it so there is no drive to create less expensive buildings and when the price for a building increases the development in rural areas stand still. The cheaper proposal seldom gets built, so the architects only draws for the rich. New material that is used in the cities is looked upon as modern materials and the local materials therefore seemed to be unpopular. The choice of material is a sign of status.

In the rural areas a building permit is only needed for public buildings. A simple overview can be conducted. For buildings with two or more levels the rules are stricter.

On Orphanages

When designing an orphanage it is important to try to understand the orphan. Ask yourself what it means to be an orphan.

The children living in most orphanages originally come from all over the country and are from different cultures and situations which could create problems. Therefore it is important to create a positive community within the orphanage. The orphanage should function as a closed system, be self-sufficient, and the people inside the system should be able to support it themselves.

Another important thing is to create a learning environment where the children can learn useful skills through helping the orphanage, for example cleaning,
doing dishes, cooking, craftsmanship and helping out in the plantation.

On construction and water supply

The knowledge of building techniques in rural areas is very traditional and mostly based on experience. When harvesting rainwater from roofs the first 200-300 liters will be too dirty for drinking water. This could be fixed by draining the first 300 liters into another tank for washing. The rest of the water should then be clean enough to drink. It is also possible to disinfect water with solar radiation.

A tip is to avoid rocky grounds and have a lot of trees to be able to create natural shades to decrease direct sunlight. Do not overdesign. Think about what the people living there actually needs.

Session 3 (Informal conversation)

It is important to think about maintenance. For an orphanage to become self-sufficient the people living there must be able to maintain it. Therefore the building needs to be sustainable and easy to maintain with minimal service.

Medical knowledge should be available at the orphanage or at least near it. HIV/AIDS is a big problem and a sensitive subject as well. Think about how to handle problems that may occur if one (or more) of the children has AIDS.

Tanzania has an oral tradition which means that people gather around the fire in the evening, telling stories in through the night, sometimes falling asleep outside. In western countries people plan so far ahead. In Tanzania, people has a shorter memory. The important thing is what is happening right now. They can normally only afford to plan for one day at a time.

The Maasai tribe build their homes in a circle with a semi closed courtyard in the middle where they keep the cattle and it can be easily guarded through the night.

Open spaces are important, the children should not feel pent up but free. They should not feel that they are locked away because they are orphans.

It is possible to provide the main part of the water through rainwater harvesting. It rains about 1000 liters per square meter and year in Tanzania. It is nice to keep the water centrally if possible, it represents life (when showing the drawing where the wells are kept centrally).

The most important thing to think about when designing spaces is how the people living there are going to use them. Do not define every space, spaces mean
different things to different people, let them decide how they should be used. One room can create several different spaces. In outside spaces stone gardens can be created to form natural places to sit.

The children should be taught to create things that can also help with maintaining the orphanage, like clay tiles for example.

A small part of cement mixed with the clay increases the sustainability of the bricks and it is possible to build strong houses without even bumring the bricks.

Think about letting the children paint the inside walls, they could be split up between the children and they can paint whatever they like on their allotted area. This will make the children care about the house and help keeping the walls clean. Let the children be a part of creating their home. It will give them a sense of ownership and make them care more about their home.

Interview with Lucas Madaha - Water engineer

This interview where more structured than those above. Therefore a more complete transcript can be provided. However, it is still classed as a semi structured interview and the questions sometimes took turns to different subjects.

What, as a water engineer, are your tasks?

I am working for Iringa District Council - Water Department as a water engineer. They are supplying 133 villages with water in different ways depending on location and access. 69% of Iringa district has access to water somehow. For example ground water through a well that has a pump driven by solar energy. The wells are drilled 100 m deep and there is approximately 114 wells in the district. 18 of the villages has gravity water schemes where brooks runs from the mountain and are led to the village. This water though has to be boiled before drinking. This way of supplying water is always the first choice because it is not as expensive as the other alternatives. Rainwater harvesting with a tank is only a supplement for water.

In Iringa there are small variations in the climate. Kibebe and Nzihi that has the same climate as Iringa and is in need of an orphanage. Kiphera and Igingilani has orphanages that is in need of improvement.

Getting land for an orphanage is not a problem but you have to know who is going to own it. An alternative could be to have an agreement with the village that you are the one starting the orphanage and later the village
Questions to be answered could be: Who is responsible for the grownup children? Is adoption maybe an alternative?

**What types of buildings are most common in rural areas?**

Brick houses with iron sheets are the most common houses in rural areas. You need windows to protect against wind and cold. Glass windows is used if possible and indoor ceilings are to prefer, often in gypsum or timber.

**What building techniques are most common in rural areas?**

Few people are building their own houses, local builders are hired if not the house is built in a very traditional way. The owner buys the building material and the house is built in steps after the owner’s capital.

**Is the use of local material common and how is the availability?**

The most common building materials are burnt bricks for walls and iron sheets with wooden supports for roofing. Stone is usually only used for the foundation. Stone walls is too expensive because of longer construction time, transportations and the cutting process. Cement is used as binding material. Stone paving is sometimes used for flooring and is not too expensive.

Burnt clay tiles used to be usual in the Iringa district but it is more expensive than iron sheets if there is not a factory nearby.

**What do you think is important to consider when planning a building in the rural areas?**

There are five questions that should be answered when building in the rural areas:

1) Where are you building?
2) What materials should be used?
3) How should the roof be built?
4) What materials are available and where?
5) What craftsmen are available?

In summary, it is important to know the place.

**What spaces or rooms are most important in rural areas?**

The most important rooms are the living room, bedroom, kitchen and toilet. The living room should be about 5x6m...
and the bedroom about 3x4m - 5x6m. The kitchen and toilet are often placed outside the house, or in separate buildings.

**How is the general knowledge in building techniques in rural areas?**

The existing knowledge is varying. Construction workers either learn through a vocational training center or through experience. Traditional building techniques are inherited but this is decreasing.

**Is there any architectural design that is common in the rural areas of the Iringa region?**

Iron sheet in aluminum is a material that currently is popular because the local population consider it looking good and working effectively. The material do not corrode as easily as iron sheets without aluminum. Today it is very common that people are copying each other and that is why most of the houses look the same in the whole of Tanzania. However, the traditional houses are differently built depending which tribe you are from. The Hehe tribe in Iringa often had round houses with thatch roofing.

**What is the cost of different building materials?**

The costs of different building materials in Tanzanian shilling (Tsh) is approximately;

- Concrete grade 25: 1:2:4 Tsh 450,000/m³
- Concrete 1:3:6 Tsh 540,000/m³

**Walls:**

- Cement blocks, 150 mm Tsh 35,000/m²
- Burnt bricks Tsh 25,000/m²

**Roofing:**

- Iron sheets Tsh 50,000/m²
- Burnt clay tiles Tsh 75,000/m²
- Aluminum sheets (complete roof) Tsh 150,000/m²
- Timber (Mininga - Bambu) Tsh 2,5 M/m³
  *(Expensive but termite free)*

**What is the most common way to acquire water, for drinking and washing, in rural areas?**

The most common way to require water is;
Groundwater via well. This water is safe to drink but it should be boiled before drinking if the water has been taken out of the well more than three days ago.

Gravity water scheme (from a river). This water should be boiled.

**What do you believe is the best way?**

The best way to acquire water depends on the place but a gravity water scheme is used if possible since it is the cheapest option. The pipes is the most costly factor here; 10,000 Tsh/meter to 50,000 Tsh/meter depending on how large the pipes are.

If there are no river nearby, groundwater is used. Groundwater, through a well, has better quality to the water and is safe to drink without cooking but it is a more expensive option.

Rainwater harvesting is used as supplement and can cover up to 20% of a household's water needs. This water needs to be cooked before drinking. If cooking the water is not a possibility it can be purified up to 50% with solar radiation. Disinfectant is not that expensive but it needs to be handled by an expert.

**Is rainwater harvesting common?**

Rainwater harvesting is becoming more common because the government has started to promote it. About 30% of the households in Iringa district is using rainwater harvesting and almost everyone who builds a new house is adding a tank for it.

**What are the costs related to the different methods of acquiring water?**

Water related costs are:

- **Tank** 20-30 m³: Tsh 30-50 M (common at schools)
- **Tank** 5 m³: Tsh 1.5 M
- **Tank** 5 m³ (whole system): Tsh 2-3 M
- **Well** (drilling 100 m): Tsh 25 M

Instead of using a tank you can lead the flood to a flat surface where a pool is built and the current goes through.

**What do you believe is the best option for an orphanage with around 50 kids and a farm with plantation and livestock?**
The general calculation values for water needs are as follows:

When using a latrine: 25 liters/day & person
When using a modern toilet: 50 liters/day & person

For agriculture: Water is pumped from a stream if possible

Important points when considering what energy and water systems to use is that the people using the system needs to be able to maintain and run it. It should be kept cheap and simple. Rainwater should be used as a complement. Solar power is cheap in the long run.

Interview with Hellena Msese - Manager of Mafinga child care center

Mafinga child care center was the first orphanage that we stayed at for a longer period than a day. On the first day, the manager of the orphanage, Hellena Msese, took us on a tour of the premises, explaining the layout. During the rest of our stay, a semi structured interview was conducted over three different session when Hellena could spare some time for us.

Tour of the premises

We have three guest houses, two of them have four rooms and the third one has three rooms with a kitchen.

The plan is to take care of the children between 0-3 years old, then send them home to their families/relatives. If they have no relatives they stay at the orphanage. The oldest one are 17 years old but when the children is about 7-8 years old they move into another house for older children. This building can house twelve children in three rooms and the “mother” has her own room. Right now there is only one building for the elder boys but one more for the girls are under construction. The children are not allowed to go into the village by themselves while they live here. Permission has to be granted from the staff. The children learns housekeeping activities like cooking food, doing laundry and so on. There is a school in the village and the younger children goes to private school.

We grow tomatoes in the greenhouse and during the rainy seasons there are other vegetables. The staff lives in the small houses and the large green ones is for the little kids. There are ten people in the staff that takes care of the children and five more who handles agriculture and so on. Most of the staff lives here with their own children and some lives in the village. There are one house for volunteers as well. The large main building, for the orphans, has three tanks for rainwater harvesting and a
big playground in the courtyard. There are four parts of this house. Where they live depends on their age. The kitchen and the canteen has large holes in the roof for ventilation when cooking food.

There are one building used for storing food and a field behind it. The fields however, does not produce enough food. The orphanage needs to buy rice, potatoes and fruit.

Interview

What is your role on the orphanage and what do you do?

Hellena is running the orphanage and makes sure that the children lives in a safe environment, handles personnel issues, communications with the government and church as well as making sure everything works as it should. In short, she makes sure that the childrens needs are met. The orphanage is owned by the church and they have to follow the government's regulations.

Are the government involved somehow?

To start an orphanage the government must inspect and approve the plan and place where the orphanage will be situated. You must prove that the building and plan can take care of the children. The place has to be secure and functioning. Reports have to be sent to the government every month which are followed up on with continual visits. During the visits they investigate if the building is up to its standard, if there is enough space, food and so on. If something is inadequate the problem has to be dealt with or else the orphanage will be closed until it is fixed. The same procedure goes with the church since it is the church that is financing us.

In short the process for starting an orphanage is to:

- Get approval from the government
- Send continual reports
- New regulations from the government
- Seminar for staff
- Continual inspections

The government can be consulted if any problem occurs.

How come you started working here?

Missionaries from Finland helped to start the orphanage. The missionaries went home in 1990 and I, who at the time worked at the hospital, was asked by the church to take over.

What is the best thing with working here?
The best part of the job is to take care of the babies. You become like a parent to them. It is the same for everybody in the staff. A proof that everybody likes it here is that the staff works in accordance to the children's needs independent on time.

Are there any negative sides?

There are few negative sides to the job but it is tough when children go home to relatives who may not be able to take care of them. It is important for the children's psychological welfare to grow up amongst family but under special circumstances it is better if the children stay at the orphanage.

In the beginning all the children came as babies and only stayed until the age of two to three years old. When I started in 1990, the children all left before the age of seven. The goal is still to be able to find a good solution for the children so they can leave before the age of three but today many children stays much longer. This situation made us build two new houses for the older children, one for the boys and one for the girls. If the children stays longer the orphanage has to organize education for them which increases the costs. The finance becomes a problem but at the same time you cannot send away the children. I want the children to feel that they always can come home. The most common situation for an orphanage is to take in very young children but there is orphanages that takes in children from the age of four to five years.

What is the most valuable experience you learned from working here?

It is important that people realizes that everybody is responsible for orphans, not only the people who are working with the children. If you cannot take care of them you can help the orphanages by for example donating money, food or just socialize with the children. A child should not be a burden.

How do you feel that the local population's relationship is towards the child care center?

The orphanage has a good relationship with the local populace. The village is nearby and the people helps if the orphanage needs it. Besides the driver and some hired worker, there are mostly women working for the orphanage. It would be desirable if a man could work with the children as well.

How do you experience daily life here?

The staff not only works here but lives here with the children as a family as well. Everyone helps each other and they do what they can to make life easier. A
schedule that is suitable for everybody is made together.

Is there anything that could be improved here?

The water supply is insufficient and has to improve, it is not enough for the agriculture and so on. This is of the highest priority right now.

More houses for the personnel is needed. Some of the staff lives in Mafinga town which can complicate things in emergency situations. The guesthouses provides the orphanage with money as well.

What is the water supply like?

The main means of acquiring water is from wells but it does not produce as much water as before. We harvest rainwater as well and if needed there is a nearby spring, this water is dirty and has to be boiled before drinking though.

How does the energy supply look like?

The electricity is bought from the government network but it is very expensive. The orphanage pays Tsh 300.000 per month to the government. It would probably be better with solar power in the long run.

How do you find the temperature and humidity in the building?

The climate in the buildings are comfortable for the most part. During the colder periods, foremost June, July and August, an extra blanket is needed. The smallest children get electrical heating during this period as well.

How do you find the natural lightning in the building?

The natural lighting is good within the buildings.

How do you find the internal design of the building?

When the orphanage was built the design and plan was good. The idea was that a young girl came with the child and stayed for two to three years, learning to take care of the child with help from the staff. The goal being that she later would be able to do it by herself. Now, only the children are taken in so that the girls can continue going to school. Everything changes and more girls are able to go to school today.

When the children are around three to four years they should begin going to preschool which the village does not have so the orphanage is trying to start one. The plan was to start a preschool in October this year but the teacher became sick. It will probably open this December though. The orphanage is planning to
integrate the children from the village to the preschool for a small sum of money.

How do you find the external design of the building?

Burnt bricks looks nice. New iron sheets for the roofing is needed since the ones being used now has started to leak. The iron sheets corrode after a couple of years.

Who designed and built the buildings?

I do not know who designed them but the government drew the drawings and the church did help. We hired local builders to build the orphanage.

Who financed the buildings?

The church financed most of the orphanage by collecting donations, for instance from a congregation in Finland. When more money is needed donations from the local population is given to the church who then helps the orphanage. The staff on the orphanage has a collect as well. The orphanage has a recommended fee of 10,000 Tsh/month, from the relatives to the child who is living there but there are few who can pay the fee because of poverty.

What spaces or areas do you consider most important here?

16. Everything is important, both the rooms on the inside and outdoor spaces, but the rooms for the infants is very important. They have to be kept clean from a health perspective.

Starting from the beginning, how would you run and design the orphanage?

First of all I would think about the surrounding environment. How is the climate and the location? Think about where you start building. You have to have access to water but it cannot be built where floods may occur during the rainy season. It should preferably be situated at a peek or where big earthquakes are uncommon. The environment should as well be in a safe distance from a village and animals.

When the orphanage started we wanted to be near a hospital and a church but not too close so diseases could spread. At this time the nearby spring had enough water but the climate change have led it to dry out.

Is there any function here you feel is missing?

The orphanage needs more and better toilets as well as more recreational areas for the older kids. The orphanage should not be dependent on donations which makes income generating activities and functions desirable.
What traditions and cultural aspects should be taken into consideration when building a child care center?

Up to four years of age, the boys and girls can sleep in the same room. When they are older than that, they sleep in separate houses.

How is food availability here?

The Maize is mostly used to make ugali and the orphanage produces about 75% of our maize consumption. It is harvested through July and August and is dried and stored. During the rainy season vegetables is grown as well. About 75% of the milk needed can be produced from the cows owned by the orphanage. The infants however, needs milk replacement which is bought. The rest of the food supplies needed are bought as well. Sometimes cows are sold or slaughtered for meat. Some of the livestock on the orphanage is owned by the staff.

Do you believe that it is possible to become self-sufficient in food supply by farming?

It is possible to become self-sufficient in food production but the soil is not fitting for all types of plants, for example beans. When it is time to cultivate the fields, the orphanage needs to hire a tractor and pay for the seeds but the rest we do by ourselves. To become self-sufficient it is important to optimize. With better knowledge of agriculture, less land can be used for a bigger harvest.

Is there something the children especially enjoy doing?

The boys like to play football and the girls' plays basketball. The playground is popular for everybody but it should be improved. Recreation sites needs to be improved, especially indoor activities, such as a place to play some cards.

How does it work when children comes here?

The children at the orphanage can arrive everywhere from Tanzania but preferably from nearby villages so the relatives can be closer. Often the local population know who is in need of help and that is how the orphanage finds out who to take in. In other cases the relatives to the child contacts the church or the government, which in tum contacts the orphanage. To get accepted you have to fill in forms and get interviewed by the government's social department.

How many children lives here? What is the capacity?

There are now 42 children at the orphanage but the capacity is 60 children. One of the children is handicapped.
Are there any requirements for living here?

To be eligible for the orphanage the mother must be gone. Muslim and Christian children are both welcome, people is what is important.

How does the staff get paid?

The staff is paid by the church but the salary is not high.

What materials were used during the construction?

The foundation is made of stone and the walls of burnt bricks. It is the best materials available. The roofing is in iron sheets.

What material are available locally?

Timber and bricks is available locally. Very few uses burnt clay tiles for roofing but iron sheets which is transported from Dar es Salaam is widely used. Stone is used for the foundation and sometimes as decoration in parts of the wall.

Do you have anything to add?

The personnel who takes care of the children should be educated or possess some knowledge through experience. There are schools who educate personnel during two years. If they are interested, the grown up kids are of course welcome to work at the orphanage.

Interview with Jessica Klinte - Founder of CCY Tanzania

CCY (Caring from Childhood to Youth) Tanzania is located in the small village of Bumilayinga and is the orphanage where we stayed for the longest time, one week. During two sessions, Jessica Klinte, one of the founders of the orphanage, was interviewed.

What is your role on the orphanage?

I have a management role and are in charge of the finance. I have to collect money to the projects, go to meetings concerning the projects with for example leaders of the village. It is me or Linnea Öman who makes the final decision.

How did you start the orphanage?

I came here in 2010 as a volunteer to the orphanage Moyo Kwa Moyo, situated in the nearby village of Matanana, and saw the beginning of the orphanage in Bumilayinga. Then the building was only a shell. Later I took over the unfinished building, started a bank account in Sweden and held lectures for eight months.
After collecting 100,000 SEK through lectures and donations I went back to Tanzania. In 2011, the building process of orphanage started and it proved to be a slow process. The orphanage finally open 14th of October 2013 on the approval of the city council. Before opening we received letters about the 14 children that would live here but only eleven came, the rest arrived the day after. The ages of the children were between two to fifteen years. The smaller kids adapted faster than the older ones but it was total chaos during the first four months.

The orphanage was built by the local craftsmen who got paid a sum per completed moment. In the beginning they were paid by the hour but this did not work since the work rate became too slow. Sometimes the craftsmen did not show up for example. Instead the salary became for example Tsh 800,000 per completed room.

What is the best thing with working here?

The best thing is to see the children develop and to actually save someone’s life. You do this partly for yourself as well, you get so much in return.

Are there any negative sides?

The hardest part is all the corruption and not being able to help everyone. Because you are white, people expect so much from you. Some people do not understand that you cannot help everyone. It is hard to not take in too many, to say no to someone in need.

What is the most valuable experience you had from working here?

I have a new perspective on life. You appreciate different things. Happiness is not found in material things but in family and community.

How does a normal day look like?

I come to the orphanage almost every day. The older children leaves early for school. Lunch is around 13.00 for the younger children and for the villages school children, they do not get lunch in school. After lunch, the younger children goes for a nap.

The usual tasks for the staff includes fetching water from the well, doing the dishes, wash clothes, gather firewood and so on. Dinner is most often 19.00 to 21.00.

Does the staff receive a salary and how much is based on volunteer work?
The first of the staff came through earlier contacts. These helped to find more personnel who got hired for a probationary period. The standard salary in Tanzania is about 200 to 300 SEK per month. At CCY, the personnel who works from 8 to 14 earns 350 to 400 SEK per month and the two “mothers”, who lives at the orphanage gets paid about 500 SEK per month. You want to give a better salary than standard but at the same time not stand out too much. The staff should also work there because they want to, not just because of the money. If one of the mothers want some vacation, one of the day workers gets to fill in the gap with the same salary as the mothers. Volunteer work is just a complement.

Is there anything that could be improved?

The routines among the staff should be improved but it is hard to implement because of the cultural differences. Although the orphanage is new the quality is sinking fast and we already have to make some renovations. Painting the walls white is an example of a bad decision. The toilets and pipes has to be reconstructed again. It is better to place the toilets in a corner or outside of the building. According to the village leaders, the boys and girls has to have separate toilets. Storage has become a problem as well. Rats and termites is a problem too.

Many of the children wets their beds. This problem was solved by having a plastic coverage over the mattress.

How do you find the temperature and humidity in the building?

The climate is comfortable but during certain periods it can become cold since there are no seals on the windows. Opening windows is also needed for ventilation.

How do you find the natural lighting in the building?

It is a bit too dark in the orphanage.

How do you find the internal design of the building?

Bigger rooms and windows would be preferable. The roof inclination should not be so high as to put the windows in shadow.

The plaster should also cover the whole walls.

How do you find the external design of the building?

The external design is okay but the shape of the buildings are too simple. Burnt clay tiles are beautiful for roofing.

Who design and built the buildings?
Ewout, from Moyo Kwa Moyo, and the local population started to build the orphanage. It was a shell when we took over.

**Who financed the buildings?**

Money was gathered from family, friends and organizations.

**What spaces are most important?**

The most important spaces are the sitting room, which should be big, the kitchen, the children's bedrooms and a playground. Every child should have a bed of their own.

**If you could start over, would you do anything differently?**

I would have prioritized contacting the big companies, where the money is, and applied for stipendiums from different foundations.

**Is there any function here you feel is missing?**

A water pump, but to drill can be complicated, a larger solar system and a chimney for the kitchen.

**How does the sanitation and routines look like?**

The pipes are badly laid and the toilet quickly becomes filthy. Since we have no chimney the kitchen becomes very smoky. The children take a bath two times a day, once before breakfast and once after lunch.

**How is the availability for water?**

It is about 600 meters to the well with the hand pump, it is shared with the local population. In the end of the dry period the well can dry out. We do not harvest the rainwater but are planning for it and we already bought a tank. The rainwater will be used for washing clothes and the children.

**What traditions and cultural aspects should be taken to consideration?**

The village is a Christian community with a touch of tribe religion. It is important that the children adapt to the African culture so the transition to the local society becomes easier. They should not be raised as Westerners. You try to be like a big family but boys and girls ought to have separate spaces. Partly due to the culture but also because of play that can become sexual.

Respect for the elder is an important part of the society but this can also become a problem when position and gender plays in.
Other problematic aspects is that physical punishment for children is deeply rooted and that the local population has deep faith in natural medicine. When it comes to clothing, the shoulders and knees should be covered. This especially applies to girls.

**What is food availability like here?**

The orphanage becomes more self-sufficient by the time maize, beans and cabbage is harvested. From October to Mars the expenses is at its highest since most of the food needed during that time has to be bought. CCY has a cow who produces milk and we plan to build a henhouse as well.

**How much of the food is produced by the orphanage?**

The orphanage produces a lot of maize but tomatoes and onions is harder to cultivate since much more water is needed for that. Rice is not possible to grow here.

**Do you believe that it is possible to have a self-sufficient food production?**

It is possible to become at least close to self-sufficient in food production but workers and fertilizer is expensive. To be able to compensate the costs with selling food you must find something unique to cultivate that meets demand. For example, chicken is very common in this village.

**How does the energy supply look like?**

The solar panel charges a battery during the day and the electricity is used during the evening for lights and a radio. The battery could be larger since the solar panel can manage a larger battery.

**Is there something the children especially enjoy doing?**

The children likes to pretend to be grown-ups, they want to help cleaning, washing and so on. Otherwise they like playing football, playing with pearls and drawing. It often gets chaotic indoors when they do activities like drawing.

**How does the process work when children arrives at the orphanage?**

The orphanage gets a letter from the village council, in the letter the child is described. After that we visit the child and makes a decision whether the child can live at the orphanage. If we decide to take the child it has to be registered. Every child has a sponsor who donates 150 SEK/month. 300 SEK/year is taken from that money to school fees and diapers and so on. If the child are at a
very young age and needs milk replacement they need 500 SEK/year from the sponsor money.

**What ages are the children here?**

0-18 years.

**How many children lives here? What is the capacity?**

There is 18 children living here and two “mothers” who works and lives here full time. In addition there is three people working here from 08.00 - 14.00 Monday to Friday, a woman and two men. The orphanage has a maximum capacity of 20 children.

In the surrounding areas there is still 180 children left to help, in total the orphanage helps around 50 children in some way.

**Are there any requirements for living here?**

There are no specific requirements but a background check is made. If a child is deemed to be in need of help they are eligible. If there are no requirements at all, some parents can use it as an excuse to leave their child on the orphanage, thinking they get a better life here. We also try to help parents and children outside of the orphanage.

**Is it easy to buy a plot of land?**

It is easy to buy land since many are selling. If there are a lot of trees on the land it can be more expensive because there is a big sawmill in the area. One hectare costs around 600 SEK.

How do you feel that the local population's relationship is with the orphanage?

The relationship with the village is good. Most of the local population are positive against the orphanage. The church, for example, has made a collect for us. It is important to have a good contact with the village. The locals and the orphanage helps each other.

**Are the government involved somehow?**

The government’s involvement in the orphanage is gradual, where the village council involvement are closest. The orphan has to be registered at the levels of city. The order is village, city, district and government.

**What material was used during the construction?**

Bricks, iron sheets, wood, cement and clay.

**What material are available locally?**
Wood, bricks and clay is local. Cement and iron sheets is transported.

**Do you know how much the cost is of different materials?**

**Costs:**
- Bricks: TSH 100/brick
- Iron sheets (10x28 feet): TSH 1.200/sheet
- Cement (50 kg): TSH 14.000/bag
- Window: SEK 100/window

Transports are expensive. A truck costs about 800 SEK/day excluding diesel. To transport something between Mafinga and Bumilayinga costs about 400 SEK.

**What is the process of starting an NGO?**

You start a nonprofit organization in Sweden and a NGO in Tanzania. To start an NGO you need to write a constitution and create a board. The Organization must then be registered and approved on all levels; municipality (Mafinga), region (Iringa) and country (Dar, Tanzania). CCY is registered and can be active in east Africa. You also need to appoint a cashier to handle the business in Sweden. It is possible to use a private account to the organization.

**Do you have any other advice or recommendations?**

Start with acquiring contacts and planning the economy. Finish all the plans and blueprints before starting the work in Tanzania. Make sure to build a good relationship with the local population. Try to create a sense of family on the orphanage. Take care to maintain the African culture. The children will later live in the Tanzanian community and should be accustomed to local standards. It is important to work with driven people who you can trust. Do not take everything at face value. This is Africa.

**Interview with Danstan Kishaka - Regional Commissioner's Office, Mbeya**

While in Mbeya, a semi structured interview was conducted with Danstan Kishaka, a secretariat Engineer working at the Regional Commissioner's office. Danstan is in charge of looking over road and building sites.

**Are there many orphans in need of help in the Mbeya region?**

Yes, there are a lot of orphans in the Mbeya region.
What is the government's role in taking care of the orphans?

We have a department who tries to contribute with money and checkups to see if they are doing well but most of the orphanage gets their money and help from the private sector.

What is the process of starting an orphanage?

To start an orphanage you need to go to the Regional Children & Orphan-Welfare Section (RCO) and describe what and how you want to start it, show them a plan. The RCO gives the guidelines to follow.

The standard rules mostly applies for the government and public buildings. When it comes to the private sector or the rural areas the rules are not that well followed. If you want to take a loan from the bank you need to have a building permit, drawings and ownership documents for the plot. In the rural areas, documentation is needed for public buildings like schools and so on.

When you are starting an orphanage, people know that you are trying to help can turn a blind eye on many things. The most important thing to get here is permission from the village council.

The documentation includes an action plan, a certificate of land ownership and a building permit which should follow the government standard. This also needs to be approved by the village council.

To work as a foreigner in Tanzania, in your case with blueprints and so on, you can temporarily register with the government. However, if there are only simpler buildings involved, like private houses or single story buildings, this is not necessary.

What is the most common methods for acquiring water in the region?

The method used for acquiring water is mostly dependent on the place. Some places has a lot of surface water, like springs and brooks, but at the drier places you need to drill a well. If a brook is available, pipes can be laid to make the water more accessible.

How is the energy situation in the rural areas?

The government has a project, led by the Rural Electrical Agency (REA), where they have as a goal to give all the villages in the region energy by 2020. Where there is no electricity generators, solar energy is used. The generators are a more expensive alternative and are therefore only used by the rich. The solar energy can be expensive to buy but in the long run becomes a cheap
alternative. The cost to use the government's energy is 360 TSH/kWh

**How is the availability and cost of different building materials??**

Workable clay are in 90-95 % of the villages in the Mbeya region which provides the opportunity to make bricks. The cost for a brick is about 100 Tsh/brick and then varies between 30-80 Tsh/brick due to transport. Ten kilometers equals + 30 Tsh/brick.

The brick oven can be built on site and then the transport costs goes away. Cement is made in Mbeya and costs about 17,000 Tsh/bag.

**Do you have any last advice for us?**

When you build a school or orphanage in the rural areas, it is preferable if the local population feels invested in the project. You ought to hold meetings with the locals and explain the advantages with the project and that you are there to help. The locals should also be allowed to participate in the project so that they get a sense of ownership and feel more invested.

**Sister Epifania - Bez Mamy (Without Mother), Mbeya**

During our two day stay at the Bez Mamy orphanage outside Mbeya, a semi-structured interview were conducted with Sister Epifania, one of the nuns taking care of the children.

**What is your role on the orphanage and what do you do?**

I look after the children, their spiritual and regular education, the food and the nurture. Joseph helps here with taking the children to school, doing manual labor and making the time table.

**How come you started working here?**

I was chosen by the congregation in 2009 and asked to work here because of my background as a teacher.

**What is the most valuable experience you learned from working here?**

It is easier if the children comes here when they are young, the older ones have a harder time adapting. The small children can be raised in a proper way.

**Is there anything that could be improved?**

The plan is that 80 children will live at the orphanage. However, we need to cultivate more to produce enough to get a profit. It is difficult at the moment since we lack
much of the tools, like a tractor, and the manpower needed. The orphanage also needs a barn for keeping livestock. The children will help out when they have the possibility but the school is a higher priority. The orphanage will be able to sell maize and wants to cultivate rice as well since it is expensive to buy. The waste goes to the livestock.

**How do you find the temperature and humidity in the buildings?**

You get used to the temperature but some children who comes from colder climates can become tired from the heat.

**How do you find the natural lightning in the building?**

Certain windows has to be covered, because of the wind, which lessens the natural light in the buildings. Glass windows would solve that problem. The windows should be opened inwards as well so that they do not get destroyed by the wind.

**How do you find the internal design of the building?**

It is satisfactory, there are many toilets and showers.

**Is there anything you would change?**

The village donated the land but it is hard to work with because there is so much stone in it. This makes it hard to dig the latrines as deep as needed and they fill up faster. Our dream is to build a secondary school and integrate it with the village.

**How do you find the external design of the building?**

I do not like the buildings very much. I like concrete better than bricks.

**Who design and built the buildings?**

The engineer who built this orphanage is Mr Kibanda.

**Who financed the buildings?**

Bez Mamy (Without Mother) is the organization who started and financed most of the orphanage. The ambassador of USA donated the money that financed the canteen. The orphanage was built by the local population.

**Is there any function here you feel is missing?**

The electricity is not enough. We want to be able to watch some television so the children can feel at home. We also dream of being self-sufficient but are in need of
tools to do so, for example a tractor, livestock house and more agriculture.

**What is the sanitation and water supply like?**

There is often enough water but the plan is to start harvest rainwater by leading it to an underground tank which keeps it cooler. The water will have to be pumped up to another tank that will have a tap so it is easy to get the water. Today we have some tanks at the sisters' house and get the rest from a spring.

**How is food availability here?**

We plant and harvest about 24 buckets of rice and 5 buckets of maize. The rice that is getting old is sold.

**Is there something the children especially enjoy doing?**

The children like to dance and play football.

**How does the process work when children arrives at the orphanage?**

The orphanage contacts the village council who gives us a list of families in bad situations who houses orphaned children. Then we visit the families and come to an understanding.

**What ages are the children here?**

The children often arrives around 4-5 years old and stays until they get a job.

**How many children lives here? What is the capacity?**

23 children are living there now but the plan to have around 80 children when the other building is done.

**Are there any requirements for living here?**

The ones that are in most need is taken in.

**How large is the plot of land?**

About 20 hectare.

**How important is the volunteer work?**

Volunteers pays with labor and, if they want to, donations. The orphanage is dependent on NGOs.

**How do you feel that the local population relationship is towards the child care center?**

The relationship is good. It is a Christian orphanage in an Islamic society but we still get along.

**Are the government involved somehow?**
The orphanage is registered but otherwise the government is not involved.

What material are available locally?

Burnt bricks, sand and stone are available locally.

Interview with David - Project coordinator at Bez Mamy (Without Mother)

While in Mbeya town, the project coordinator, David, of Without Mother were available and we conducted a short semi-structured interview with him.

What is your role on the orphanage and what do you do?

I organize and plan jobs for construction, get food, pay salaries and so on.

How come you started working here?

My “brother” Chris worked at Without Mother earlier. When he quit, the orphanage needed more staff and hired me.

Is there anything that could be improved?

The sanitation needs to be improved. The water is not safe to drink and the children get sick. The environment in for example the kitchen and the playground are not safe enough either. We need more solar cells as the ones we have does not give enough power. More trees needs to be planted as well to provide shadow but the soil needs to be made more fertile first.

How do you find the natural lighting, temperature and humidity in the buildings?

The climate is too hot during the day and too cold during the night but the natural lighting is good.

How do you find the internal design of the buildings?

The buildings today could change. The kids’ needs more storage space for clothes and the windows has to be designed in a different way, the wind are destroying them. The construction plan is good.

How do you find the external design of the building?

I want some external changes. For example there should be more shadowed areas and the walls can be plastered and painted.

Who design/built the buildings?

Tomas from the Czech Republic and Chris from Tanzania designed the buildings. The local craftsmen then built
them. No professional group, like an architect or engineer, was needed.

**Who financed the buildings?**

The Czechs financed the buildings and a large percentage of the money still comes from them. Other incomes comes from volunteers.

**What spaces or areas are most important?**

The kids are only sleeping in the bedrooms and like to play outside, for example football. In the future we want to plant grass. Today the children are living 2-4 persons per room but have the capacity to take 6 persons.

**Starting from the beginning, how would you run and design the orphanage?**

The most important thing is to adapt the design to the children's ages. Smaller children is expensive since they need milk replacement and more clothes which needs to be washed more often and so on. It is difficult to find personnel who are passionate about the work.

**Is there any function here you feel is missing?**

Sometimes there is water shortage but we plan to by a large water tank for rainwater harvesting and perhaps dig a well. We already have a water tank at the sisters’ house.

**What is the sanitation and water supply like?**

A company delivers water. We have a timetable for activities like cleaning, cooking and getting firewood. There are always different persons doing the activities every day. The children takes responsibility for washing themselves.

**How is food availability here?**

The orphanage always have food but sometimes it can be difficult to have enough. We make a food budget for three to four months at a time. The children eats mostly ugali but we want to provide a better variation. The orphanage owns two fields where maize and rice are produced. The maize field is close to the orphanage but the rice field is far away. We hire temporary personnel to the farm, however the fields do not produce enough food and we have to buy most of it. We want a bigger farm but first we need more resources like a tractor, an irrigation plan and more workers. The children helps when they can, mostly in the weekends, but school is the priority.

**How does the process work when children arrives at the orphanage?**
The village council shows which families have orphaned children. The family is contacted and they can decide if they want help at home, with school uniform and school fees and so on, or if they want to send the child to the orphanage.

**Are there any requirements for living here?**

The orphanage does not accept the smallest children, they need to be above four years of age but mostly they are from seven and up. The younger ones need more help which the orphanage is not equipped to handle.

**How do you feel that the relationship with the local population is?**

We teach the children to be friendly to everybody and to have good discipline. When the orphanage first started we had a problem with the local population who did not want to have a Christian orphanage here because it is a Muslim village. Sometimes the families refuse to give the children to the orphanage even if they do not have the resources to take care of them. I believe the bad response is due to ignorance.

**Is the government involved somehow?**

The government is really not involved in the orphanage but we have to send them reports on how it is going. It is the private sector that is involved.

**What materials was used during the construction?**

Bricks and timber were used. Bricks become strong when it is built with cement. Timber is used for windows and trusses. Cement, sand, concrete, and iron sheets as well.

**What material are available locally?**

Stone and burnt bricks are locally available. The mud used for the bricks are not that good though. Sand is available but some of it contains too much salt which can lead to fungus in the walls. Sand is common but you need to drive around looking for it.

**Do you have anything to add?**

Use an architect for the design. Make sure to support the children's talents. If someone is good at football you need to make sure he or she has a football available. In other words, give the children a chance to thrive.

Interview with Elvis Francis - Landscape architect at MUST
Elvis Francis was our contact at the Mbeya University of Science and Technology (MUST). The interview were semi structured.

**What are you working with right now?**

I hold lectures as a teacher assistant on MUST/MIST, who also has a consulting firm that I sometimes work for. Occasionally I visit construction sites.

**Do you have any experience in designing similar projects?**

I have some experience of orphanages but they are not work related.

**If you were a part of designing an orphanage, what would be the most important thing to consider?**

The most important thing is the users, in this case the children. You have to design it for them, for example think about their age and so on. The material should be used to capture the children's imagination. It is important to have sustainable materials, to avoid flat roofs and think about the landscape and how it affects the children. The playground should for example be built on a soft surface. It is important to have activities that develops the children's minds, for example a workshop or a farm that they can help with.

**What types of buildings is most common in rural areas around here?**

Clay bricks, burned bricks and cement blocks is often used, sometimes with plaster. According to the law the municipality do not allow clay bricks (sunburned bricks), they have to be burned. But this law is sometimes ignored in the rural areas. The municipality wants the region to evolve in the right direction, be built in the right way.

**Are there any details in design that is common or specific for this area?**

They build a stone foundation with cement. The walls are in burnt bricks and are strengthened around the windows. The roofing is iron sheets.

**What types of material can be found locally here?**

Stone, clay, bricks and wood. I do not think that termites is a big problem in Mbeya but I have not lived here for long. There are however a problem with some sort of insects which eats wood. Burnt clay tiles are mostly used by rich people but mainly because of lacking knowledge. Stone is the most common material to use in foundations. Showcases are important.
What space or room is most important to consider when building in rural areas?

The most important room is the sitting room but the toilet and kitchen are of course important too. The toilet is often placed outside the house according to tradition, but some have inside toilets. The kitchen is most often placed outside as well. People in Tanzania like to sit by the fire, especially in the highland where the climate is colder. It is a tradition to sit by the fire and share knowledge and stories with each other. Corn husks is often used as firewood.

How is the general knowledge of building techniques in rural areas?

You start by digging out the foundation and fill it with stone, cement and mud. Then you put up stakes where the walls should be, cut a bamboo stick in the middle and put them up between the stakes and fill up the form with mud. Grass is used for roofing. This is the traditional local method of building.

How does the building process work around here?

Find local craftsmen (fundis) that are then given specifications by for example drawing a simple sketch on the ground and when you agree and understand each other the building begins. According to the law everybody needs an architect, engineer and a building permission to start but in reality it does not work like that, especially in the rural areas. This only applies for larger buildings due to the safety risk.

What type of roofing is best to use around here?

Saddle roofs is the best due to the climate and the architecture. A flat roof gives a feeling of public buildings and saddle roofs can be associated to homes for the local people.

What is the most important to consider when planning outdoor spaces?

It is important to think about orientation, movement and activities. How to move between places. Think about where you place the different functions. It is nice to have paved surfaces and many green areas. Levels and drainage surfaces are important during the rainy season when the water needs to be drained quickly. Think about which flowers and trees can be grown at the place.

What types of food can easily be cultivated here compared to Iringa?

In Mbeya, Maize, beans, rice and potatoes are common. Iringa is almost the same but less rice plantations.
What is the best way to plan a plantation here?

Rice needs more water and you will need an irrigation plan or a pond nearby. Maize can be planted on regular fields. Beans are planted two months later together with the maize so that they can be harvested at the same time.

Is it possible to become self-sufficient in food production through agriculture for an orphanage of approximately 40 kids?

Yes. The land is very fertile. Just plant more than is needed to sell and make a profit. You can make a lot of money selling watermelons for example. You need to hire a tractor to prepare the field and workers but the children can help when possible. About ten to twenty hectares should be needed but there are a lot of local knowledge available. Most plantations however, are dependent on the rainy periods which requires much more land to get the same harvest. With an irrigation system you can harvest four times a year compared to two. A greenhouses are good as well and can increase production. A plantation is not a big investment as long as you get a hold of the land for it.

Seeds are relatively cheap:

- Melon seeds costs about Tsh 150,000 per kilo.
- Maize seeds costs about Tsh 75,000 per kilo.

What is the most common way to acquire water in rural areas?

Drinking water is supplied by authorities called Mbosa. Rainwater is gathered and treated. Wells or springs. Wells are the best alternative due to that it is just a onetime cost and the water is healthy and contains minerals.

Is water harvesting common here?

Rainwater harvesting is not common, maybe more so for agriculture.

What is the best way to acquire electricity in rural areas?

Solar power is the best alternative. It is just a onetime investment which becomes cheaper in the long run.

Do you have any other recommendations regarding building an orphanage in rural areas?

It is important to think about storage areas, partly for the plantation but also for donations and so on. Playgrounds and spaces for activities, like sports, should be made available. Think about religion as well; maybe a church and a mosque should be situated nearby.
Ilula
While visiting and living for two nights, in the rural village of Ilula, some semi structured interviews and informal conversations were conducted with the local population. This to get a better understanding of how daily life looked like in a rural upland village.

Informal conversation with Pastor Golden Mdeke

What do you think is the most important room in a house?
The master bedroom is the most important room in the house, if possible with private toilet and shower. The kitchen is also important, especially that it is clean and that it is separate from the storage. The sitting room serves an important function as well as it is the social space of the house. I think a house with round shapes and high buildings are beautiful.

What kind of material is most common here?
Burnt bricks, sand, stone, concrete as well as timber and iron sheets for roofing.

What kind of building material is available here?
Clay and stone.

How do you get a hold of water?
Water supply is a big problem in Ilula. There are no water in the village so you have to drive or go to fetch it.

Are there many orphans in this area?
There are a lot of orphans here.

What do you believe is most important for the orphans?
Education is the most important thing for children. We are trying to build a youth vocational center but we do not have enough money and need a project manager. We have started a community based organization which is registered. The government supports the construction of these centers since Tanzania needs more educated workers.

Is it expensive to build here?
Iron sheets for roofing costs about Tsh 15.000 per sheet.

The church we are now building costs about Tsh 400.000-600.000 in total.
IOP, the Norwegian orphanage was given the land by the village and the villagers made the road leading up to it for free.

Interview with Mary Mongi

20 year old, works in hotel management.

Can you try to describe a typical week for you?

I go up at 6.30 every day to wash clothes and make breakfast. Then I plan lunch and take care of my child in general.

At home, what do you do to relax (at your free time)?

I like to chat with people and listen to music.

How do you define the word home?

A house is a place in which people live.

Have you built your own house?

This house is built by my family and I inherited it. I would like plaster on the walls.

What spaces or rooms are of most importance to you?

The bedroom. You need to feel safe where you sleep and have mosquito netting. You can get sick otherwise.

Are there any details or designs you feel is important to a building?

I would like to have electricity, a TV and a sofa on the inside and a fence outside the house.

What kind of material is most common here?

Cement, paint, sand, water, clay and bricks. Roofing is in timber and iron sheets.

How do you get a hold of water?

Water can be bought nearby but the ones selling is fetching it by truck. It costs Tsh 500 per bucket.

Are there many orphans in this area?

Yes. They need a home, somewhere to live. Some orphans lives with relatives. Education is important. People try to help if they can.

Interview with Olipa Ngumbi

Middle aged shop worker
Can you try to describe a typical week for you?

I wake up, fetch water, clean the house and make breakfast. Then make sure that we have enough food for the day.

At home, what do you do to relax (at your free time)?

Singing makes me happy.

How do you define the word home?

Home is family.

Have you built your own house?

We are renovating the house now; painting it and laying a new roof.

What spaces or rooms are of most importance to you?

The master bedroom. I spend a lot of time there and it is the place where I can spend time with my husband.

Are there any details or designs you feel is important to a building?

I like it when the house is surrounded with businesses and movement.

What kind of material is most common here and what kind of building material do you think is the best to use?

Iron sheets, and a lot of trees for shadow.

What do you believe is most important for the orphans?

A clean and safe environment is important as well as food and education. The children should have a place to play sports as well as a playground.

Interview with Amnos Chengula

Middle aged farmer

Can you try to describe a typical week for you?

I spend my days farming.

At home, what do you do to relax (at your free time)?

When I have free time I work extra as a motorcycle driver to help my mother and wife.

How do you define the word home?

It is a place to live and a place to build relationships.
Have you built your own house?
Yes, I built a clay house with nine rooms. If I could do it again I would build it with concrete instead.

What spaces or rooms are of most importance to you?
The bedroom and the sitting room.

Are there any details or designs you feel is important to a building?
Plaster and paint makes houses more beautiful.

What kind of building material do you think is the best to use?
Burnt bricks is the best material.

How do you get a hold of water?
I fetch water for washing myself with my motorcycle. It is longer to fetch drinking water. It takes about 30 minutes, 3 hours to walk. To harvest rainwater you need gutters and a tank or big cans.

What do you believe is most important for the orphans?
Food, clothes and a good place to sleep. The location should be far away from the village for safety. The children should have spaces for sports and play.

Interview with Alfema Edvardy Msavi
Entrepreneur

Can you try to describe a typical week for you? What daily routines do you have at home?
I go to the morning-prayer every day and after that I make carpets.

At home, what do you do to relax (at your free time)?
I like resting.

How do you define the word home?
A place where people live.

Have you built your own house?
The house belongs to the family. I live here with one child. I would like to have a house in concrete blocks and a new plan with bedroom, sitting room, child room and a room for renting out.
What spaces or rooms are of most importance to you?
The bedroom. I keep my important documents and clothes there. It is private.

Are there any details or designs you feel is important to a building?
Plastering and iron sheets. I would like to have a local fence, it protects against dust.

How do you get a hold of water?
The nearest well is far away.

What do you believe is most important for the orphans?
They need psychological help and prayers for protection but also clothes, a clean environment and education. Classrooms should be most important.

Interview with Hezron Mohanga and Anastasia Msola
Farmer and electrician / Teacher

Can you try to describe a typical week for you?
Hezron: I work with the plantation.
Anastasia: I make food and prepare the children for school. I work as a teacher in a confirmation class as well.

At home, what do you do to relax (at your free time)?
Reading.

How do you define the word home?
Family. A place to congregate.

Have you built your own house?
Yes, with clay and plastering and iron sheets for roofing. It is different now. I would like to have bigger rooms, a toilet on the inside and a storage.

What spaces or rooms are of most importance to you?
The toilet and kitchen, for safety and cleanliness.

Are there any details or designs you feel is important to a building?
A fence and plastering. Painted walls and a ceiling.

What kind of building material do you think is the best to use?
Concrete because of sustainability.

**What kind of building material is available here?**

Cement and timber is easy to get a hold of. Otherwise burnt bricks.

**How do you get a hold of water?**

We live close to the river and that water can be used for washing. We buy drinking water.

**What do you believe is most important for the orphans?**

Good food, education, clothes and God's word. They need a space for sports and play as well.

Hezron: The orphanage should be situated near the village in case they need help. It is easier to visit then as well.

Anastasia: It should not be too close to the village for the children's safety.
8.2 Early idea sketches

Site plan ideas
Layout ideas
View & idea sketches